A COMPARISON OF PSYCHOPHYSIOLOGICAL EFFECTS OF TWO YOGA RELAXATION TECHNIQUES

Thesis Submitted for the Award of

DOCTOR OF PHILOSOPHY (Ph.D.)
IN YOGIC SCIENCES

by

PATIL SARANG SHASHIKANT

DIVISION OF YOGA AND LIFE SCIENCES
SWAMI VIVEKANANDA YOGA ANUSANDHANA SAMSTHANA
Deemed University (recognized by the Ministry of Human Resource Development,
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Under the Guidance of

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C E R T I F I C A T E

This is to certify that Patil Sarang Shashikant who has been given Ph.D. registration with effect from September 11, 2002 by the Swami Vivekananda Yoga Anusandhana Samsthana Deemed University under the Division of Yoga and Life Sciences has successfully completed the required 'training' in acquiring the relevant background knowledge in Yogic Sciences related to Psychophysiology, and has completed the required 'course of research' for not less than two years to submit this thesis entitled "A COMPARISON OF PSYCHOPHYSIOLOGICAL EFFECTS OF TWO YOGA RELAXATION TECHNIQUES" as per the regulations of the University.

Shirley Telles M.B.B.S., M.Phil., Ph.D.
Professor & Head
Department of Biosciences
(Guide)

H.R. Nagendra M.E., Ph.D.
Vice-chancellor
(Co-guide)

Date:
Place:

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 (SVYASA), Bangalore, under the guidance of Dr. Shirley Telles, Prof. & Head, Dept. of Biosciences and Dr. H.R. Nagendra, Vice Chancellor, Swami Vivekananda Yoga Anusandhana Samsthana Deemed University, Bangalore.

I also declare that the subject matter of my thesis entitled "A COMPARISON OF PSYCHOPHYSIOLOGICAL EFFECTS OF TWO YOGA RELAXATION TECHNIQUES" has not previously formed the basis of the award of any degree, diploma, associate ship, fellowship or similar titles.

Place: Bangalore **PATIL SARANG SHASHIKANT**

Date: (Candidate)

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

No duty is more urgent than that of acknowledgement.

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Bangalore
Date: **PATIL SARANG SHASHIKANT**

C O N T E N T S

L I S T O F T A B L E S

L I S T O F P L A T E S A N D F I G U R E S

A B S T R A C T

Background:

Cyclic meditation (CM) is a technique which consists of cycles of yoga postures interspersed with periods of supine rest (SR). A previous study showed that following cyclic meditation compared to a comparable period of supine rest there was a greater reduction in oxygen consumption (32.1% verses 10.1%), in breath rate (3.6 cycles per minute verses 1.9 cycles per minute), and a greater increase in tidal volume (266.3 ml versus 161 ml). However in this study three issues remained unresolved, these were (i) the changes which occurred during the practice, not merely after it were not studied, (ii) the study cited above used a closed circuit Benedict – Roth apparatus which has drawbacks, i.e. it may be inaccurate and breathing through it requires effort, and (iii) the study demonstrated reduced physiological (metabolic) arousal without attempting to assess the mental state or functioning.

Aims and Objectives:

The present study was designed to compare cyclic meditation with an equal period of supine rest, with respect to: (1) oxygen consumption and related variables using an open-circuit apparatus, (2) an electrophysiological variable considered as an index of attention, viz., the P300, (3) the actual performance in a paper pencil cancellation task which requires the ability to sustain and shift attention, and (4) the heart rate variability (HRV) to get additional information about the level of arousal.

Subjects and Design:

The study was performed on 53 healthy male volunteers 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' (23 minutes) and 'Post' (5 minutes) states. While oxygen consumption (and related variables) and heart rate variability were recorded throughout both types of sessions, the P300 (recorded at Fz, Cz and Pz) and the letter cancellation task were assessed in 'Pre' and 'Post' periods.

Results:

There was a significant increase in oxygen consumption during the practice of cyclic meditation when the subjects were actually practicing yoga postures, by 55.10%. However the oxygen consumption reduced to the initial values at the end of CM, and decreased still further post CM (by 19.39% less than 'pre' CM). In contrast, in the SR session, oxygen consumption reduced 7.28% 'during' supine rest and 4.83% post SR. The changes in the HRV were an increase in LF and decrease in HF and increase in LF/HF ratio during the practice of postures in CM, which returned to baseline values towards end of CM. Further, post CM there was reduction in LF, increase in HF and decrease in LF/HF ratio. In the SR session there was no significant change in HRV. There was a significant increase in the P300 amplitude and decrease in P300 latency post CM compared to pre, at all three recording sites. In the SR session the P300 amplitude showed no significant change however P300 latency reduced in the post period of SR compared to pre period. The net scores obtained in the six letter cancellation task were significantly more (suggesting improvement) in the post CM period compared to pre CM. The net scores in the post SR period were also more than pre SR period, but less in magnitude than CM.

Conclusion:

These results suggest that CM produces a hypo-metabolic physiological state along with an improvement in the ability to show selective and focused attention to target stimuli (evidenced by the changes in P300 and performance in letter cancellation task).

