

**A COMPARATIVE STUDY OF THE PSYCHOPHYSIOLOGICAL EFFECTS OF
CYCLIC MEDITATION AND SUPINE REST (SHAVASANA)**

Thesis submitted by
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Towards the partial fulfillment of
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**STANDARD INTERNATIONAL TRANSLITERATION CODE USED TO
TRANSLITERATE SANSKRIT WORDS**

a	=	अ	ña	=	ढ	pa	=	प
ā	=	आ	ca	=	च	pha	=	फ
i	=	इ	cha	=	छ	ba	=	ब
ī	=	ई	ja	=	ज	bha	=	भ
u	=	उ	jha	=	झ	ma	=	म
ū	=	ऊ	ñ	=	ञ	ya	=	य
ṛ	=	ऋ	ṭa	=	ट	ra	=	र
ṝ	=	ॠ	ṭha	=	ठ	la	=	ल
e	=	ए	ḍa	=	ड	va	=	व
ai	=	ऐ	ḍha	=	ढ	śa	=	श
o	=	ओ	ṇa	=	ण	ṣa	=	ष
au	=	औ	ta	=	त	sa	=	स
m̐	=	अं	tha	=	थ	ha	=	ह
ḥ	=	अः	da	=	द	kṣa	=	क्ष
ka	=	क	dha	=	ध	tra	=	त्र
kha	=	ख	na	=	न	jña	=	ज्ञ
ga	=	ग						
gha	=	घ						

ABSTRACT

Background

Cyclic meditation combines ‘stimulating’ and ‘calming’ practices, based on a statement in ancient yoga texts suggesting that this combination may be helpful to reach mental equilibrium. Cyclic meditation consists of cycles of yoga postures interspersed with periods of supine rest. Practicing cyclic meditation reduced psychophysiological arousal based on a decrease in oxygen consumption and changes in the heart rate variability suggestive of a shift towards vagal dominance. Cyclic meditation improved the performance in a P300 event related potential task and also improved the performance in a letter cancellation task more than relaxation in the corpse posture (*shavasana*). Both tasks require selective attention and concentration. The benefits were ascribed to possible stress reducing effects of cyclic meditation, as the practice reduces physiological and cortical arousal. This was ascribed to reduced anxiety, though this was not assessed. The effects of cyclic meditation on MLAEPs have not been studied.

Aim

The present study was intended to compare cyclic meditation (CM) with an equal period of supine rest (SR), with respect to: (1) the performance in a psychomotor tasks, included digit-letter substitution task (DLST) which is a measure of attention, as well as two tasks for motor functions (i.e., letter copying task and circle dotting task), (2) components of Wechsler memory scale as well as state anxiety (STAI) to determine if anxiety influenced performance, and (3) midlatency auditory evoked potentials (MLAEPs) using a Nicolet Bravo, U.S.A., apparatus, to

understand whether information processing at different cortical and sub-cortical levels is facilitated or not by CM and SR,

Methods

The study was performed on fifty-seven healthy male participants with age range from 18 to 40 years (group average age \pm S.D., 26.5 ± 4.6 years), who were each studied in two sessions, one of cyclic meditation and the other of supine rest. Each session consisted of Pre (5 minutes), During (22:30 minutes) and Post (15 minutes) states while middle latency auditory evoked potentials (MLAEPs) were recorded and all the other paper pencil tasks were assessed in Pre and Post periods of CM and SR.

Results and Discussion

In the present study, the increase in the Pa and Nb wave peak latencies following meditation is contrary to earlier studies in which midlatency auditory evoked potentials were recorded during and after meditation. In particular, meditation on a syllable of significance (i.e., 'OM') was earlier shown to significantly reduce the Nb wave peak latency. 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. 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 (*āsanas*) as well as periods of meditation, rather than meditation alone.

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 supine rest where the Na wave peak latency increased and the Na wave is believed to be generated at the mesencephalic-diencephalic level. The Pa wave corresponds to the activity at the superior-temporal gyrus and the Nb wave corresponds to the primary auditory cortex. The level of change appeared to differ between supine rest (which produced changes in the Na wave) suggesting mesencephalic-diencephalic level changes, and cyclic meditation, where the changes which followed the practice appeared to be at a cortical level.

Also, in the present study, on a different group of cyclic meditation practitioners, performance in a digit- letter substitution task improved after cyclic meditation but not after supine rest. This may be related to the fact that the two psychomotor tasks (i.e., the letter cancellation task and the digit-letter substitution task) assess comparable, yet different cognitive abilities. The letter cancellation task assesses the ability to sustain and shift attention, immediate memory, visual scanning, and motor speed for repetitive motor activity. The digit-letter substitution task also requires the ability to sustain and shift attention, immediate memory (of the digit-letter combination), and the task tests the speed of information processing, as well as the ability to process information and shift the attentional focus between digits and letters. It is difficult to say whether the improved performance in the letter cancellation task following both cyclic meditation and supine rest in an earlier study and the improved performance in the

digit-letter substitution task after cyclic meditation alone in the present study, was due to differences in the abilities assessed by the tasks or the fact that the yoga practitioners in the two studies were different. In the present study, after both cyclic meditation and supine rest, the performance in the tasks for motor speed in a repetitive motor task was improved. The circle dotting task, studied here also evaluates spatial intelligence and manual speed. The letter copying task was used as a test for motor speed, which allowed the repetitive motor activity component of the digit-letter substitution task to be assessed separately as has been described elsewhere. Hence, the ability to carry out a repeated motor activity was better after cyclic meditation and supine rest, with a greater magnitude of improvement after cyclic meditation. Hence, in the present study, improved repetitive motor activity and motor speed may have contributed to the better performance in the digit-letter substitution task. The improvement in the DLST following CM was 21.0 percent (as described earlier), while the letter copying task was improved by 14.0 percent and the performance in the circle dotting task was improved by 19.0 percent. In contrast there was no improvement in DLST scores after SR, but the improvement in the letter copying task was 4.3 percent and the improvement in the circle dotting task was 4.1 percent. Hence, an improvement in motor speed may have contributed to the better performance in the DLST after cyclic meditation.

With respect to the Wechsler memory scale the increase in scores for the digit span and associate learning tasks following CM was greater [digit span forward (27.7 percent), backward (33.5 percent), associate learning, easy (20.7 percent), and associate learning hard (37.7 percent)] than the increase following

SR [digit span forward (16.1 percent), backward (9.2 percent), associate learning, easy (9.4 percent), and associate learning, hard (10.6 percent)]. Also, there was a greater magnitude of decrease in state anxiety after CM (22.4 percent) compared to after SR (5.6 percent). The digit span tests assess attention, concentration and primary working memory. Earlier studies have shown that CM practice increases selective attention more than an equal duration of supine rest. The present results suggest that primary working memory also improves with CM practice. Verbal paired associate learning assesses integration of information and episodic memory. The present results suggest an improvement in these aspects of memory after both CM and SR, with a greater magnitude of increase after CM. The present results suggest that movement as a part of cyclic meditation may actually facilitate performance in attention and memory tasks more than an equal duration of time in a conventional relaxation posture (*shavasana*).

Conclusion

The practice of CM has resulted in prolonged latencies of evoked potentials generated within the cerebral cortex, supporting the idea of cortical inhibition after CM. The present study also showed better performance in a digit-letter substitution task, as well as in tasks for motor speed following the practice of CM. Following a period of supine rest there was improved performance in tasks for motor speed, but not in the digit-letter substitution task. The study also showed that CM practice improves the performance in memory tasks and reduces state anxiety more than a comparable period of SR.

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D E C L A R A T I O N

I, hereby declare that this study was conducted by me at Swami Vivekananda Yoga Anusandhana Samsthana (S-VYASA), Bangalore, under the guidance of Dr. H.R. Nagendra, Vice-chancellor and Dr. Shirley Telles, Prof. & Head, Dept. of Biosciences, Swami Vivekananda Yoga Anusandhana Samsthana, Deemed University, Bengaluru.

I also declare that the subject matter of my thesis entitled A COMPARATIVE STUDY OF THE PSYCHOPHYSIOLOGICAL EFFECTS OF CYCLIC MEDITATION AND SUPINE REST (ŚAVĀSANA) has not previously formed the basis of the award of any degree, diploma, associate-ship, fellowship or similar titles.

Date:

SUBRAMANYA PAILOOR

Place: Bengaluru

(Candidate)

A C K N O W L E D G E M E N T

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Date:

Place: Bengaluru

SUBRAMANYA PAILOOR

CHAPTER-1

Introduction

Meditation has been described as a training in awareness which, over long periods produces definite changes in perception, attention, and cognition (Brown, 1977). Meditation is a specific state of consciousness featured by deep relaxation and internalized attention (Murata, Takahashi, Hamada, Omori, Kosaka, Yoshida, & Wada, 2004). However, it may not be possible for everyone to begin their practice of yoga with meditation. Meditation in fact, forms the sixth and seventh stages of the eight limbs (*aṣṭāṅga*) described by the sage *Patañjali* [*Patañjali*, circa 900 B.C.] (Taimini, 1986). While many practitioners do learn meditation directly, others find it easier to pass through the other stages, learning yoga postures (*āsanas*) and regulated breathing (*prāṇāyāmas*), first (Nagendra & Nagarathna, 1997). For those who find it difficult to commence the practice of meditation there are two possible risks. Some people may find that they feel drowsy and even fall asleep other people may have a series of thoughts rushing through their minds preventing them getting into a meditative state. For this reason a technique of ‘moving meditation’, which combines the practice of yoga postures with guided meditation was devised, called cyclic meditation (CM), by H.R. Nagendra, Ph.D., which is conducive to getting into a meditative state. This technique has its’ origin in an ancient Indian text, *Māndūkya Upaniṣat* (Chinmayananda, 1984). It is interesting to note that CM does induce a quiet state of mind, which is compatible with the description of meditation (*dhyāna* or effortless expansion), according to *Patañjali*. This description states that ‘*Tatra pratyayaikatānatā dhyānam*’

(*Patañjali's Yoga Sūtras*, Chapter 3: Verse 2). This means that the uninterrupted flow of the mind towards the object chosen for meditation is *dhyāna* (Taimini, 1986). Indeed, all meditations, irrespective of the strategies involved are believed to help reach this state. There are several strategies in meditation. These include breath awareness, awareness of internal sensations, directing the attention to a *mantra* or a *koan*, and keeping the eyes open with the gaze fixed on the object of meditation, among other methods.

This technique i.e., CM consists of recurring cycles of physical postures (*āsanas*) and supine rest in a meditative state of mind. Earlier studies on meditation have shown that during the practice there were physiological changes which are suggestive of both alertness and rest (Telles, & Desiraju, 1993; Telles, Nagarathna & Nagendra, 1994). This has led to an interest whether the practice of meditation would improve the performance in the tasks requiring attentiveness and vigilance (Kember, 1985). However, attentiveness requires increased sympathetic nervous system (Telles, Raghuraj, Maharana & Nagendra, 2007). Hence, it would appear that meditation and performance in attentional tasks may not be compatible.

In the case of CM, which has been described above, this was not the case, studies on heart rate variability (HRV) showed that after the practice of CM the LF power and LF/HF ratio decreased whereas HF power increased which is suggestive of shift towards vagal dominance. This is similar to the HRV changes following equal duration of SR, but with lesser magnitude of change. These

changes were suggestive of reduced sympathetic activity and reduced physiological activation. However, an earlier study on oxygen consumption showed that a period of cyclic meditation significantly reduced the oxygen consumption to a greater degree (32.1 percent) than a comparable period of supine rest (Telles, Reddy & Nagendra, 2000). A recent study also showed that after the practice of CM, oxygen consumption decreased (19.3 percent) compared to following SR (4.8 percent) (Sarang & Telles, 2006a). Hence, the two studies showed that CM practice reduced oxygen consumption and minute ventilation to a greater degree than SR. In contrast to the changes in HRV, these changes were suggestive of reduced physiological activation. In a state of reduced physiological activation it could be presumed that the ability to focus attention would be less. Being attentive is a necessary pre-requisite for various tasks including primary working memory, associate learning and certain motor tasks which require precision. However, there were two studies also on the effects of CM compared to SR in normal volunteers which showed that following CM the performance in the event related P300 auditory oddball task was better both compared to the pre state and compared to the SR session (Sarang & Telles, 2006c). This improvement was a decrease in the P300 peak latency and an increase in the P300 peak amplitude (Sarang & Telles, 2006c). The P300 event-related brain potential (ERP) is a neuro-electrical measure for selective attention which does not require any motor activity. The P300 component of event-related brain potentials (ERPs) is generated when persons attend to and discriminate stimuli which differ in a single aspect. In

the study cited this was pitch, or frequency. The P300 reflects fundamental cognitive events requiring attentional and immediate memory processes (Polich, 1999). The results suggest that CM enhanced these cognitive processes. Another study examined the performance in a letter cancellation task, once again before and after CM and SR, as this task requires selective attention, concentration, visual scanning abilities, and a repetitive motor response (Sarang & Telles, 2007). As in the P300 study the performance following CM was better in terms of improved net scores which were significantly higher, after both practices, though the magnitude of change was more after CM than after SR (26 percent versus 14 percent). Unlike the P300, the performance in a cancellation task requires certain motor speed during a repetitive motor activity. Hence, the improved performance in this task could be related to improved attention as well as improved motor activity. This latter speculation is particularly relevant as yoga practice has been shown to improve the performance in motor tasks (Telles, Hanumanthaiah, Nagarathna & Nagendra, 1993; Telles, Raghuraj, Ghosh & Nagendra, 2006).

Hence, the present study was designed to determine the effect of both CM and SR on performance in a digit-letter substitution task, which is also a measure of attention as well as two tasks for motor functions (i.e., a letter copying task, and a circle dotting task). In addition to this the effects of CM and SR were studied on components of the Wechsler memory scale as well as state anxiety (STAI) to determine if anxiety influenced performance. Finally, in an attempt to understand whether sensory processing at cortical and sub-cortical levels is facilitated or not

by CM and SR, midlatency auditory evoked potentials (MLAEPs) were recorded at the beginning and end of both practices.

CHAPTER-2

LITERARY
RESEARCH ON CM

2.1 CONCEPTS OF CYCLIC MEDITATION WITH SPECIAL REFERENCE TO TRADITIONAL YOGIC AND SPIRITUAL LITERATURE

'In a state of mental inactivity awaken the mind; when agitated, calm it; between these two states realize the possible abilities of the mind. If the mind has reached the state of perfect equilibrium then do not disturb it again'

(Māṇḍūkya Upaniṣat Kārikā: 3.44).

Review of scientific literature:

Table 1: Studies on Relaxation techniques:

Author & Year of Publication	(N)	Experimental Design Variable studied	Findings
Vempati, R.P., & Telles, S. (2002). <i>Psychological reports</i> ,90(2), 487-94.	35	Yoga Gp: practiced isometric relaxation technique (IRT) Control Gp: practical supine rest (SR) Case control study Variables: before and after. i) Autonomic variables like HRV, HR, RR and Finger plethysmogram in 15 subjects. ii) O2 consumption, breathe rate and breathe volume in 25 subjects.	Significant decrease in oxygen consumption and increase in breath volume were recorded after guided relaxation.
Malathi, A. & Damodaran, A. (1999). <i>Indian Journal Physiology and Pharmacology</i> , 43(2), 218-224.	50 exam going medical students	Yoga gp: yoga based relaxation technique Control gp: routine activities Pre-post design Psychological variables studies: Feedback scores Spill Berger's anxiety scale Global cerebral blood flow (CBF)	Yoga gp showed: (i) ↓in anxiety (ii) less failures compared to control group (iii) ↑ concentration, self confidence, ↓ irritability, ↑ attentiveness, efficiency and interpersonal relationship

<p>Lou, H.C., Kjaer, T.W., Friberg, L., Wildschiodtz, G., Holm, S. & Nowak, M.A. (1999). <i>Human Brain Mapping</i>, 7(2), 98-105.</p>	<p>9 young adults experienced yoga teachers Yoga-nidra relaxation meditation</p>	<p>distribution (with the 150 – H2O PET technique) and spectral EEG analysis was done in two sessions:</p> <ul style="list-style-type: none"> (i) during the yoganidra relaxation meditation (ii) during the resting state of normal consciousness. 	<p>(i) In meditation, differential activity was seen, with the noticeable exception of V1, in the posterior sensory and associative cortices known to participate in imagery tasks. (ii) In the resting state of normal consciousness differential activity was found in dorso-lateral and orbital frontal cortex, anterior cingulate gyri, left temporal gyri, left inferior parietal lobule, striatal and thalamic regions, pons and cerebellar vermis and hemispheres, structures thought to support an executive attentional network.</p>
<p>Kjaer, T.W. (2002). <i>Brain Research Cognitive Brain Research</i>, 13(2), 255-259.</p>	<p>Yoga-nidra relaxation meditation</p>	<p>Participants underwent two 11C-raclopride PET scans: one while attending to speech with eyes closed, and one during active meditation</p>	<p>(i) ↑ in the release of endogenous dopamine in the ventral striatum Decreased blood flow in prefrontal, cerebellar and subcortical regions</p>

Table 2: Studies on Progressive Muscle Relaxation:

<p>Lehrer, P.M., Schoicket, S., Carrington, P. & Woolfolk, R.L. (1980). <i>Behavior Research and Therapy</i>, 18(4), 293-303.</p>	<p>32 ss, normal healthy volunteers, with no prior experience</p>	<p>Randomly allocated in 3 groups Gp I: Clinically standardized meditation (CSM) similar to TM (n=10); Gp II: Progressive muscle relaxation (n = 10); Gp III: control (n = 12) Randomized controlled trial 5 min pre→ 20 min during→ 5 min post Stressors: given by loud sound (100 dB -1000 Hz) and flashes of lights Variables: (i) SC, HR, frontal and occipital EEG, forearm and frontalis EMG (ii) State-Trait Anxiety scale, IPAT Anxiety Inventory.</p>	<p>(i) Meditation group exhibited higher heart rates and higher integrated frontalis EMG activity, but they also showed greater cardiac decelerations following each tone, more frontal alpha and fewer symptoms of cognitive anxiety than other two groups. (ii) Relaxation group showed more muscular relaxation.</p>
<p>Lehrer, P.M., Woolfolk, R.L., Rooney, A.J., McCann, B. & Carrington, P. (1983). <i>Behavior Research and Therapy</i>, 21(6), 651-662.</p>	<p>61 Ss with anxiety (IPAT scale)</p>	<p>Gp I: Progressive muscle relaxation (n = 19) Gp II: Clinically standardized meditation (n = 23) Gp III: waiting list control (n = 19) Randomized sampling Stressors: loud sounds, light, small stress creating movie Variables: (i) SC, HR, EKG, EEG-Fz,</p>	<p>(i) Both techniques generated positive expectancies and produced ↓ in a variety of self reported symptoms & on EMG. (ii) Progressive muscle relaxation produced greater ↓ in forearm EMG responsiveness to stressful stimulation & generally more powerful therapeutic</p>

		O1O2, forearm and frontalis EMG (ii) State-Trait Anxiety scale, IPAT Anxiety Inventory	effect than meditation. (iii) Meditation produced ↑ cardiac orienting responses to stressful stimuli, ↑ absorption in the task & better motivation
Carrington, P., Collings, G.H.Jr., Benson, H., Robinson, H., Wood, L.W., Lehrer, P.M., Woolfolk, R.L. & Cole, J.W. (1980). <i>Journal of Occupational Medicine</i> , 2(4), 221-231.	154 telephone employees	Gp I: Progressive muscle relaxation (PMR); Gp II: Clinically standardized meditation (CSM); Gp III: Respiratory one method meditation (ROM); Gp IV: Waiting list control Randomized controlled trial 5.5 months of intervention Psychological variables: Self reported stress scores	(i) The meditation groups (not the PMR group) showed significantly more symptom reduction than the controls. (ii) The meditation groups had a 78% compliance rate at 5.5 months with treatment effect seen whether subjects practiced their techniques frequently or occasionally.
Orme-Johnson, D.W. (1973). <i>Psychosomatic Medicine</i> , 35, 341-349	EXPT I: 8 8 controls EXPT II: 6 8 controls Experience 2-36 months	EO MEDTN EO REST→ NON MEDTN → REST (10 min) EC (10 min) (10 min) EXPT I: GSR habituation & Spontaneous GSR changes EXPT II: Spontaneous GSR changes	Meditators Vs Controls (i) Initially more stable (ii) Habituated faster (11 trials Vs 26.1 trials) (iii) less spontaneous fluctuations of 100 Ω or more.

Table 3: Studies on Tai chi:

<p>Brown, D. (1984). <i>Perceptual Motor Skills</i>, 58, 775-784.</p>	<p>21 ss Vipassana meditators</p>	<p>Studied before and after a three month period during which: 'meditators, practiced 16 hours/d and 'controls' practiced for 2 hours per day. Variables: (i) Detection threshold based on the duration of light flashes. (ii) Discrimination threshold based on interval between successive light flashes</p>	<p>Meditators Vs control' after 3m period: (i) Detection threshold: could detect shorter light flashes. (ii) Discrimination threshold: required a shorter interval to differentiate flashes.</p>
<p>Jin, P. (1992). <i>Journal of Psychosomatic Research</i>, 36(4), 361-370.</p>	<p>48 male and 48 female</p>	<p>Tai Chi practitioners were randomly assigned to four treatment groups: (i) Tai Chi, (ii) brisk walking, (iii) meditation and (iv) neutral reading Randomized controlled design Variables: Mental arithmetic and other difficult tests were chosen as mental challenges, and a stressful film was used to produce emotional Tai Chi, a moving meditation, was examined for its efficacy in post-stressor recovery.</p>	<p>In all groups (i) ↓ the salivary cortisol level (ii) the mood states were also improved. (iii) In general the stress-reduction effect of Tai Chi characterized moderate physical exercise. Heart rate, blood pressure, and urinary catecholamine changes for Tai Chi were found to be similar to those for walking at a speed of 6 km/hr.</p>

Table 4: Studies on Evoked potentials:

<p>Murthy, et al., (1998). P300 amplitude and antidepressant response to Sudarshan Kriya Yoga (SKY). <i>Journal of affective disorders</i>, 50(1), 45-8.</p>	<p>45</p>	<p>Sudarshana Kriya Yoga; Patients: depressed vs. dysthymic vs. Controls. Variable studied P300 using auditory odd ball</p>	<p>Improvement in depressive symptoms and increase in P300 amplitude in novice meditators; effect may be due to alleviation of depression</p>
<p>Liu et al., (1990). Changes in brainstem and cortical auditory potentials during Qi-Gong meditation. <i>American Journal of Chinese Medicine</i>, 18(3-4), 95-103</p>	<p>21</p>	<p>The variables studied were ABR, MLR, AEP. It was taken before, during, and after meditation</p>	<p>ABR- increased I - V wave amplitudes; MLR- decreased Na- Pa amplitudes; Decreased P200 amplitude</p>
<p>Telles, S. & Naveen, K.V. (2004). <i>Psychological Reports</i>, 94 (2), 398 – 400</p>	<p>16 male volunteers</p>	<p>Self as control design 5 min pre → 20 min BK medtn → 5 min post – Medtn session 6 min pre → 20 min random thinking → 6 min post – Control session</p> <p>Variables: AEP-MLRs – Middle latency auditory evoked potentials from Cz-A2</p>	<p>There was decrease in the peak latency of the Na wave (a negative wave between 14 and 19 ms) during meditation. Since the neural generator of this wave lies at the midbrain-thalamic level, it was inferred that the meditation reduces conduction time at this level.</p>

<p>Panjwani, et al. (2000). Effect of Sahaja yoga meditation on auditory evoked potentials (AEP) and visual contrast sensitivity (VCS) in epileptics, <i>Applied Psychophysiology and Biofeedback</i>, 1, 1-12</p>	<p>34</p>	<p>Epilepsy patients: Yoga group vs. "sham yoga". Variables studied were ABR, MLR, Visual Contrast Sensitivity [VCS]</p>	<p>ABR= no effects; MLR= increased Na- Pa amplitude at 6 months in meditation group; VCS increased</p>
<p>Telles, S. & Desiraju, T. (1993). <i>Indian Journal of Medical Research</i>, 98, 237-239.</p>	<p>14 ss, two groups, matched for age Gp I: 7 experienced (range 5-20 yrs) Gp II: 7 naive</p>	<p>Self as control design Meditation vs. Non-meditation condition; Before vs. during meditation technique Variable studied is MLR</p>	<p>Nb latency decreased in meditation but no effect seen in control session, small effect size</p>
<p>Telles, S., Nagarathna, R. & Desiraju, T. (1994). <i>International Journal of Neuroscience</i>, 76 (1-2), 87-93.</p>	<p>18 male volunteers Gp I: 9 experienced meditators Gp II: 9 naive</p>	<p>Self as control design: Experienced vs naive Meditation vs. Non-meditation condition; baseline vs. "OM" meditation vs. repetition of "one" Variable studied is MLR</p>	<p>Na amplitude increased in meditation and decreased in non- meditation; Na amplitude decreased while repeating "one"</p>

Table 5: Studies on Measures of attention:

<p>Yesavage, J.A. & Jacob, R. (1984). <i>Experimental Aging Research</i>, 10(4), 211- 214.</p>	<p>25 normal elders</p>	<p>All were trained in two techniques to improve face-name recall (i) Technique of relaxation training, (ii) Technique of a mnemonic device Variables: before and after i) Anxiety scale ii) Attentions measures iii) Face name recall measure</p>	<p>i) Relaxation ↑ memory processing capacity and improved attention than other techniques. ii) Relaxation also ↓ anxious rumination.</p>
<p>Critchley, H.D., Melmed, R.N., Featherstone, E., Mathias, C.J. & Dolan, R.J. (2001). <i>Brain</i>, 124 (5), 1003-1012.</p>	<p>10 ss</p>	<p>Gp I : Biofeedback relaxation Gp II: Relaxation without feedback Gp III: Control corresponding to gp I Gp IV: Control corresponding to gp II Self as control design Assessed before and after Variables: PET for cerebral activity relating to the cognitively driven modulation of sympathetic activity.</p>	<p>i) Relaxation showed ↑ in left anterior cingulated and globus pallidus activity. ii) Where as biofeedback showed no ↑ in activity compared with random feedback.</p>

Table 6: Studies on Yoga and motor tasks:

<p>Sarang, SP. & Telles, S. (2007). <i>Perceptual & Motor Skills</i>. 105(2), 379-385.</p>	<p>69</p>	<p>Self as control, CM vs. Supine rest. The variable studied was SLCT (Six letter cancellation test).</p>	<p>Cyclic Meditation improves the performance in letter cancellation task, which requires selective attention, concentration, visual scanning abilities, and a repetitive motor response.</p>
<p>Sharma, V.K., Das, S., Mondal, S., Goswami, U., Gandhi, A. (2006). <i>Indian Journal of Physiology and Pharmacology</i>, 50(4), 375-83.</p>	<p>30</p>	<p>Randomized control trial.</p> <p>Experimental group(Group-1): Sahaj yoga meditation as adjunct</p> <ol style="list-style-type: none"> a. Letter cancellation test (LCT) b. Trail making test 'A' (TTA) c. Trail making test 'B' (TTB) d. Ruff figural fluency test (RFFT) e. Forward digit span (FDS) f. Reverse digit span test (RDS) 	<p>After 8 weeks, both Group 1 and Group 2 subjects showed</p> <p>(i)Significant improvement in LCT, TTA & TTB but improvement in LCT was more marked in Group 1 subjects.</p> <p>(ii) Also, there was significant improvement in RDS scores in only Group 1 subjects (P < 0.05).</p>

<p>Dash, M. & Telles, S. (1999). <i>Indian Journal of Physiology and Pharmacology</i> 43(4), 458-62.</p>	<p>a) 53 adults (yoga group) b) 152 children (yoga group) c) 38 adults (Non-Yoga group)</p>	<p>Yoga Vs Non- yoga (control group). Variables studied : 30-second tapping speed (TS) test at three time intervals, a) 0-10 second (TS1), b) 10-20 seconds (TS2) c) 20-30 seconds (TS3).</p>	<p>(i) Significant (Student's t-test) increase in all three TS values following 10 days of yoga in children and 30 days of yoga in adults. (ii) TS2 and TS3 were significantly lower than TS1. (ii) An increase in motor speed for repetitive finger movements following yoga training, but not in strength or endurance, as the increase was not sustained over 30 sec</p>
<p>Manjunath, & Telles, (1999). <i>Indian Journal of Physiology and Pharmacology</i>, 43(2), 225-9.</p>	<p>80 subjects belonging to four groups.</p>	<p>Multiple group study correlating Age, Gender and motivation to learn yoga with the performance in perceptual motor skill. Variable studied was tweezers dexterity scores.</p>	<p>a) Scores of the volunteers who learnt yoga increased significantly b) No change in scores of deputed subjects and non-yoga groups. c) The factors such as age and gender did not appear to contribute to the difference in performance d) Motivation to learn yoga appeared to influence the magnitude of increase.</p>

Table 7: Studies on cyclic meditation.

Reference	Subjects	Design of Experiment and Variables Studied	Findings
<p>Telles, S., Reddy, S.K. & Nagendra, H.R. (2000). <i>Applied Psychophysiology and Bio feedback</i>, 25(4), 35-41.</p>	<p>40 Male volunteers Aged: 27.5 ± 5.7 years</p>	<p>All alternately practiced Cyclic meditation and <i>śavāsana</i>. Self as controlled trial 5 min baseline → 23 min CM → 5 min rest in sitting position Variables: before and after (i) Oxygen consumption. (ii) Breath rate (iii) Breath volume</p>	<p>(i) Significant ↓ in amount of OC and in breath rate and increased in breath volume was observed in both groups. (ii) O₂ consumption decreased 32.1% after CM compared with 10.1% after <i>śavāsana</i>. (iii) Breath rate reduced by 3.6 c/min after CM, and by 1.9c/min after SH (iv) Breath amplitude increased 28.8% after CM and 15.9% after <i>śavāsana</i>.</p>
<p>Sarang, S.P., & Telles, S. (2007). <i>Perceptual and Motor Skills</i>, 105(2), 379-85</p>	<p>69 male volunteers, Age range: 18 to 48 years</p>	<p>Self as control design Variable: Six letter cancellation task</p>	<p>(i) After both practices, the net scores were significantly higher, although the magnitude of change was more after Cyclic Meditation than after Supine Rest (24.9% versus 13.6%). (ii) Reduction in scores for wrong cancellations after Cyclic Meditation and not after Supine Rest.</p>

<p>Sarang, S.P., & Telles, S. (2006). <i>Applied Psychophysiology and Biofeedback</i>. 31(2), 143-53.</p>	<p>50 male volunteers</p>	<p>Self as control design</p> <p>Variables:</p> <ol style="list-style-type: none"> 1. Oxygen consumption, 2. minute ventilation, 3. tidal volume 4. breath rate 	<p>(i) 19.3 % decrease in oxygen consumption after cyclic meditation.</p> <p>(ii) 4.8 % decrease in oxygen consumption after Shavasana.,</p>
<p>Sarang, S.P., & Telles, S. (2006). <i>International Journal of Neuroscience</i>, 116(12), 1419-30.</p>	<p>42 volunteers</p>	<p>Self as control design</p> <p>Variable: P300</p>	<p>(i) Reduction in the peak latencies of P300 after cyclic meditation at Fz, Cz, and Pz compared to the "pre" values.</p> <p>(ii)) Reduction in the peak latencies of P300 after supine rest at Fz, Cz, and Pz compared to the "pre" values, but magnitude of change is less.</p>
<p>Sarang, S.P., & Telles, S. (2006). <i>International Journal of Stress Management</i>, 13 (4), 460-475</p>	<p>42 male volunteers</p>	<p>Self as control design</p> <p>Recordings were made; pre 5 min, during 22 min 30 sec and post 5 min in both CM and SR sessions.</p> <p>Variable: Heart rate variability (HRV)</p>	<p>(i) Decrease in LF & LF / HF ratio during yoga postures of CM and after CM.</p> <p>(ii) Heart rate increased during the yoga postures and decreased in guided relaxation and after CM.</p> <p>(iii) Increase in HF after CM</p> <p>(iv) There was no change supine rest</p>

3.0 REVIEW OF THE SCIENTIFIC LITERATURE ON MEDITATION

3.1.1 STUDIES ON MEDITATION

Yoga includes practices such as physical postures, regulated breathing and meditation among other techniques. Meditation is a specific state of consciousness characterized by deep relaxation and internalized attention (Murata, 2004). It comes as the seventh of the eight steps or limbs of yoga as described traditionally [Patanjali, *circa* 900 B.C.]. There are several different meditation techniques being practiced world-wide today. Some of the well known meditation includes Transcendental meditation [TM], Zen meditation, Tibetan Buddhist meditation, Qi-Gong meditation, Brahmakumaris *Rāja* Yoga meditation, *Ānanda Marga* meditation, *Kuṇḍalini* meditation, Meditation on ‘OM’, *vipāśana* meditation and mindfulness meditation. Many novices find it difficult to practice meditation initially and some people find it easier to begin by practicing yoga postures. Based on this a ‘moving meditation’ called cyclic meditation was evolved which has cycles of yoga postures alternating with guided relaxation while lying supine.

In Cyclic Meditation (CM), the period of practicing yoga postures constitutes the ‘awakening’ practices, whereas periods of supine rest comprise the ‘calming practices’. An essential part of the practice of Cyclic Meditation is being aware of sensations arising in the body. This supports the idea that a combination of stimulating and calming techniques practiced with a background of relaxation and awareness (during CM) may reduce psychophysiological arousal more than resting in a supine posture for the same

duration. The practice of CM includes yoga postures (*asanas*) which involve muscle stretching and has diverse benefits.

Numerous studies have been documenting various physiological changes and clinical benefits after the practice of various kinds of meditations, including CM, some of them which are most relevant to the present research are mentioned below, and have also been summarised in **Table 1 and 2**.

3.1.1.A Studies on relaxation techniques:

3.1.1.A1 Studies on yoga based relaxation techniques

These techniques have shown to reduce physiological signs of arousal (Vempati & Telles, 2002). Thirty five male volunteers whose ages ranged from 20 to 46 years were studied in two sessions of yoga-based guided relaxation and supine rest. Assessments of autonomic variables were made for fifteen subjects, before, during, and after the practices. Oxygen consumption and breath volume were recorded for twenty five subjects, before and after both types of relaxation. A significant decrease in oxygen consumption and increase in breath volume were recorded after guided relaxation. There were comparable reductions in heart rate and skin conductance during both types of relaxation. During yoga relaxation the power of the low frequency component of the heart-rate variability spectrum reduced, whereas the power of the high frequency component increased, suggesting reduced sympathetic activity. Also, subjects with a baseline ratio of $LF/HF > 0.5$, showed a significant decrease in the ratio after guided relaxation, while subjects with a ratio ≤ 0.5 at baseline showed no such change. These results suggested that sympathetic activity

decreased after guided relaxation based on yoga, depending on the baseline levels.

The effect of a yoga based relaxation technique on psychological variables in exam going students was studied (Malathi & Damodaran, 1999). The study was conducted on fifty medical students during routine activities and prior to their examination. The Anxiety status (Spill Berger's anxiety scale) showed a significant reduction after yoga practice. In addition, the anxiety score which rose prior to exams showed a significant reduction on the day of exam after practice. These results showed the beneficial role of yoga based relaxation techniques in not only causing reduction in basal anxiety level but also attenuating the increase in anxiety score in stressful state such as exams. The feedback scores also indicated improvement in various variables such as better sense of wellbeing, feeling of relaxation, improved concentration, self-confidence, improved efficiency, good interpersonal relationship, increased attentiveness, lowered irritability levels, and an optimistic outlook in life.

3.1.1.A2 Studies on Yoganidrā

Global cerebral blood flow (CBF) distribution (with the 15O-H₂O PET technique) and spectral EEG analysis was done in nine young adults, who were highly experienced yoga teachers, both during *yoganidrā* relaxation and resting states. During meditation differential activity were seen, with the noticeable exception of V1 in the posterior sensory and associative cortices known to participate in imagery tasks. In the resting state of normal consciousness (compared with meditation as a baseline), differential activity was found in dorso-lateral and orbital frontal cortex, anterior cingulate gyri, left temporal

gyri, left inferior parietal lobule, striatal and thalamic regions, pons and cerebellar vermis and hemispheres, structures which are thought to support an executive attentional network (Lou, Kjaer, Friberg, Wildschiodtz, Holm & Nowak, 1999).

Another study has demonstrated an association between endogenous neurotransmitter release and conscious experience (Kjaer, Bertelsen, Piccini, Brooks, Alving & Lou, 2002). Using 11C-raclopride PET, increased endogenous dopamine release in the ventral striatum was found during *yoganidrā* meditation. Participants underwent two 11C-raclopride PET scans: one while attending to speech with eyes closed, and one during active meditation. During *yoganidrā* meditation 11C-raclopride binding in ventral stream decreased by 7.9 percent. This corresponded to a 65 percent increase in endogenous dopamine release. The reduced raclopride binding correlated significantly with a concomitant increase in EEG theta activity, a characteristic feature of meditation. All participants reported a decreased desire for action during meditation, along with heightened sensory imagery. This suggested that being in the conscious state of meditation causes a suppression of cortico-striatal glutamatergic transmission.