Yoga is an ancient Indian Science and way of life, which includes the practice of specific postures, regulated breathing, and meditation (Taimini, 1961). Meditation has been described as a training in awareness which produces definite changes in perception, attention and cognition (Brown, 1977). Based on changes in oxygen consumption, carbon dioxide elimination, breath rate and the EEG, the practice of Transcendental meditation was reported to induce a 'wakeful hypo-metabolic physiologic state' (Wallace, Benson, & Wilson, 1971). Similarly, a decrease in oxygen consumption occurred following meditation on a meaningful syllable, 'OM' which was accompanied by decrease in cutaneous blood flow suggesting an increase in sympathetic vasomotor tone. This suggested that meditation on 'OM' produces a state of alertful rest (Telles, Nagarathna, & Nagendra, 1998).

In contrast to meditation, the metabolic rate increased both during a sitting (Rai, Ram, Kant, Madan, & Sharma, 1994) and a standing yoga posture (Rai & Ram, 1993), when these postures were compared with supine rest and with sitting in a chair. In particular the standing yoga posture (*virāsana*) induced a hyper-metabolic state with increased sympathetic activity, which disappeared when the subject adopted a supine posture (*śavāsana*). Hence while oxygen consumption decreased following meditation, an increase in oxygen consumption was during or after yoga postures. This difference may be related to the fact that meditation decreases muscular effort, whereas yoga postures, though practiced with relaxation, may increase muscular effort relative to supine rest.

These results suggest that meditation may be associated with greater mental calmness compared to yoga postures. It is worth noting that traditional yoga texts (*Māndukya Upaniṣat)*, say that it may also sometimes be desirable to stimulate the mind (Swami Chinmayananda, 1984). The verse 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 do not disturb it again'. For most persons routinely, the mental state is somewhere between the extremes i.e., 'inactive' or 'agitated'. Hence a combination of 'awakening' and 'calming' practices may be better suited to reach a balanced, relaxed state.

Cyclic meditation is a technique derived based on the above idea drawn from the traditional texts which include the practice of four yoga postures interspersed with supine rest, hence consisting of a combination of both 'stimulating' and 'calming' practices (Nagendra & Nagarathna, 2003). In the activating phase, the yoga postures are practiced about four times slower than that required by classical description. This slower practice requires more effort than that required by the usual practice. In cyclic meditation the awareness is maintained throughout the practice with closed eyes, witnessing changes which occur in the body such as, changes in respiratory rate, heart rate, blood flow and contraction and relaxation of muscles.

A single study evaluated the physiological effects of cyclic meditation (CM) compared to supine rest in corpse posture (*śavāsana,* SH) in forty male volunteers aged between 20 and 47 (group mean $\pm$ SD, 27.0 $\pm$ 5.7) years

(Telles, Reddy, & Nagendra, 2000). Each individual was tested before and after both cyclic meditation and *śavāsana* sessions, and the order of sessions was altered for alternate subjects. The duration of sessions for CM and SH were same, i.e., 23 minutes. Assessments of oxygen consumption, breath volume and breath frequency were made before and after each session while breathing oxygen through a closed circuit Benedict-Roth apparatus (Mountcastle, 1980). There was a significant decrease in the amount of oxygen consumed and in breath rate and an increase in breath volume after both types of sessions. However, the magnitude of change on all three measures was greater after CM: (i) Oxygen consumption decreased 32.1% after CM compared with 10.1% after SH; (ii) breath rate decreased 18.0% after CM and 15.2% after SH; and (iii) breath volume increased 28.8% after CM and 15.9% after SH.

These results were different from those of another study done on Tai Chi Chuan (TCC) meditation based on Oriental principles, which included slow body movements (hence called 'moving' meditation) (Lan, Chen, Lai, & Wong, 2001). Fifteen men aged between 26 and 56 (group mean $\pm$ SD, 39.9 $\pm$ 9.5) years participated in this study. Subjects had experience of classical Yang TCC practice more than one year (group mean $\pm$ SD, 5.8 $\pm$ 2.4 years). Heart rate responses and oxygen consumption were measured during practice of TCC by using an open circuit K4 telemetry system. Blood lactate was measured before and immediately after TCC practice. Additionally, breath-by-breath measurement of cardiorespiratory 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 were compared to determine the exercise intensity of TCC. While performing TCC, the mean HR of subjects was 140 $\pm$10 beats per minute, and the mean oxygen consumption was 21.4 $\pm$ 1.5 ml/kg/min. Compared with the data of the exercise test, the HR during TCC practice was 58% of the heart rate range. The oxygen consumption during TCC practice was 55% of the VO_2 peak. 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. However it is important to note that though the TCC practice consist slow mindful body movements it does not involve supine rest like CM.

Since both CM and Tai Chi Chuan are meditation techniques which include movements but have different effects on oxygen consumption, it was considered necessary to detect whether the difference was related to the fact that CM includes postures interspersed with supine rest, while Tai Chi Chuan consists of movements alone, or whether the difference could be related to difference in the measuring techniques. In the study on the CM, the measurements were made while breathing through a closed circuit apparatus, whereas in the Tai Chi Chuan study assessments were done by using an open circuit apparatus.