3.1.1.B Studies on progressive muscle relaxation:

Thirty six volunteers were assigned to one of three conditions: progressive relaxation, clinically standardized meditation, or a waiting list control group asked to relax daily (without specific instruction). At the end of five week period, they were tested for psycho physiological and cognitive responses to stressful stimuli. The meditation group exhibited higher heart rate and higher

integrated frontalis electromyographic (EMG) activity, but they also showed greater cardiac decelerations following each tone, more frontal alpha and fewer symptoms of cognitive anxiety than other two groups. The relaxation group showed more muscular relaxation (Lehrer, Schoicket, Carrington & Woolfolk, 1980).

A randomized controlled study was done to compare the effect of relaxation technique which employ a somatic attentional focus (progressive muscle relaxation) and technique with cognitive focus (*mantra* meditation) on 61 subjects with anxiety (Lehrer, Woolfolk, Rooney, McCann & Carrington, 1983). Both techniques generated positive expectancies and produced decrease in a variety of self-reported symptoms and on EMG. Progressive muscle relaxation produced greater reduction in forearm EMG responsiveness to stressful stimulation and generally more powerful therapeutic effect than meditation. It was also seen that meditation produced greater cardiac orienting responses to stressful stimuli, greater absorption in the task and better motivation.

Another study compared relaxation and meditation as part of a program of stress-reduction in industry (Carrington, Collings, Benson, Robinson, Wood, Lehrer, Woolfolk & Cole, 1980). A total of 154 New York telephone employees self-selected for stress, learned one of three techniques: clinically standardized meditation (CSM), respiratory one method meditation (ROM) or progressive relaxation (PMR) or served as wait list controls. At 5.5 months, the treatment groups showed clinical improvement in self-reported symptoms of stress, but only the meditation groups showed significantly more symptom reduction than the controls.

Oxygen consumption, tidal volume, respiratory rate, heart rate, systolic and diastolic blood pressure were measured before the subjects (n = 39) learned Transcendental meditation (n = 21) or Jacobson's progressive relaxation (n = 18) and immediately after learning both techniques and again tested after 5, 10, and 15 weeks follow-up. Both groups displayed significantly lowered metabolic rates (reduction in oxygen consumption, tidal volume, respiratory rate, diastolic blood pressure and heart rate). However the Transcendental meditation group displayed more significant decrease during meditation and during activity than did the progressive relaxation group. The more significant and comprehensive results for meditators were explained primarily in terms of the greater amount of time the Transcendental meditation group spent on their technique, plus the differences in the two techniques themselves (Throll, 1982).

Orme-Johnson (1973) reported a study on 16 subjects; half of them were meditators and other half controls. The mediators had a mean experience of fifteen months. They studied GSR habituation and spontaneous GSR fluctuations. In a second experiment, they studied 6 meditators (with experience of meditation ranging from 2 - 54 months) and 8 non-meditators. Though habituation was initially similar for the two groups, the meditators habituated in significantly fewer trials than non-meditators. Also, there was a low frequency of spontaneous GSR fluctuations in meditators as compared to controls.

3.1.1.C Studies on Tai Chi Chuan meditation

Tai Chi Chuan (TCC) consists of a combination of a series of rhythmic sequential movements providing a smooth, continuous, low-intensity activity

and a kind of yogic relaxation through deep breathing and self-awareness. This is a traditional Oriental ‘moving’ meditation technique based on Taoist philosophical principles of Yin and Yang (the opposite forces) and breathing techniques. Tai Chi practitioners have claimed a number of beneficial effects from its frequent use such as relief from muscular tension, reduced anxiety, stress, and pain, and increased balance, self-awareness, and strength (Sandlund & Norlander, 2000).

3.1.1.C1 Studies on psycho-physiological changes

A study assessed psychological and physiological changes following Tai Chi practice in thirty three beginners and thirty three practitioners (Jin, 1989). The subjects were divided into three groups on the basis of experience, time of practice, and phase (before, during, or after Tai Chi intervention). The Profile of Mood States (POMS), Trait Anxiety Inventory form, heart rate, noradrenaline excretions, and cortisol concentrations was assessed before and after the practice. Compared to baseline, practice of Tai Chi raised heart rate, increased noradrenalin-excretion in urine, and decreased salivary cortisol concentration. Elevated heart rates during testing indicated Tai Chi as a moderate cardiovascular exercise. Cortisol levels dropped compared to pre-testing; Jin explains this with the fact that the Tai Chi physical workload only represents 50 percent of Vo_2 max, (indicating a low workload). Subjects reported less tension, depression, anger, fatigue, confusion, state-anxiety and their mood improved significantly during Tai Chi, and remained positive even a hour after practice.

Another study examined the ventilatory and cardiovascular responses to the long form of Yang's style TCC (Brown, Mucci, Hetzler & Knowlton, 1989). In addition, the subjects TCC responses were compared to their ventilatory and cardiovascular responses during cycle ergometry at oxygen consumption (V_{O_2}) equivalent to the mean TCC - V_{O_2} . Cardiac output, stroke volume, and heart rate were not significantly different between TCC exercise and cycle ergometry at the same oxygen consumption. It was concluded that, during TCC, expert practitioners show significantly different ventilatory-responses leading to more efficient use of the ventilatory volume than would be expected from comparable levels of exertion on a cycle ergometer.

Similar study was done on 15 men aged between 26 to 56 (group mean \pm SD, 39.9 ± 9.5) years for heart rate responses and oxygen consumption during the practice of TCC by using an open circuit K4 telemetry system (Lan, Chen, Lai & Wong, 2001). Subjects had experience of classical Yang TCC practice more than one year (group mean \pm SD, 5.8 ± 2.4 years). Blood lactate was measured before and immediately after TCC practice. Additionally, breath-by-breath measurement of cardio respiratory function and sequential determination of blood lactate were performed during the incremental exercise of leg cycling. Measurements obtained during the TCC practice and exercise testing was compared to determine the exercise intensity of TCC. Compared with the data of the exercise test, the HR during TCC practice was 58 percent of the heart rate range. The oxygen consumption during TCC practice was 55 percent of the VO_2 peak. Additionally, the level of blood lactate immediately after TCC practice was 3.8 mm, which reflected the level of lactate during

TCC, approximated the onset of blood lactate accumulation (OBLA). This indicated that TCC provides moderate aerobic exercise.

The efficacy of Tai chi in post-stress recovery was done in another study (Jin, 1991). 48 adult male and 48 adult female Tai Child practitioners were randomly assigned to 4 treatment groups: Tai Chi, brisk walking, meditation, and neutral reading. The experimenter was blind to the study and had the subjects come in twice to the laboratory conducted the experiment. The participants were then subjected to both mental and emotional stress, arithmetic and other difficult mental tests under time pressure; loud noise, and an emotionally stressful movie. After the second session, the groups continued with one hour of each of the experimental activities. The heart rate, urine, blood pressure, and tension/mood scales (POMS and STAI-Y) were measured. The results showed that the exercise intensity of Tai Chi and brisk walking was considered as moderate and resulted in a release of nor-adrenaline, which may be beneficial to health. All four conditions appeared to be effective in reducing mood disturbance, and the Tai Chi group showed a greater reduction in state anxiety compared to the reading group.

Psychological changes associated with sixteen week moderate and low intensity exercise training programs, two of which possessed a cognitive component, were evaluated. Subjects were healthy, sedentary adults, 69 women and 66 men. Participants were randomly assigned to a control group, moderate intensity walking group, low intensity walking group, low intensity walking plus relaxation response group, or mindful exercise group - a Tai Chi type program. Women in the mindful exercise group experienced reductions in mood disturbance (tension, depression, anger, confusion, and total mood

disturbance) and an improvement in general mood. This supported the hypothesis that exercise plus cognitive strategy training programs are more effective than exercise programs lacking a structured cognitive component in promoting psychological benefits (Brown, Wang, Ward, Ebbeling, Fortlage, Puleo, Benson & Rippe, 1995).

Another study compared post-exercise affect after sessions of aerobic dance, weight training, martial arts, Tai-Chi and yoga, and as a control, music appreciation (Szabo, Mesko, Caputo & Gill, 1999). The results indicated that the combined Tai Chi and yoga group reported higher levels of ‘tranquillity’ than all other exercise groups. Further, they reported lower psychological distress, fatigue, and exhaustion as compared to the martial arts group.

3.1.1.D Studies on Yoga and evoked potentials:

Sudarshan Kriyā Yoga (SKY) is (a combination of regulated breathing, awareness and relaxation) a meditation system with an emphasis on breathing techniques. This technique was used as an intervention for depression and comparisons were made with the healthy control subject groups (Murthy, Gangadhar, Janakiramaiah & Subbakrishna, 1998). At three months, the P300 amplitude increased to control levels in the patient group after initial values at zero ($7.5\mu\text{V}$) and one month ($10.4\mu\text{V}$) that were well below normal values ($14.4\mu\text{V}$) at both time points. Taken together, these reports suggest the possibility of some effects on the P300 component related to SKY.

In another study, ERPs were obtained before and after a 30 min meditation or rest period from experienced meditators (yoga based) compared to matched non-meditator controls (Banquet & Lesévre, 1980). Subjects were

instructed to respond to each stimulus and to refrain from responding whenever they detected an omitted stimulus, so that state and trait effects could be evaluated under response and non-response conditions. The results were the following, for the meditators, P300 amplitude increased post-meditation; for the controls P300 amplitude decreased post-rest. The meditators as compared to the controls demonstrated shorter response time (RT) and greater accuracy before and after the meditation period, with RT shorter than P300 latency for the meditators but longer than P300 latency for the controls in both the pre-and post-conditions. They conclude that long-term meditative practice could increase selective attention capacity that improves vigilance level to affect ERP measures. Such state effects also are consistent with meditation affecting de-automization of stimulus processing.

Experienced (with 10-12 years of practice) yoga based concentrative meditators showed decreased amplitude in the later components of the SEPs (Lyubimov, 1999). Similar Yogic meditators produced somatosensory EP amplitude decrease, when instructed to block out the sensory stimuli, whereas the controls produced no such effects. Further, the early components decreased only on the recording sites ipsilateral to stimulation side, but late components decreased bilaterally (Gordeev, Baziian & Liubimov, 1992). This outcome implies that some concentrative meditation practices states can block sensory input at a sub-cortical level.

The Self-Regulation Method is a meditation technique combining aspects of Zen practice and Autogenic Training (Ikemi, 1988; Ikemi, Tomita, Kuroda, Hayashida & Ikemi, 1986). After a five-week training course, EEG and CNV assessments were carried out prior to and during practice as well as

during a drowsy state. CNV was obtained with a choice task to the imperative second stimulus. During meditation accuracy increased and shorter RTs were observed, whereas during drowsiness accuracy decreased and longer RTs occurred. EEG demonstrated increased theta and decreased beta power for meditation, but during both meditation and drowsiness reduced CNV amplitudes for the choice-task were found. CNV processes therefore may be sensitive to meditation state.

Different changes in evoked potentials (ABR, MLR & P200) were observed before, during, and after a Qi-gong meditation session in a within-subject design (Liu, Cui, Li & Huang, 1990). ABR Waves I through V increased in amplitude 55-76%, whereas MLR Na and Pa amplitudes decreased 50-73% during Qi-gong meditation relative to the before and after conditions. It was hypothesized that the brainstem may be synergistically released from descending inhibition to produce the ABR amplitude increase when the initial cortical activity indexed by MLR potentials decreases during meditation. Also, presenting 10 m sec. tones Qi-gong meditators were assessed before, during, and after a 30 min Qi-gong meditation session. P200 amplitude decreased 44% from the baseline to the meditation state and returned to baseline after meditation suggestive of attenuated cortical responses/believed to be due to inhibition of neural activity at thalamo-cortical and cortical levels.

Sensory visual potentials evoked by a light flash were employed to compare four populations: (i) long-term Qi-gong meditation practitioners, (ii) long-term Neiyang-gong practitioners—a variant of the older Qi-gong method, (iii) beginning Neiyang-gong meditation practitioners, and (iv) non-meditating control subjects (Zhang, Zheng, Zhang, Yu & Shen, 1993). Visual flash

potentials were obtained under eyes open conditions before, during, and after the meditative practice or analogously for a rest period in controls. The flash potentials were classified as early (N80-P115-N150) and late (N150-P200-N280) components, with peak-to-peak amplitudes measured. The long-term traditional Qi-gong practitioners demonstrated marginally significant decreased amplitude for the early and later flash potentials during meditation. However, the Neiyang-gong practitioners demonstrated increased amplitudes for both the early and late flash potentials. No effects of meditation were reported for the beginning Neiyang-gong or control groups. It was concluded that the two types of Qi-gong meditative practice produce opposite effects on the relative excitability of the visual cortex, such that the more traditional Qi-gong leads to cortical inhibition and reduced flash potential amplitudes (Cui, 1987).

More recently, the effect of BK meditation in 16 experienced Brahmakumaris *Rāja* Yoga meditators was studied using middle latency auditory evoked potentials. There was a significant decrease in peak latency of the Na wave (14–19 msec.), suggesting that the meditation practice reduced time for conduction of auditory information at the midbrain-thalamic level (Telles & Naveen, 2004).

Sahaja Yoga emphasizes adopting the witness posture towards thoughts instead of flowing with them during meditation and is therefore very close to the mindfulness type of meditation. The practice of this method was assessed in three groups of young adult epileptic patients (Panjwani, Selvamurthy, Singh, Gupta, Mukhopadhyay & Thakur, 2000). One group practiced *Sahaja* meditation, another group sat quietly in ‘sham’ meditation, and a control

patient group had no meditation instruction. ABR and MLR measures were obtained prior to the meditation intervention, three months, and six months later. No ABR effects were obtained, but the *Sahaja* Yoga group demonstrated an increase in MLR Na-Pa amplitude at six months. Although *Sahaja* Yoga meditation in normal control subjects was not assessed, this outcome also suggests the influence of meditation on initial cortical auditory processing.

An early study on meditation (Telles & Desiraju, 1993) used for the first time two important modifications in the research design for yoga research. Here subjects were studied using the 'self-as-control' design and the two types of sessions, meditation and non-meditation, were repeated thrice in each subject. This study highlighted two points, (i) meditation is best described as a physiological state of 'alertful rest', and (ii) considerable physiological variations are seen both intra- and inter-individually. This study assessed the effects of meditation on the syllable 'OM' on mid-latency auditory evoked potentials, it was found that in seven experienced meditators during meditation there was a significant decrease in the peak latency of the Nb wave (the maximum negativity occurring between 35 and 65 ms). In another study on the effects of meditation on 'OM' on mid-latency auditory evoked potentials were studied in experienced meditators and novices (Telles, Nagarathna & Nagendra, 1994). There were two types of sessions before, during and after (i) mental repetition of 'OM' (meditation session) and (ii) mental repetition of 'ONE' (control session). The experienced meditators showed a significant increase in the peak amplitude of the Na wave (the maximum negative peak between 14 and 18 msec.) during the meditation with a significant decrease in the Na wave peak amplitude during the control session. Hence during mental

repetition of a meaningful syllable ('OM') and of a neutral syllable ('ONE') neural changes occurred at the same level (possibly diencephalic) though in opposite directions.

3.1.1.E Studies on measures of attention:

There have been reports of other studies on TM indicating its clinical applications and usefulness in enhancing the cognitive performance and perceptual and motor skills. Banquet (1973) compared meditators with matched controls measuring the hypo-metabolic state reaction time (RT) during a series of visual stimuli. Meditators showed faster RT with less mistakes, and N100 and P200 of larger amplitude and shorter latency. The transient effects were opposite for the two groups, i.e., longer RT and larger P300 amplitude was observed following meditation while following rest there was no change in RT and a decrease in the P300 amplitude. These results suggest selective attention capacity and information processing strategies associated with meditation.

TM practice was studied using a passive auditory paradigm listening trial with variable inter-stimulus intervals (1-4 seconds) between identical tone stimuli (Cranson, Goddard & Orme-Johnson, 1990). The subjects were non-meditator controls, novice, and highly experienced TM meditators with mean ages of 20, 28, and 41 years, respectively; IQ scores did not differ among the groups. Passive P300 potential latency was shorter for the two meditation groups, with the long-term meditators showing the shortest P300 latency regardless of their age. These results imply that AEPs might reflect meditation trait differences. An auditory oddball task was used with eyes-closed to assess

experienced TM meditators at pre-test baseline, after 10 min of rest, or after 10 min of TM practice with conditions counterbalanced across subjects (Travis & Miskov, 1994). P300 latency decreased at Pz after TM practice relative to no change after the rest condition. Taken together, these reports suggest the possibility of some meditation effects on the P300 component.

Travis, Tecce, Arenander and Wallace (2002) studied patterns of EEG coherence, power and contingent negative variation in long-term meditating subjects who report that Transcendental Experiences (TE), which first occurred during their Transcendental Meditation (TM) practice, now subjectively co-exist with waking and sleeping states. In order to investigate neurophysiological correlates of this state, they recorded the EEG in these subjects and in two comparison groups during simple and choice contingent negative variation (CNV) tasks. In individuals reporting the integration of the transcendent with waking and sleeping, CNV was higher in simple but lower in choice trials, and 6 - 12 Hz EEG amplitude and broadband frontal EEG coherence were higher during choice trials. Increased EEG amplitude and coherence, characteristic of TM practice, appeared to become a stable EEG trait during CNV tasks in these subjects. Hence they proposed that these significant EEG differences may underlie the inverse patterns in CNV amplitude seen between groups. An 'Integration Scale,' constructed from these cortical measures, was considered to possibly characterize the transformation in brain dynamics corresponding to increasing integration of the transcendent with waking and sleeping. CNV is an event related potential occurring between a warning stimulus and an imperative stimulus requiring a response. Late CNV amplitudes were largest in meditators who had transcendent experiences daily.

Since late CNV reflects proactive preparatory processes including mobilization of motor, perceptual, cognitive, and attentional resources, the data were taken to suggest that transcendent experiences enhance cortical responses and executive functioning.

Frontal midline theta activity is generated by anterior cingulate cortex, medial prefrontal cortex, and/or dorsolateral prefrontal cortex. This activity is correlated with attention-demanding tasks (Polich, 2004). Recently, the frontal midline theta rhythm was correlated with cardiac autonomic activities during Zen meditation (Kubota, Sato, Toichi, Murai, Okada, Hayashi & Sengoku, 2001). A standard procedure of Zen meditation requiring sustained attention and breath control was employed as the task to provoke frontal midline theta rhythm (F_m theta), and simultaneous EEG and ECG recordings were performed. For the subjects in which F_m theta activities were provoked (6 men, 6 women, 48 percent of the total subjects), peripheral autonomic activities were evaluated during the appearance of F_m theta as well as during control periods. Successive inter-beat intervals were measured from the ECG, and heart rate variability was used to assess cardiac sympathetic and parasympathetic functions separately. Both sympathetic and parasympathetic indices were increased during the appearance of F_m theta compared with control periods. Theta band activities in the frontal area were correlated negatively with sympathetic activation. This suggested a close relationship between cardiac autonomic function and activity of the medial frontal neural circuitry. In another study conducted on twenty two healthy subjects to evaluate the effect of Zen meditation on EEG coherence and heart rate variability (HRV) in relation to trait anxiety scores, there was an increase in slow alpha interhemispheric

EEG coherence in the frontal regions and an increase in the HF power and a decrease in the LF/HF ratio and heart rate (Murata, Takahashi, Hamada, Omori, Kosaka, Yoshida & Wada, 2004). These results suggest that lower trait anxiety more readily induces meditation with a predominance of internalized attention, while higher trait anxiety more readily induces meditation with a predominance of relaxation.

Recently, Takahashi, et al. (2005) quantitatively analyzed changes in psychophysiological variables during Zen meditation in twenty normal adults, and evaluated the results in association with personality traits assessed by Cloninger's Temperament and Character Inventory (TCI). During meditation, there was an increase in fast theta power and slow alpha power on EEG predominantly in the frontal area, whereas an increase in the normalized unit of high-frequency (nuHF) power (as a parasympathetic index) and decrease in the normalized unit of low-frequency (nuLF) power and LF/HF (as sympathetic indices) were observed through analyses of heart rate variability. They analyzed the possible correlations among these changes in terms of the percent change during meditation using the control condition as the baseline. The percent change in slow alpha EEG power in the frontal area, reflecting enhanced internalized attention, was negatively correlated with that in nuLF as well as in LF/HF and was positively correlated with the novelty seeking score (which has been suggested to be associated with dopaminergic activity). The percent change in fast theta power in the frontal area, reflecting enhanced mindfulness, was positively correlated with that in nuHF and also with the harm avoidance score (which has been suggested to be associated with serotonergic activity). These results suggest that internalized attention and

mindfulness as two major core factors of behaviours of mind during meditation are characterized by different combinations of psychophysiological properties and personality traits. (Takahashi, Murata, Hamada, Omori, Kosaka, Kikuchi, Yoshida & Wada, 2005)

A study was conducted on attentional capacity in twenty five normal elderly subjects who were trained in techniques to improve face-name recall (Yesavage & Jacob, 1984). Techniques consisted of relaxation training and a mnemonic device. Their anxiety was measured simultaneously with attentional measures. Results indicated that subjects showing the significant reduction in anxiety and cognitive interference and the significant increase in attention also showed the most face-name recall following training. The results suggest that the anxiety in elderly persons has a cognitive component that interferes with performance on attentional and memory tasks, but which can be reduced through relaxation training.

In another study PET was used to investigate cerebral activity relating to the cognitively driven modulation of sympathetic activity (Critchley, Melmed, Featherstone, Mathias & Dolan, 2001). The subjects were trained to perform a biofeedback relaxation exercise that reflected electrodermal activity and were subsequently scanned performing repetitions of four tasks: biofeedback relaxation, relaxation without biofeedback and two corresponding control conditions in which the subjects were instructed not to relax. Relaxation was associated with significant increase in left anterior cingulate and globus pallidus activity, whereas no significant increase in activity was associated with biofeedback compared with random feedback. The interaction between biofeedback and relaxation, highlighting activity unique to

biofeedback relaxation, was associated with enhanced anterior cingulate and cerebellar vermal activity. This study implicated the anterior cingulate cortex in the intentional modulation of bodily arousal and suggests a functional neuro-anatomy of how cognitive states are integrated with bodily responses.

3.1.1.F Studies on motor tasks:

The performance in a six-letter cancellation task was assessed with 69 male volunteers, ages 18 to 48 years, immediately before and after two yoga-based relaxation techniques (Cyclic Meditation and Supine Rest) and a control session of equal duration. After both practices, the net scores were significantly higher, although the magnitude of change was more after Cyclic Meditation than after Supine Rest (24.9% versus 13.6%). There was reduction in scores for wrong cancellations after Cyclic Meditation and not after Supine Rest. The control group showed no change. The results suggested that Cyclic Meditation brings about a greater improvement in performance in this task, which requires selective attention, concentration, visual scanning abilities, and a repetitive motor response (Sarang & Telles, 2007).

Another study on the effects of Yoga on cognitive functions in Major Depression has shown improvement in memory, vigilance and anxiety levels (Sharma, 2006). The 30 patients suffering from major depression (age 18 to 45 years) were randomly divided into two groups: Group 1: (10 males and 5 Females) Patients who practised Sahaj Yoga meditation and also received conventional anti-depressant medication. Group 2: (9 males and 6 Females) Patients who only received conventional antidepressant medication. Group 1 patients were administered Sahaj Yoga practice for 8 weeks. Neuro-cognitive

test battery consisting of Letter cancellation test (LCT), Trail making test 'A' (TTA), Trail making test 'B' (TTB), Ruff figural fluency test (RFFT), Forward digit span (FDS) & Reverse digit span test (RDS) was used to assess following cognitive domains: Attention span, visuo-motor speed, short-term memory, working memory and executive functions. After 8 weeks, both Group 1 and Group 2 subjects showed significant improvement in LCT, TTA & TTB but improvement in LCT was more marked in Group 1 subjects. Also, there was significant improvement in RDS scores in only Group 1 subjects ($P < 0.05$). The results thereby, demonstrate that Sahaj Yoga practice in addition to the improvement in various other cognitive domains seen with conventional anti-depressants, can lead to additional improvement in executive functions like manipulation of information in the verbal working memory and added improvement in attention span and visuo-motor speed of the depressives.

Another interesting study was done to assess perceptual-motor speed and nonverbal intelligence in individuals practicing transcendental meditation and TM-Sidhi programme (Jedrczak, 1986). The results of multiple regression analysis showed that when motivation, age, sex, education and duration of practice were kept constant; it was the number of months of practice of the TM-Siddhi programme that significantly predicted higher performance on two of the three perceptual-motor speed and nonverbal intelligence tests.

A finger tapping task was used to assess motor speed (MS) of both hands in 53 adults and 152 children before and after yoga training and in 38 adults of a non-yoga (control) group. All subjects were right hand dominant. The 30-second tapping speed (TS) test was considered as three time intervals, i.e. 0-10 second (TS1), 10-20 seconds (TS2) and 20-30 seconds (TS3). There

was a significant (Student's t-test) increase in all three TS values following 10 days of yoga in children and 30 days of yoga in adults. However for both groups at baseline and final assessments, TS2 and TS3 were significantly lower than TS1. Hence the TS were increased after yoga training during the first 10-seconds of the test but not during the next 20 seconds. These results suggest an increase in motor speed for repetitive finger movements following yoga training, but not in strength or endurance, as the increase was not sustained over 30 sec (Sarang & Telles, 2007).

The effect of yoga on musculoskeletal discomfort and motor functions was assessed in 291 professional computer users, using self-rated musculoskeletal discomfort, hand grip strength, tapping speed, and low back and hamstring flexibility (Telles, 2009). They randomized as Yoga (YG; n=146) and Wait-list control (WL; n=145) groups. YG group practiced yoga for 60 minutes daily, for 5 days in a week and WL group spent the same time in their usual recreational activities. Follow-up assessments at the end of 60 days showed that the YG group (n=62) showed a significant decrease in the frequency, intensity and degree of interference due to musculoskeletal discomfort, an increase in bilateral hand grip strength, the right hand tapping speed, and low back and hamstring flexibility (repeated measures ANOVA and post hoc analysis with Bonferroni adjustment). In contrast, the WL group (n=56) showed an increase in musculoskeletal discomfort and a decrease in left hand tapping speed.

The factors influencing the improvement of perceptual-motor skills after their practice of yoga was studied by correlating age, gender, and motivation to learn yoga with the performance in a dexterity task following the

practice (Manjunath, 1999). The test involved using a tweezer to place metal pins in evenly spaced holes in a metal plate within four minutes. Following yoga the scores of the volunteers who learnt yoga increased significantly, whereas there was no change in scores of deputed subjects and non-yoga groups (Wood, 1986). The results were unlike the later studies and showed no significant difference in the performance of either the fine motor or the gross motor task was noted for persons practicing meditation and persons who were nonmeditators but were given the opportunity to relax prior to a motor task. Likewise, no significant difference was noted in the pattern of response to the imposed fine motor or gross motor task by meditators or relaxed nonmeditators.

3.1.2 Scientific Studies on Cyclic Meditation (CM)

The studies described below were all carried out at the Swami Vivekananda Yoga Research Foundation, Bangalore, India, where the technique was devised.

3.1.2.A Studies on autonomic and respiratory variables

In a previous study, heart rate variability (HRV) was studied in forty-two male volunteers in cyclic meditation (CM) and supine rest (SR) sessions. The high frequency (HF) power of the HRV increased during both CM and SR practice, which is considered to suggest increased vagal tone (Sarang & Telles, 2006). 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). The study showed parasympathetic dominance. The exact mechanism underlying the effect of CM on the autonomic nervous system is difficult to determine. The effect may be brought about by reduced cortical activity, which in turn may modify the activity at the level of the hypothalamus.

An earlier study on thirty-five male volunteers (ages between 20-46 yrs) showed a significant decrease in oxygen consumption and increase in breath volume were recorded after guided relaxation practiced for 10 minutes compared to the equal duration of supine rest. During guided relaxation the power of the LF component of the heart-rate variability spectrum reduced, whereas the power of the HF component increased, suggesting reduced

sympathetic activity (Vempati & Telles, 2002). However, another study on forty-male volunteers (ages 16 to 46 yrs) showed that Isometric relaxation technique practiced for a minute showed that there was a reduction in the physiological signs of anxiety and stress (Vempati & Telles, 1999). More recently, a study on thirty-male volunteers (ages ranging from 20 to 33 years) showed a decrease in heart rate (HR), low frequency power (LF power), LF/HF ratio, and an increase in the number of pairs of Normal to Normal RR intervals differing by more than 50 ms divided by total number of all NN intervals (pNN50) following the practice of cyclic meditation (CM) suggestive of a shift towards sympatho-vagal balance in favour of parasympathetic dominance during sleep (Patra & Telles, 2009).

3.1.2.B Studies on applications in reducing occupational stress levels

In a subsequent study correlating CM and heart rate variability, a two-day CM program decreased occupational stress levels and baseline autonomic arousal in twenty-six asymptomatic, male, middle managers (Vempati & Telles, 2000). Hence, suggesting significant reduction in sympathetic activity. The mechanisms underlying the decrease in occupational stress levels may be related to decrease autonomic arousal (sympathetic activation) as well as psychological factors, though this remains a speculation.

3.1.2.C Studies on metabolism and oxygen consumed

An earlier study on oxygen consumption showed that a period of cyclic meditation significantly reduced the oxygen consumption to a greater degree (32.1%) than a comparable period of supine rest (Telles, Reddy & Nagendra, 2000). Recent study also showed that after the practice of CM oxygen

consumption decreased (19.3 percent) compared to following SR (4.8 percent). Also, the change in oxygen consumption suggested that after the practices (but not during) there was a period of physiological relaxation which was more after CM compared to SR (Sarang & Telles, 2006). The energy expenditure (EE), respiratory exchange ratio (RER) and heart rate (HR) of 50 male volunteers were assessed before, during, and after the sessions of CM and sessions of supine rest. CM reduced the energy expenditure more than supine rest alone (Sarang & Telles, 2006). The studies cited above were conducted using the self-as-control design. The reason why the practice of CM reduces oxygen consumption could be related to decreased oxygen consumption of the brain and the skeletal muscles (which are probably more relaxed with the practice of CM).

3.1.2.D Studies on attention and electrophysiology

Earlier studies showed that, despite the changes suggestive of parasympathetic dominance following CM, there was 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 (Sarang & Telles, 2006). The P300 component of event-related brain potentials (ERPs) is generated when persons attend to and discriminate stimuli which differ in a single aspect. More recently, middle latency auditory evoked potentials (0-100ms range) were examined in forty-seven male volunteers before and after the practice of CM, which has resulted in prolonged latencies of evoked potentials generated within the cerebral cortex, supporting the idea of cortical inhibition after CM (Subramanya & Telles, 2009). The studies cited above were conducted using the self-as-control

design. The mechanism by which CM may improving attention while reducing sympathetic tone may be related to increased proprioceptive input (during the practice of *asanas*) to the Reticular Activating System (RAS), which in turn keeps cortical areas receptive and active (Kandel, Schwartz & Jessel, 2000). This is difficult to understand as generally increased alertness and vigilance is associated with an increase in sympathetic tone.

3.1.2.E Studies on performance in a cancellation task

In a previous study the effect of CM practice on the performance in a letter cancellation task, was assessed in sixty-nine male volunteers (whose ages ranged from 18 to 48 years). There was improved performance in the task which required selective attention, concentration, visual scanning abilities, and a repetitive motor response following CM (Sarang & Telles, 2007). The results were interpreted to suggest that the improved performance after CM suggests that the practice not only globally enhances performance but also selectively reduces the probability of being distracted. Again it is difficult to understand how CM practice which is associated with reduced sympathetic activity, increases the performance in an attention task. As described above this may be via increased proprioceptive input to the Reticular Activating System.

3.1.2.F A study on memory and anxiety

In a recent study, on fifty-seven male volunteers (group average age \pm S.D., 26.6 ± 4.5 years) the immediate effect of CM and SR were studied on memory and state anxiety (Subramanya & Telles, 2009). A cyclical combination of yoga postures and supine rest in CM improved memory scores immediately

after the practice and decreased state anxiety more than rest in a classical yoga relaxation posture (*shavasana*). Like the P300 event-related potential and the letter cancellation task, performance in the memory task requires increased alertness. The mechanism (as described above) remains speculative.

3.1.2.G A Study on polysomnography

In a recent study, whole night polysomnography measures and the self-rating of sleep were assessed on the night following a day in which thirty-male volunteers practiced CM twice (approximately 22:30 minutes each time). This was compared to another night when they had two, equal duration sessions of supine rest (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 were less. The practice of CM during the day time has been shown to increase the percentage of slow wave sleep in the subsequent night (Patra & Telles, 2009). CM has a number of components which may facilitate sleep, such as increased physical activity, muscle stretching, and introspection.

2.1 CONCEPT OF CYCLIC MEDITATION WITH SPECIAL REFERENCE TO TRADITIONAL YOGIC AND SPIRITUAL LITERATURE

'In a state of mental inactivity awaken the mind; when agitated, calm it; between these two states realize the possible abilities of the mind. If the mind has reached the state of perfect equilibrium then do not disturb it again'

(Māṇḍūkya Upaniṣat Kārikā: 3.44).

2.1.1 BACKGROUND AND SCOPE

In the philosophies of *Yoga* and *Vedānta*, meditation is a mental process by which the meditator becomes one with the object of meditation. Concentration (*dhāraṇā*) is the preliminary stage of this process; when concentration becomes effortless and continuous, it takes the form of meditation (*dhyāna*), in which the mind flows continuously towards its object. The culmination of meditation is total absorption (*samādhi*) in the object of meditation.

Meditation is not ordinary concentration; it is the highest form of spiritual concentration. Concentration becomes spiritual when it is conscious, active, and focused on one single spiritual object, within oneself or outside oneself. In this concentration, the whole attention, physical and mental, the nervous system and the unconscious mind, is mobilized and focused on the chosen object. When the mental focus is not conscious and deliberate, it is considered a lower type of concentration. This occurs when people watch a movie or listen to a song, or when they are aroused by anger or greed. Such sub-conscious, lower concentration dissipates psychic energy to a great extent. If physical work and exercise involve the use of physical energy, then worry, anxiety, and mental restlessness deplete psychic energy. Further, subconscious concentration on diverse subjects creates scattered channels of energy that are not regular and straight. Such haphazard concentration creates endless whirlpools in the mind and body. Meditation restores

this energy balance. It counteracts the effects the effects of wrong concentration, whether conscious or subconscious.

There are three components of every form of worship: the object of worship, the act of worship, and the worshipper. In the beginning, the three are distinct from one another, but in the end, the three merge into one. This unitary state of absorption in the object of worship is the goal of all meditation. In the state of *samādhi*, truth is revealed in its pristine purity.

The depth of the seeker's inner absorption is measured by the intensity of three kinds of spontaneous transcendence. First, when he loses himself in the state of inner absorption, he transcends the idea of time and therefore, becomes oblivious of the lapse of time. Second, he transcends the idea of place and is not aware of the surrounding environment. And third, he completely transcends his I-consciousness and all thoughts about himself. The mind in the state of absorption is compared to an empty stage from which all the actors have exited, but where the lights still shine on the empty stage. In the state of absorption, the seeker witnesses the true light of the Self, pure and blissful.

Meditation may be objective or subjective. In objective meditation, the object or ideal is thought to be outside the body. Objective meditation may be associated with, or conditioned by, a sound symbol or a form symbol. In objective meditation associated with a sound symbol, the seeker repeats a sacred word indicative of the all-pervading nature of *Brahman*. As he repeats the sacred word, he meditates on its meaning. In objective meditation associated with a form

symbol, the seeker meditates on some external form or object signifying Infinite *Brahman*. He first concentrates on a form symbol and then gradually takes his mind away from the form of the symbol and concentrates it on Brahman, which the symbol represents. He tries to see *Brahman* through the symbol as one sees the ocean in and through the waves or the forest in and through the trees. Objective meditation has two states of absorption, as mentioned earlier: *savikalpa samādhi* and *nirvikalpa samādhi*. In the *savikalpa* state, the seeker remains conscious of the object of meditation, while in the *nirvikalpa* state, he becomes one with it.

In subjective meditation, according to *Advaita Vedānta*, the ideal or form is placed within the meditator, usually in the region of the heart. The beginner thinks of the heart as a physical organ shaped like a lotus bud. Inside this bud is luminous space described by the *Vedānta* texts as the abode of *Brahman*. As the seeker progresses in meditation, he begins to feel that his heart is not just a physical organ but a part of his mind where the reflection of *Brahman* is perceived. At this stage, meditation is raised from the physical level to the mental level. Then the seeker casts *Brahman* in the mold of his mind, forming a mental image of it. At the final stage, this image in his heart becomes one with *Brahman*, the all-pervading Pure Consciousness.

As in the objective meditation, so in the subjective meditation, the ideal may be associated with, or conditioned by, a sound or form symbol. When it is

associated with a sound symbol, the seeker repeats a sacred word indicative of *Brahman*. While repeating the sacred word, he meditates on its meaning, concentrating on the sound of the repetition. The sound gradually becomes dissolved into silence. In subjective meditation associated with a form symbol, the seeker observes as a witness the various thought-waves that arise in his mind, and his mind gradually becomes absorbed in its role as witness.

Three factors, which will be dealt with in turn in the next three sections of this thesis, are (1) the object of concentration in meditation; (2) the center of consciousness where the mind is held during meditation; and (3) the method employed to invoke concentration.

The sacred texts of *Yoga* and *Vedānta* maintain that the ideal or object of meditation must not be changed. Practice of meditation using more than one method is fraught with danger. Meditation has two aspects: meditation as the root and meditation as the fruit.

Many people think that meditation is a process of passive reflection or just letting things happen, but actually it is a conscious process of guiding the mind by oneself. In meditation it is the alertness of the mind that matters most, not the length of time devoted to meditation. Meditation becomes counterproductive when separated from its spiritual goal or practiced in an unorthodox way or without moral and ethical preparation. It is dangerous for an impure mind to practice concentration because it brings about a severe backlash in the form of falling into the depths of the subconscious.

2.1.2 AIMS AND OBJECTIVES

The present review was conducted to:

- Compile authentic information on cyclic meditation from classical Yogic and Spiritual literature.
- Explore the concept of *laya* (Stupor), *Sambodhana* (awaken), *Vikṣipta* (agitations) and *Samatva* (equilibrium) from different classical & Yogic texts.
- Define and present concept of cyclic meditation technique.
- Study the five altered states of mind (Five *Citta Bhūmis*).

2.1.3 MATERIALS AND METHODS

2.1.3. A - Source material

The study has reviewed many scriptures especially Vedic sources and Classical Yogic Texts including:

- I. Vedic sources - Upaniṣads: (i) Īśāvāsyā Upaniṣat (ii) Kena Upaniṣat (iii) Kaṭha Upaniṣat (iv) Muṇḍaka Upaniṣat (v) Māṇḍūkya Upaniṣat (vi) Aitareya Upaniṣat (vii) Taittirīya Upaniṣat (viii) Praśna Upaniṣat (ix) Chāndogya Upaniṣat (x) Bṛhadāraṇyaka Upaniṣat (xi) Śvetāśvatara Upaniṣat.
- II. Yogic texts: Classical yoga texts: (i) Patañjali yoga sūtras, Vyāsa bhaṣya and Yoga Vartika on Patañjali yoga sūtras (ii) Bhagavad gītā, (iii) Haṭha yoga pradīpikā, (iv) Gheraṇḍa saṁhītā and (v) Śiva saṁhītā.
- III. Other Texts: (i) Atmabodha, (ii) Vivekacūḍāmaṇi, (iii) Tattvabodha, (iv) Yogavāsiṣṭha and (v) Prakaraṇa Granthas

2.1.3. B - Methods

The verses, explaining the mind and its facets as well as states of minds, were collected and compiled in systematic way; especially relevant to the present study i.e., Cyclic meditation and its components, different aspects of cyclic meditation, from the above mentioned sources were systematically complied.

2.1.4 CHARACTERISTICS AND ASPECTS OF MIND IN YOGIC TEXTS

2.1.4.A States of mind:

It is very essential to be aware of the stages of the mind, both in the moment and throughout the day, at which one is functioning. It reveals the depth of practice that one might be able to currently practice. Some aspects of yoga meditation apply to every human being, though we need to be mindful of which is most fitting and effective for a person with this or that state of mind.

At the beginning of *Patañjali Yoga Sūtras*, sage *Vyāsa muni* explains in his commentary that there are five states of mind and Yoga is the nature of the mind which is common in all these five states.

योगः समाधिः स च सार्वभौमः चित्तस्य धर्मः । क्षिप्तं मूढं विक्षिप्तम् एकाग्रं निरुद्धम् इति

चित्तभूमयः । तत्र विक्षिप्ते चेतसि विक्षेपोपसर्जनीभूतः समाधि योगपक्षे वर्तते । यस्तु एकाग्रे चेतसि

सद् भूतमर्थं प्रद्योतयति क्षिणोति च क्लेशान् कर्मबन्धनानि श्लथयति निरोधमभिमुखं करोति स

सम्प्रज्ञातो योग इति आख्यातते । (पतञ्जलियोगसूत्रम् .(योगवार्तिकम्), सूत्रम् -१ ॥ १)

Yogaḥ samādhiḥ sa ca sārvaabhaumaḥ cittasya dharmah | Kṣiptam mūḍham

vikṣiptam ekāgram nirudham iti cittabhūmayah | Tatra vikṣipte cetasi

vikṣepopasarjanībhūtaḥ samādhi yogapakṣe varttate | Yastu ekāgre cetasi sad

bhūtamartham pradyotayati kṣiṇoti ca kleśān karmabandhanāni ślathayati

nirodhamabhimukhaṃ karoti sa samprajñāto yoga iti ākhyātaḥ

(Patañjaliyogasūtram – Yogavārtikam, Sūtram -1.1)

Yoga is *samādhi*; and that is a quality of the mind which belongs to all (its) stages. The stages of the mind are *kṣiptam* (the restless), *mūḍham* (the infatuated), *vikṣiptam* (the distracted), *ekāgram* (the one-pointed) and *nirodhama* (the restricted). Of these, in the distracted state of mind the ‘*samādhi*,’ being subordinated by distractions, cannot be included in yoga. In the one-pointed mind, when there is illumination of the object as it really is, when there is weakening of the afflictions, when there is loosening of the bonds of *karma*, and when its goal is the restriction (of all modifications of the mind) that is known as ‘*samprajñāta yoga*’.

Five states of mind: *Vyāsa muni* names five states of mind, of which the one-pointed (*ekāgra*) (1.32) state of mind is the desired state of mind for the practice of Yoga. These five states of mind range from the severely troubled mind to the completely mastered mind.

1. *Kṣipta* - disturbed
2. *Mūḍha*- dull
3. *Vikṣipta* - distracted

4. *Ekāgra* - one-pointed

5. *Nirodhaḥ* - mastered

Of the five states of mind (described below in more detail), the latter two (one-pointed and mastered) are most desirable for the deeper practice of yoga meditation. For most people, our minds are usually in one of the first three states (disturbed, dull, or distracted). To deal with the troubled mind and the lethargic mind is progress, leading one to a merely distracted mind, from where one can more easily work on training the mind in one-pointedness.

1. *Kṣipta* (disturbed): The *kṣipta* mind is disturbed, restless, troubled, wandering. This is the least desirable of the states of mind, in which the mind is troubled. It might be severely disturbed, moderately disturbed, or mildly disturbed. It might be worried, troubled, or chaotic. It is not merely the distracted mind (*Vikṣipta*), but has the additional feature of a more intense, negative, emotional involvement.

2. *Mūḍha* (dull): The *mūḍha* mind is stupefied, dull, heavy, and forgetful. With this state of mind, there is less of a running here and there of the thought process. It is a dull or sleepy state, somewhat like ones experiences when depressed, though we are not here intending to mean only clinical depression. It is that heavy frame of mind we can get into, when we want to do nothing, to be lethargic, to be a couch potato.

The *Mūḍha* mind is barely beyond the *Kṣipta*, disturbed mind, only in that the active disturbance has settled down, and the mind might be somewhat more easily trained from this place. Gradually the mind can be taught to be a little bit steady in a positive way, only occasionally distracted, which is the *Vikṣipta* state. Then the mind can move on in training to the *Ekāgra* and *Nirodhaḥ* states.

3. *Vikṣipta* (distracted): The *Vikṣipta* mind is distracted, occasionally steady or focused. This is the state of mind often reported by students of meditation when they are wide awake and alert, neither noticeably disturbed nor dull and lethargic. Yet, in this state of mind, one's attention is easily drawn here and there. This is the *monkey mind* or *noisy mind* that people often talk about as disturbing meditation. The mind can concentrate for short periods of time, and is then distracted into some attraction or aversion. Then, the mind is brought back, only to again be distracted.

The *Vikṣipta* mind in daily life can concentrate on this or that project, though it might wander here and there, or be pulled off course by some other person or outside influence, or by a rising memory. This *Vikṣipta* mind is the stance one wants to attain through the foundation yoga practices, so that one can then pursue the one-pointedness of *Ekāgra*, and the mastery that comes with the state of *Nirodhaḥ*.

4. *Ekāgra* (one-pointed): The *Ekāgra* mind is one-pointed, focused, and concentrated (*Yoga Sūtras* 1.32). When the mind has attained the ability to be one-pointed, the real practice of Yoga meditation begins. It means that one can focus on tasks at hand in daily life, practicing *karma* yoga, the yoga of action, by being mindful of the mental process and consciously serving others. When the mind is one-pointed, other internal and external activities are simply not a distraction.

The ability to focus attention is a primary skill for meditation and *samādhi*.

The person with a one-pointed mind just carries on with the matters at hand, undisturbed, unaffected, and uninvolved with those other stimuli. It is important to note that this is meant in a positive way, not the negative way of not attending to other people or other internal priorities. The one-pointed mind is fully present in the moment and able to attend to people, thoughts, and emotions at will. The one-pointed mind is able to do the practices of concentration and meditation, leading one onward towards *samādhi*. This ability to focus attention is a primary skill that the student wants to develop for meditation and *samādhi*.

5. *Nirodhaḥ* (mastered): The *Nirodhaḥ* mind is highly mastered, controlled, regulated, restrained (*Yoga Sūtras* 1.2). It is very difficult for one to capture the meaning of the *Nirodhaḥ* state of mind by reading written descriptions. The real understanding of this state of mind comes only through practices of meditation and

contemplation. When the word *Nirodhaḥ* is translated as controlled, regulated, or restrained, it can easily be misunderstood to mean suppression of thoughts and emotions.

By knowing this, we can deal with our minds so as to gradually stabilize the mind in the *fourth* state, the state of one-pointedness (Note that this use of the phrase fourth state is different from that used in relation to the fourth state of *turīya*). This is the state of mind which prepares us for the fifth state, in which there is mastery of mind. (The first two states might also be dominant or intense enough that they manifest as what psychologists call mental illness.) Knowing where your mind is now tells you how to get where you're going. Anticipating (the question as to what those fields of the mind are, he says-“*Kṣiptam*” etc. When the mind is active in the objects alone, through the quality of activity (rajas) it is ‘*kṣiptam*’: it is deluded (*mūḍha*) when, through the quality of inertia (*tamas*) it is engaged in sleep, etc.; the distracted (*vikṣipta*) is better than ‘*kṣipta*’; (but) though, (in this state), there is concentration, because of a preponderance of the quality of brightness (*sattva*) the mind, because of rajas alone is active, in the objects, in between; that lamp like mind which has its flame-tip in one object alone, is one-pointed (*ekāgra*); because of pure- *sattva* (the mind) can stay steadily for a decided length of time, which will be mentioned later, in one object alone, like a lamp placed in a windless place. Therefore, even though there is some one-pointedness

in the three (states of) *kṣipta*, etc. it (the definition of *samādhi*) does not pervade there (in *kṣipta* etc.)

Nirodhaḥ is that (state) which has all the activities restricted; it means that there is only the residue of subliminal impressions (in this state). It is only by assailing attachment, which is the qualities of rajas, that men face pain, etc. while in *tamas*; (in order to indicate this), there is no mention of *mūḍha* before *kṣipta*.

In order to bring out the said over-pervasive (*Vyāsa*) divides the said fields of the mind (into) examples and counter-examples)- “*tatra vikṣipte*” etc. “*tatra*”=amongst those five (states), the concentration present in the *vikṣipta* state of mind is little and since it has much *vikṣepa* in it, it cannot be included, “*na yogapakṣe*” under the heading of yoga, as it is not the cause for removing afflictions; and in no way will the concentration and practice existing in the states of *kṣipta* and *mūḍha* (be counted as yoga); this is the idea. Therefore, there is no defect in not mentioning the *kṣipta* and *mūḍha* states as counter-examples.

Having mentioned the first three fields (*kṣipta*, *mūḍha* and *vikṣipta*) as counter –examples through (the mention of) *vikṣipta*, he says that only the last two (*ekāgra* and *nirodhaḥ*) are examples by “*yastu ekāgre*” etc. “*yastu*” that concentration, “*ekāgre cetasi*” = existing in the one-pointed mind, “*prakarsena*

dyotayati”=brings face to face “*artham*” =the object of concentration, “*sadbhūtam*”= as it exists truly, and, as a result, “*kṣiṇoti*”= destroys the five afflictions beginning with *avidyā*. Then, by the removal of the cause (of bondage) “*karma bandhanāni*”=the binding causes of the intellect and the *puruṣa*, in the form of merit (*dharma*) and demerit (*adharma*) “*ślathayati*” = are made incapable of producing ‘*dharma*, and ‘*adharma*’ (*adṛṣṭā*) and it also “*nirodhamabhimukham karoti*”=brings (one) near to concentration not-conscious – of an – object (*asamprajñāta* yoga); by giving rise to extreme detachment, this should be added.

(*Yoga Vārtikam Sūtram 1*)

2.1.4.B Facets of mind:

Tattvabodha defines the *Antaḥkaraṇa* or the inner organ now:

संकल्पविकल्पात्मकं मनः । निश्चयात्मिका बुद्धिः । अहंकर्ता अहंकारः । चिन्तनकर्तृ चित्तम् । मनसो देवता चन्द्रमाः । बुद्धेः ब्रह्मा । अहंकारस्य रुद्रः । चित्तस्य वासुदेवः ॥३५॥१॥

Saṅkalpavikalpātmakam manaḥ. Niścayātmikā buddhiḥ. Ahaṅkartā ahaṅkāraḥ. Cintanakartṛ cittam. Manaso devatā candramāḥ. Buddheḥ brahmā. Ahaṅkārasya Rudraḥ. Cittasya vāsudevaḥ. 35.1.

Manah the mind is *saṅkalpa vikālpātmakam* that which wavers, *buddhiḥ* the intellect is *niścayātmikā* decisive, *ahaṅkāraḥ* the ego *ahaṅkartā* is the creator of the sense of I, *cittam* the memory *cintanakartā* is that which makes us cogitate, *manaso* of the mind *devatā* the deity is *candramāḥ* the moon, *buddheḥ* of the intellect (it is) *brahmā Brahmā*, *ahaṅkārasya* of the ego *rudraḥ Rudra*; *cittasya* of the memory *vāsudevaḥ Vāsudeva*.

The mind is that which wavers, the intellect is the decisive faculty; the ego is the creator of the sense of “I”, the memory is that which makes us cogitate. The deity of the mind is the moon; that of the intellect is *Brahmā*; that of the ego is *Rudra*; and that of the memory is *Vāsudeva*.

What is meant by this *Manas, Buddhi, Citta, Ahaṅkāra*? *Citta* is the mindstuff a part of the *mahat* it is the generic name for the mind itself, including all its various states.

‘Suppose on a summer evening, there is a lake, smooth and calm, without a ripple on its surface. And suppose someone throws a stone into this lake. What happens? First there is the action, the blow given to the water; next the water rises and sends a reaction towards the stone, and that reaction takes the form of a wave. First the water vibrates a little, and immediately sends back a reaction in the form of a wave. The *Citta* let us compare to this lake, and the external objects are like

the stones thrown into it. As soon as it comes in contact with any external object by means of these *Indriyas* - the *Indriyas* must be there to carry these external objects inside there is a vibration, what is called *Manas*, indecisive.

“Next there is a reaction, the determinative faculty, *Buddhi*, and along with this *Buddhi* flashes the idea of *Aham* and the external object. Suppose there is a mosquito sitting upon my hand. This sensation is carried to my *Citta* and it vibrates a little; this is the psychological *Manas*. Then there is a reaction, and immediately comes the idea that I have a mosquito on my hand and that I shall have to drive it off. Thus, these stones are thrown into the lake, but in the case of the lake every blow that comes to it is from the external world, while in the case of the lake of the mind, the blow may either come from the external world or the internal world. This whole series is what is called the *Antahkaraṇa*.

Vivekacūḍāmaṇi also explains very clearly about the mind and its work with full of examples:

निगद्यतेऽन्तः करणं मनोधीरहं कृतिश्चित्तमिति स्ववृत्तिभिः ।

मनस्तु संकल्पविकल्पनादिभिः बुद्धिः पदार्थाध्यवसायधर्मतः ॥९५ ॥

अत्राभिमानादहमित्यहंकृतिः स्वार्थानुसंधानगुणेन चित्तम् ॥९६ ॥

Nigadyate'ntaḥkaraṇaṁ manodhī. rāhaṁ kṛtiscittamiti svavṛttibhiḥ.

Manastu saṅkalpavikalpanādibhiḥ buddhiḥ padārthāndhyavasāyadharmataḥ. 95.

Atrābhimānādahamityahaṅkṛtiḥ svārthānusandhānaguṇena cittaṁ. 96.

The inner organ (*Antaḥkaraṇa*) is called *Manas*, *Buddhi*, *Ahaṅkāra* or *Citta*, according to their respective functions: *Manas*, from its considering the pros and cons of a thing; *Buddhi*, from its property of determining the truth of objects; the *Ahaṅkāra* (ego), from its identification with this body as one's own self; and *Citta*, from its function of remembering things it is interested in.

2.1.4.C - Obstacles of mind in Meditation:

For those practicing meditation, *Vedānta* teaches about four great obstacles:

1. *Laya*
2. *Vikṣepa*
3. *Kaṣāya*

1. *Laya*

The first of them is torpidity, which is lapsing into a state of sleep called *laya*. *Laya* is a kind of stagnation, under the influence of which the aspirant feels disinclined to make fresh efforts. It is a kind of mental sleep generated by a condition of

inertia in the system it is to be overcome by vigorous practices of concentration and self-exertion, and by moderation in the ways of living. The *Jivan-Mukti-Viveka* says:

Incomplete sleep, indigestion, overeating, and physical exertion are the causes of inactivity (*laya*)..... He should eat easily digestible food sparingly, avoiding labour, desireless and without exertion should always sit in a place which is solitary and free from disturbances; or he should control the vital breath in the way he is accustomed to do.

2. *Vikṣepa*

The second obstacle is *vikṣepa*, a condition of the mind when it is troubled by old thoughts, old memories, and old tendencies. *Vikṣepa* can make an aspirant abandon spiritual practice or become irregular in it. The distractions caused by *vikṣepa* become intense when the aspirant summons his will to concentrate in a conscious way. When the good thoughts of the mind combine, the contrary thoughts also combine to give joint resistance. This reaction of the mind is mechanical. A worldly thought, when repeated, turns into a tendency. Tendencies, becoming ingrained, recur, following the old rut they created earlier. They do not go away of themselves. They cannot be uprooted by rational thinking. The aspirant needs patience and forbearance to overcome them, by developing countertendencies. The recurrence of the old tendencies only proves that a part of

the mind still entertains those tendencies and repeatedly pampers them. They need to be overcome slowly and gradually. A screw driven into a wall with thirty turns requires an opposite thirty turns to get it out. Repeated practice of concentration backed by thoughts of dispassion and discrimination is the only way to overcome this obstacle.

3. *Kaṣāya*

The third obstacle is called *kaṣāya*. The mind under this condition is suddenly seized by a violent attachment to a long-forgotten experience of sense enjoyment. The memory suddenly resurrects from the subconscious depths and agitates the aspirant like a gust of wind. The obstacle of *kaṣāya* is to be overcome by detachment and discrimination.

The obstacles are due to the resistance of the body and to bodily habits, to the mind and its deep-rooted *saṁskāras*, or tendencies, and to the intellect and its nondiscrimination between delusion guise, gross and subtle, and shift their gears from the physical level to the mental level and from the mental level to the spiritual level. The desirous of reaching the goal must prepare to face the obstacles and know the ways of overcoming them.

Obstacles in Meditation Enumerated by *Patañjali*:

According to the *Yoga Aphorisms* of *Patañjali*, the obstacles in meditation are,

1. Disease,
2. Mental inertia
3. Doubt
4. Delusion
5. Sloth
6. Craving for sense enjoyment
7. False perception
8. Failure in concentration
9. Falling away from concentration.

1. DISEASE

Sickness of the body is a great hindrance to the practice of meditation. It draws the mind again and again to the physical level and makes it difficult to move toward concentration. Good health is an indispensable necessity for the practice of meditation. The body and the mind are closely related to each other, so that sickness of the body makes the mind incapacitated to a great extent. There can be no concentration whatsoever so long as the body, because of its ill health, is unable to cooperate with the efforts of the aspirant.

2. MENTAL INERTIA

Mental inertia is due to the preponderance of *tamas*, or inertia of the mind. Under such circumstances, the mind is unwilling to stir. This is caused by the absence of any definite purpose of life and a lack of resolution of the mind.

3. DOUBT

Doubts of various kinds arise in the mind of the aspirant when there is no clearly defined goal for him to attain and no standard by which he can judge and measure his progress. Whenever the aspirant meets with an obstacle, he begins to doubt whether he is following the right method and whether his subject of meditation is proper. Doubts are caused by the impurities of the mind, which exert resistance from the subconscious level. The aspirant cannot avoid doubt in the early stages and must wrestle with it with positive resignation and discrimination until he has tasted the inner bliss of meditation to some extent. Doubts are of three kinds: about the certainty of the result, about the impossibility of the result, and contrary thoughts.

4. DELUSION

Delusion is a lack of reflection upon the means of attaining concentration. It is not doubt about the object of knowledge, but the aspirant may not be following the right means to attain the goal. The aspirant may overemphasize or oversimplify one or more steps toward meditation. He may be following the practice but ignoring the aspect of regularity. A dream experience may be taken as a spiritual

experience, a temporary thrill may be regarded as progress, and attachment may pass for duty. Delusion is overcome by loyalty to the prescribed rules of practice, to the teaching, and to reflection.

5. SLOTH

Under the influence of sloth, the mind is unable to stir, as distinguished from “unwilling” to stir, as in the case of mental laziness. Sloth is often due to some defect of the mind caused by an inadequate supply of energy. In order to overcome this condition of sloth, the aspirant is advised to summon his will, comply with the laws of good health, and persist in his will, comply with the laws of good health, and persist in his practice, no matter how uninteresting or mechanical such practice may be. Only the stern will of an ascetic can overcome sloth.

6. CRAVING FOR SENSE ENJOYMENT

Craving for sense enjoying arises in the mind of an aspirant practicing meditation. This is due to the resistance of the subconscious part of the mind. As the mind begins to rise to the upper level of consciousness, the drags of the subconscious begin to become more intense. Through meditation, holy thoughts are poured into the mind and go deep down into the subconscious level, and contrary thoughts that were lying in the core to the subconscious come to the surface. *Samskāras* of worldly desires cannot be rationalized, forgotten, or ignored. They must be neutralized by cultivating counter- *samskāras*.

7. FALSE PERCEPTION

An aspirant practicing meditation is often deluded by his own mind. He may take a thing for what it is not. He may take a temporary emotional thrill for a spiritual experience. He may imagine that he sees light or hears sounds during meditation because of his heightened thinking. He may get entangled in some spurious experiences of a psychic nature, lose sight of the goal, be sidetracked. The cause of such false perception is lack of discrimination and reflection. Success in meditation is not measured by dream experiences, emotional excitement, or psychic attainments. The aspirant must understand that a dream is a dream, not a reality, and that emotions rise and fall. A tangible attainment is to be measured in terms of transformation of character.

The suggested remedy for false perception is heightening of the spirit of dispassion and sharpening of discriminatory thinking. The aspirant must go forward and not be satisfied with taking something as everything. A true spiritual realization carries its own credentials. It silences doubt and strengthens faith. Any phenomenon that does not fulfill these two conditions must be taken as temporary and short-lived.

8. FAILURE IN CONCENTRATION

It has been found that in spite of right resolution and clear understanding of the goal, an aspirant fails to attain a particular level of concentration. This failure is due to hidden contrary tendencies and attachments of the subconscious mind

known as *samskāras*. *Samskāras* are the seeds of past indulgent living. They do not die of themselves. As an aspirant practices concentration and meditation, they begin to appear on the surface level and drag his mind down.

As a remedy, the aspirant must cultivate counter-*samskāras* by the regularly of meditation. The uninterrupted practice of meditation on one subject, consciously and regularly, helps develop a counter-*samskāras*. This counter - *samskāras* of a single thought-wave, through repeated practice over a long period, neutralizes all contrary *samskāras* of the mind

9. FALLING AWAY FROM CONCENTRATION

The aspirant practicing meditation may gain a certain level of concentration, but soon it may be lost. This may happen because of a lack of effort to advance further. In the journey toward the goal, if you do not proceed you will recede. It is necessary not merely to make a gain, but also to attain stability in that gain. The remedy for this obstacle is unrelenting effort and continuity of practice, however, unpleasant and distasteful that practice may be.

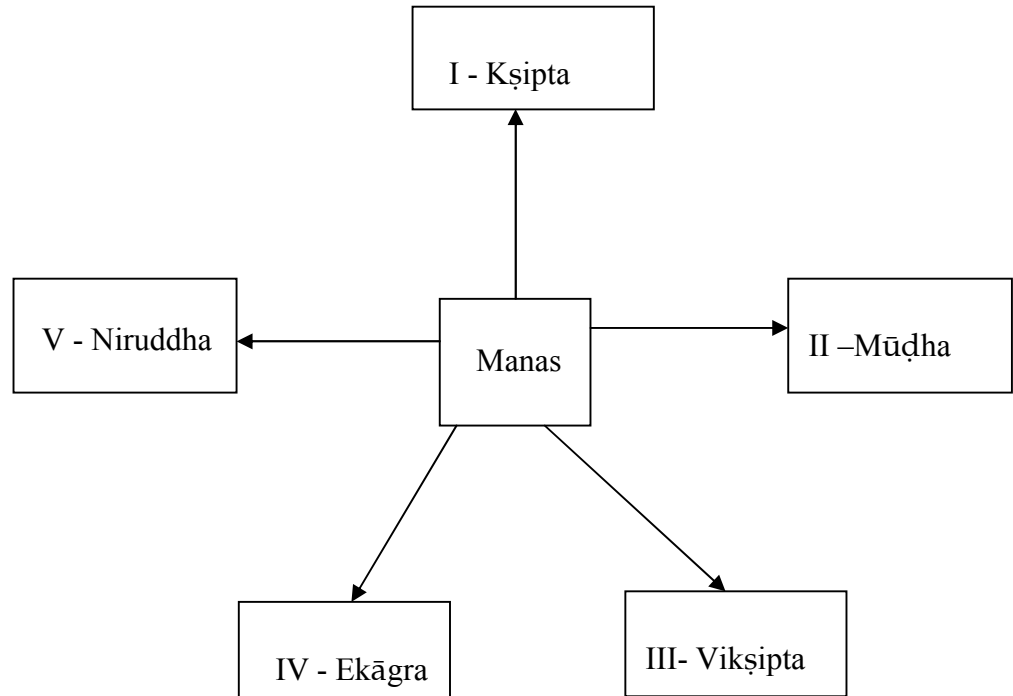
The nine obstacles explained by *Patañjali*, are of specific nature in regard to the practice of concentration, meditation, and *samādhi*. Besides these, there can be other obstacles, such as attachment to objects, persons, or ideas; especially related to the lack of mastery over the ground rules of *yama* and *niyama*.

The enumerated nine obstacles bring in their wake four disturbances:

1. Grief
2. Mental distress
3. Restlessness of the body
4. Irregular breathing.

Grief is that which upsets the mind. It may ensue either from disharmony of the physical condition or from inner conflict due to opposing desires. When grief is combined with the feeling of incapacity, attempting to remove grief leads to despair and despondency. The upsetting of the equilibrium, whether of the body or of the mind, results in restlessness within, and that restlessness is manifested in the disequilibrium of breathing.

Figure 1: Schematic of Stages of Mind



Mind will be wandering from one stage to another all the time until Yoga is achieved.

I – *Kṣipta*: a state where our mind is fluctuating all the time. Here Rajas is predominant supported by Tamas.

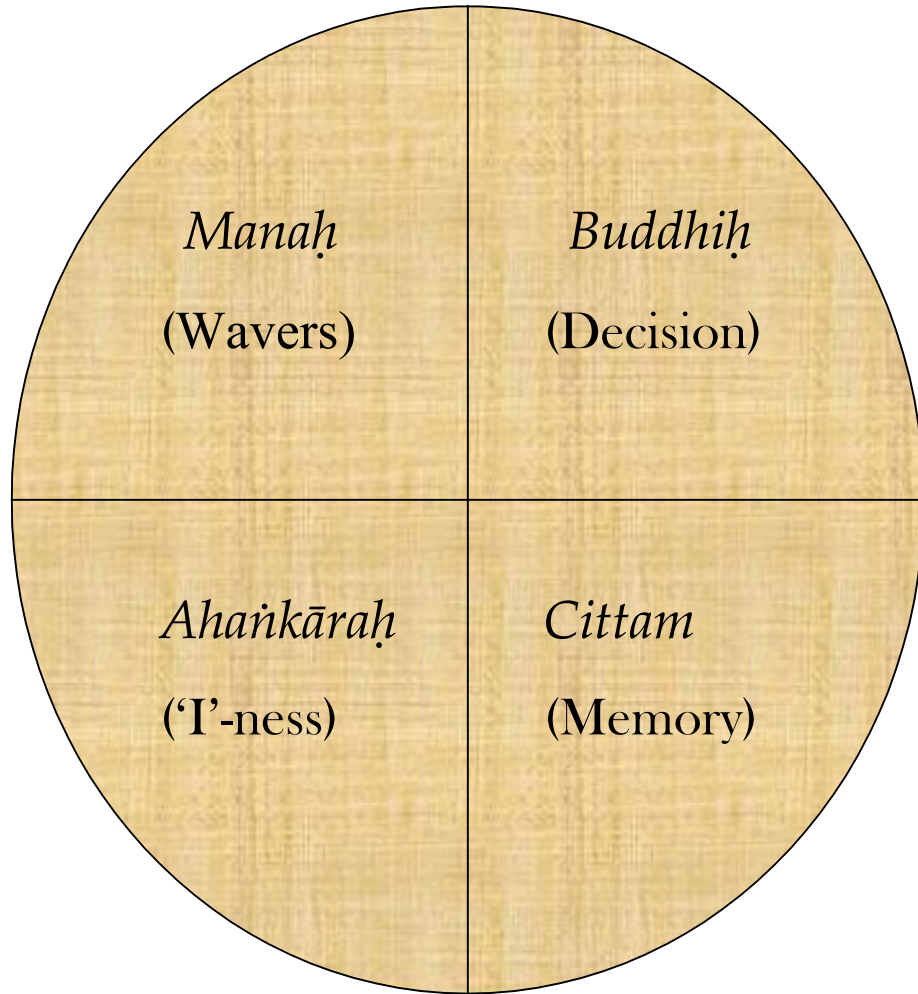
II – *Mūḍha*: a state where the mind is dormant probably in the sleep state. Here Tamas is predominant supported by Rajas.

III- *Vikṣipta*: a state where the mind is getting concentrated for fraction of seconds. Here Sattva is predominant supported by Rajas.

IV – *Ekāgra*: a state where the mind is totally concentrated with an object and there is only Sattva but other two *Guṇas* as in the seed form.

V – *Niruddha*: a state where the mind has stopped to produce any modification. No *Guṇas* are seen in this state.

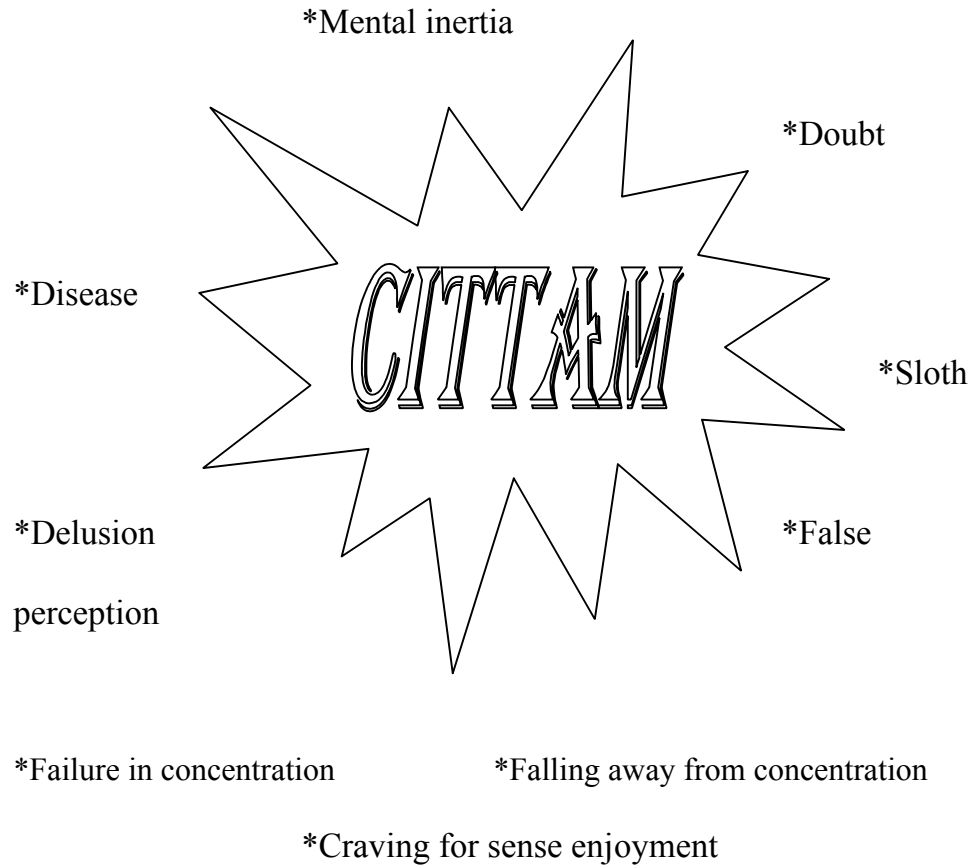
Figure 2: Facets of mind



Four faculties of *Antaḥkaraṇa* work together in any cognitive process -

- *Manah* the mind is *Saṅkalpa-Vikālpātmaḥ* that which wavers,
- *Buddhih* the intellect is *Niścayātmikā* decisive,
- *Ahaṅkāraḥ* the ego *Ahaṅkartā* is the creator of the sense of I,
- *Cittam* the memory *Cintanakartā* is that which makes us cogitate.

Figure 3: Obstacles of mind in Meditation:



According to the *Yoga Aphorisms of Patañjali*, the obstacles in meditation are:

1. Disease (*Vyādhīḥ*)
2. Mental inertia (*Styānam*)
3. Doubt (*Samśayaḥ*)
4. Delusion (*Pramādaḥ*)

5. Sloth (*Alasyam*)
6. Craving for sense enjoyment (*Avirathi*)
7. False perception (*Bhrāntidarśanam*)
8. Failure in concentration (*Alabdhabhūmikātvam*)
9. Falling away from concentration (*Anāvasthitātvam*).

2.1.5 CONCEPT OF CYCLIC MEDITATION – LAYA, SAMBODHANA, VIKṢIPTA AND SAMATVA

2.1.5. A - Core concept

Cyclic meditation is based on a concept that a combination of both ‘calming’ and ‘stimulating’ measures help in reaching a state of mental equilibrium. It is derived from a statement in Sage *Gauḍapāda’s Māṇḍūkya Upaniṣat Kārikā*:

लये सम्बोधयेत् चित्तं विक्षिप्तं शमयेत् पुनः ।

सकषायं विजानीयात् समप्राप्तं न चालयेत् ॥३.४४ ॥

Laye sambodhayet cittam vikṣiptam śamayet punaḥ,

Sakaṣāyam vijñānīyāt samaprāptam na cālayet. 3.44

‘In a state of mental inactivity awaken the mind; when agitated, calm it; between these two states realize the possible abilities of the mind. If the mind has reached the state of perfect equilibrium then do not disturb it again’

(Māṇḍūkya Upaniṣat Kārikā: 3.44)

For the most persons the mental states while doing routine activities (not necessarily associated with yoga) is neither ‘inactive’ nor ‘excited’, but is somewhere between these extremes and hence a combination of ‘awakening and calming’ measures may be better suited to reach a balanced, relaxed state. The foregoing idea drawn from the traditional texts is the basis for this *yoga* practice called ‘*Cyclic Meditation*’.

Cyclic meditation has a very strong scriptural background. This particular chapter of this work deals with the concept of *Vikṣipta*, *Laya*, *Sambodhana* and *Samatva* i.e., on which the whole concept of CM is based on. Starting from Vedic sources till *Purāṇas* are scriptures looked into for conceptualizing the technique of Cyclic Meditation.

2.1.5. B – *Vikṣiptam (Excitement)*

Māṇḍūkya Kārikā

यदा न लीयते चित्तं न च विक्षिप्यते पुनः ।

अनिङ्गनमनाभासं निष्पन्नं ब्रह्म तत्तदा ॥३॥४६॥

Yadā na līyate cittam na ca vikṣipyate punaḥ.,

Aniṅganamanābhāsaṁ niṣpannam brahma tattadā. 3.46

Stripped off its states of trance and its state of desire-agitations, that is to say, when the mind becomes quiet and does no more raise apparitions of thoughts, then it verily becomes *Brahman*.

Bhagavad Gītā:

चञ्चलं हि मनः कृष्ण प्रमाथि बलवद् दृढम् ।

तस्याहं निग्रहं मन्ये वायोरिव सुदुष्करम् ॥ गीताः ॥ ६.३४ ॥

Cañcalaṁ hi manaḥ kṛṣṇa pramāthi balavad dṛḍham,

Tasyāhaṁ nigrahaṁ manye vāyoriva suduṣkaram. Gītā. 6.34

Arjuna said:

“O *Kṛṣṇa*! Verily, the mind is fickle, turbulent, powerful and unyielding.

To control it, I think, is as difficult as controlling the wind itself.”

Yogavāsīṣṭham

न हि चञ्चलताहीनं मनः क्वचन दृश्यते ॥७॥३३॥

चञ्चलत्वं मनोधर्मो वह्नेः धर्मो यथोष्णता ।

Na hi cañcalatāhīnaṁ manaḥ kvacana dṛśyate. 7.31

Cañcalatvaṁ manodharma vahneḥ dharmo yathošṇatā.

Devoid of movement, the mind is not perceived anywhere indeed. Movement is the nature of the mind as heat is the characteristic of fire.

संसारख्ये महारण्ये प्रभ्रमन्ति मनांसि हि ॥६॥३३॥

Saṁsārākhye mahāraṇye prabhramanti manānsi hi.6.33

In this great forest of wordly existence, minds indeed wander about.

क्वचित् क्वचित् कदाचिच्च तस्मात् उद्यन्ति शक्तयः ।

देशकालादिवैचित्र्यात् क्षमातलादिव शालयः ॥६॥४४॥

Kvacit kvacit kadācicca tasmāt udyanti śaktayaḥ.

Deśakālādivaicitryāt kṣmātalādiva śālayaḥ. 6.44

In one place and in another and at some time or other, energies rise from it like rice (rising) from the surface of the earth, by the diversity of place, time and the like.

Viveka Cūḍāmaṇi

एषाऽऽवृतिर्नाम तमोगुणस्य शक्तिर्यया वस्त्ववभासतेऽन्यथा ।

सैषा निदानं पुरुषस्य संसृतेः विक्लेषशक्तेः प्रसरस्य हेतुः ॥११५ ॥

Eṣā''vṛatirnāma tamoguṇasya śaktiryayā vastvavabhāsate'nyathā.

Saiṣā nidānaṁ puruṣasya saṁsṛteḥ vikṣepaśakteḥ prasarasya hetuḥ. 115

The veiling power belongs to tamas. It makes for the wrong projection of objects differently (from what they are). It is the root cause of the functioning of the projecting power and is the original cause for the procession of samsāra (man's transmigration).

पञ्चेन्द्रियैः पञ्चभिरेव होतृभिः प्रचीयमानो विषयाज्यधारया ।

जाज्वल्यमानो बहुवासनेन्धनैः मनोमयोऽग्निः दहति प्रपञ्चम् ॥१७० ॥

Pañcendriyaiḥ pañcabhireva hotṛbhiḥ pracīyamāno viṣayājyadhārayā.

Jājvalyamāno bahuvāsanendhanaiḥ manomayo'gniḥ dahati prapañcam. 170

The *manomaya kośa* is the sacrificial fire. The five organs are the sacrificing priests. They pour into the fire the oblations of the sense-objects. The various *vāsanās* are the fuel. With these the *manomaya kośa* burns out the world.

विषयाभिमुखं दृष्ट्वा विद्वांसमपि विस्मृतिः ।

विक्षेपयति धीदोषैः योषा जारमिव प्रियम् ॥३२४ ॥

Viṣayābhimukhaṁ dr̥ṣṭvā vidvāṁsamapi vismṛtiḥ.

Vikṣepayati dhīdoṣaiḥ yoṣā jāramiva priyam.324

Finding him inclined to sense-objects, forgetfulness confounds even a learned man through defects of the intellect like a damsel distracting a paramour.

2.1.5. C – Laya (Stupor)

Māṇḍūkya Kārikā

उपायेन निगृह्णीयाद्विक्षिप्तं कामभोगयोः ।

सुप्रसन्नं लये चैव यथा कामो लयस्तथा ॥३ ॥४२ ॥

Upāyena nigṛhṇīyādvikṣiptaṁ kāmabhogayoḥ.

Suprasannaṁ laye caiva yathā kāmo layastathā. 3.42

A mind distracted with desires and enjoyments as well as mind enjoying the pleasure of “complete oblivion” (Laya) should be brought under perfect discipline by awakening it through proper channels. For, the “state of trance” or “oblivion” (Laya) is as harmful as agitations of desires.

Yogavāsishṭham

जगत् तस्यां अवस्थायां अन्धे तमसि लीयते ।

सप्तावस्था इति प्रोक्ताः मयाऽज्ञानस्य राघव ॥७ ॥५९ ॥

एकैका शतशाखाऽत्र नानाविभवरूपिणी ।

Jagat tasyāṁ avasthāyāṁ andhe tamasi līyate.

Saptāvasthā iti proktāḥ mayā'jñānasya rāghava. 7.59

Ekaikā śataśākhā'tra nānāvibhavarūpiṇī.

In that state (of deep sleep) the world is dissolved in utter darkness. *Rāghava! (Rāma!)*, The seven states of spiritual ignorance have thus been told by me. Each one of them is hundred-branched in this respect, appearing like various powers.

तस्मात् वासनया बद्धं मुक्तं निर्वासनं मनः ।

सम्यगालोकनात् सत्यात् वासना प्रविलीयते ॥९ ॥३१ ॥

Tasmāt vāsanayā bāddhaṁ muktaṁ nirvāsanam manaḥ.

Samyagālokanāt satyāt vāsanā pravilīyate. 9.31

Therefore, the mind is bound by mental impressions and set free by the absence of mental impressions. Mental impression melts away by proper perception and by (meditation on) Truth.

वासनाविलये चेतः शाम्यत्यस्त्रेहदीपवत् ।

अस्य संसारदुःखस्य सर्वोपद्रवकारिणः ॥९॥३२॥

उपाय एक एवास्ति मनसः स्वस्य निग्रहः ।

Vāsanāvīlaye cetaḥ śāmyatyasnehadīpavat.

Asya saṁsāraduḥkhasya sarvopadravakāriṇaḥ. 9.32

Upāya eka evāsti manasaḥ svasya nigrahaḥ.

On the dissolution of mental impressions, the mind is extinguished like a lamp without oil. There is only one remedy for the pain of this worldly existence which causes all trouble. That is, the restraint of one's own mind.

Viveka Cūḍāmaṇi

विलक्षणं यथा ध्वान्तं लीयते भानुतेजसि ।

तथैव सकलं दृश्यं ब्रह्मणि प्रविलीयते ॥५६५॥

Vilakṣaṇaṁ yathā dhvāntaṁ līyate bhānutejasi.

Tathaiva sakalaṁ dṛśyaṁ brahmaṇi pravilīyate. 565

As darkness which is distinct (from sunshine) vanishes in the lustre of the sun, similarly all that is perceptible merges in *Brahman*.

2.1.5. D – Sambodhana (Awaken)

Here is the mantra from *Kathopaniṣat* which is a sort of *sambodhana*, encouraging anyone who is affected by the ignorance. Ignorance represents *Tamo-guṇa*, which is a genus of *Laya* in:

उत्तिष्ठत जाग्रत प्राप्य वरान् निबोधत ।

क्षुरस्य धारा निशिता दुरत्यया दुर्गं पथस्तत् कवयो वदन्ति ॥१॥३॥१४॥

Uttiṣṭhata jāgrata prāpya varān nibodhata.

Kṣurasya dhārā niśitā duratyayā durgam pathastat kavayo vadanti. 3.14

(Kaṭhopeniṣat 3.14).

Arise, awake, (O man)! Realise (that Ātman) having approached the excellent (teachers). Like the sharp edge of a razor is that path, difficult to cross and hard to tread,-so say the wise.

Arise, O mortals, sleeping in ignorance without beginning and proceed to acquire knowledge of the self. Awake and put an end to the horrible slumber of ignorance, the seed of all evils.

एहेहीति तमाहुतयः सुवर्चसः सूर्यस्य रश्मिभिर्यजमानं वहन्ति ।

प्रियां वाचमभिवदन्त्योऽर्चयन्त्य एष वः पुण्यः सुकृतो ब्रह्मलोकः ॥१॥२॥६॥

Ehyehīti tamāhutayaḥ suvarcasāḥ sūryasya raśmibhiryajamānaḥ vahanti.

Priyāṁ vācamabhivadantyo'rcayantya eṣa vaḥ puṇyaḥ sukṛto brahmalokaḥ.1.2.6

(Muṇḍaka Upaniṣat 1.2.6)

Saying, ‘Come, come’ uttering pleasing words such as, ‘This is your well- earned, virtuous path which leads to heaven’, and offering him adoration, the scintillating oblations carry the sacrifice along the rays of the sun.

The *suvarcasah*, scintillating (oblations); welcoming (him) *ehi ehi iti*, with the words ‘Come, come’; and *abhi-vadantyaḥ*, uttering; *priyām vācam*, pleasant words, in the form of praise etc.; and *arcayantyaḥ*, adoring; *vahanti*, carry him, that is to say, they carry him while uttering such pleasant words as, ‘*Eṣaḥ*, this; is *vah*, your; *punyaḥ*, virtuous; *sukrtaḥ*, well-earned; road to *brahmalokaḥ*, heaven, which is your result.’ From the context it follows that *brahmaloka* (lit. the world of Brahma) means heaven.

This *karma*, unassociated with knowledge (*upāsanā*, meditation), is being decried by showing that it has only this limited result; that it is the product of ignorance, desire and action; and that it is for this reason unsubstantial and the source of misery.

Māṇḍūkya Kārikā

मनसो निग्रहायत्तमभयं सर्वयोगिनाम् ।

दुःखक्षयः प्रबोधश्चाप्यक्षया शान्तिरेव च ॥३॥४०॥

Manaso nigrāhāyattamabhayaṁ sarvayoginām.

Duḥkhakṣayaḥ prabodhaścāpyakṣayā śāntireva ca. 3.40

Yogīs who do not follow the Path of knowledge as declared in this *Kārikā* depend upon the control of their mind for fearlessness and destruction of misery, and also the knowledge of the Self and eternal peace.

उत्सेक उदधेर्यद्वत्कुशाग्रेणैकबिन्दुना ।

मनसो निग्रहस्तद्वद्भवेदपरिखेदतः ॥३॥४१॥

Utseka udadheryadvatkusāgreṇaikabindunā.

Manaso nigrahastadvadbhavedaparikhedataḥ. 3.41

The mind can be brought under control only by relentless effort like that which is required to empty the ocean drop by drop with the help of the front tip of a *Kuśā*-grass-blade.

Yogavāsiṣṭham

विबोधैकानुसन्धानात् चिदंशात्मतया मनः ॥७॥३२॥

चिदेकतां उपायाति दृढाभ्यासवशादिह ।

Vibodhaikānusandhānāt cidanśātmatayā manaḥ.7.32

Cidekatām upāyāti dṛḍhābhyāsavaśādiha.

The mind, because of its being of the nature of a part of consciousness (or pure intelligence) attains to the state of the one undivided consciousness by inquiry into (or reflection on) pure intelligence (or perception) and by the power of firm practice.

नाहं दुःखी न मे देहो देहादन्यः परोऽस्महम् ।

इति निश्चयवानन्तः क्षीणाविद्यो विमुच्यते ॥७॥३९॥

Nāham duḥkhī na me deho dehādanyaḥ paro'smham.

Iti niścayavānantah kṣīṇāvidyo vimucyate. 7.39

“I am not distressed. I have no (limitation of the) body. I am the Supreme Spirit different from the body.” One who has this firm conviction within, and whose spiritual ignorance has been destroyed, is liberated.

अज्ञस्यार्धप्रबुधस्य सर्वं ब्रह्मोति यो वदेत् ॥९॥४०॥

महानरकजालेषु स तेन विनियोजितः ॥

Ajñasyārdhaprabuddhasya sarvaṁ brahmeti yo vadet. 9.40

Mahānarakajāleṣu sa tena viniyojitaḥ.

Whoever tells one who is ignorant or half-awake that all is *Brahman* (the Supreme Spirit), he (the ignorant one) is disposed of to the great web of hell by him.

तेषां पदं महाबाहोऽनुगन्तव्यं हि सर्वदा ।

कोऽहं कथं इदं चेति प्रयत्नेन विचार्यताम् ॥१०॥७०॥

Teṣāṁ padam mahābāho'nugantavyam hi sarvadā.

Ko'ham katham idam ceti prayatnena vicāryatām. 10.70

Mighty-armed! (*Rāma!*) Their foot-steps must indeed be followed always.

“Who am I? How is this (visible universe born)?”. Thus, let it be investigated with effort.

Viveka Cūḍāmaṇi

विषयेभ्यः परावर्त्य स्थापनं स्वस्वगोलके ।

उभयेषामिन्द्रियाणां स दमः परिकीर्तितः ॥२३॥

Viṣayebhyaḥ parāvartya sthāpanam svasvagolake.

Ubhayeṣāmindriyāṇāṁ sa damaḥ parikīrtitaḥ. 23

The retention of both kinds of senses in their respective orbs withdrawing them from sense-objects is spoken of as *dama*.

सम्यगास्थापनं बुध्देः शुध्दे ब्रह्मणि सर्वदा ।

तत्समाधानमित्युक्तं न तु चित्तस्य लालनम् ॥२७॥

Samyagāsthāpanam budhdeḥ śudhde brahmaṇi sarvadā.

Tatsamādhānamityuktaṁ na tu cittasya lālanam. 27

The perfect establishment of the buddhi always in the pure (*nirguṇa*)

Brahman is said to be *samādhāna*, not the indulgence of the mind.

निद्राया लोकवार्तायाः शब्दादेरपि विस्मृतेः ।

क्वचिन्नावसरं दत्त्वा चिन्तयात्मानमात्मनि ॥२८७॥

Nidrāyā lokavārtāyāḥ śabdāderapi vismrteḥ.

Kvacinnāvasaraṁ dattvā cintayātmānamātmani. 287

Without giving any quarter to forgetfulness (of the *ātman*) arising from sleep, wordly talk and objects of (music) sound etc., meditate in your mind on the *ātman*.

2.1.5. E - *Śamanam*

Māṇḍūkya Kārikā

नाऽस्वादयेत्सुखं तत्र निःसङ्गः प्रज्ञया भवेत् ।

निश्चलं निश्चरच्चित्तमेकीकुर्यात्प्रयत्नतः ॥३॥४५॥

Nā'svādayetsukhaṁ tatra niḥsaṅgaḥ prajñayā bhavet.

Niścalaṁ niścaraścittamekīkuryātpṛayatnataḥ. 3.45

Mind should not be allowed to enjoy the Bliss that is eked out of the condition of *Samādhi*. It should be freed from attachment to such happiness through a steady exercise of discrimination. If the mind once having attained the state of equanimity, seeks to rush out into the external objects, then it should be unified with the Self again with self-effort.

Bhagavad-Gītā

शनैः शनैरुपरमेद् बुद्ध्या धृतिगृहीतया ।

आत्मसंस्थं मनः कृत्वा न किञ्चिदपि चिन्तयेत् ॥६॥२५॥

Śanaiḥ śanairupamed buddhyā dhṛtigṛhītayā.

Ātmasaṁsthaṁ manaḥ kṛtvā na kiñcidapi cintayet. 6:25

“Setting that mind firmly on the Self under the direction of a steadfast intellect, one should practise tranquility little by little and abstain from every kind of thought.”

यतो यतो निश्चरति मनश्चञ्चलमस्थिरम् ।

ततस्ततो नियम्यैतदात्मन्येव वशं नयेत् ॥६.२६ ॥

Yato yato niścarati manaścañcalamasthiram.

Tatastato niyamya itadātmanyeva vaśaṁ nayet. 6:26

“From whatsoever reason this wavering and fickle mind wanders away, it should be curbed and brought to abide in the Self alone.”

Yogavāsīṣṭham

स्वपौरुषैकसाध्येन स्वेप्सितत्यागरूपिणा ।

मनःप्रशममात्रेण वेना नास्ति शुभा गतिः ॥७ ॥२८ ॥

Svapauruṣaikasādhyena svepsitatyāgarūpiṇā.

Manaprasamamātreṇa venā nāsti śubhā gatiḥ. 7.28

There is no happy state without the one thing, namely, the tranquillity (or cessation) of the mind, which is to be accomplished only by one’s own effort and which is of the nature of renunciation of one’s desire.

मनः प्रशमने राम मोक्ष एवावशिष्यते ।

अत्र ते शृणु वक्ष्यामि वृत्तान्तमिममुत्तमम् ॥७ ॥२ ॥

Manah prasamane rāma mokṣa evāvaśiṣyate.

Atra te śṛṇu vakṣyāmi vṛattāntamimamuttamam. 7.2

Rāma! With the quenching of the mind, only liberation remains. In this matter, I shall tell you an excellent narrative. Hear this.

तथेदं जगदाभोगि मनोमननमात्रकम् ।

संयमात् मनसः शान्तिं एति संसारविभ्रमः ॥७ ॥२७ ॥

Tathedaṁ jagadābhogi manomananamātrakam.

Sanyamāt manasaḥ śāntiṁ eti saṁsāravibhramah. 7.27

Just as the state of being an outcaste (arose) in Lavana only due to the power of illusion, this experience of the world is a mere imagination of the mind. By the restraint of the mind, the delusion of wordly existence reaches alleviation.

अथवा सर्वकर्तृत्वं अकर्तृत्वं च राघव ॥१० ॥५८ ॥

सर्वं त्यक्त्वा मनः पीत्वा सत्तामात्रः स्थिरो भव ।

Athavā sarvakartṛtvaṁ akartṛtvaṁ ca rāghava. 10.58

Sarvaṁ tyaktoā manah pītvā sattāmātraḥ sthīro bhava.

Or else, Rāghava! abandoning all (conceptions such as), the state of an all-doer or a non-doer and drinking up (or absorbing) the mind, be firm (or steady) as mere existence (or Being).

मया तानि विवेकेन नीयन्ते परमं शमम् ।

कानिचित् मत्तिरस्कारात् नरकेषु पतन्त्यधः ॥६॥३४ ॥

Mayā tāni vivekena nīyante paramaṁ śamam.

Kānicit mattiraskārāt narakeṣu patantyaḍhaḥ. 6.34

They are led by me, by discrimination, to supreme tranquillity. Some, by disregarding me, fall down into hells.

Viveka Cūḍāmaṇi

सुषुप्तिकाले मनसि प्रलीने नैवास्ति किञ्चित् सकलप्रसिद्धेः ।

अतो मनःकल्पित एव पुंसः संसार एतस्य न वस्तुतोऽस्ति ॥१७३ ॥

Suṣuptikāle manasi pralīne naivāsti kiñcit sakalaprasiddheḥ.

Ato manaḥkalpita eva puṁsaḥ saṁsāra etasya na vastuto'sti. 173

It is well-known that there is nothing in dreamless sleep when the mind is stilled. Hence the *saṁsāra* is a creation of the mind. It does not exist in reality.

यथा यथा प्रत्यगवस्थितं मनः तथा तथा मुञ्चति बाह्यवासनाः ।

निःशेषमोक्षे सति वासनानां आत्मानुभूतिः प्रतिबन्धशून्या ॥२७७ ॥

Yathā yathā pratyagavasthitam manaḥ tathā tathā muñcati bāhyavāsanāḥ.

Niḥśeṣamokṣe sati vāsanānām ātmānubhūtiḥ pratibandhasūnyā. 277

To the extent to which the mind is turned and established inward, it gives up the external *vāsanās*. When all the *vāsanās* are completely extinguished, the experience of the *ātman* (*Brahman*) is free from all obstacles.

बाह्ये निरूद्धे मनसः प्रसन्नता मनःप्रसादे परमात्मदर्शनम् ।

तस्मिन् सुदृष्टे भवबन्धनाशः बहिर्निरोधः पदवी विमुक्तेः ॥३३६॥

Bāhye nirūddhe manasaḥ prasannatā manaḥprasāde paramātmadarśanam.

Tasmin sudṛṣṭe bhavabandhanāśaḥ bahirnirodhaḥ padavī vimukteḥ. 336

When the external is controlled, the mind becomes peaceful. When the mind is peaceful, there arises the soul-sight of the *Paramātman*. When that is well realised, there is annihilation of the bonds of *saṁsāra*. So, external control is what helps to secure the state of liberation.

निरस्तरागा निरपास्तभोगाः शान्तास्सुदान्ता यतयो महान्तः ।

विज्ञाय तत्त्वं परमेतदन्ते प्राप्ताः परां निर्वृतिमात्मयोगात् ॥४७२॥

Nirastarāgā nirapāstabhogāḥ śāntāssudāntā yatayo mahāntaḥ.

Vijñāya tattvaṁ parametadante prāptāḥ parāṁ nirvṛtimātmayogāt. 472

The great yatis who have discarded all attachments and pleasures, perfectly restraining themselves and at peace realising the highest truth, at the end attained supreme bliss by their realisation of the *ātman*.

तूष्णीमवस्था परमोपशान्तिः बुध्देरसत्कल्पविकल्पहेतोः ।

ब्रह्मात्मना ब्रह्मविदो महात्मनः यत्राद्वयानन्दसुखं निरन्तरम् ॥१॥५२७॥

Tūṣṇīmavasthā paramopasāntiḥ buddherasatkalpavikalpahetoḥ.

Brahmātmanā brahmavido mahātmanaḥ yatrādvayānandasukhaṁ nirantaram.

527

To the *mahātmā* who is the knower of *Brahman*, the mind which is the cause of imagination of the unreal, remains silent by reason of his being *Brahman* (having realised *Brahman*) in the enjoyment of permanent bliss of non-dual experience.

2.1.5. F CYCLIC MEDITATION

Cyclic Meditation (CM) is a ‘moving’ meditation technique devised to address the needs and problems of modern man (Nagendra, Nagrathana, 2001). Many people find it difficult to relax and get into a meditative state if asked to sit with their eyes closed while others feel drowsy and even fall asleep. Cyclic meditation involves a combination of gentle yogic stretching and relaxation. It is based on the principles culled from classical yogic texts like *Māṇḍūkya Upaniṣat Kārikā* (Chinmayananda, 1984) and *Yoga Sūtras* of *Patañjali*. This technique is developed and propagated by Swāmi Vivekānanda Yoga Anusandhāna Saṁsthāna and is widely used as an effective therapeutic measure and technique of stress

management. It is called so, because it consist the measures of ‘relaxation’ and ‘stimulation’ in cyclic order. This technique includes the practice of certain yoga postures interspersed with relaxation while supine, thus achieving a combination of both ‘stimulating’ and ‘relaxation’ practices.

Cyclic meditation is based on a concept that a combination of both ‘calming’ and ‘stimulating’ measures help in reaching a state of mental equilibrium. It is derived from a statement in Sage *Gauḍapāda’s Māṇḍūkya*

Upaniṣat Kārikā:

लये सम्बोधयेत् चित्तं विक्षिप्तं शमयेत् पुनः ।

सकषायं विजानीयात् समप्राप्तं न चालयेत् ॥३.४४ ॥

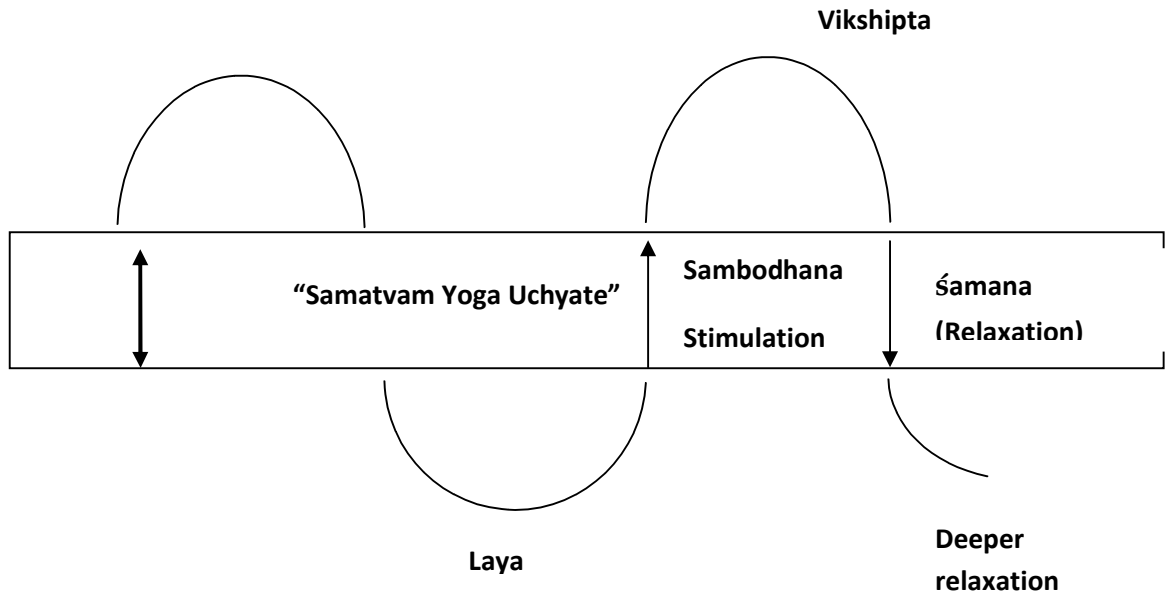
Laye sambodhayet cittam vikṣiptam śamayet punaḥ.

Sakaṣāyam vijñānīyāt samaprāptam na cālayet. 3.44

‘In a state of mental inactivity awaken the mind; when agitated, calm it; between these two states realize the possible abilities of the mind. If the mind has reached the state of perfect equilibrium then do not disturb it again’

(Māṇḍūkya Upaniṣat Kārikā: 3.44).

Figure 4: Concept of *Laya* and *Vikṣipta*



For the most persons the mental states while doing routine activities (not necessarily associated with *yoga*) is neither ‘inactive’ nor ‘excited’, but is somewhere between these extremes and hence a combination of ‘awakening and calming’ measures may be better suited to reach a balanced, relaxed state. The foregoing idea drawn from the traditional texts is the basis for this *yoga* practice called ‘*cyclic meditation*’.

Meditation is to gain mastery over the body and mind. The two main hurdles for gaining mastery over the mind are stupor (*laya*) and agitations (*vikṣipta*) of mind. This happens in all spiritual (*sādhana*) practices. The solution

given by Sage *Gauḍapāda* is to address (*sambodhana*) the mind again and again when in stupor or oblivion, and slow down (*praśamana*) the mind when agitated. This important principle of practice is found intrinsically knit in all spiritual practices. In all meditation techniques this concept of focusing (activation) and defocusing (slowing down) is present in different proportions. However, to practice this one requires being constantly watchful and aware about changes occurring in the body and mind. Cyclic meditation helps to hone this skill (*kausāla*) as it consists the cycles of activating (*sambodhana*) and relaxing (*praśamana*) phases with unbroken (*taila dhāravat*) dispassionate (*niḥsaṅgaḥ*) awareness. The activation and relaxation is not alone meant at physical level, but of mind as well. The mind is alternately activated by focusing and confining (*deśa bandha*) on different changes occurring in body and mind; and relaxed by the process of defocusing (*ānantasamāpattibhyām*) with the attitude of witness. Thus, cyclic meditation contains the intermittent cycles of *dhāraṇā* (pointed awareness) and *dhyāna* (pervasive awareness) finally stabilizing in the effortless expansive meditative state (*samatva*).

Sage *Gauḍapāda* further says that when the mind is awakened from the lethargy (*laya*) and is withdrawn from other objects, but is not established in equipoise and continues in an intermediate state, then *vijñānīyāt*, one should

know; that mind to be *Sakaṣāyam*, tinged with desire, in a state of latency. From that state too, it should be diligently led to equipoise. When one practices this awakening (from *laya*) and calming (from *vikṣipta*) again and again the knots, blocks and latent desires in the subtle layers of mind (*kaṣāya*) surface and get released. This process of meditation helps to address all the unresolved patterns, issues, fears and phobias deep within the subconscious field. When mind settles in the state of balanced equipoise (*samaprāptam*), one must understand the possibilities of mind again getting distracted and hence should not move from that state. Sage *Gauḍapāda* further says in *Māṇḍūkya Upaniṣat Kārikā* that:

यदा न लियते चित्तं न च विक्षिप्यते पुनः ।

अनिङ्गनमनाभासं निष्पन्नं ब्रह्म तत्तदा ॥३॥४६॥

Yadā na liyate cittam na ca vikṣipyate punaḥ.

Aniṅganamanābhāsam niṣpannam brahma tattadā. 3.46

‘When the mind is brought under control through the aforesaid process, does not become lost, in sleep; and also does not again, become dispersed amidst objects; and when the mind become motionless like a lamp in a windless place (*aniṅganama*); and does not get carried away by anything (*anābhāsam*); then it gets absorbed and becomes pure expansive Consciousness (*niṣpannam brahma*)’.
(*Māṇḍūkya Upaniṣat Kārikā*: 3.46).

Technique of Cyclic Meditation

In the activating phase of cyclic meditation, the yoga postures are practiced about four times slower than that required by classical description. This slower practice requires more effort and subtle awareness than that required by the usual practice. The awareness is kept up throughout the practice with closed eyes, aloofly witnessing the changes occurring in the body like, changes in respiratory rate, heart rate, blood flow and contraction and relaxation of muscles (Nagendra & Nagrathana, 2001). The postures and relaxation are practised in such a way that it sets a slow cyclic rhythm in the body, *prāṇa* (vital energy) and the mind.

Being involved in specific practices keeps an overactive mind ‘busy’ and also stops one from falling asleep. For the best effects it is useful to (i) keep the eyes closed (ii) breathe slowly and rhythmically, and (iii) tune the awareness to the changes occurring in the body while doing slow and unhurried movements. During the practice of cyclic meditation the attention is enhanced by recognizing pointed awareness, linear awareness, surface awareness, three-dimensional-awareness and all pervasive awareness of body and mind. The practice of cyclic meditation is based on the principles described in the Patañjali yoga sūtras (Taimini, 1961):

स्थिरसुखमासनम् ॥ *Sthirasukhamāsanam.* (PYS: 2.46)

प्रयत्नशैथिल्यानन्तसमापत्तिभ्याम् ॥ *Prayatnaśaithilyānantasamāpattibhyām.* (PYS: 2.47)

ततो द्वन्द्वानभिघातः ॥ *Tato dvandvānabighātaḥ.* (PYS: 2.48)

The postures are practiced slowly according to one's physical capacity and comfort. The stability, effortlessness and mindfulness are emphasized while performing the body movements. In the final stage meditator is instructed to expand the awareness on infinite object like sky or ocean, and are encouraged to remain in that state effortlessly for longer duration. Thus though cyclic meditation is a moving technique, it consists of all the characteristic features of meditation (*dhyāna*): (i) single thought, (ii) effortlessness (*prayatnaśaithilyā*) (iii) mindfulness (*sākṣī bhāva*) (iv) slowness (*naidhānyā*), and (v) blissful expansiveness (*anantasamāpatti*). The dual process of awareness and relaxation (stimulate – relax combination) not only releases the imbalances at body level but also at mental and emotional levels. The understanding of the subtleties of cyclic meditation by *Jñāna Yoga* brings about cognitional transformation to resolve the subtle intellectual conflicts. Therefore, cyclic meditation is considered as a holistic tool with other practices of the yoga powered by comprehensive knowledge base.

The relaxation techniques that are practiced in cyclic meditation are IRT (instant or isometric relaxation technique), QRT (quick relaxation technique) and DRT (deep relaxation technique). In IRT, the sudden isometric contraction of all muscles in the body is followed by brief relaxation while supine. The QRT is practiced in supine posture, where whole body is put in to rest while being aware of breathing process and the movement of abdomen and chest along with respiration. In DRT, the body is systematically relaxed part by part in supine position. Further the deep relaxation is provided and subtle awareness is

maintained by chanting the syllables ‘A’, ‘U’, ‘M’ and ‘OM’ in sequential order. According to *Māṇḍūkya Upaniṣat* the syllables ‘A’ ‘U’ and ‘M’ constitute the primordial sound ‘OM’, which is at the base of all creations.

Depending upon the applied needs, different versions of cyclic meditation have been designed. The basic version consists four standing postures (*tāḍāsana*, *ardhakaṭīcakrāsana*, *pādahastāsana* and *ardhacakrāsana*) interspersed with IRT and DRT. The pictorial description of the postures in cyclic meditation is given in **Figure 5**. See **Appendix-1** for complete description of technique of cyclic mediation. In present study this basic version of cyclic meditation was investigated. In advanced version four standing and two sitting postures (*śaśāṅkāsana* and *ūṣṭrāsana*) are interspersed with IRT (instant or isometric relaxation technique), QRT (quick relaxation technique) and DRT (deep relaxation technique).

Figure 5: Postures in cyclic meditation.



Tāḍāsana



**Aardhakaṭīcakrāsana
(Right side)**



**Aardhakaṭīcakrāsana
(Left side)**



Pādahastāsana



Ardhacakrāsana



Supine posture for IRT, QRT and DRT

2.1.6 SUMMARY

Yoga is a way of life, which offers various techniques to achieve the goal, Meditation is one of techniques that helps to purify and direct in the right way to accomplish what we intend. Here is the unique technique of meditation which is based on stimulation and relaxation that has traditional basis.

Yoga includes diverse practices, such as physical postures (*āsanas*), regulated breathing (*prāṇāyāma*), meditation and lectures on philosophical aspects of yoga. Meditation in fact, is the seventh out of eight steps prescribed to reach an ultimate stage of spiritual emancipation (*Patañjali, circa 900 B.C.*). While many practitioners do learn meditation directly, others find it easier to pass first through the other stages, learning yoga postures (*āsanas*) and regulated breathing (*prāṇāyāma*). It is postulated that when a novice attempts to meditate directly, there could be two responses based on the quality of the mind viz., (i) a *rājasika* – active (personality) mind would be restless all through the session and (ii) a *tāmasika* – a mind with inertia could fall asleep. This problem of the mind is addressed in the *Māṇḍukya Upaniṣat*. Based on this a technique of ‘moving meditation’, which combines the practice of yoga postures with guided meditation was evolved, called cyclic meditation (CM), by H.R. Nagendra, Ph.D., which has its’ origin in an ancient Indian text, *Māṇḍukya Upaniṣat*. It is interesting to note that CM does induce a quiet state of mind, which is compatible with the

description of meditation (*dhyāna* or effortless expansion), according to *Patañjali*. This description states that ‘*Tatra pratyayaikatānatā dhyānam*’ (*Patañjali Yoga Sūtras*, Chapter 3: Verse 2). This means that the uninterrupted flow of the mind towards the object chosen for meditation is *dhyāna*. Indeed, all meditations, irrespective of the strategies involved are believed to help reach this state. There are several strategies in meditation. These include breath awareness, awareness of internal sensations, directing the attention to a *mantra* or a *koan*, and keeping the eyes open with the gaze fixed on the object of meditation, among other methods.

The verse on which CM is based, states: ‘In a state of mental inactivity awaken the mind; when agitated, calm it; between these two states realize the possible abilities of the mind. If the mind has reached a state of perfect equilibrium, then do not disturb it again’. The underlying idea is that, for most persons, the mental state is routinely somewhere between the extremes of being ‘inactive’ or of being ‘agitated’ and hence to reach a balanced, relaxed state the most suitable technique would be one which combines ‘awakening’ and ‘calming’ practices.

In Cyclic Meditation, the period of practicing yoga postures constitutes the ‘awakening’ practices, whereas periods of supine rest comprise the ‘calming practices’. An essential part of the practice of Cyclic Meditation is being aware of sensations arising in the body. This supports the idea that a combination of stimulating and calming techniques practiced with a background of relaxation and awareness (during CM) may reduce psychophysiological arousal more than resting in a supine posture for the same duration. The practice of CM, includes yoga

postures (*āsanas*) which involve muscle stretching and this has diverse benefits.

The effects, benefits and possible mechanisms underlying CM are given below.

Cyclic meditation (CM) involves slow practice of *yoga* postures interspersed with relaxation, allowing any feelings or sensations to arise, while maintaining a specific attentional stance: awareness of the phenomenal field as an attentive and non-attached observer without judgment or analysis.

Generally in meditational practice the two main hurdles for gaining mastery over the mind are stupor (*laya*) and excitement (*vikṣipta*). The solution given by Sage *Gauḍapāda* is to awaken (*sambodhana*) the mind when it is dull, and slow down (*praśamana*) when agitated. This important principle of practice is intrinsically present in all meditation practices. However, to practice this, one requires being constantly watchful and aware about changes occurring in the body and mind. Cyclic meditation helps to hone this skill (*kauśala*) as it consists the cycles of activating (*sambodhana*) and relaxing (*praśamana*) measures practised with unbroken (*taila dhāravat*) dispassionate (*niḥsaṅgaḥ*) awareness. The activation and relaxation is not alone meant at physical level, but of mind as well. The cyclic meditation contains the intermittent cycles of *dhāraṇā* (pointed awareness) and *dhyāna* (pervasive awareness) finally stabilizing in the effortless expansive meditative state.

3.0 REVIEW OF THE SCIENTIFIC LITERATURE

Science without religion is lame, religion without science is blind.

Albert Einstein (1879 - 1955)

‘Science, Philosophy and Religion: a symposium’, 1941

CHAPTER-4

Aim and Objectives

4.0 AIM AND OBJECTIVES

4.1 AIM AND OBJECTIVES OF THE STUDY

The present study was intended to obtain a greater understanding of the technique, cyclic meditation, measuring indicators of psycho-cognitive changes, anxiety state, repetitive motor activity and indicators for levels of attention. Hence changes in the following variables were compared following cyclic meditation as compared to a comparable period of supine rest;

- (i) Performance in a digit-letter substitution task (DLST),
- (ii) Performance in a letter copying task (LCT),
- (iii) Repetitive motor response through a circle dotting task (CDT),
- (iv) Performance in a Wechsler memory scale (WMS),
- (v) State anxiety through state trait anxiety inventory (STAI), and
- (vi) Midlatency auditory evoked potentials (MLAEPs) recorded at Cz electrode site referenced to linked earlobes (A1-A2).

4.2 RATIONALE OF THE STUDY

In several previous studies meditation practice has been shown to reduce physiological arousal (in terms of metabolism, sympathetic activity and levels of attention). However, the results varied across meditation techniques and for a given meditation technique, results varied across meditation practitioners. In spite of this inter and intra meditation variability, there remains a view that meditation is a state of hypo-arousal. Hypo-arousal may suggest that mental alertness is reduced. Indeed, this is often looked upon as a possible drawback of practicing meditation.

That is, that one may become hypo-aroused and hence less alert. The present study was planned to measure variables indicative of performance (i.e., performance in a digit letter substitution task, letter copying task, circle dotting task, Wechsler memory scale), and also of state anxiety, as well those indicative of information processing at different cortical and sub-cortical levels (i.e., MLAEPs). This was considered important to get a comprehensive model of the meditation technique, in this case cyclic meditation.

4.3 HYPOTHESIS

Cyclic meditation combines ‘stimulating’ and ‘calming’ practices, based on a statement in an ancient yoga text which suggests that this combination may be helpful to reach mental equilibrium. The underlying idea is that for most persons the mental state is routinely somewhere between the extremes of being ‘inactive’ or of being ‘agitated’ and hence to reach a balanced, relaxed state the most suitable technique would be one which combines ‘awakening’ and ‘calming’ practices.

The hypothesis of this study was that the practice of cyclic meditation would induce a mental and physiological state characterized by reduced anxiety along with improved cognitive performance.

CHAPTER-5

Methods

In this thesis the changes in (i) mid-latency auditory evoked potentials (MLAEPs), (ii) d2 test of attention, (iii) digit symbol substitution test (DSST), and (iv) visual analog scale were studied in normal healthy male volunteers following four mental states viz., cyclic meditation (CM) and *śavāsana* (supine rest, SR).

Methodology of the research has been described under the following sub-headings:

5.1: PARTICIPANTS

5.2: DESIGN OF THE STUDY

5.3: VARIABLES STUDIED

5.4: INTERVENTIONS

5.5: DATA EXTRACTION

5.6: DATA ANALYSIS

5.1 PARTICIPANTS

5.1.1 Sample size

Sixty participants were studied in four separate sessions i.e., *cancelata*, *ekagrata*, *dharana* and *dhyana*. The sample size was calculated based on an effect size obtained from a previous study of changes in cyclic meditation (Sarang & Telles, 2006). It was calculated using G*Power software, Version 3.0.10 (Faul, Erdfelder, Lang, & Buchner, 2007), where the level was 0.05, power = 0.95 and the recommended sample size was forty-four participants.

5.1.2 Selection and source of participants

The participants had a minimum of six months experience of practice of meditation Om, and were regular in their practice. The participants were residential students at Swami Vivekananda Yoga Anusandhana Samsthana, a Deemed University, Bangalore. They had all enrolled for graduate and postgraduate programs in yoga.

5.1.3 Inclusion criteria

Participants who fulfilled following conditions were included in the study: (i) The participants were healthy volunteers with age range from 18 to 40 years (group mean age \pm S.D., 26.5 ± 4.6 years), (ii) male participants alone were studied as auditory evoked potentials (Yadav, Tandon & Vaney, 2002), autonomic variables (Yildirim, Kabakci, Akgul, Tokgozoglu & Oto, 2002) and oxygen consumption (Das & Jana, 1999), have been shown to vary with the phases of the menstrual cycles in females and (iii) all participants had experience of practice of both yoga relaxation techniques, ranging between 6 and 54 months (group average experience \pm S.D., 24.4 ± 13.7 months). They were all regular in practice. In addition, the study was conducted following two months of supervised practice of CM and SR for about 30 minutes on alternate days as a 'refresher course'. The assessment of their practice was based on the opinion of the senior teacher [equivalent to a *Guru*]. The further details of each participant have been given in the Table 8, Table 9, Table 10, & Table 11.

5.1.4 Exclusion criteria

The following criteria were used to exclude the volunteers: (i) The presence of cognitive and/or neurological disorders based on a medical history and routine clinical examination, (ii) in take of medication, which is known to influence cognitive functions, (iii) auditory deficits assessed by checking the auditory thresholds of each ear separately was excluded, (iv) participants who had difficulty in focusing/concentrating, based on an interview, and (v) smoking or alcoholism which may have influenced the cognitive functions. None of the participants had to be excluded based on these criteria.

5.1.5 Ethical considerations

The participants were explained about the aims and methods of the study and the informed consent was signed by all participants (a sample copy is enclosed in **Appendix-2**). None of them were aware of the hypothesis of the study. Approval was obtained from the Institutional Ethical Committee.

Table 8: The characteristics of participants in digit-letter substitution task and circle dotting task administered pre and post of cyclic meditation and supine rest sessions.

Sl. No.	Participant Code	Age	Experience in months	No. of minutes / day	No. of days / month
1	DIL	21	8	30	20
2	GAU	24	6	30	25
3	DIN	24	12	30	26
4	PAR	20	6	30	20
5	ARV	21	8	30	15
6	MAN	22	8	30	25
7	JOS	25	12	30	25
8	SHA	21	6	30	20
9	BHA	25	36	60	30
10	BID	21	12	30	18
11	AMR	25	24	30	20
12	ACH	37	48	60	30
13	GAN	25	12	30	25
14	VAR	29	36	60	25
15	RAJ	25	12	30	19
16	SON	26	12	30	28
17	VEN	29	36	45	25
18	VIM	39	12	30	30
19	HAR	23	8	30	15
20	OMP	27	12	30	28
21	SAI	30	36	90	30
22	PAR	26	12	30	24
23	MAN	20	6	30	19
24	SHA	22	36	60	26
25	VIC	21	36	60	25
26	BAN	21	36	60	25
27	HAR	24	24	60	28
28	OMK	25	48	60	28
29	RAG	25	48	60	30
30	RUC	24	24	60	28
31	ASH	26	30	45	25
32	HIR	25	18	60	20
33	MAN	25	24	45	25

34	RAJ	28	24	30	20
35	SAR	35	48	60	30
36	RAN	25	24	45	25
37	SWA	33	24	60	26
38	SHA	27	24	30	25
39	DHA	25	12	30	20
40	GAN	22	18	30	20
41	ARJ	21	12	45	25
42	RAN	22	18	30	20
43	SIT	27	36	60	26
44	AMI	26	24	45	20
45	NEE	27	12	30	18
46	SAT	27	12	30	20
47	VIK	29	24	60	27
48	RUD	34	48	60	25
49	SHI	33	24	30	28
50	GOP	35	24	30	28
51	DEE	28	36	60	30
52	VIV	27	36	60	28
53	SAT	31	36	45	25
54	SAN	34	48	60	25
55	BAL	33	48	90	30
56	JOJ	31	24	30	25
57	SUR	30	48	60	25
	Mean	26.54	24.35	44.47	24.44
	SD	4.59	13.71	16.28	4.03

Table 9: The characteristics of participants in letter copying task administered pre and post of cyclic meditation and supine rest sessions.

Sl. No.	Subject Code	Age	Experience in months	No. of minutes / day	No. of days / month
1	AMI	22	18	20	25
2	ARV	21	22	30	25
3	ASH	25	36	30	26
4	BAL	31	54	30	20
5	BHA	21	30	30	15
6	DIL	21	24	30	25
7	DIN	25	24	45	25
8	HAR	24	30	30	20
9	HAR	21	18	60	30
10	HEI	25	30	30	18
11	HIR	24	30	30	20
12	JAY	26	24	60	30
13	JOJ	29	36	30	25
14	KSA	33	48	60	25
15	MAN	25	42	30	19
16	MAN	23	36	30	28
17	RAG	27	42	45	30
18	RUD	34	48	45	30
19	SAN	30	48	30	15
20	SHA	27	24	30	28
21	SON	26	24	60	25
22	SUB	23	18	30	24
23	SWA	29	30	30	19
24	VEN	28	30	60	26
25	AMR	24	36	60	25
26	BAN	20	36	30	25
27	BID	25	24	60	28
28	DEE	27	42	60	28
29	DHA	28	24	30	25
30	SAI	30	48	60	28
31	GAN	24	24	45	25
32	GAU	25	24	60	20
33	GOP	36	30	45	25
34	JOS	37	36	30	20

35	KRR	24	24	60	30
36	MAN	31	24	45	25
37	N RG	29	30	60	26
38	NAO	26	24	30	25
39	NEE	26	30	30	20
40	OMP	23	36	30	20
41	OMK	26	48	45	25
42	PAR	22	30	30	20
43	RAJ	28	36	60	26
44	RAN	24	24	45	20
45	RUC	25	30	30	18
46	SAT	30	30	30	20
47	SAT	29	24	60	27
48	SHA	25	30	60	25
49	SHA	24	24	30	28
50	SHI	26	24	30	28
51	SIT	29	48	60	30
52	SON	27	24	30	28
53	SURY	31	30	45	25
54	VAR	28	30	60	25
55	VIC	24	36	90	30
56	VIK	27	24	30	25
57	PAR	33	24	30	25
Mean		26.54	31.12	42.19	24.44
SD		3.76	8.85	14.97	3.91

Table 10: The characteristics of participants in Wechsler memory scale and state anxiety inventory (STAI) administered pre and post of cyclic meditation and supine rest sessions.

Sl. No.	Participant Code	Age	Experience in months	No. of minutes / day	No. of days / month
1	SUS	23	36	60	30
2	RAG	26	48	60	30
3	JOS	39	12	30	25
4	BAL	26	8	30	15
5	HAR	25	8	30	15
6	BAL	32	48	90	30
7	JAN	34	9	30	20
8	JAY	31	6	30	20
9	PRA	28	36	60	25
10	SAN	24	6	30	15
11	AMR	26	24	30	20
12	RAJ	27	36	60	25
13	OMP	27	12	30	28
14	SUB	25	6	60	28
15	BHA	28	36	60	30
16	VEN	30	36	45	25
17	MAH	28	6	45	20
18	JAM	26	12	30	18
19	HAR	23	24	60	28
20	AMI	25	24	45	20
21	KUN	30	6	45	20
22	SHA	26	6	45	24
23	SHR	24	24	30	25
24	MAN	23	8	30	25
25	ARV	21	8	30	15
26	DIL	23	8	30	20
27	SAN	29	48	60	25
28	VIS	20	18	60	18
29	SAN	23	18	60	20
30	SIT	30	36	60	26
31	DAM	20	6	30	15
32	SUM	19	6	30	18
33	RAJ	23	12	30	19

34	SAT	34	36	45	25
35	RA	27	24	45	25
36	MAN	34	6	30	20
37	RUD	34	48	60	25
38	MAL	23	6	30	20
39	SAN	34	48	60	25
40	SAT	25	12	30	20
41	ASH	24	30	45	25
42	NIT	26	12	30	18
43	ARJ	24	12	45	25
44	VIR	20	6	30	20
45	DHA	26	12	30	20
46	SWA	22	12	60	28
47	DIG	22	6	30	20
48	DHA	24	6	30	15
49	MAN	25	12	30	20
50	PAR	21	6	30	20
51	SWA	34	12	45	26
52	GHA	30	48	30	25
53	NAG	34	12	30	20
54	SUN	20	6	30	20
55	SUD	27	12	60	28
56	VIK	29	12	60	25
57	SAR	32	48	90	30
Mean		26.58	18.96	43.16	22.49
SD		4.54	14.69	15.80	4.42

Table 11: The characteristics of participants in midlatency auditory evoked potentials (MLAEPs) administered pre and post of cyclic meditation and supine rest sessions.

Sl. No.	Participant Code	Age	Experience in months	No. of minutes / day	No. of days / month
1	SUS	23	36	60	30
2	RAG	26	48	60	30
3	JOS	39	12	30	25
4	BAL	26	8	30	15
5	HAR	25	8	30	15
6	BAL	32	48	90	30
7	JAN	34	9	30	20
8	JAY	31	6	30	20
9	PRA	28	36	60	25
10	SAN	24	6	30	15
11	AMI	26	24	30	20
12	RAJ	27	36	60	25
13	OMP	27	12	30	28
14	SUB	25	6	60	28
15	BHA	28	36	60	30
16	VEN	30	36	45	25
17	MAH	28	6	45	20
18	JAM	26	12	30	18
19	HAR	23	24	60	28
20	AMI	25	24	45	20
21	KUN	30	6	45	20
22	SHA	26	6	45	24
23	SHR	24	24	30	25
24	MAN	23	8	30	25
25	ARV	21	8	30	15
26	DIL	23	8	30	20
27	SAN	29	48	60	25
28	VIS	20	18	60	18
29	SAN	25	18	60	20
30	SIT	30	36	60	26
31	DAM	20	6	30	15
32	SUM	19	6	30	18

33	RAJ	23	12	30	19
34	SAT	33	36	45	25
35	RAN	27	24	45	25
36	MAN	34	6	30	20
37	RUD	34	48	60	25
38	SUB	28	48	60	25
39	MAL	23	6	30	20
40	SAN	34	48	60	25
41	SAT	25	12	30	20
42	ASH	24	30	45	25
43	NIT	26	12	30	18
44	ARJ	24	12	45	25
45	VIR	20	6	30	20
46	DHA	26	12	30	20
47	SWA	22	12	60	28
Mean		26.51	20.19	43.72	22.51
SD		4.35	14.93	14.94	4.43

5.2 DESIGN OF THE STUDY

Pilot trials were conducted on ten participants for paper pencil tasks like digit letter substitution task, letter copying task, circle dotting task, Wechsler memory scale, state anxiety inventory and midlatency auditory evoked potentials in order to find out the effectiveness of the study design and duration of meditation experience, appropriateness of study variables, and to observe the trends following the practice of cyclic meditation.

5.2.1 Structure of sessions

Participants were assessed in ten sessions. They underwent five cyclic meditation sessions, while (i) recording the digit letter substitution task (DLST) (this task was administered to the group at a time), (ii) recording the letter copying task (this task was administered to the group at a time) (iii) circle dotting task (this task was administered to the group at a time), (iv) recording the Wechsler memory scale and state anxiety inventory (STAI) (these tasks were administered individually), and (v) recording midlatency auditory evoked potentials (MLAEPs). Similarly, the same participants underwent five supine rest sessions separately, while (i) recording the digit letter substitution task (DLST) (this task was administered to the group at a time), (ii) recording the letter copying task (this task was administered to the group at a time) (iii) circle dotting task (this task was administered to the group at a time), (iv) recording the Wechsler memory scale and state anxiety inventory (STAI) (these tasks were administered individually), and (v) recording midlatency auditory evoked potentials (MLAEPs). Supine rest (SR) was considered as control session for cyclic meditation (CM) because (i)

supine posture is best known position for relaxation and (ii) in earlier studies, CM was compared to SR in corpse posture (*śavāsana*) (Telles, Reddy & Nagendra, 2000; Sarang & Telles, 2006, 2007).

The performance in the three tasks (i.e., DLST, letter copying task and circle dotting task) was also assessed before and after an equal duration of a no-intervention or control period to compare with (i) cyclic meditation, and (ii) supine rest sessions. The aim was to determine whether changes may have been a practice effect.

5.2.2 Order of sessions

The cyclic meditation (A) and supine rest (B) sessions were recorded alternately. For example in 5 subjects (S): S1 – ABAB; S2 – BABA; S3 – ABAB; S4 – BABA; S5 – ABAB, and so on. This was to prevent the influence of being exposed to the laboratory for the first time from influencing the results. The recordings were made on different days, not necessarily on consecutive days but at the same time of the day.

5.2.3 Time allocation within the sessions

Digit letter substitution task, letter copying task, circle dotting task, Wechsler memory scale and state anxiety inventory (STAI) were performed in two states i.e., Pre and Post. Midlatency auditory evoked potentials (MLAEPs) were recorded in four states i.e., Pre, Post 1, Post 2 and Post 3. The time allocation within these sessions has been shown schematically in **Figure 6 & 7**.

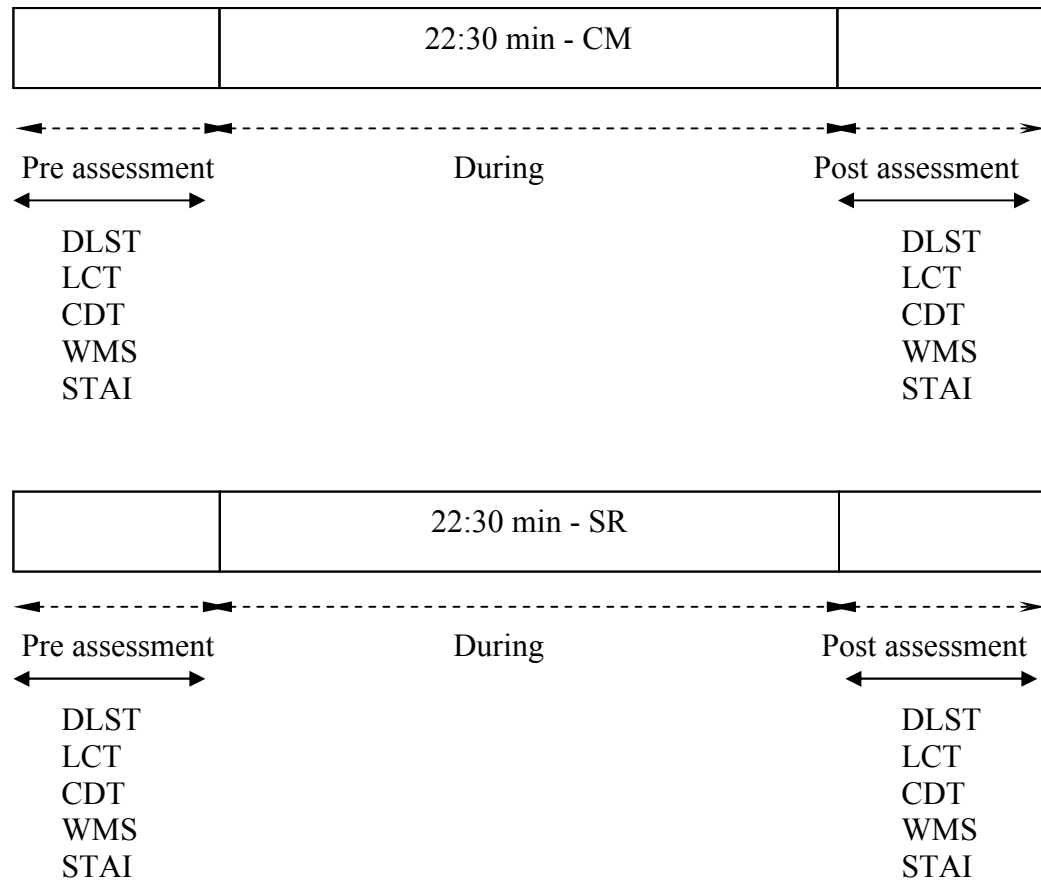
5.2.3A Cyclic meditation session: All the paper pencil tasks were assessed Pre and Post CM practice. The first 5 minutes of the Pre cyclic meditation period was in

the sitting position with eyes closed, followed by 22 minutes 30 seconds of the During period, where participants were given cyclic meditation practice using pre-recorded instructions. This was followed by 15 minutes post cyclic meditation in the sitting position with eyes closed while midlatency auditory evoked potentials (MLAEPs) were recorded. There was no recording during the practice of CM.

5.2.3B *Supine rest session:* All the paper pencil tasks were assessed Pre and Post SR practice. The first 5 minutes of the Pre supine rest period was in the sitting position with eyes closed, followed by 22 minutes 30 seconds of the During period, where participants were given supine rest in the corpse posture (*śavāsana*) without instructions. This was followed by 15 minutes post supine rest in the sitting position with eyes closed while midlatency auditory evoked potentials (MLAEPs) were recorded. There was no recording during the practice of SR.

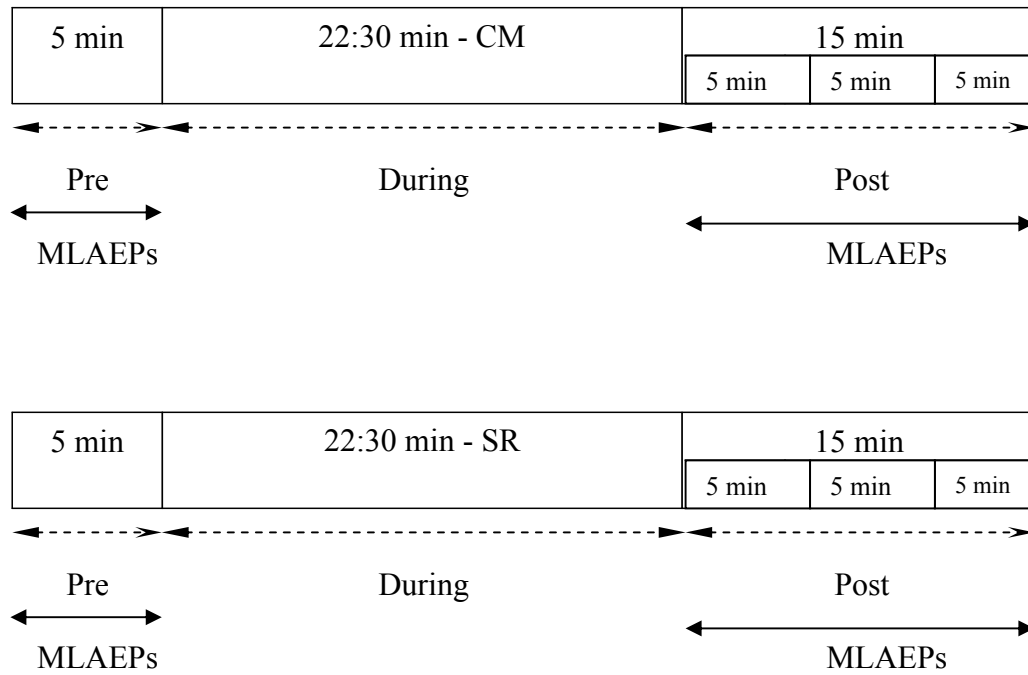
For both sessions i.e., CM and SR, the recordings of midlatency auditory evoked potentials (MLAEPs) were made with the Post period longer (i.e., 15 minutes). This was done to assess the effect over a length of time. Hence, each session lasted for 42:30 minutes; of which 22:30 minutes was spent in the practice of CM or SR, preceded (Pre) by 5 minutes in the sitting position with eyes closed and followed (Post) by 15 minutes in the sitting position with eyes closed.

Figure 6: Time allocation within sessions: for psychological variables.



- CM = Cyclic Meditation
- SR = Supine Rest
- DLST = Digit Letter Substitution Task
- LCT = Letter Copying Task
- CDT = Circle Dotting Task
- WMS = Wechsler Memory Scale
- STAI = State Anxiety Inventory

Figure 7: Time allocation within sessions: MLAEPs



CM = Cyclic Meditation

SR = Supine Rest

MLAEPs = Midlatency Auditory Evoked Potentials

5.3 VARIABLES STUDIED

The word parameter is described as ‘characteristic of distribution or relationship in the population which are estimated by statistical analysis of a sample of observations’ whereas, the word variable denotes ‘measurement or attribute on which observations are made’ (Altman, Gore, Gardner & Pocock, 1993). Hence in the present thesis the term ‘variable’ has been used to describe the assessments studied.

5.3.1 Digit letter substitution task (DLST)

Digit-letter substitution task measures psychomotor performance. Substitution tasks require cognitive performance, recognition, processing, integration, visual selectivity and a repetitive motor response. A digit letter substitution task was administered to assess functions such as selective and focused attention, speed of perception and processing, as well as a repetitive motor response requiring motor speed. The digit letter substitution task has been used in similar type of design on Indian population (Natu & Agarwal, 1997). A sample worksheet of digit letter substitution task is given in **Appendix-3**.

5.3.1.A Testing procedure

The digit letter substitution task consisted of a worksheet on which digits (1 to 9) were arranged randomly in 12 rows and 8 columns (Natu & Agarwal, 1997). An instruction key for “letter-for-digit” substitutions was shown at the top. Participants were required to make as many letter-for-digit substitutions as possible in 90 seconds. They were told that there were two possible strategies, i.e., marking all nine digits in the random order they occurred, or selecting any one

digit at a time. They were to choose whichever strategy suited them. They were also told that they could follow a horizontal, vertical or a random path according to their choice. The total number of substitutions was counted and each substitution scored as '1'. Where the wrong letter was substituted, these 'errors' were counted, (also as '1'each) and totaled as 'Wrongly attempted'. The total number of substitutions and error substitutions were scored as described and the net scores were calculated by deducting errors (wrong substitutions) from the total substitutions attempted.

As this test was administered at the beginning and at the end of the interventions, which required 22:30 minutes, to avoid any retest effect parallel worksheets were prepared by changing the digit-letter pairs in the 'key' and by randomly changing the sequence of digits in the working section (Agarwal, Kalra, Natu, Dadhich & Deswal, 2002). Hence, half the participants (n=29) received worksheet A before a session, while the other half (n=28) received worksheet B before the session. Those who received worksheet A before the session received worksheet B after the session. This was reversed for the remaining participants. Similarly, there were different worksheets for the remaining sessions. The digit letter substitution task has been used in a similar design in an Indian population, which indicated the validity of the task to study immediate effects (Natu & Agarwal, 1997).

5.3.1.B Reliability and validity of the test

Reliability refers to the consistency of measurement which is reflected in the reproducibility of the scores. The digit letter substitution task has been evaluated

for its reliability and validity based on standard criteria. Reliability is ascertained based on (i) temporal stability and (ii) internal consistency (Singh, 2002). To assess temporal stability the correlation coefficient was calculated using the published pilot data (Sarang & Telles, 2007) collected in twenty nine male healthy volunteers 'without any intervention'. The correlation was made for the data collected before and after twenty three minutes (Spearman's correlation coefficient). The variable for which the correlation was made (i.e., the net score) demonstrated the temporal stability ($r = .781$, $P = .002$). Since the digit letter substitution task comprises one variable, internal consistency can not be calculated.

Validity concerns what the test measures and how well it does so. In the present study the digit letter substitution task is directly related to the cognitive performance of the person being examined. The digit-letter substitution task measures psychomotor performance. Substitution tasks require cognitive performance, recognition, processing, integration, visual selectivity and a repetitive motor response. A digit letter substitution task was administered to assess functions such as selective and focused attention, speed of perception and processing, as well as a repetitive motor response requiring motor speed (Lezak, 1995). Hence it may be said that the content validity of this test is adequate for the purpose for which it is intended.

5.3.2 Letter copying task (LCT)

The letter copying task determined the psychomotor and motor speed component of the digit-letter substitution task as has been described elsewhere. A letter copying task was administered to assess functions such as attention, and a repetitive motor response. The letter copying task is similar to digit letter substitution task has been used in similar type of design on Indian population (Natu & Agarwal, 1997). A sample worksheet of letter copying task is given in **Appendix-4**.

5.3.2.A Testing procedure

The letter copying task determined the psychomotor and motor speed components of the digit-letter substitution task as has been described elsewhere (Morrens, Hulstijn & Sabbe, 2008). Participants were given the same worksheets as for the DLST, however, in this task, participants did not have to attempt to substitute digits for letters based on the key provided. Instead, they were asked to fill in all the boxes provided with a single letter using their dominant hand. This was the first letter mentioned in the digit-letter substitution key. They were given 90 seconds to do this. This task was completed by all 57 participants. The total number of letters filled in was counted and each letter was scored as '1'.

5.3.2.B Reliability and validity of the task

The letter copying task is a derived task from a standard task i.e., digit-letter substitution task (DLST) which has undergone the required norms for reliability and validity.

5.3.3 Circle dotting task (CDT)

Circle dotting task require attention and a repetitive motor response. A circle dotting task was administered to assess functions such as attention and a repetitive motor response. A sample worksheet of circle dotting task is given in **Appendix-5**.

5.3.3.A Testing procedure

In the circle dotting task, the targets were two circles drawn on paper, 6 cm in diameter with 24.5 cm between their centers. In this paper-and-pencil task, participants were asked to make a dot within the circumference of both circles alternately, using their dominant hand, as rapidly as possible. This task is based on a standard “circle-dotting task” for motor speed (Lezak, 1995). They were given 90 seconds to complete the task. Only those dots which were actually within the circumference of either circle were counted. Those which were on the circumference were not counted. Separate scores (where one correctly placed dot was scored as ‘1’) were noted for the circle on the left and the circle on the right.

For all tasks, the task sheets were scored by a person who was unaware whether the participant was in a cyclic meditation or supine rest session and whether the assessment was made at the beginning or at the end of a session.

5.3.3.B Reliability and validity of the task

The circle dotting task is a derived task from a standard task i.e., finger tapping task which has undergone the required norms for reliability and validity.

5.3.4 Wechsler Memory Scale (WMS)

Changes are seen in two brain areas associated with memory i.e., (i) The frontal lobe which controls certain executive memory processes and (ii) hippocampus leading to the deterioration of explicit memory capacities. Also, studies have shown that both short term and long term memories change as one gets older. Hence, attention and concentration (digit span forward and backward), and associate learning (easy and hard), sections of the WMS were used in this study. A sample worksheet of WMS is given in **Appendix-6**.

5.3.4.A Testing procedure

Assessments were made individually while participants were seated at ease. The answers were recorded on a separate sheet for each subject. Since the questionnaire was already evaluated for reliability and validity for use in an Indian population, the standardized English version of the questionnaire was administered in the present study. As this test was administered at the beginning and at the end of the interventions which were for 22:30 minutes, to avoid any retest effect parallel worksheets were prepared as has been done for the Logical Memory subtest of the WMS-Revised, by changing the digits and words to eliminate serial testing artifacts when retesting (Morris, Kunka, & Rossini, 1997).

In the present study, the following components of memory were tested using sections of the Wechsler memory scale i.e., (i) attention and concentration (digit span forward and backward), and (ii) associate learning (easy and hard). Each section had 10 items in it. (i) digit span forward and backward (each correct answer was scored as “1” and the sum of all correct answers for digit span forward

and backward were recorded separately), and (ii) associate learning (each easy answer was scored as “1” and difficult or (hard) answer as “2”).

5.3.5 State anxiety inventory (STAI)

State anxiety was assessed using standard self-report questionnaire such as the State Anxiety Inventory (STAI). A sample questionnaire of STAI is given in **Appendix-6**.

5.3.5.A Testing procedure

The anxiety levels were assessed using the State Anxiety Inventory (STAI) (Spielberger, 1970). This is a well known self-report questionnaire for measuring two distinct anxiety concepts: state (current) and trait (dispositional). The STAI consists of two independent scales, which measures state and trait anxiety with 20 items each. The S-Anxiety scale (STAI) consists of twenty statements that evaluate how the respondent feels "right now, at this moment". In responding to the S-Anxiety scale, the participants choose the number that best describes the intensity of their feelings on a four-point scale: (1) not at all, (2) somewhat, (3) moderately so, and (4) very much so. Each STAI item is given a weighted score of 1 to 4. A rating of 4 indicates the presence of high levels of anxiety for ten S-Anxiety items (#3, 4, 6, 7, 9, 12, 13, 14, 17 and 18). A high rating indicates the absence of anxiety for the remaining ten S-Anxiety items. The scoring weights for the anxiety-present items are the same as the chosen numbers on the test form. The scoring weights for the anxiety absent items are reversed. Scores for the S-Anxiety scale can vary from a minimum of 20 to a maximum of 80. Scores between 20 and 40 indicate mild anxiety, between 40 and 60 indicate moderate anxiety and above

60 indicate severe anxiety. The scale has shown excellent reliability and validity across populations (Spielberger, 1989).

Assessments were made individually. The answers were recorded on a separate sheet for each participant. The test was administered at the beginning and at the end of the interventions which were for 22:30 minutes.

For all the tests task sheets were blind scored by a person who was unaware whether the participant was in a CM or a SR session and whether the assessment was made at the beginning or at the end of a session.

5.3.5.B Reliability and validity of the test

State Trait Anxiety Inventory (STAI) has been used widely in earlier studies on Indian populations and has a concurrent validity ranging from 0.75 to 0.80 with other tests (Spielberger, Gorsuch et.al, 1970). The scale has shown excellent reliability and validity across populations (Spielberger, 1989).

5.3.6 Computer averaged midlatency auditory evoked potentials (MLAEPs).

5.3.6. A Rationale for studying middle range of evoked potentials.

MLAEPs were chosen for this study with the premise that the conscious processes of meditation actively involved several cortical mechanisms and that corticofugal controls may exert significant alterations in the processing of information at the brainstem and thalamic levels (Steriade & Llinas, 1988; Telles, Joseph, Venkatesh & Desiraju, 1992; Raghuraj & Telles, 2004). Hence it was preferred to work out in detail changes in the mesencephalon-diencephalon and primary auditory cortex levels which are the generators for MLAEPs (Liégeois-Chauvel, Musolino, Badier, Marquis & Chauvel, 1994). The midlatency auditory evoked potentials were recorded using Nicolet Bravo System (USA). **Figure 8** shows the Nicolet Bravo EP 4- channels amplifier and closed circuit T.V.

5.3.6. B Specifications of Nicolet Bravo System

The Bravo EP (Nicolet, USA) is a 4-channel evoked potential acquisition and review system with options of performing wide variety of tests such as Auditory, Somatosensory, Visual Evoked Potentials and P300 Event Related Potentials (ERP). The Bravo EP amplifier has 4 acquisition channels, a head-box for electrode connections and a LED electrode impedance panel. To perform AEP tests, acoustically shielded earphone is used to deliver either 'tone' or 'click' stimulus. The acoustic stimulus intensity (in dB) has the following options: sound pressure level (SPL), peak sound pressure level (pSPL), peak equivalent sound pressure level (peSPL) and normal hearing level (nHL). In this study normal hearing level (nHL) was used for acquisition. The Bravo EP has optional software package which allows running P300 cognitive response test. The main features of the

P300 optional software include 4-channel recording and independent averaging for frequent and rare stimuli (Nicolet Biomedical Inc., 1998). Percent error calculated for Nicolet Bravo System was 0.03 percent.

Figure 8: Bravo Evoked Potentials System, Nicolet, USA.



Nicolet Bravo system (Nicolet Biomedicals, U.S.A.) a 4-channel EP acquisition and analysis system with a closed circuit TV on the left.

A subject seated in a sound attenuated cabin with electrodes at Cz (active) referred to linked ear lobe and a ground electrode (FPz), with acoustically shielded ear phones to deliver binaural clicks during the recording of MLAEPs.



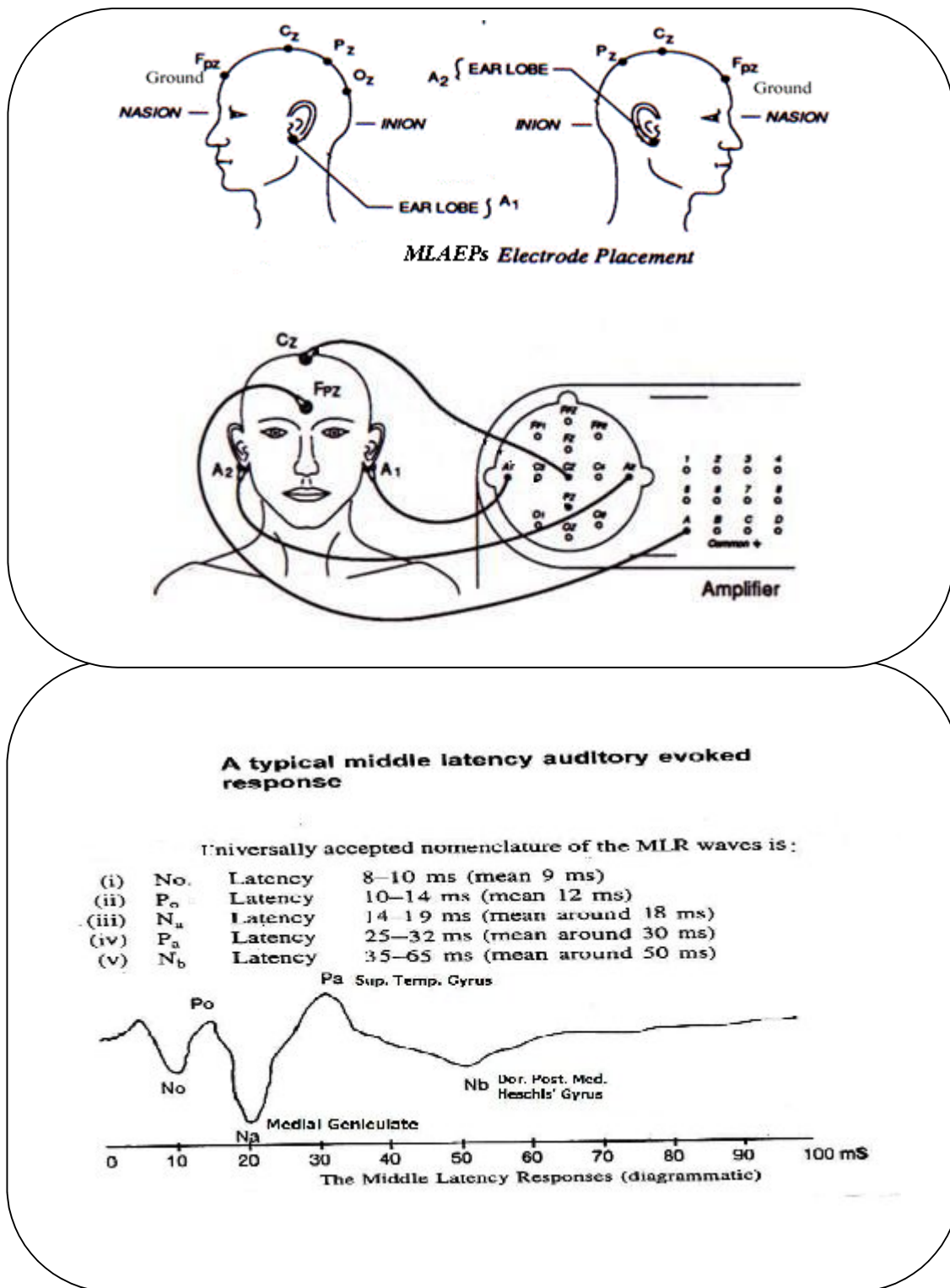
5.3.6. C Recording condition

The participants were individually assessed in a sound attenuated and dimly lit cabin with eyes closed. The recording leads were led out of the cabin, and connected to the Nicolet Bravo System (USA). The participants were monitored on a closed-circuit television and instructions were given through two-way intercom, so that participants could remain undisturbed during a session.

5.3.6. D Electrode positions

Silver chloride disk electrodes were affixed with electrode gel (Ten 20 conductive EEG paste, D.O. Weaver and Co. USA) at the Cz (vertex) scalp site, referred to linked earlobes (A1-A2) with a ground electrode on forehead (FPz). The placement of the electrode was done according to the International 10-20 system (Jasper, 1958). See **Figure 9**. In all cases, the electrode impedance was kept below 5 k Ω at all the sites.

Figure: 9: Electrode sites and schematic of latency and amplitude of midlatency responses.



5.3.6.E Amplifier settings

Midlatency auditory evoked potentials (MLAEPs) were recorded using the Nicolet Bravo System (U.S.A). The MLAEPs were computer averaged in 1500 trial sweeps, in the 10-100 ms range. The electroencephalographic (EEG) activity was amplified with a sensitivity of 50 μ V and filter bandpass 5 to 1000 Hz. The artifact rejection was kept at 90%. There was no pre-stimulus delay.

5.3.6.F Stimulus characteristics

Binaural click stimuli of alternating polarity and 50 μ s in duration with a frequency of 5 Hz were used to trigger online averaging of the EEG. The stimulus intensity was kept at 80 dBnHL which was shown in a previous study to be adequate to evoke the responses without disturbing the subjects' attention to the breathing practices (Telles, Joseph, Venkatesh & Desiraju, 1992; Raghuraj & Telles, 2004).

5.3.6.G Recording procedure

Participants were asked to avoid substances which influence cognitive performance (e.g., coffee, containing caffeine) for the day preceding and the day of the recording. Where this was unavoidable the session was taken on other day. Midlatency auditory evoked potentials were recorded in the eyes closed sitting position. A trial session was given to rule out any hearing deficit and their hearing threshold for each ear was determined separately by giving monaural click stimuli through close fitting ear phones (TDH-39, Amplivox, UK) See **Figure 8** Midlatency responses were recorded before and immediately after the intervention.

5.3.6.H Variables measured

The following variables were measured:

1. Peak latencies (ms) of midlatency responses of Na, Pa, and Nb waves were recorded from Cz position (vertex electrode site).
2. Peak amplitudes (μV) of midlatency responses of Na, Pa, and Nb waves recorded from Cz position (vertex electrode site).

5.4 INTERVENTIONS

5.4.1 Cyclic Meditation

During the cyclic meditation practice, 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 the yoga text, the *Mandukya Upanishad* (Chinmayananda, 1984); followed by isometric contraction of the muscles of the body ending with supine rest (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. in *tadasana* 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.). The postures were practiced slowly, with awareness of all the sensations felt. The total duration of the practice was 22:30 min. (Telles, Reddy & Nagendra, 2000; Sarang & Telles, 2006).

The key features of cyclic meditation are (i) postures interspersed with relaxation, (ii) slowness of movements, (iii) continuity, (iv) inner awareness, (v) feeling of heart beat, changes in blood flow and sound resonance, and (vi) recognition of linear, surface, three-dimensional and all pervasive awareness. The

principle of cyclic meditation and its practical details are elaborated in section ‘literary research on CM’ **Figure 5** section as well as in **Appendix-1**.

5.4.2 Supine rest

Supine rest was practiced as traditional *śavāsana* (the corpse posture), 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 (Muktibodhananda, 2004). This practice lasted 22:30 min., so that the duration was the same as for CM.

5.4.3 Control session

During this session, the participants were seated and their thoughts wandered at random. They were not given any other specific instructions, except for the fact that they were told that they were to avoid meditating. This practice lasted for 22:30 min., the session was also at the same time of the day as the CM and SR sessions.

5.5 DATA EXTRACTION

5.5.1 Digit-letter substitution task:

Digit letter substitution task consisted of a worksheet on which digits (1-9) were arranged randomly in 12 rows and 8 columns (Natu & Agarwal, 1997). A code of 'letter-for-digit' was shown on the top. Participants were required to write down as many letter-for-digit substitutions as possible in 90 seconds. They were told that there were two possible strategies, i.e., marking all nine digits in the random order they occurred, or selecting any one digit at a time. They were to choose whichever strategy suited them. They were also told that they could follow a horizontal, vertical or a random path according to their choice. The total number of substitutions were counted and each substitution scored as '1'. Where the wrong letter was substituted these 'errors' were counted, (also as '1' each) and totalled as 'Wrongly attempted'. The total number of substitutions and wrong substitutions were scored as described and the net scores were calculated by deducting wrong substitutions from the total substitutions attempted.

As this test was administered at the beginning and at the end of the interventions, which required 22:30 minutes, to avoid any retest effect parallel worksheets were prepared by changing the digit-letter pairs in the 'key' and by randomly changing the sequence of digits in the working section (Agarwal, Kalra, Natu, Dadhich & Deswal, 2002). Hence, 50 percent of the participants (n=29) received one set of worksheets (A) before a session, while the other 50 percent (n=28) received worksheet B before the session. After the session, those who received worksheet A before the session received worksheet B after the session.

This was reversed for the remaining participants. Similarly, there were different worksheets for the remaining sessions. The digit letter substitution task has been used in a similar design in an Indian population, which indicated the validity of the task to study immediate effects (Natu & Agarwal, 1997).

5.5.2 Letter-copying task:

The letter copying task determined the psychomotor and motor speed component of the digit-letter substitution task as has been described elsewhere (Morrens, Hulstijn & Sabbe, 2008). Participants were given the same worksheets as for the DLST, however in this task, participants did not have to attempt to substitute digits for letters based on the key provided. Instead, they were asked to fill in all the boxes provided with a single letter using their dominant hand. This was the first letter mentioned in the digit-letter substitution code. They were given 90 seconds to do this. This task was completed by all 57 participants. The total number of letters filled in were counted and each letter was scored as '1'.

5.5.3 Circle dotting task:

In the circle dotting task, the targets were two circles drawn on paper, 6 cm in diameter with 24.5 cm between their centers. In this paper and pencil task, participants were asked to make a dot within the circumference of both circles alternately, using their dominant hand, as rapidly as possible. This task is based on a standard 'circle dotting task' for motor speed (Lezak, 1995). They were given 90 seconds to complete the task. Only those dots which were actually within the circumference of either circle were counted. Those which were on the

circumference were not counted. Separate scores (where one correctly placed dot was scored as '1') were noted for the circle on the left and the circle on the right.

For all tasks, the task sheets were blind scored by a person who was unaware whether the participant was in a cyclic meditation or supine rest session and whether the assessment was made at the beginning or at the end of a session.

5.5.4 Wechsler memory scale:

Assessments were made individually while subjects were seated at ease. The answers were recorded on a separate sheet for each subject. Since the questionnaire was already evaluated for reliability and validity for use in an Indian population, the standardized English version of the questionnaire was administered in the present study. As this test was administered at the beginning and at the end of the interventions which were for 22:30 minutes, to avoid any retest effect parallel worksheets were prepared as has been done for the Logical Memory subtest of the WMS-Revised, by changing the digits and words to eliminate serial testing artifacts when retesting (Morris, Kunka, & Rossini, 1997).

In the present study, the following components of memory were tested using sections of the Wechsler memory scale i.e., (i) attention and concentration (digit span forward and backward), and (ii) associate learning (easy and hard). Each section had 10 items in it. (i) digit span forward and backward (each correct answer was scored as "1" and the sum of all correct answers for digit span forward and backward were recorded separately), and (ii) associate learning (each easy answer was scored as "1" and difficult or (hard) answer as "2").

5.5.5 State anxiety inventory (STAI):

The anxiety levels were assessed using the State Anxiety Inventory (STAI) (Spielberger, 1970). This is a well known self-report questionnaire for measuring two distinct anxiety concepts: state (current) and trait (dispositional). The STAI consists of two independent scales, which measures state and trait anxiety with 20 items each. The S-Anxiety scale (STAI) consists of twenty statements that evaluate how the respondent feels "right now, at this moment". In responding to the S-Anxiety scale, the subjects choose the number that best describes the intensity of their feelings on a four-point scale: (1) not at all, (2) somewhat, (3) moderately so, and (4) very much so. Each STAI item is given a weighted score of 1 to 4. A rating of 4 indicates the presence of high levels of anxiety for ten S-Anxiety items (#3, 4, 6, 7, 9, 12, 13, 14, 17 and 18). A high rating indicates the absence of anxiety for the remaining ten S-Anxiety items. The scoring weights for the anxiety-present items are the same as the chosen numbers on the test form. The scoring weights for the anxiety absent items are reversed. Scores for the S-Anxiety scale can vary from a minimum of 20 to a maximum of 80. Scores between 20 and 40 indicate mild anxiety, between 40 and 60 indicate moderate anxiety and above 60 indicate severe anxiety. The scale has shown excellent reliability and validity across populations (Spielberger, 1989).

Assessments were made individually. The answers were recorded on a separate sheet for each subject. The test was administered at the beginning and at the end of the interventions which were for 22:30 minutes.

For all the tests task sheets were blind scored by a person who was unaware whether the participant was in a CM or a SR session and whether the assessment was made at the beginning or at the end of a session.

5.5.6.A Computer averaged midlatency auditory evoked potentials (MLAEPs):

The Na, Pa and Nb waves were studied. These waves were detected in relation to the Pa wave (Morlet, Bertrand, Salord, Boulieu, Pernier & Fischer, 1997), as it appears to be most the prominent, robust and stable component in adults (Kileny, Paccioretti & Wilson, 1987), as follows: the Na wave was the maximum negative peak preceding the Pa wave, which is a positive component occurring between 25 and 32 ms. The Nb wave was taken as the first maximum negative component immediately following the Pa wave. Computerized quantification of peak amplitudes and peak latencies of these three waves was made with the pre-stimulus baseline as reference. **See Figure 10.**

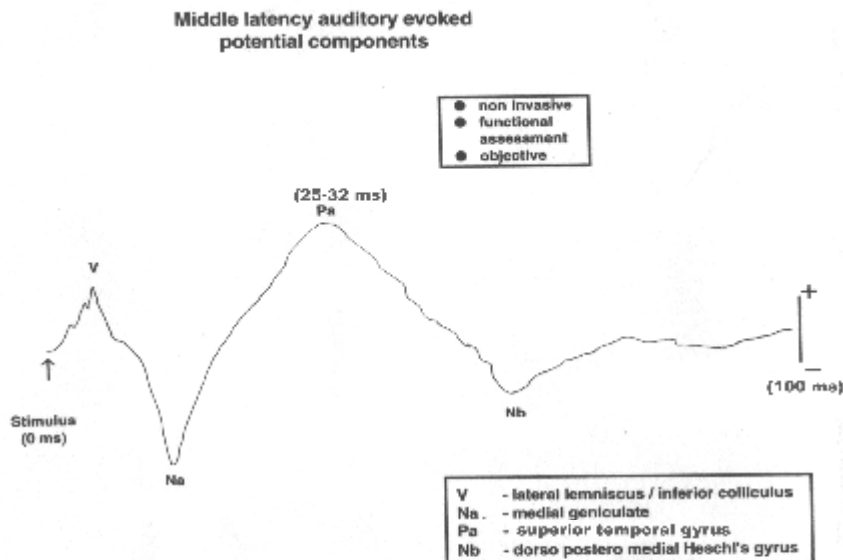


Figure 10: A typical tracing of midlatency auditory evoked potentials

The waveforms were visually inspected off-line for artifact and the peak latency and the peak amplitude were obtained by selection with the cursor. The selection was performed by the experimenter. A sample record of middle latency responses using Nicolet Bravo EP system (U.S.A.) is presented in **Figure 11**.

5.5.6.B Neural generators for MLAEPs:

Peak latency (msec) is defined as the time from stimulus onset to the point of maximum positive amplitude within the latency window. Peak amplitude (μV) is defined as the voltage difference between a pre stimulus baseline and the largest positive going peak within a given latency window.

The latencies and the neural generators for the 3 MLAEP components are given below:

MLAEP components	Latency (msec)	Neural Generator
Na wave	14-19	Medial geniculate body
Pa wave	25-32	Superior temporal gyrus
Nb wave	35-65	Dorso-posterior-medial part of the Heschl's gyrus i.e., the primary auditory cortex

5.6 DATA ANALYSIS

The raw data obtained for each subject in each recording session were tabulated separately. Statistical analysis was done using SPSS (Version 10.0) in the following steps:

- (i) The group mean and standard deviation were calculated and data were tested for variance and normal distribution by F-test and Kolmogorov-Smirnov test respectively.
- (ii) For the normally distributed data, repeated measures analyses of variance (ANOVA) were performed with two 'Within subjects' factors, i.e., Factor 1: Sessions; CM and SR and Factor 2: States; 'Pre', & 'Post' in case of all psychological variables and 'Pre', 'Post 1', 'Post 2', and 'Post 3' in case of MLAEPs. These repeated measures ANOVA were carried out for each variable separately.
- (iii) Subsequently, *post-hoc* tests with Bonferroni adjustment were performed to compare the data of the 'Post' period in case of all psychological variables with those of the respective 'Pre' period and also the different states were compared between sessions, and *Post-hoc* analyses with least significant difference were performed to compare the data of the 'Post 1', 'Post 2', and the 'Post 3' periods in case of MLAEPs (as MLAEPs show small, difficult to detect changes).

Table 12: Time allocation within the sessions while recording psychological variables.**Cyclic meditation session**

Pre assessment	←-----Cyclic meditation (22:30 minutes: eyes closed)-----→				Post assessment
	D1 5 minutes	D2 5 minutes	D3 5 minutes	D4 7:30 minutes	
Sitting position	Prayer IRT Linear awareness Standing up <i>Tāḍāsana</i> Centering Observation of changes <i>Ardhakaṭīcakraśana</i> (Right side)	Observation of changes <i>Ardhakaṭīcakraśana</i> (Left side) Observation of changes Balance <i>Pādahastāsana</i>	Observation of changes <i>Ardhacakraśana</i> Observation of changes Lying down Linear awareness Surface awareness Part by part relaxation	DRT 'A' chanting 'U' chanting 'M' chanting AUM chanting Coming out of body Merging with sky <i>Sukhāsana</i> Prayer	Sitting position

Supine rest session

Pre assessment	←-----Supine rest (22:30 minutes: eyes closed)-----→				Post assessment
	D1 5 minutes	D2 5 minutes	D3 5 minutes	D4 7:30 minutes	
Sitting position	Supine rest	Supine rest	Supine rest	Supine rest	Sitting position

Note: D1 to D4 = Phases of During state (no recording), IRT = Instant relaxation technique (Journal of Indian Psychology, 1999, 17, 46-52) DRT = Deep relaxation technique (Psychological Reports, 2002, 90, 487-494).

Table 13: Time allocation within the sessions while recording midlatency auditory evoked potentials.**Cyclic meditation session**

Pre 5 minutes (eyes closed)	←-----Cyclic meditation (22:30 minutes: eyes closed)-----→				Post 15 minutes (eyes closed)
	D1 5 minutes	D2 5 minutes	D3 5 minutes	D4 7:30 minutes	
Sitting position	Prayer IRT Linear awareness Standing up <i>Tāḍāsana</i> Centering Observation of changes <i>Ardhakaṭīcakraśana</i> (Right side)	Observation of changes <i>Ardhakaṭīcakraśana</i> (Left side) Observation of changes Balance <i>Pādahastāsana</i>	Observation of changes <i>Ardhacakraśana</i> Observation of changes Lying down Linear awareness Surface awareness Part by part relaxation	DRT 'A' chanting 'U' chanting 'M' chanting AUM chanting Coming out of body Merging with sky <i>Sukhāsana</i> Prayer	Sitting position

Supine rest session

Pre 5 minutes (eyes closed)	←-----Supine rest (22:30 minutes: eyes closed)-----→				Post 15 minutes (eyes closed)
	D1 5 minutes	D2 5 minutes	D3 5 minutes	D4 7:30 minutes	
Sitting position	Supine rest	Supine rest	Supine rest	Supine rest	Sitting position

Note: D1 to D4 = Phases of During state (no recording), IRT = Instant relaxation technique (Journal of Indian Psychology, 1999, 17, 46-52) DRT = Deep relaxation technique

CHAPTER-6

Results

The results of the variables studied during two yoga relaxation sessions i.e., cyclic meditation (CM) and supine rest (SR) are described under the two main categories of variables. These are (i) digit-letter substitution task, letter copying task, circle dotting task, Wechsler memory scale and state anxiety recorded before and after the interventions, and (ii) midlatency auditory evoked potentials (MLAEPs) recorded before and after (where 'post' being longer than the 'pre') the interventions.

6.1 DIGIT LETTER SUBSTITUTION TASK [DLST]

6.1.1 Recapitulation

The digit-letter substitution task was administered in fifty-seven participants in three types of sessions, viz., (i) cyclic meditation, (ii) supine rest, and (iii) control. As described under Methods (data analysis), separate repeated measures ANOVAs were performed to compare the Pre and Post states of three sessions. Assessments were made immediately at the beginning and end of each session. Separate sessions were conducted for each of the assessments. The data were analyzed using the repeated measures analyses of variance (ANOVAs) with two Within Subjects Factors, i.e., States, with two levels (pre and post) and Sessions, with three levels (cyclic meditation (CM), supine rest (SR) and a control (CT)). *Post-hoc* tests with Bonferroni adjustment were used to detect significant differences between mean values. The group average values \pm S.D. are given in **Table 14**.

Table 14: Scores obtained in a Digit-Letter Substitution Task, Before and After Cyclic Meditation (CM), Supine Rest (SR), and Control (CT) Sessions. Values are groups mean \pm S.D.

Variables	State	Session		
		Cyclic Meditation (CM) [n = 57]	Supine Rest (SR) [n = 57]	Control (CT) [n = 57]
Total Substitutions	Pre	51.79 \pm 9.21	51.68 \pm 11.16	51.86 \pm 9.42
	Post	62.60 \pm 9.88***@@@	53.33 \pm 10.34	53.26 \pm 8.59
Wrong Substitutions	Pre	0.18 \pm 0.43	0.35 \pm 0.74	0.30 \pm 0.57
	Post	0.11 \pm 0.36@@@	0.53 \pm 1.14	0.53 \pm 0.89
Net Substitutions	Pre	51.61 \pm 9.19	51.33 \pm 10.88	51.56 \pm 9.36
	Post	62.49 \pm 9.85***@@@	52.81 \pm 9.95	52.74 \pm 8.62

** $p < 0.01$, *** $p < 0.001$, RM ANOVA, with Bonferroni adjustment, before compared with after of respective session.

@@@ $p < 0.001$, RM ANOVA, with Bonferroni adjustment, after CM compared with after SR and after CT sessions.

6.1.2 Total score, score for wrong substitutions and net score

The total number of substitutions and wrong substitutions were scored and the net scores were calculated by deducting wrong substitutions from the total substitutions attempted.

The repeated measures analyses of variance (ANOVAs) showed a significant difference between the three types of sessions (i.e., CM, SR and CT) for (i) total scores ($F = 8.95$, $df = 1.453, 81.384$, $p < 0.001$, Huynh-Feldt epsilon = 0.73; $\eta^2 = 0.33$), (ii) errors or wrong substitutions ($F = 0.70$, $df = 1.534, 85.905$, $p < 0.004$, Huynh-Feldt epsilon = 0.77; $\eta^2 = 0.07$), and (iii) net scores ($F = 10.26$, $df = 1.391, 77.895$, $p < 0.001$, Huynh-Feldt epsilon = 0.70; $\eta^2 = 0.36$).

There was a significant difference between the two States for (i) total scores ($F = 119.32$, $df = 1, 56$, $p < 0.001$, Huynh-Feldt epsilon = 1.000; $\eta^2 = 0.10$), and (ii) net scores ($F = 115.83$, $df = 1, 56$, $p < 0.001$, Huynh-Feldt epsilon = 1.000; $\eta^2 = 0.11$).

There was a significant difference in the interaction between Sessions and States for (i) total scores ($F = 66.67$, $df = 1.822, 102.042$, $p < 0.001$, Huynh-Feldt epsilon = 0.88; $\eta^2 = 0.41$) and (ii) net scores ($F = 73.84$, $df = 1.828, 102.356$, $p < 0.001$, Huynh-Feldt epsilon = 0.91; $\eta^2 = 0.43$), suggesting the two factors were not independent of each other.

Post-hoc tests for multiple comparisons were performed with Bonferroni adjustment and all comparisons were made with the respective before states. After cyclic meditation there was a significant increase in total scores ($p < 0.001$) and net scores ($p < 0.001$), compared to before. Also, the scores after cyclic meditation

were significantly different from scores after both supine rest and control sessions for total scores ($p < 0.001$), errors or wrong substitutions (CM Vs SR, $p < 0.021$; CM Vs CT, 0.002; SR Vs CT, $p < 0.001$) and net scores ($p < 0.001$).

See **Figure 12**, **Figure 13** and **Figure 14**. The group average values \pm S.D. are given in **Table 14**. The actual data of individual participants in CM, SR and control sessions are presented in **Table 25** and **Table 26** (See **Appendix -8**)

Figure 12: Total score in digit-letter substitution task, Before and After Cyclic Meditation (CM), Supine Rest (SR), and Control (CT) Sessions. Values are groups mean \pm S.D.

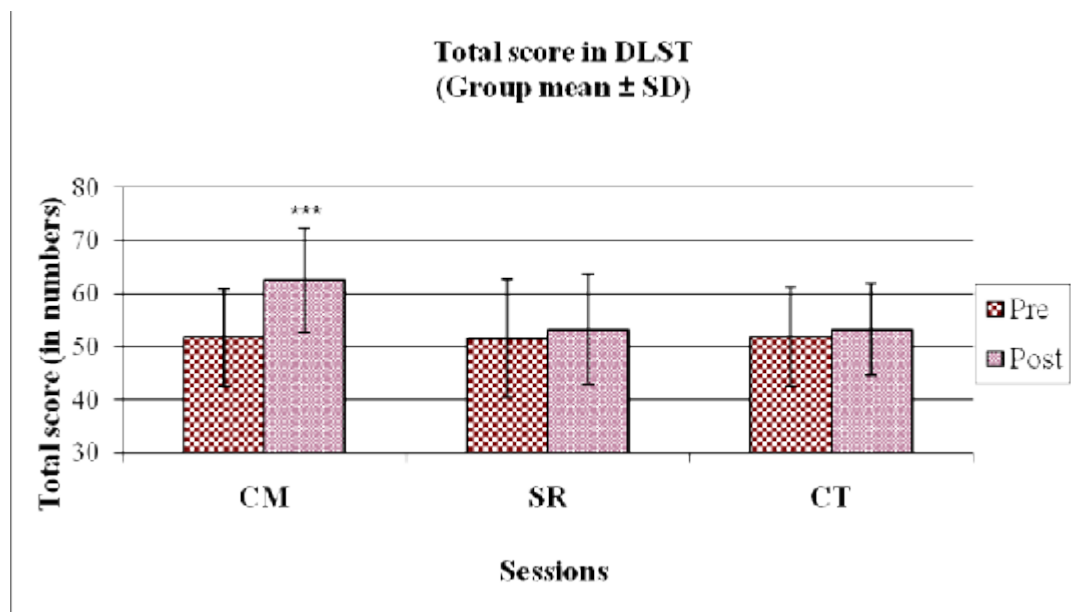


Figure 13: Net score in digit-letter substitution task, Before and After Cyclic Meditation (CM), Supine Rest (SR), and Control (CT) Sessions. Values are groups mean \pm S.D.

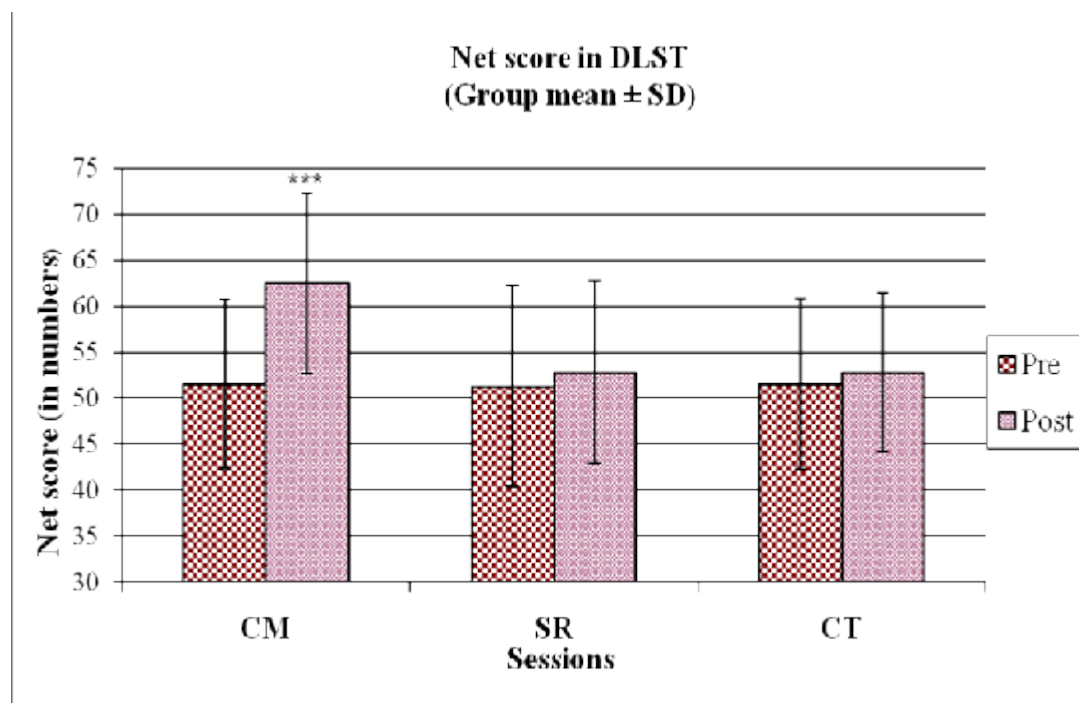
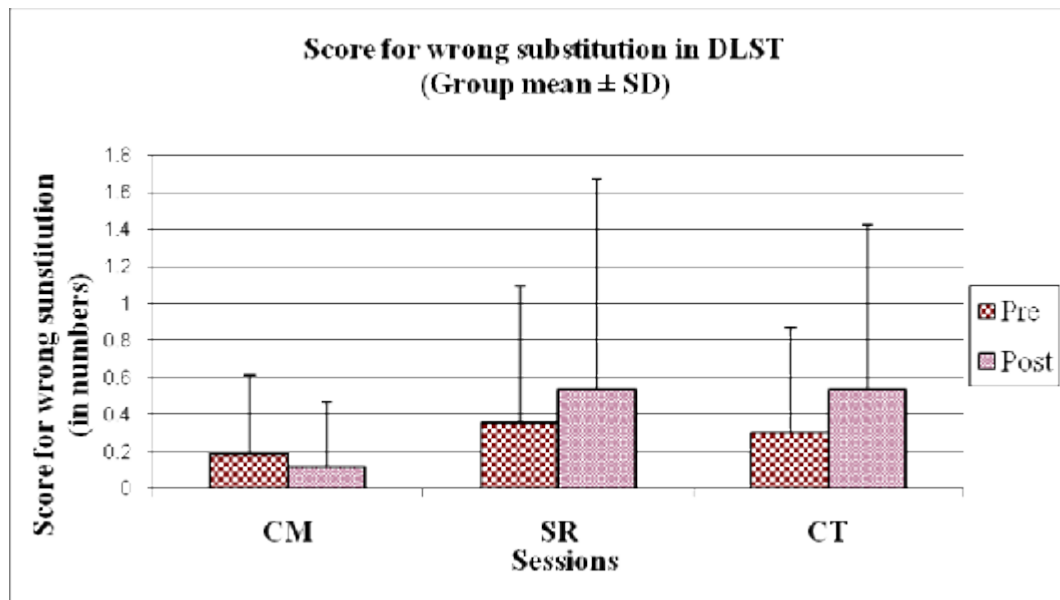


Figure 14: Score for wrong substitution in digit-letter substitution task, Before and After Cyclic Meditation (CM), Supine Rest (SR), and Control (CT) Sessions. Values are groups mean \pm S.D.



6.2 LETTER COPYING TASK [LCT]

6.2.1 Recapitulation

The letter copying task was administered in fifty-seven participants in three types of sessions, viz., (i) cyclic meditation, (ii) supine rest, and (iii) control. As described under Methods (data analysis), separate repeated measures ANOVAs were performed to compare the Pre and Post states of three sessions. Assessments were made immediately at the beginning and end of each session. Separate sessions were conducted for each of the assessments. The data were analyzed using the repeated measures analyses of variance (ANOVAs) with two Within Subjects Factors, i.e., States, with two levels (pre and post) and Sessions, with three levels (cyclic meditation (CM), supine rest (SR) and a control (CT)). *Post-hoc* tests with Bonferroni adjustment were used to detect significant differences between mean values. The group average values \pm S.D. are given in **Table 15**.

Table 15: Total score in letter copying task, Before and After Cyclic Meditation (CM), Supine Rest (SR), and Control (CT) Sessions. Values are groups mean \pm S.D.

Variable	State	Session		
		Cyclic Meditation (CM) [n = 57]	Supine Rest (SR) [n = 57]	Control (CT) [n = 57]
Total attempted	Pre	86.93 \pm 13.41	86.42 \pm 12.67	85.32 \pm 10.95
	Post	98.44 \pm 13.24***@@@	90.16 \pm 10.94***	86.82 \pm 9.36

** $p < 0.01$, *** $p < 0.001$, RM ANOVA, with Bonferroni adjustment, before compared with after of respective session.

@@@ $p < 0.001$, RM ANOVA, with Bonferroni adjustment, after CM compared with after SR and after CT sessions.

6.2.2 Total score

The total scores of letter copying task were calculated before and after the practice of three types of sessions, viz., (i) cyclic meditation, (ii) supine rest, and (iii) control. The repeated measures ANOVAs showed a significant difference between the three Sessions (i.e., CM, SR and CT) for total scores ($F = 15.05$, $df = 1.185,66358$, $p < 0.001$, Huynh-Feldt epsilon = 0.58; $\eta^2 = 0.21$).

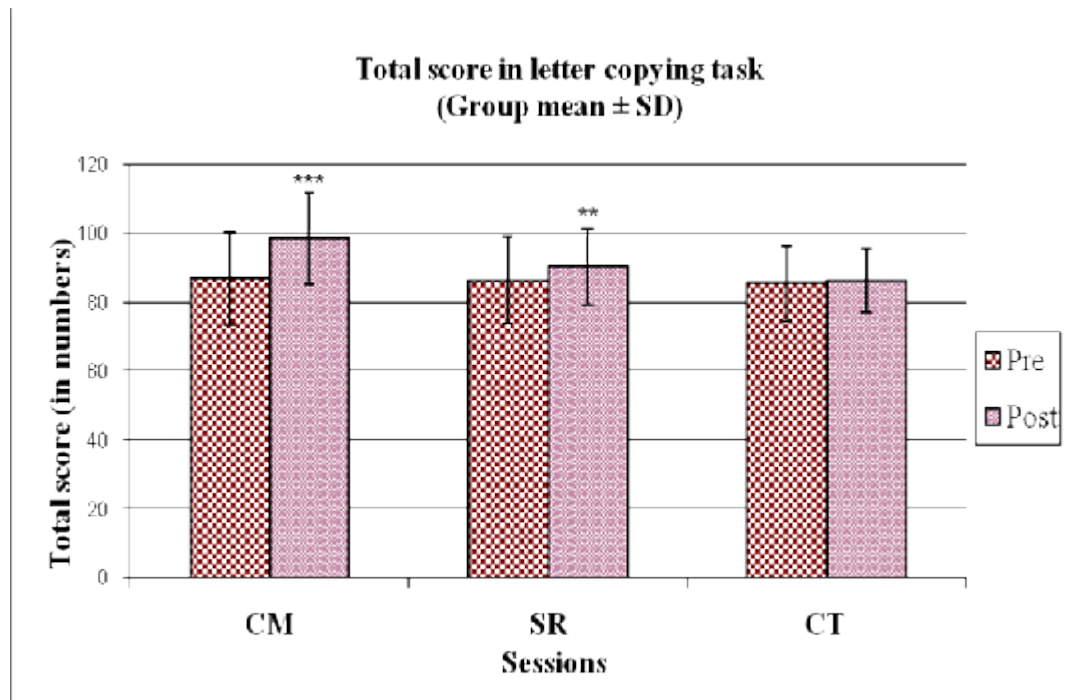
There was a significant difference between the two States for total scores ($F = 127.19$, $df = 1,56$, $p < 0.001$, Huynh-Feldt epsilon = 1.000; $\eta^2 = 0.69$).

There was a significant difference in the interaction between Sessions and States for total scores ($F = 88.54$, $df = 1.217,68.158$, $p < 0.001$, Huynh-Feldt epsilon = 0.60; $\eta^2 = 0.61$), suggesting the two factors were not independent of each other.

Post-hoc tests for multiple comparisons were performed with Bonferroni adjustment and all comparisons were made with the respective before states. There were significant increases in total scores of the letter copying task following CM ($p < 0.001$), SR ($p < 0.001$), and CT ($p < 0.002$) compared to the respective before values. Also, after cyclic meditation the scores were significantly different from the scores after both supine rest and control sessions ($p < 0.001$, for both comparisons).

See **Figure 15**, The group average values \pm S.D. are given in **Table 15**. The actual data of individual participants in CM, SR and control sessions are presented in **Table 27 and 28** (See **Appendix-8**).

Figure 15: Total score in letter-copying task, Before and After Cyclic Meditation (CM), Supine Rest (SR), and Control (CT) Sessions. Values are groups mean \pm S.D.



6.3 CIRCLE DOTTING TASK [CDT]

6.3.1 Recapitulation

The circle dotting task was administered in fifty-seven participants in three types of sessions, viz., (i) cyclic meditation, (ii) supine rest, and (iii) control. As described under Methods (data analysis), separate repeated measures ANOVAs were performed to compare the Pre and Post states of three sessions. Assessments were made immediately at the beginning and end of each session. Separate sessions were conducted for each of the assessments. The data were analyzed using the repeated measures analyses of variance (ANOVAs) with two Within Subjects Factors, i.e., States, with two levels (pre and post) and Sessions, with three levels (cyclic meditation (CM), supine rest (SR) and a control (CT)). *Post-hoc* tests with Bonferroni adjustment were used to detect significant differences between mean values. The group average values \pm S.D. are given in **Table 16**.

Table 16: Total score (left and right circle) in a circle dotting task, Before and After Cyclic Meditation (CM), Supine Rest (SR), and Control (CT) Sessions. Values are groups mean \pm S.D.

Variable	State	Session		
		Cyclic Meditation (CM) [n= 57]	Supine Rest (SR) [n = 57]	Control (CT) [n = 57]
Left circle	Pre	71.75 \pm 12.85	69.86 \pm 13.87	70.98 \pm 11.57
	Post	86.07 \pm 11.70***@@@	72.68 \pm 12.90***	72.33 \pm 9.62
Right circle	Pre	72.53 \pm 12.73	69.23 \pm 13.92	71.65 \pm 11.80
	Post	86.61 \pm 11.94***@@@	72.12 \pm 13.00***	72.44 \pm 9.48

** $p < 0.01$, *** $p < 0.001$, RM ANOVA, with Bonferroni adjustment, before compared with after of respective session.

@@@ $p < 0.001$, RM ANOVA, with Bonferroni adjustment, after CM compared with after SR and after CT sessions.

6.3.2 Total Scores of left circle and right circle

The total scores of left and right circle were calculated before and after the practice of three types of sessions, viz., (i) cyclic meditation, (ii) supine rest, and (iii) control. The repeated measures ANOVAs showed a significant difference between the three Sessions (i.e., CM, SR and CT) for both (i) left circle scores ($F = 23.42$, $df = 1.526, 85.437$, $p < 0.001$, Huynh-Feldt epsilon = 0.75; $\eta^2 = 0.30$), and (ii) right circle scores ($F = 28.06$, $df = 1.565, 87.66$, $p < 0.001$, Huynh-Feldt epsilon = 0.78; $\eta^2 = 0.33$).

Similarly, there was a significant difference between the two States for (i) left circle scores ($F = 106.69$, $df = 1, 56$, $p < 0.001$, Huynh-Feldt epsilon = 1.000; $\eta^2 = 0.66$), and (ii) right circle scores ($F = 104.15$, $df = 1, 56$, $p < 0.001$, Huynh-Feldt epsilon = 1.000; $\eta^2 = 0.65$).

Also, there was a significant difference in the interaction between Sessions and States for (i) left circle scores ($F = 66.63$, $df = 1.808, 101.248$, $p < 0.001$, Huynh-Feldt epsilon = 0.88; $\eta^2 = 0.54$), and (ii) right circle scores ($F = 77.21$, $df = 1.838, 102.911$, $p < 0.001$, Huynh-Feldt epsilon = 0.92; $\eta^2 = 0.58$), suggesting the two factors were not independent of each other.

Post-hoc tests for multiple comparisons were performed with Bonferroni adjustment and all comparisons were made with the respective before states. After CM and SR there were significant increases for (i) left circle scores ($p < 0.001$), and (ii) right circle scores ($p < 0.001$). Also, scores after cyclic meditation were significantly different from scores after both supine rest and control sessions for (i) left circle scores ($p < 0.001$) and (ii) right circle scores ($p < 0.001$).

See **Figure 16**, and **Figure 17**. The group average values \pm S.D. are given in **Table 16**. The actual data of individual participants in CM, SR and control sessions are presented in **Table 29 and Table 30** (See **Appendix-8**).

Pearson Correlation Coefficient

The Pearson correlation coefficient test was performed between the percentage changes in the three tasks, viz., (i) a digit-letter substitution task (DLST), (ii) a letter copying task, and (iii) a circle dotting task, and months of experience. There was a significant positive correlation between the percentage change in net scores in the digit letter substitution task after CM with experience of yoga, in months ($r = 0.30, p < 0.05, n = 57$).

Figure 16: Total score in circle dotting task (left circle), Before and After Cyclic Meditation (CM), Supine Rest (SR), and Control (CT) Sessions. Values are groups mean \pm S.D.

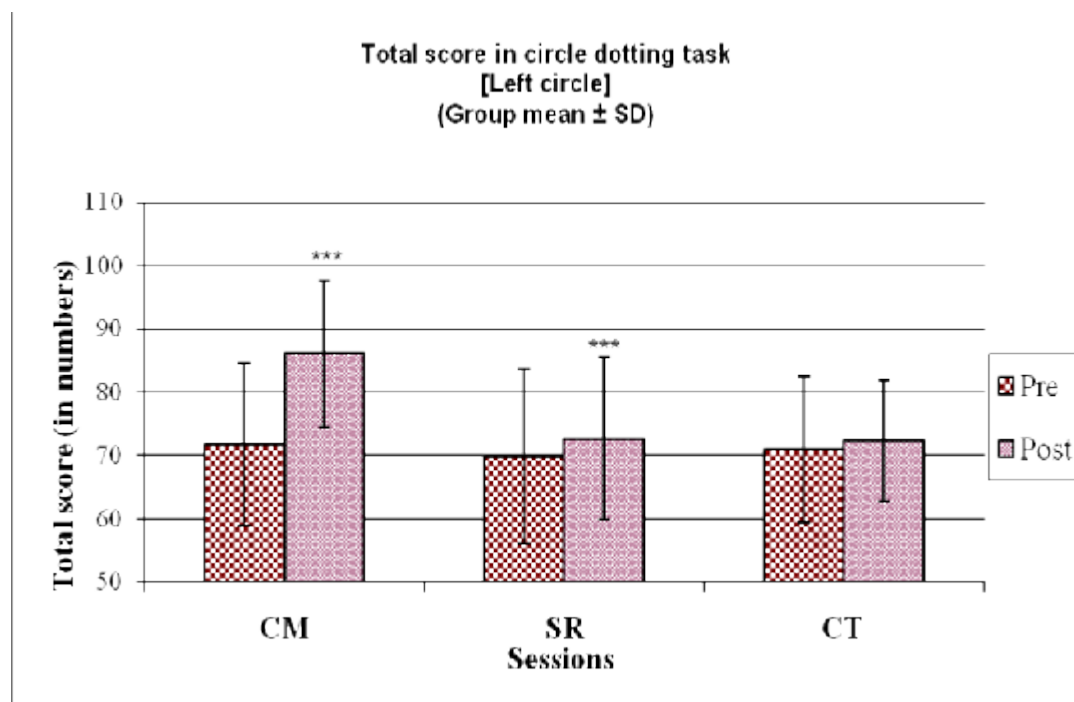
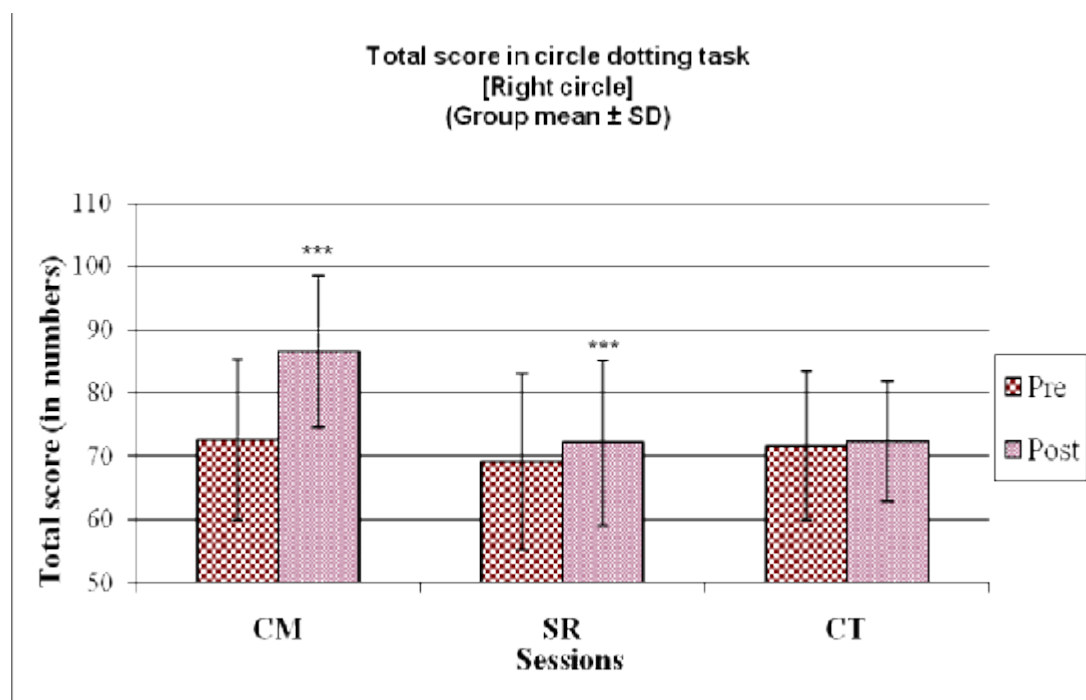


Figure 17: Total score in circle dotting task (right circle), Before and After Cyclic Meditation (CM), Supine Rest (SR), and Control (CT) Sessions. Values are groups mean \pm S.D.



6.4 WECHSLER MEMORY SCALE [WMS]

6.4.1 Recapitulation

A Wechsler memory scale was administered in fifty-seven participants in cyclic meditation and supine rest sessions. The different aspects of memory recorded using the Wechsler memory scale were (i) digit span (forward and backward) and (ii) associate learning (easy and hard). As described under Methods (data analysis), separate repeated measures ANOVAs were performed to compare the Pre and Post states of both the sessions. The study assessed the short term effect of two different yoga relaxation techniques on the performance in sub-sections of the Wechsler memory scale. The data were analyzed using the repeated measures analyses of variance (ANOVAs) with two Within Subjects Factors, i.e., (i) States, with two levels (pre and post) and (ii) Sessions, with two levels (CM and SR). *Post-hoc* tests with Bonferroni adjustment were used to detect significant differences between mean values. The group average values \pm S.D. are given in **Table 17**.

Table 17: Scores obtained in the sections of the Wechsler memory scale before and after Cyclic Meditation and Supine Rest. Values are groups mean \pm S.D.

Variable	State	Session	
		Cyclic meditation (CM) [n=57]	Supine Rest (SR) [n=57]
Digit span Forward	Pre	6.28 \pm 1.40	6.33 \pm 0.89
	Post	8.02 \pm 1.29***	7.35 \pm 0.95***
Digit span Backward	Pre	5.07 \pm 1.47	6.28 \pm 0.65
	Post	6.77 \pm 1.35***	6.86 \pm 0.83***
Associate learning- easy	Pre	14.30 \pm 2.04	14.09 \pm 1.88
	Post	17.26 \pm 0.84***	15.42 \pm 1.63***
Associate learning- hard	Pre	14.04 \pm 3.77	14.18 \pm 2.40
	Post	19.33 \pm 2.91***	15.68 \pm 2.67***

*** p <0.001, RM ANOVA, with Bonferroni adjustment, before compared with after of CM or of the respective SR session

6.4.2 Digit span (forward and backward) and associate learning (easy and hard)

5.4.2.A Digit span forward:

The scores of digit span forward were calculated before and after the practice of cyclic meditation and supine rest session. The digit span forward showed a significant difference between the two Sessions ($F = 4.073$, $df = 1,56$, $p < 0.048$, Huynh-Feldt epsilon = 1.000), and the two States ($F = 286.378$, $df = 1,56$, $p < 0.001$, Huynh-Feldt epsilon = 1.000). Also, there was a significant difference in interaction between Sessions and States ($F = 13.372$, $df = 1,56$, $p < 0.001$, Huynh-Feldt epsilon = 1.000), suggesting the two factors were not independent of each other.

Post-hoc tests for multiple comparisons performed with Bonferroni adjustment showed digit span forward scores after CM were significantly more than before ($p < 0.001$). Also, when the digit span forward scores after CM were compared to those after SR, they were significantly different ($p < 0.001$).

See **Figure 18**. The group average values \pm S.D. are given in **Table 17**. The actual data of individual participants in CM and SR are presented in **Table 5.4.2**. (See **Appendix-8**).

5.4.2.B Digit span backward:

The scores of digit span backward were calculated before and after the practice of cyclic meditation and supine rest session. The digit span backward showed a significant difference between the two Sessions ($F = 15.734$, $df = 1,56$, $p < 0.001$, Huynh-Feldt epsilon = 1.000), and the two States ($F = 124.363$, $df = 1,56$, $p < 0.001$, Huynh-Feldt epsilon = 1.000). Also, there was a significant difference in

interaction between Sessions and States ($F = 37.913$, $df = 1,56$, $p < 0.001$, Huynh-Feldt epsilon = 1.000), suggesting the two factors were not independent of each other.

Post-hoc tests for multiple comparisons performed with Bonferroni adjustment showed digit span backward scores increased after CM ($p < 0.001$). Also, when the digit span backward scores after CM were compared to those after SR, they were significantly different ($p < 0.001$). See **Figure 19**. The group average values \pm S.D. are given in **Table 17**. The actual data of individual participants in CM and SR sessions are presented in **Table 31**. (See **Appendix-8**).

6.4.2.C Associate learning - easy:

The scores of associate learning (easy) were calculated before and after the practice of cyclic meditation and supine rest session. The associate learning (easy) showed a significant difference between the two Sessions ($F = 16.464$, $df = 1,56$, $p < 0.001$, Huynh-Feldt epsilon = 1.000), and the two States ($F = 237.857$, $df = 1,56$, $p < 0.001$, Huynh-Feldt epsilon = 1.000). Also, there was a significant difference in interaction between Sessions and States ($F = 37.063$, $df = 1,56$, $p < 0.001$, Huynh-Feldt epsilon = 1.000), suggesting the two factors were not independent of each other.

Post-hoc tests for multiple comparisons performed with Bonferroni adjustment showed associate learning (easy) scores increased after CM ($p < 0.001$). Also, when the scores of the associate learning (easy) after CM were compared to those after SR, they were significantly different ($p < 0.001$). See **Figure 20**. The

group average values \pm S.D. are given in **Table 17**. The actual data of individual participants in CM and SR sessions are presented in **Table 31**. (See **Appendix-8**).

6.4.2.D Associate learning - hard:

The scores of associate learning (hard) were calculated before and after the practice of cyclic meditation and supine rest session. The associate learning (hard) showed a significant difference between the two Sessions ($F = 16.414$, $df = 1,56$, $p < 0.001$, Huynh-Feldt epsilon = 1.000), and the two States ($F = 268.486$, $df = 1,56$, $p < 0.001$, Huynh-Feldt epsilon = 1.000). Also, there was a significant difference in interaction between Sessions and States ($F = 94.418$, $df = 1,56$, $p < 0.001$, Huynh-Feldt epsilon = 1.000), suggesting the two factors were not independent of each other.

Post-hoc tests for multiple comparisons performed with Bonferroni adjustment showed associate learning (hard) scores increased after CM compared to before ($p < 0.001$). Also, when the scores of the associate learning (hard) after CM were compared to those after SR, they were significantly different ($p < 0.001$). See **Figure 21**. The group average values \pm S.D. are given in **Table 17**. The actual data of individual participants in CM and SR sessions are presented in **Table 31**. (See **Appendix-8**).

Figure 18: Score in Wechsler memory scale: digit span forward before and after cyclic meditation and supine rest sessions; values are groups mean \pm SD.

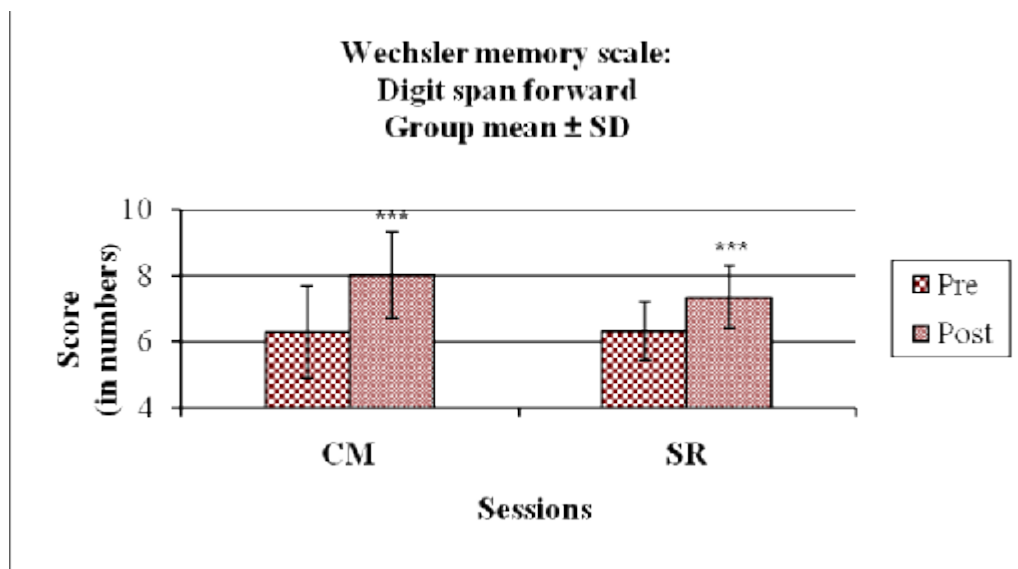


Figure 19: Score in Wechsler memory scale: digit span backward before and after cyclic meditation and supine rest sessions; values are groups mean \pm SD.

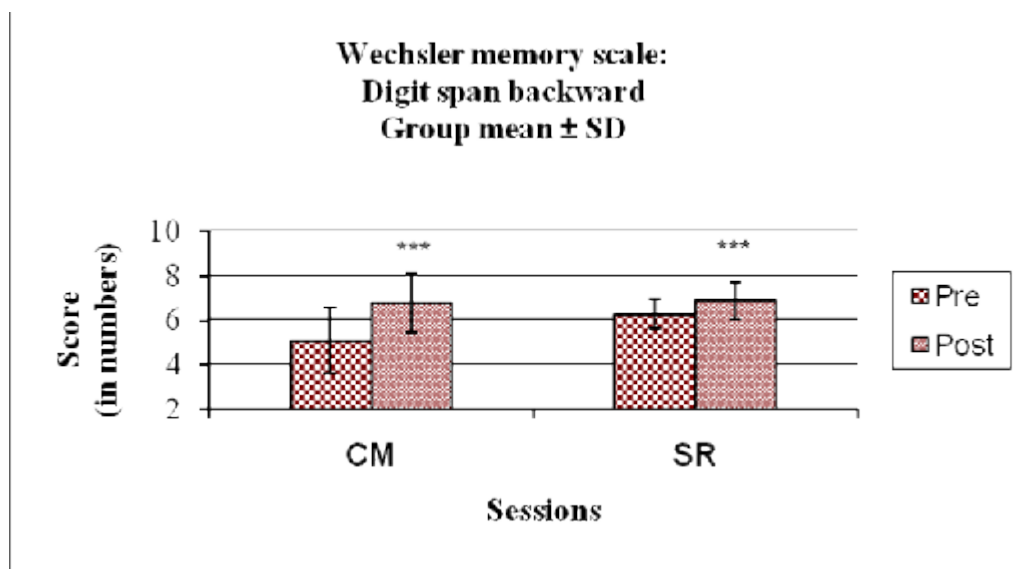


Figure 20: Score in Wechsler memory scale: associate learning (easy) before and after cyclic meditation and supine rest sessions; values are groups mean \pm SD.

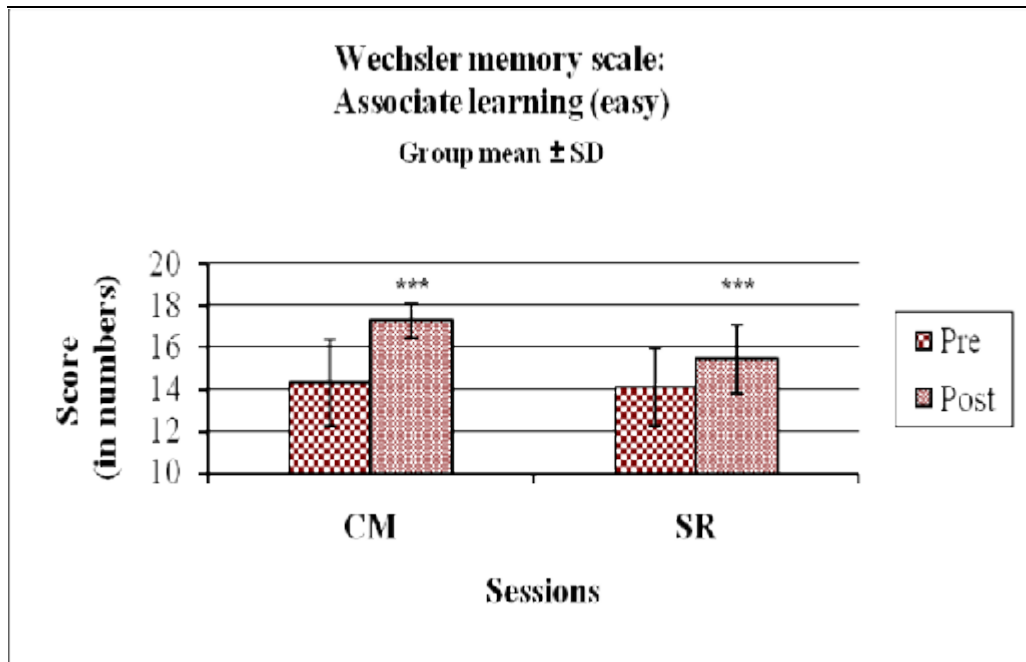
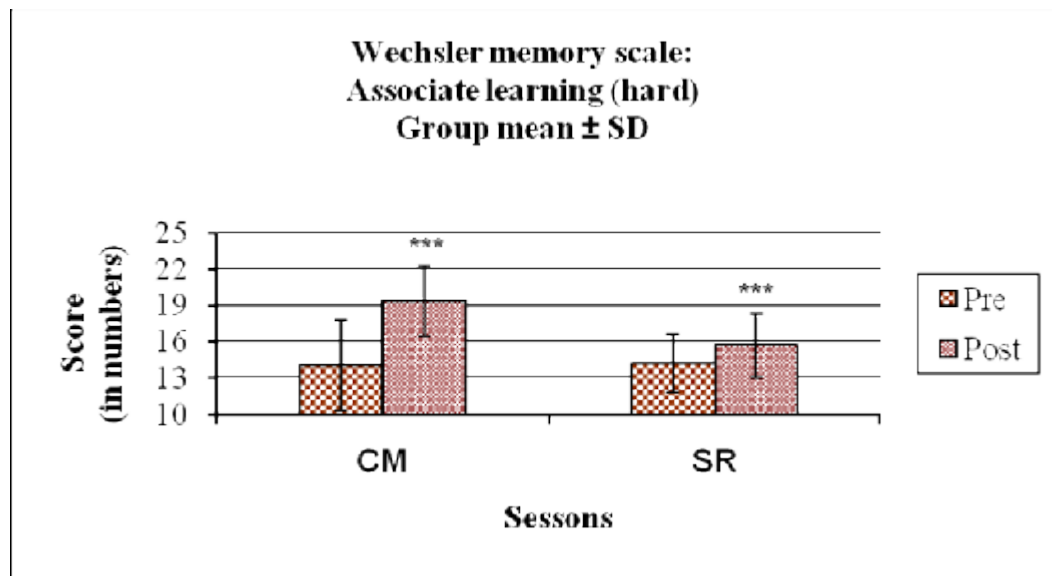


Figure 21: Score in Wechsler memory scale: associate learning (hard) before and after cyclic meditation and supine rest sessions; values are groups mean \pm SD.



6.5 STATE ANXIETY INVENTORY [STAI]

6.5.1 Recapitulation

A state anxiety inventory was administered in fifty-seven subjects in cyclic meditation and supine rest sessions. As described under Methods (data analysis), separate repeated measures analyses of variance (ANOVAs) were performed to compare the state anxiety levels. The study assessed the short term effect of two different yoga relaxation techniques on the state anxiety. For the repeated measures analyses of variance (ANOVAs) there were two Within Subjects Factors, i.e., (i) States, with two levels (pre and post) and (ii) Sessions, with two levels (CM and SR). *Post-hoc* tests with Bonferroni adjustment were used to detect significant differences between mean values. The group average values \pm S.D. are given in **Table 18**.

Table 18: Scores obtained in a State Anxiety Inventory (STAI) scale before and after Cyclic Meditation and Supine Rest. Values are groups mean \pm S.D.

Variable	State	Session	
		Cyclic meditation (CM) [n=57]	Supine Rest (SR) [n=57]
STAI	Pre	38.58 \pm 6.44	38.37 \pm 6.49
	Post	29.93 \pm 5.75***†††	36.21 \pm 6.16***†††

*** $p < 0.001$, RM ANOVA, with Bonferroni adjustment, before compared with after of CM or of the respective SR session

††† $p < 0.001$, RM ANOVA, with Bonferroni adjustment, after CM compared with after SR session

6.5.2 State anxiety inventory scores

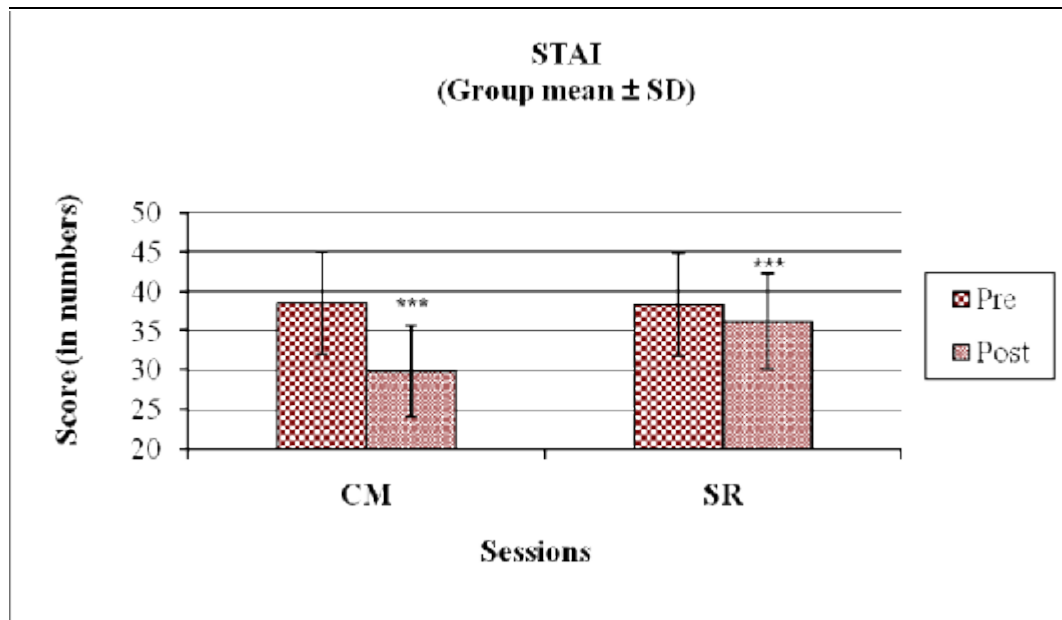
The total scores of state anxiety were calculated before and after the practice of cyclic meditation and supine rest session. The repeated measures ANOVA showed a significant difference between the two Sessions ($F = 54.916$, $df = 1,56$, $p < 0.001$, Huynh-Feldt epsilon = 1.000), and the two States ($F = 175.445$, $df = 1,56$, $p < 0.001$, Huynh-Feldt epsilon = 1.000). Also, there was a significant difference in interaction between Sessions and States ($F = 178.796$, $df = 1,56$, $p < 0.001$, Huynh-Feldt epsilon = 1.000), suggesting the two factors were not independent of each other.

Post-hoc tests for multiple comparisons performed with Bonferroni adjustment showed state anxiety scores decreased after CM and SR, but, the magnitude of change was less following SR. Also, when the state anxiety scores after CM were compared to those after SR, they were significantly different ($p < 0.001$). See **Figure 22**. The group average values \pm S.D. are given in **Table 18**. The actual data of individual participants in CM and SR sessions are presented in **Table 32**. (See **Appendix-8**).

Pearson Correlation Coefficient

There were no significant correlations between percentage changes in (i) digit span forward, (ii) digit span backward, (iii) associate learning–easy, or (iv) associate learning–hard with Spielberger’s state anxiety scores, for both CM and SR sessions ($p > 0.05$, for all comparisons).

Figure 22: Total score in state anxiety inventory before and after cyclic meditation and supine rest sessions; values are groups mean \pm SD.



6.6 COMPUTER AVERAGED MIDLATENCY AUDITORY EVOKED POTENTIALS (MLAEPs)

6.6.1 Recapitulation

The midlatency auditory evoked potentials (peak latency and peak amplitude) were recorded in forty-seven subjects in cyclic meditation and supine rest sessions from Cz electrode site, referenced to linked earlobes. Three main components have been studied which occur in the mid latency range (i.e., 0-100 ms). These 3 components are the Na wave (the maximum negativity occurring between 14 to 19 ms) the Pa wave (the maximum positivity between the Na wave and 35 ms) and the Nb wave (the maximum negativity between 35 and 65 ms) (Telles & Naveen, 2004; Raghuraj & Telles, 2004). For each of these 3 components the peak latencies and peak amplitudes were recorded in both the sessions. In each session there were four periods viz., Pre, Post 1, Post 2, and Post 3. The potentials were recorded from Cz (vertex) site and referenced to linked earlobes (A1-A2). As described under Methods (Data analysis), data were analysed using repeated measures ANOVAs to compare the Pre, Post1, Post2, and Post3 states of both the sessions. *Post-hoc* analyses with least significant difference were performed to detect significant differences between mean values. The group average values \pm S.D. are given in **Table 19**.

Table 19: 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 \pm SD.

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

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

6.6.2 Peak latency of MLAEPs recorded at Cz

The repeated measures ANOVA which consisted of the two within-subjects factors, i.e., (i) Sessions (cyclic meditation, supine rest) and (ii) States (Pre, Post 1, Post 2 and Post 3) for MLAEPs peak latency (ms) recorded at Cz, showed 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). The repeated measures ANOVA showed no-significant difference between States and interaction between Sessions and States for the peak latencies of Na and Nb waves.

Post-hoc analyses with least significant difference were performed and all comparisons were made with the respective 'Pre' states. Post cyclic meditation 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'. Post supine rest 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 19**. See **Figure 23**, **Figure 24** and **Figure 25**. The groups mean values \pm S.D. for the peak latencies (in ms) and peak amplitudes (in μ V) of Na, Pa and Nb components of midlatency auditory evoked potentials before and after Cyclic meditation (CM) and Supine rest (SR) sessions are given in **Table 19**. The actual data of individual participants in CM and SR sessions are presented with group mean \pm SD in **Table 33**, **Table 34** and **Table 35** respectively (See **Appendix-8**).

Figure 23: Peak Latencies for Na wave recorded at pre, post 1, post 2, and post 3 of cyclic meditation and supine rest sessions; values are group mean \pm SEM.

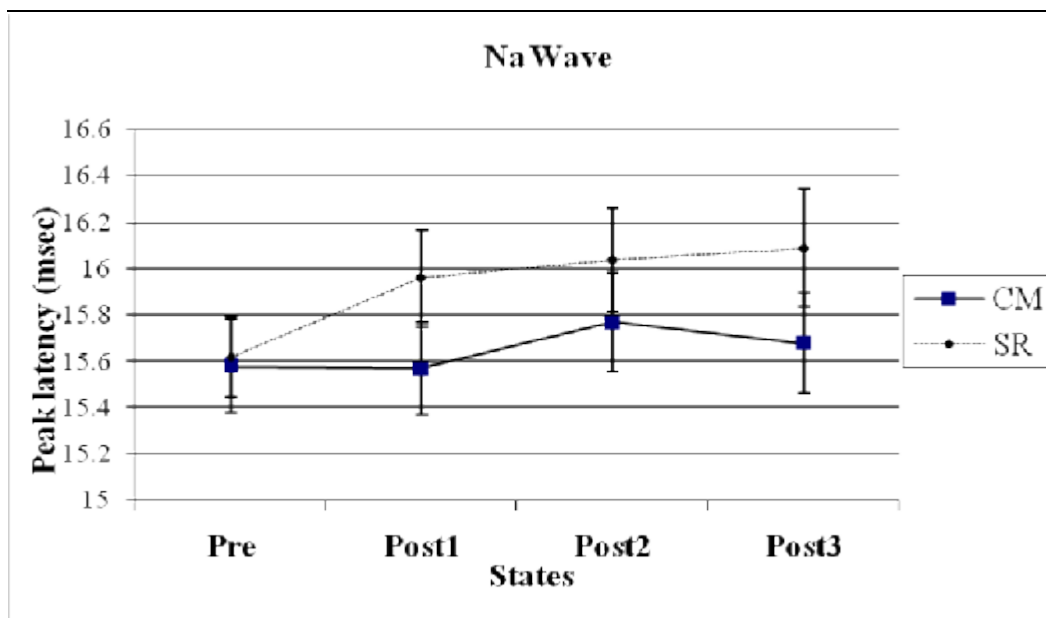


Figure 24: Peak Latencies for Pa wave recorded at Pre, Post 1, Post 2, and Post 3 of cyclic meditation and supine rest sessions; values are group mean \pm SEM.

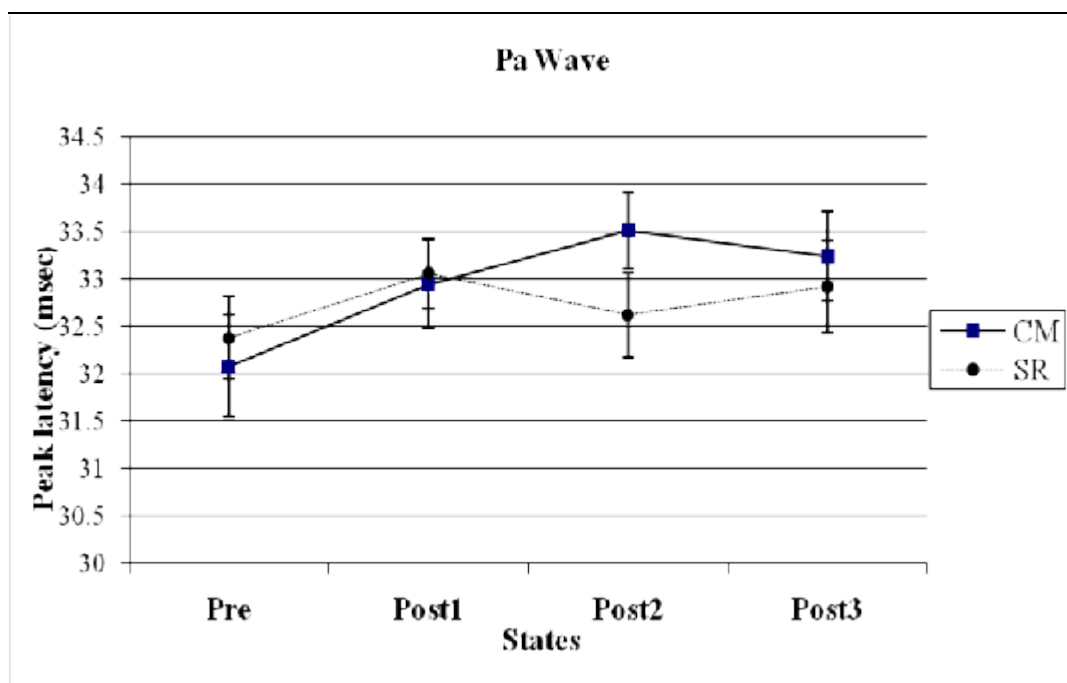
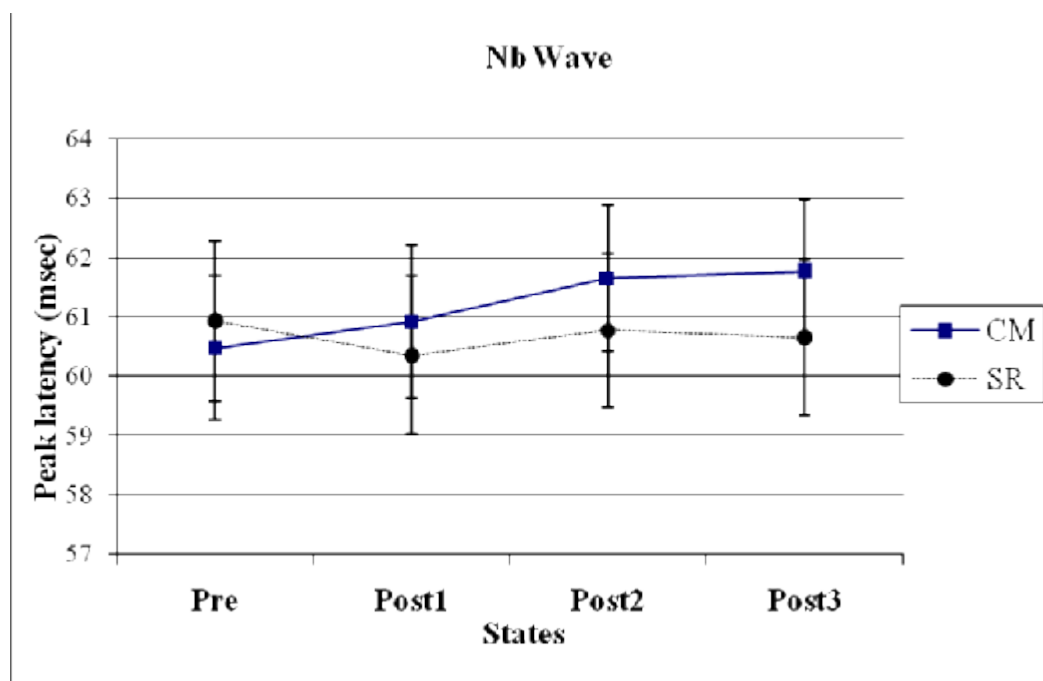


Figure 25: Peak Latencies for Nb wave recorded at Pre, Post 1, Post 2, and Post 3 of cyclic meditation and supine rest sessions; values are group mean \pm SEM.



6.6.3 Peak amplitude of MLAEPs recorded at Cz

The repeated measures ANOVA which consisted of the two within-subjects factors, i.e., (i) Sessions (cyclic meditation, supine rest) and (ii) States (Pre, Post 1, Post 2 and Post 3) for MLAEPs peak amplitudes (in μV) recorded at Cz, showed 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 waves.

Post-hoc analyses with least significant difference were performed and all comparisons were made with the respective 'Pre' states. Post cyclic meditation there was a significant increase in the peak amplitude of the Nb wave ($p < 0.05$) compared to 'pre'. These changes have been indicated in **Table 19**. See **Figure 26, 27 and 28**. The groups mean values \pm 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 Cyclic meditation (CM) and Supine rest (SR) sessions are given in **Table 19**. The actual data of individual participants in CM and SR sessions are presented with group mean \pm SD in **Table 36, Table 37 and Table 38** respectively (See **Appendix-8**).

Figure 26: Peak Amplitudes for Na wave recorded at Pre, Post 1, Post 2, and Post 3 of cyclic meditation and supine rest sessions; values are groups mean \pm SEM.

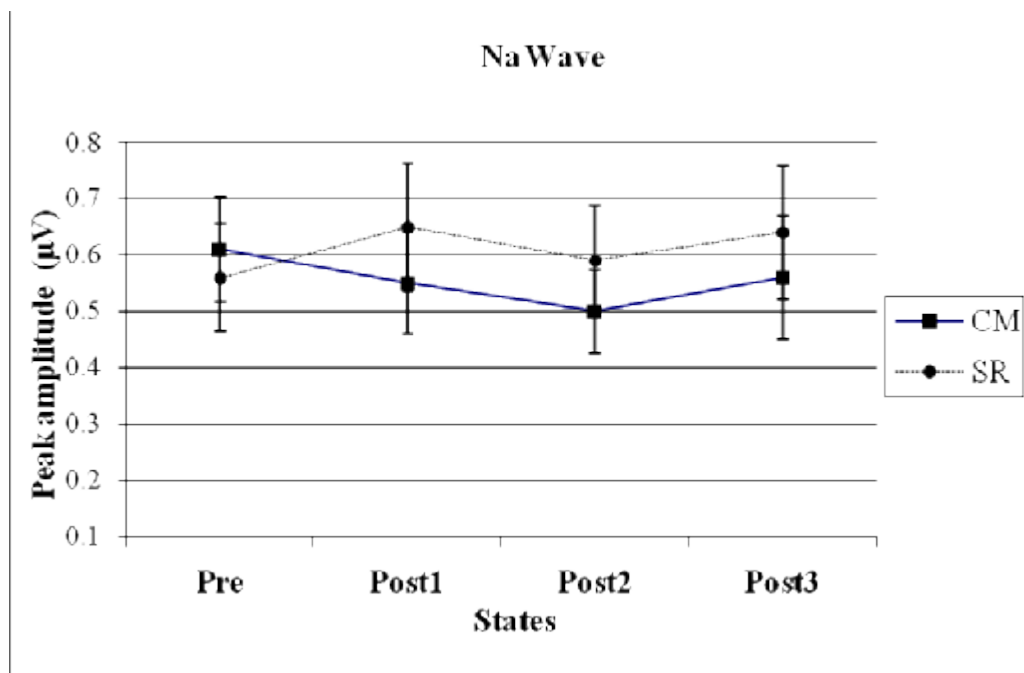


Figure 27: Peak Amplitudes for Pa wave recorded at Pre, Post 1, Post 2, and Post 3 of cyclic meditation and supine rest sessions; values are groups mean \pm SEM.

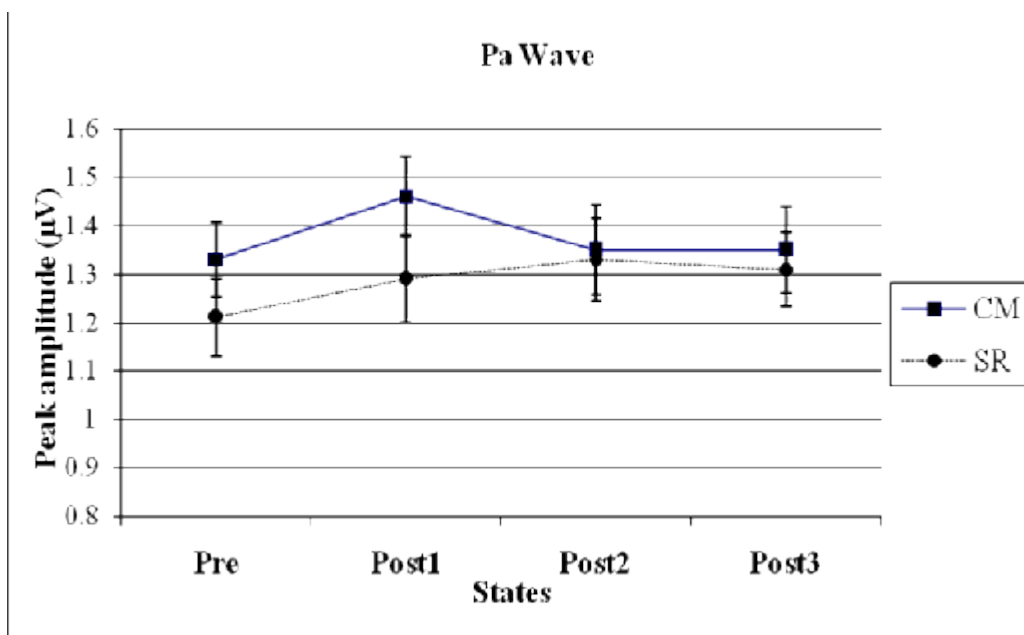
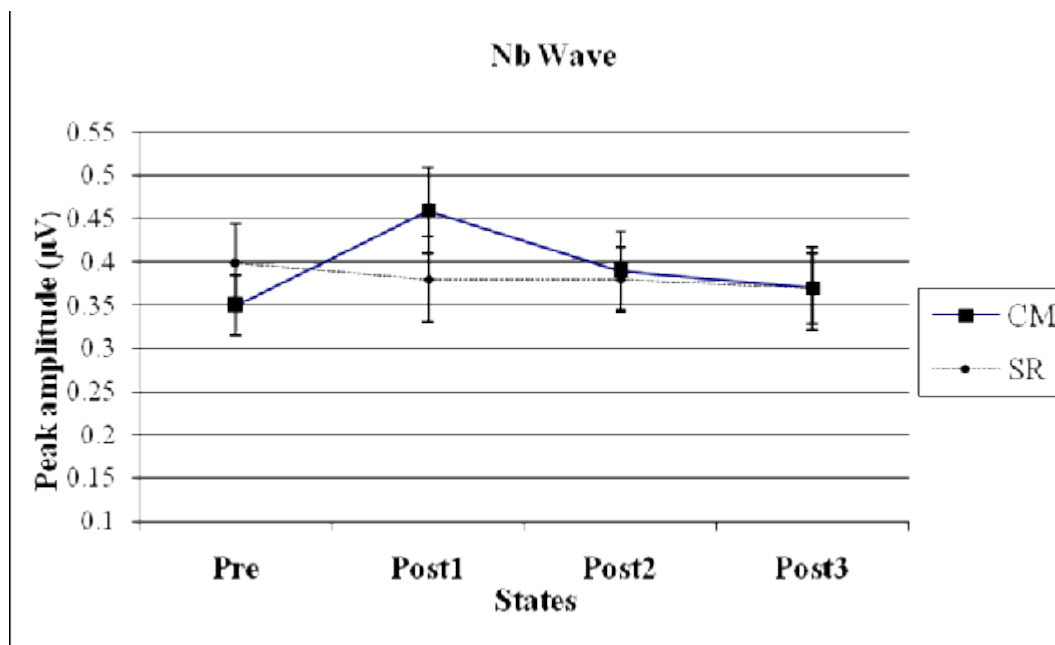


Figure 28: Peak Amplitudes for Nb wave recorded at Pre, Post 1, Post 2, and Post 3 of cyclic meditation and supine rest sessions; values are groups mean \pm SEM.



CHAPTER-7

Discussion

The most pertinent results detailed in the previous section are discussed under the three main categories of variables (i) performance in psychomotor tasks (i.e., DLST, circle dotting task and letter copying task), (ii) Wechsler memory and state anxiety, and (iii) Midlatency auditory evoked potentials (MLAEPs) measured before (Pre) and after (Post) the sessions.

7.1 PERFORMANCE IN PSYCHOMOTOR TASKS (i.e., DLST, Circle dotting task, Letter copying task)

Participants showed better performance in a digit-letter substitution task, as well as in tasks for motor speed following the practice of cyclic meditation. Following a period of supine rest for an equal duration there was improved performance in tasks for motor speed, but not in the digit-letter substitution task. There were no significant changes in the control group suggesting no re-test effect.

The digit-letter substitution task measures psychomotor performance (Gerrard, Wheeldon & McDevitt, 1995). This task is based on earlier developed substitution tests (e.g., the Digit Symbol Substitution Test) but uses over-learned signs (i.e., letters) instead of the symbols used in other substitution tasks (van der Elst, van Boxtel, van Breukelen & Jolles, 2006). The task assesses attention, speed of perception and processing, as well as a repetitive motor response requiring motor speed (Orlowiejska-Gillert, Pajak, Szczudlik, Kawalec & Pomykalska, 1998; de Groot, Hornstra, Roozendaal & Jolles, 2003). The results suggest that the practice of cyclic meditation enhances overall performance, i.e., the total scores, but also results in lower numbers of wrong attempts or errors (based on net scores)

compared to the supine rest session. However, before CM the scores of wrong attempts was lower than before SR or the control session, though neither difference was statistically significant.

Table 20: Summary of trend of changes in Digit-letter substitution task in cyclic meditation, supine rest and control sessions; values are percent change.

Variables	CM	SR	CT
Total attempted	↑ 20.87%	↑ 3.19 %	↑ 2.70 %
Wrongly attempted	NS	↑ 51.43 %	↑ 76.67 %
Net attempted	↑ 21.08 %	↑ 2.88 %	↑ 2.29 %

Note: N = 57, NS: No significant change, ↑ : increase, which was statistically significant.

The improved scores in the letter copying task and the circle dotting task following Cyclic Meditation (CM) show that speed for repetitive motor activity was also better after CM. This may have contributed to the better performance in the DLST after cyclic meditation, especially since the magnitude of change in the three tasks was comparable. The percentage change in the DLST after CM was 21.0, while the percentage changes in the ‘letter copying task’ and ‘circle dotting task’ were 13.0 and 19.0, respectively.

Table 21: Summary of trend of changes in Letter copying task and Circle dotting task in cyclic meditation, supine rest and control sessions; values are percent change.

Tasks	Variables	CM	SR	CT
Letter copying task	Total attempted	↑	↑	↑
		13.24 %	4.33 %	1.76 %
Circle dotting task	Left Circle	↑	↑	↑
	Right Circle	↑	↑	↑
		19.96 %	4.04 %	1.90 %
		19.41 %	4.17 %	1.10 %

Note: N = 57, NS: No significant change, ↑: increase, which was statistically significant.

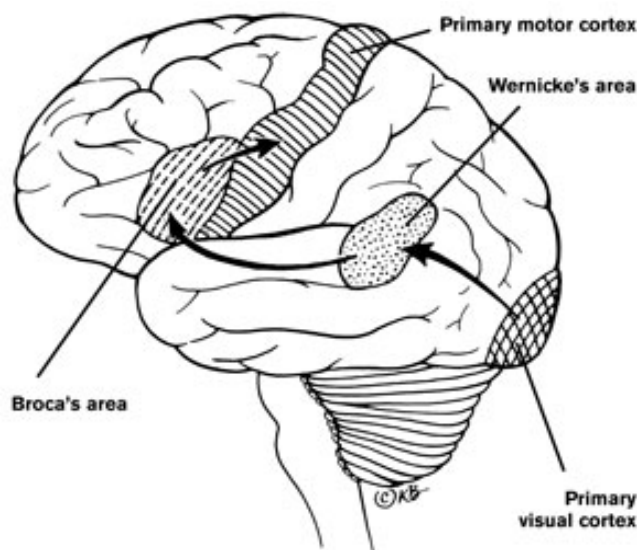
Cyclic meditation is so-called as it consists of alternating cycles of practicing yoga postures interspersed with periods of supine relaxation (Nagendra & Nagarathna, 1997). This ‘moving meditation’ was devised by H.R. Nagendra, Ph.D. based on a description from ancient yoga texts (Chinmayananda, 1984). The practice has been shown to be followed by a period of reduced physiological arousal based on a decrease in oxygen consumption and minute ventilation (Telles, Reddy & Nagendra, 2000; Sarang & Telles, 2006a), changes in the heart rate variability (Sarang & Telles, 2006b) and increased slow wave sleep in the subsequent night following day time practice of CM (Patra & Telles, 2009). However these changes occurred simultaneously with a decreased latency and

increased amplitude in the P300 (Sarang & Telles, 2006c) as well as improved performance in a letter cancellation task (Sarang & Telles, 2007). The P300 reflects the ability to sustain and shift attention while discriminating between stimuli which differ in a single aspect, e.g., frequency of tones (Polich, 1999). The P300 also indicates cognitive events requiring attentional and immediate memory processes. Similarly, cancellation tasks also require sustained attention, as well as visual scanning and activation and inhibition of rapid responses along with motor speed. These results taken together suggest that cyclic meditation induces a state of reduced physiological arousal with improved performance in tasks requiring attention.

Several meditation techniques have been shown to reduce anxiety and feelings of tension (Kozasa, Santos, Rueda, Benedito-Silva, & De Ornellas, 2008). In many cases a reduction in anxiety is associated with better performance. For, example, persons with high levels of trait-anxiety took longer to color name threatening words, compared to neutral words, when assessed on a modified Stroop color naming paradigm (Fox, 1993). High trait anxious subjects were also distracted by separate color words which produced no interference for subjects with low trait anxiety. The results suggested that high trait anxiety is associated with a general inability to maintain attentional focus, not specific for ‘threatening’ stimuli. While anxiety was not measured in the present study, one may speculate that reduction of anxiety could have contributed to the better performance.

In a previous study, following both cyclic meditation and supine rest, participants performed better in a letter cancellation task (Sarang & Telles, 2007). In the present study, on a different group of cyclic meditation practitioners, performance in a digit- letter substitution task improved after cyclic meditation but not after supine rest. This may be related to the fact that the two psychomotor tasks (i.e., the letter cancellation task and the digit-letter substitution task) assess comparable, yet different cognitive abilities. The letter cancellation task assesses the ability to sustain and shift attention, immediate memory, visual scanning, and motor speed for repetitive motor activity. The digit-letter substitution task also requires the ability to sustain and shift attention, immediate memory (of the digit-letter combination), and the task tests the speed of information processing, as well as the ability to process information and shift the attentional focus between digits and letters. It is difficult to say whether the improved performance in the letter cancellation task following both cyclic meditation and supine rest in an earlier study (Sarang & Telles, 2007) and the improved performance in the digit-letter substitution task after cyclic meditation alone in the present study, was due to differences in the abilities assessed by the tasks or the fact that the yoga practitioners in the two studies were different. In the present study, after both cyclic meditation and supine rest, the performance in the tasks for motor speed in a repetitive motor task was improved. The circle dotting task, studied here also evaluates spatial intelligence and manual speed (de Andrés, Sánchez, Hidalgo & Díaz, 2004). The letter copying task was used as a test for motor speed, which

allowed the repetitive motor activity component of the digit-letter substitution task to be assessed separately as has been described elsewhere (Morrens, Hulstijn & Sabbe, 2008) . Hence, the ability to carry out a repeated motor activity was better after cyclic meditation and supine rest, with a greater magnitude of improvement after cyclic meditation. This may be related to previous reports of better motor coordination and better performance in motor tasks after yoga practice which included relaxation (Madan, Thombre, Bharathi, Nambinarayan, Thakur, Krishnamurthy & Chandrabose, 1992; Telles, Hanumanthaiah, Nagarathna & Nagendra, 1993).



Schematic illustrating motor strip of cerebral cortex

Hence, in the present study, improved repetitive motor activity and motor speed may have contributed to the better performance in the digit-letter substitution task. The improvement in the DLST following CM was 21.0 percent (as described earlier), while the letter copying task was improved by 14.0 percent

and the performance in the circle dotting task was improved by 19.0 percent. In contrast there was no improvement in DLST scores after SR, but the improvement in the letter copying task was 4.3 percent and the improvement in the circle dotting task was 4.1 percent. Hence, an improvement in motor speed may have contributed to the better performance in the DLST after cyclic meditation. This is to some degree not supported by the improvement in P300 after CM, as the P300 latency is an index of stimulus processing rather than response generation and is used as a motor-free measure of cognitive function.

Improved motor speed in a repetitive motor activity task following yoga has been considered to be related to better motor co-ordination (Telles, Hanumanthaiah, Nagarathna & Nagendra, 1993) either associated with, or independent of, improved muscular efficiency following yoga (Madan, Thombre, Bharathi, Nambinarayan, Thakur, Krishnamurthy & Chandrabose, 1992).

Given the fact that yoga practice has effects on attention, and motor speed, the present findings show that it is difficult to determine the exact contribution of improvement in either ability following yoga, if a task requires both abilities. Hence it is best to use tasks which selectively measure a specific function. In conclusion, in the present study it is difficult to say to what degree an improvement in (i) attention and information processing speed and / or (ii) an improvement in motor speed contributed to the increased DLST scores after CM.

7.2 WECHSLER MEMORY AND STATE ANXIETY

Following the practice of cyclic meditation (CM) and Supine rest (SR) there were increased scores in tasks for attention, concentration and integration. For all scores the magnitude of change was greater following CM compared to following SR. Also, both CM and SR were followed by a decrease in state anxiety, with a greater decrease following CM. Memory scores and state anxiety were not correlated.

Digit span forward assesses attention and concentration, and indicates the short-term primary memory (Lichtenberger, Kaufman, & Lai, 2001). Digit span backward also assesses attention and concentration, and indicates short-term working memory. Paired associate learning assesses integration and indicates episodic memory. Hence these aspects of memory may be considered to have improved with both practices.

Table 22: Summary of trend of changes in state anxiety inventory and Wechsler memory scale in cyclic meditation and supine rest sessions; values are percent change.

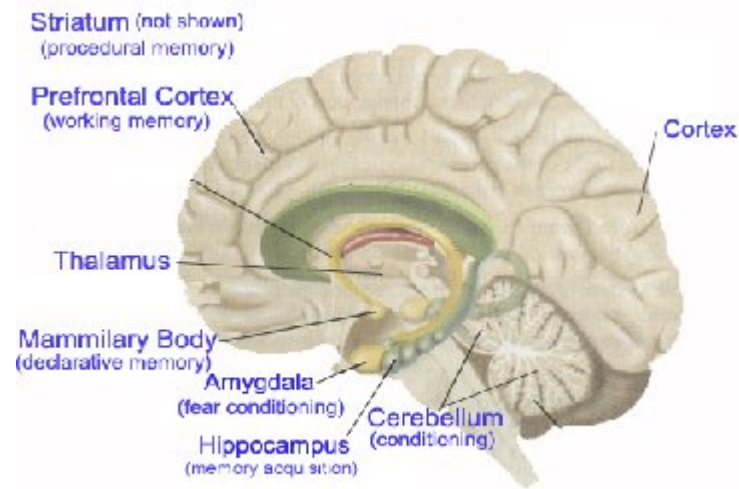
Variable	CM	SR
STAI score	↓ 22.42 %	↓ 5.63 %
Digit span Forward	↑ 27.71 %	↑ 16.11 %
Digit span Backward	↑ 33.53 %	↑ 9.24 %
Associate learning- Easy	↑ 20.70 %	↑ 9.44 %
Associate Learning- Hard	↑ 37.68 %	↑ 10.58%

Note: N = 57, NS: No significant change ↓ : Decrease, which was statistically significant.

In an earlier study 108 children whose ages ranged from 10 to 17 years, were randomly allocated to four groups, with each group practicing a specific yoga breathing technique (Naveen, Nagarathna, Nagendra, & Telles, 1997). Verbal and spatial memory was assessed initially and after ten days. The study examined the effects of specific yoga breathing practices on hemisphere-specific memory tasks. Here, irrespective of the type of breathing technique practiced all participants showed an increase in spatial memory. In a subsequent study, spatial and verbal

memory test scores were assessed in children following yoga and fine arts (Manjunath & Telles, 2004). Both groups were assessed on the memory tasks at the beginning and end of ten days of their respective interventions. The group which practiced yoga, including physical postures, breathing techniques, meditation and guided relaxation improved delayed recall of spatial information. In the two studies cited above the improvement in memory scores following yoga was considered to be possibly related to the fact that reduced anxiety can improve performance in tasks requiring learning and memory (Saltz, 1970), and the anxiety reducing effects of yoga are well known (Platania-Solazzo, Field, Blank, Seligman, Kuhn, Schanberg, & Saab, 1992; Kozasa, Santos, Rueda, Benedito-Silva, & De Ornellas, 2008).

In an earlier study the effect of CM practice on the performance in a letter cancellation task, was assessed in 69 male volunteers (whose ages ranged from 18 to 48 years) (Sarang & Telles, 2007). There was improved performance in the task which required selective attention, concentration, visual scanning abilities, and a repetitive motor response following CM. The results were interpreted to suggest that the improved performance after CM suggests that the practice not only globally enhances performance but also selectively reduces the probability of being distracted. Hence, yoga practice may be improving memory by reducing anxiety as well as by reducing the ability to be distracted by external or internal stimuli. This is of relevance as reduced distractability is a necessary pre-requisite for attention and for consolidating memories (Baddeley, 1993).



Schematic illustrating the brain areas concerned with memory

In the present study, twenty-three minutes of cyclic meditation or of supine rest were followed by a decrease in state anxiety. The exact mechanism by which yoga practice may be reducing state anxiety is not known. Slow and deep breathing is known to increase the parasympathetic tone and is associated with a calm mental state (Kaushik, Mahajan & Rajesh, 2006). Also, rapid yoga breathing techniques are followed by periods of slow electroencephalogram (EEG) frequencies and subjectively rated calmness (Novak, Lepicovska, & Dostalek, 1992).

The practice of CM consists of alternating cycles of practicing yoga postures interspersed with periods of supine relaxation when the person is given instructions to help them reach a meditative state (Nagendra & Nagarathna, 1997). This supports the idea that a combination of stimulating and calming techniques practiced with a background of relaxation and awareness (during CM) may reduce

psychophysiological arousal more than resting in a supine posture for the same duration. The practice of CM, includes yoga postures (*asanas*) which involve muscle stretching and this has diverse benefits. For example, muscle stretching associated with yoga postures is believed to help in reducing pain (Garfinkel & Schumacher, 2000). Apart from these effects which are not difficult to associate with yoga practice, more complex effects of yoga *asanas* have also been shown. For example, magnetic resonance spectroscopic imaging in eight yoga practitioners and eleven non-yoga practitioners showed definite changes after a sixty-minute yoga session, compared to a sixty-minute reading session in the non-yoga practitioners, for comparison (Streeter, Jensen, Perlmutter, Cabral, Tian, Terhune, Ciraulo, & Renshaw, 2007). The main difference seen was an increase in brain levels of gamma amino butyric acid (GABA) after the yoga session. It was speculated that this could be the basis to consider using yoga in the management of anxiety disorders. More recently the practice of CM has resulted in prolonged latencies of evoked potentials generated within the cerebral cortex, supporting the idea of cortical inhibition after CM (Subramanya & Telles, 2009).

However in the absence of complex investigations, the exact mechanism by which CM reduces state anxiety more than SR remains a speculation. In summary, the present study shows that CM practice improves the performance in memory tasks and reduces state anxiety more than a comparable period of SR.

7.3 MIDLATENCY AUDITORY EVOKED POTENTIALS [MLAEPs]

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 (Deiber, Ibañez, Fischer, Perrin, Mauguière, 1988), the Pa wave corresponds to the activity at the superior temporal gyrus (Kileny, Paccioretti, Wilson, 1987) and intra-cerebral recording in man 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 (Liégeois-Chauvel, Musolino, Badier, Marquis, Chauvel, 1994). A decrease in peak latency is considered as suggestive of facilitated transmission due to increased speed of conduction in the underlying neural generators (Malhotra, 1997). 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 (Woods & Clayworth, 1985).

In the present study, the increase in the Pa and Nb wave peak latencies following meditation is contrary to earlier studies in which midlatency auditory evoked potentials were recorded during and after meditation (Telles & Naveen,

2004; Telles & Desiraju, 1993). In particular, meditation on a syllable of significance (i.e., 'OM') was earlier shown to significantly reduce the Nb wave peak latency (Streeter, Jensen, Perlmutter, Cabral, Tian, Terhune, Ciraulo, Renshaw, 2007). 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 (Telles & Naveen, 2004).

Table 23: Summary of changes in latency and amplitude in MLAEPs in cyclic meditation and supine rest sessions, values are percent change.

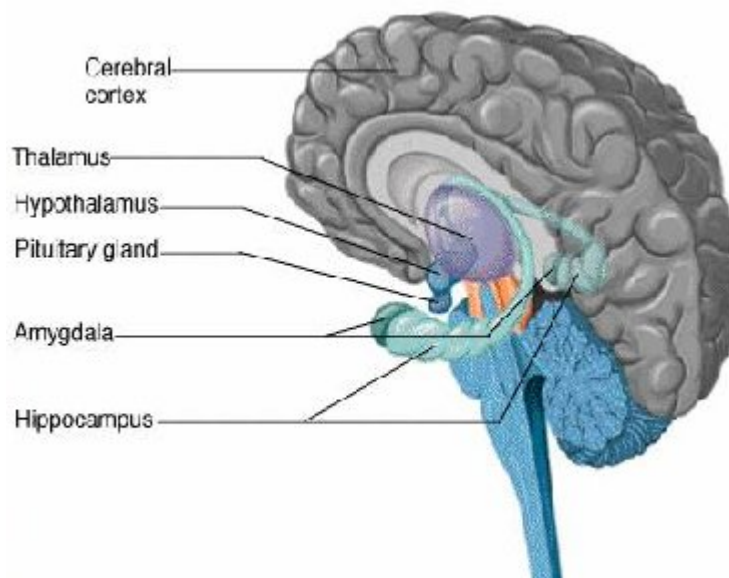
Wave	Phases	Cyclic Meditation		Supine Rest	
		Latency (ms)	Amplitude (μ V)	Latency (ms)	Amplitude (μ V)
Na	Post 1	NS	NS	NS	NS
	Post 2	NS	NS	↑	NS
	Post 3	NS	NS	↑	NS
Pa	Post 1	NS	NS	NS	NS
	Post 2	↑	NS	NS	NS
	Post 3	↑	NS	NS	NS
Nb	Post 1	NS	↑	NS	NS
	Post 2	NS	NS	NS	NS
	Post 3	↑	NS	NS	NS

Note: N = 47, NS: No significant change, ↑ : increase, ↓ : Decrease, which was statistically significant.

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 (Streeter, Jensen, Perlmutter, Cabral, Tian, Terhune, Ciraulo, Renshaw, 2007). Yoga practitioners who completed a sixty minute session of yoga postures (*asanas*) were compared with subjects who completed a sixty minute reading session. Magnetic resonance spectroscopic imaging assessed GABA-to-creatine ratios prior to and after interventions. The yoga practitioners showed a twenty-seven percent 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 (Kandel, Schwartz & Jessell, 2000). 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 (Henry, 2004). Apart from the somatosensory pathway GABAergic inhibition in auditory sub-cortical and cortical areas is also known (Ma, Kelly & Wu, 2002). 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 supine rest 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 cyclic meditation and supine rest, 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 (Morlet, Bertrand, Salord, Boulieu, Pernier, Fischer, 1997). The Nb wave corresponds to activity at the dorso-posterior-medial part of the Heschl's gyrus i.e., the primary auditory cortex (Kileny, Paccioletti & Wilson, 1987). 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 (Woods & Clayworth, 1985), this suggests that cyclic meditation practice is associated with increased activity at the level of the primary auditory cortex.



Mid - Sagittal Section – Human Brain

The increase in the Nb wave peak amplitude following cyclic meditation 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 (Panjwani, Selvamurthy, Singh, Gupta, Mukhopadhyay & Thakur, 2000). However there were certain important differences between the study of Panjwani et al. (Panjwani, Selvamurthy, Singh, Gupta, Mukhopadhyay & Thakur, 2000) 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 six months of meditation practice was studied, whereas in the present study the immediate effect of practicing cyclic meditation was assessed by comparing post practice recordings with recordings made before practice. The two studies also differed in the type of meditation practice. Cyclic meditation consists of periods of supine rest

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 supine rest 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 participants could remain undisturbed during a session. By observing the participants on the closed-circuit television it was possible to detect if the participants 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 (Sarang & Telles, 2006b). 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 (Sarang & Telles, 2006a). 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 were 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 thirty male participants practiced CM twice

(approximately 23 minutes each time) (Patra & Telles, 2009). This was compared to another night when they had two, equal duration sessions of supine rest (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 were 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 (Sarang & Telles, 2006b), oxygen consumption (Sarang & Telles, 2006a) and polysomnography (Patra & Telles, 2009) 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 (Muktibodhananda, 2004).

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: (i) the fact that the participants may have been aware of the effects of cyclic meditation and hence have had certain expectations which would have influenced the outcome. Also, (ii) 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 (Telles, Reddy & Nagendra, 2000; Sarang & Telles, 2006a; 2006b). 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 (Sarang & Telles, 2006c). 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 (Halgren, Marinkovic, Chauvel, 1998). 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 (Polich, 1999). As described earlier, the Pa wave corresponds to the activity at the superior-temporal gyrus (Kileny, Paccioretti & Wilson, 1987) 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 supine rest (which produced changes in the Na wave)

suggesting mesencephalic-diencephalic level changes, and cyclic meditation, where the changes which followed the practice appeared to be at a cortical level.

CHAPTER-8

*Appraisal
of the Study*

GENERAL

The appraisal of the research work in this doctoral thesis is presented under the following headings:

1. Summary of the findings
2. Implications of the study
3. Applications of the study
4. Limitations of the study
5. Suggestions for future studies

8.1 SUMMARY OF THE FINDINGS

The study was performed on fifty-seven healthy male participants with age range from 18 to 40 years (group average age \pm S.D., 26.5 ± 4.6 years), who were each studied in two sessions, one of cyclic meditation and the other of supine rest. Each session consisted of Pre (5 minutes), During (22:30 minutes) and Post (15 minutes) states while middle latency auditory evoked potentials (MLAEPs) were recorded and all the other paper pencil tasks were assessed in Pre and Post periods of CM and SR.

Hence, the present study was designed to determine the effect of both CM and SR on digit letter substitution task, which is also a measure of attention as well as two tasks for motor functions (i.e., letter copying task and circle dotting task), in addition to this the effects of CM and SR were studied on components of Wechsler memory scale as well as state anxiety (STAI) to determine if anxiety influenced

performance. Finally, in an attempt to understand whether sensory processing at cortical and sub-cortical levels is facilitated or not by CM and SR, midlatency auditory evoked potentials (MLAEPs) were recorded at the beginning and end of both practices.

For each of the variables the data were analyzed separately using repeated measures ANOVA followed by *post-hoc* analysis.

The practice of CM has resulted in prolonged latencies of evoked potentials generated within the cerebral cortex, supporting the idea of cortical inhibition after CM. The present study also showed better performance in a digit-letter substitution task, as well as in tasks for motor speed following the practice of CM. Following a period of supine rest there was improved performance in tasks for motor speed, but not in the digit-letter substitution task. The study also showed that CM practice improves the performance in memory tasks and reduces state anxiety more than a comparable period of SR.

8.2 CONCLUSION

The practice of CM has resulted in prolonged latencies of evoked potentials generated within the cerebral cortex, supporting the idea of cortical inhibition after CM. The present study also showed better performance in a digit-letter substitution task, as well as in tasks for motor speed following the practice of CM. Following a period of supine rest there was improved performance in tasks for motor speed, but not in the digit-letter substitution task. The study also showed that CM practice

improves the performance in memory tasks and reduces state anxiety more than a comparable period of SR.

8.3 IMPLICATIONS OF THE STUDY

The present study demonstrated that approximately 23 minutes of cyclic meditation (CM) as well as 23 minutes of supine rest (SR) in *shavasana* had a favorable effect on performance tasks for selective attention, repetitive motor activity, primary working memory and associate learning. In addition to an improvement in performance both practices were associated with lower state anxiety. However, in all cases the magnitude of change was greater following CM compared to the change following SR.

This implies that the cyclical combination of yoga postures (*asanas*) and rest while supine has an even greater effect on the performance tasks cited above compared to SR. This may be related to the fact that CM practice decreases state anxiety more than SR.

In addition to the performance task the present study also assessed the effects of CM and SR on midlatency auditory evoked potentials. This was to assess at what level along the neuraxis any change occurred. A decrease in latency of components generated within the cerebral cortex occurred following CM whereas SR was followed by decreased latency in sub-cortical components. Decreased latency implies increased inhibition. Hence, CM practice may be a method to reduce cortical excitation and increase cortical inhibition.

8.4 APPLICATIONS OF THE STUDY

I. Digit letter substitution task (DLST):

The improvement in DLST performance following CM suggests that this practice may be useful in conditions associated with attentional deficits. There are widely differing conditions in which attention is impaired. These include slow learners, mentally challenged persons with various types of disorders, attention deficits and attention-deficit hyperactivity disorder (ADHD).

II. Letter copying task (LCT) and Circle dotting task (CDT):

The improved performance in this repetitive motor task following CM, suggests that CM practice can improve muscle performance for a repetitive task with a possible reduction in fatigue. This has widely ranging applications such as use of a computer keyboard, assembly systems in factories, as well as other tasks requiring greater precision.

III. Wechsler memory scale (WMS):

The improved performance in primary working memory on associate learning, suggests applications of CM practice in education, most white-collar jobs and prevention and perhaps management of certain degenerative conditions in which memory is affected.

IV. State anxiety inventory (STAI):

Decrease in subjectively rated state anxiety level following CM, suggests its' usefulness in stress management and reducing anxiety.

V. Midlatency auditory evoked potentials (MLAEPs):

Cortical level changes following CM support the applications mentioned above, i.e., CM may be useful in anxiety disorders and conditions associated with cortical arousal, one such condition could be epilepsy though it is necessary to keep in mind that CM practice includes certain *āsana*s where safety issues would have to be considered.

8.5 LIMITATIONS OF THE STUDY

The chief limitation of this as well as most previous studies is that the assessments were made before and after the practice but not during the practice. Quite obviously the performance tasks could not be given to the participants during any yoga practice. In the case of MLAEPs recordings were not done during the practice as CM includes the practice of yoga postures and this was found to lead to movement artifact. An attempt was made to deal with this difficulty by testing whether telemetric measurements of MLAEPs would be artifact free. A telemetric recording on a small sample (n=6; unpublished data) showed that the evoked potential waveforms were contaminated with movement artifact. The other limitation of the present study was that there was no way to determine whether the participants had brief episodes of micro-sleep during SR. Apart from these two limitations both the design of the study and assessments have been used earlier and hence, there was no other major limitations.

8.6 SUGGESTIONS FOR FUTURE STUDIES

The present findings have suggested certain applications of the practice of CM in healthy individuals as well as in certain pathological conditions, e.g., anxiety disorders. Hence, future studies may assess the impact of CM in these populations.

Apart from this the decreased cortical activity following CM in the present thesis is based on evoked potential recordings. In order to get a more conclusive idea about whether cortical activity increases or decreases with CM, recordings of cerebral blood flow using various specialized techniques could be done.

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Table 24: Final summary of changes after cyclic meditation and supine rest sessions.

Practice	Variables studied	Post	
Cyclic meditation	Measures of neuro-psychological change	Digit-letter substitution task	<i>Improved psychomotor performance</i> ↑ Net scores, ↓ wrong scores
		Letter copying task	<i>Improved repetitive motor activity</i> ↑ total scores
		Circle dotting task	<i>Improved repetitive motor activity</i> ↑ total scores
		Wechsler memory scale	<i>Improved memory</i> ↑ memory scores
		State anxiety inventory	<i>Reduced anxiety state</i> ↓ anxiety scores
	Measures of cognitive change	MLAEPs	Cortical inhibition
Supine rest	Measures of neuro-psychological change	Digit-letter substitution task	<i>No Improvement in psychomotor performance</i> ↑ wrong scores
		Letter copying task	<i>Improved repetitive motor activity</i> ↑ total scores but magnitude of change was less.
		Circle dotting task	<i>Improved repetitive motor activity</i> ↑ total scores but magnitude of change was less.
		Wechsler memory scale	<i>Improved memory</i> ↑ memory scores but magnitude of change was less.
		State anxiety inventory	<i>Reduced anxiety state</i> but magnitude of change was less. ↓ anxiety scores
	Measures of cognitive change	MLAEPs	Mesencephalic and diencephalic inhibition
Control	Measures of neuro-psychological change	Digit-letter substitution task	<i>No Improvement in psychomotor performance</i> ↑ wrong scores
		Letter copying task	<i>No Improvement in repetitive motor activity</i> ↓ total scores
		Circle dotting task	<i>No Improvement in repetitive motor activity</i> ↓ total scores

Note: ↑: Increase, ↓: Decrease

ABSTRACT

Subramanya Pailoor

Title: A Comparative Study of the Psychophysiological effects of Cyclic Meditation and Supine Rest (Shavasana).

Guides: Dr. H. R. Nagendra and Dr. Shirley Telles

Design: Self as control design (CM & SR)

Source: Students of S-VYASA

The study was intended to compare cyclic meditation (CM) with an equal period of supine rest (SR), with respect to: **Attentional tasks** : (1) the performance in a psychomotor tasks, included digit-letter substitution task (DLST) which is a measure of attention, as well as two tasks for motor functions (i.e., letter copying task and circle dotting task), (2) components of Wechsler memory scale as well as state anxiety (STAI) to determine if anxiety influenced performance, and (3) **Evoked Potentials**: Midlatency auditory evoked potentials (MLAEPs) using a Nicolet Bravo, U.S.A., apparatus, to understand whether information processing at different cortical and sub-cortical levels is facilitated or not by CM and SR.

Conclusion: The practice of CM has resulted in prolonged latencies of evoked potentials generated within the cerebral cortex, supporting the idea of cortical inhibition after CM. The present study also showed better performance in a digit-letter substitution task, as well as in tasks for motor speed following the practice of CM. Following a period of supine rest there was improved performance in tasks for motor speed, but not in the digit-letter substitution task. The study also showed that CM practice improves the performance in memory tasks and reduces state anxiety more than a comparable period of SR.