While breathing through the Benedict Roth closed circuit apparatus some subjects find it hard to breath normally through a mouthpiece and valves and the serious criticism of the method is that the accuracy of the determination depends on the ability of a subject to breathe regularly. If the rate or amplitude (or both) of respiration are irregular it is difficult to decide precisely where to draw the sloping line (Judy, 1982). This could be the reason for inter-subject variability and baseline difference in oxygen consumption found in the earlier study on CM (Telles, Reddy, & Nagendra, 2000). In closed circuit systems the subject breathes from a reservoir of 100% oxygen which creates artificial situation. The resistance offered by the breathing circuit to large breathing volumes required during exercise is considerable, and the rate of carbon dioxide removal by the absorber may be inadequate during moderate and heavy exercises for accurate results (AARC Clinical Practice Guidelines for Metabolic Measurement using Indirect Calorimetry during Mechanical Ventilation, 1994). The breathing resistance is increased, inspiratory time is prolonged, and the work of breathing may be increased as much as 10% in closed systems (Branson, 1990), whereas in open circuit method the subject breathes in ambient room air, and hence it does not increase the work of breathing. Generally open circuit system is regarded as a more accurate measure than closed circuit as it is less prone to error, especially during the exercise (Matarese, 1997).

It is necessary to mention that the oxygen consumption was measured as a possible indicator of the level of physiological arousal and muscular effort

(Fig.1.A) (West, 1995). Also a recent study has attempted to correlate the metabolic rate with the life span (Fig.1.B) (Ricklef, & Finch, 1995).

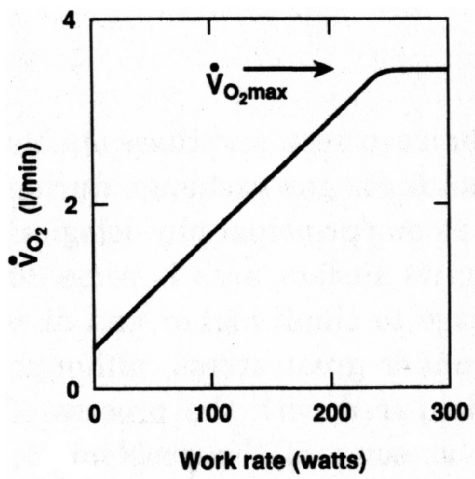


Fig. 1.A: Oxygen consumption increases nearly linearly with work rate until the VO_2 max is reached (From: West, 1995).

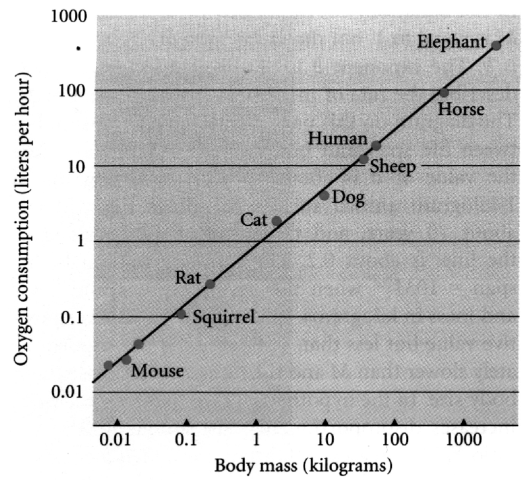


Fig. 1.B: The relationship between metabolic rate and body mass in various species of mammals. The line represents the allometric equation BMR = 0.7 M $^{0.75}$ (From: Ricklef, & Finch, 1995)

In addition, since CM was associated with a significant decrease in oxygen consumption by 32.1%, which is generally suggestive of a calm mental state, for e.g., in sleep (Wallace, Benson, & Wilson, 1971) the oxygen consumption decreases by about 15% it was considered interesting to understand how CM influenced cognitive attentional mechanisms. The assessments which ware selected were two, one was electrophysiological (viz., the P300 using the auditory oddball paradigm) and the other was a paper and pencil task (the six letter cancellation test).

The P300 event related brain potentials (ERP) reflect fundamental cognitive events requiring attentional and immediate memory processes. This ERP component is often obtained with 'oddball' paradigm, wherein two stimuli are presented in a random order with one occurring more frequently than the other. The subject is required to discriminate the infrequent target stimulus from the frequent standard stimulus by responding covertly or overtly to the target – typically an easy task (Polish, 2004).

Cancellation tasks require visual selectivity and a repetitive motor response. These tasks assess many functions such as selective and focused attention, visual scanning, and the activation and inhibition of rapid responses (Lezak, Riddle, & U'ren, 1986).

In addition, to these tests for attention it was considered interesting to understand the autonomic activity based on heart rate variability. The reason was sympathetic nervous system is related with attention (Fredrikson, & Engel, 1985). Considering that the oxygen consumption was decreased after CM, it was decided to study both measures of (i) attention and (ii) autonomic activity based on heart rate variability to assess how they would be influenced by the practice of cyclic meditation.

STANDARD TRANSLITERATION CODE

a	=	अ	**ṅa**	=	ङ	**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
e	=	ए	**ṭa**	=	ट	**ra**	=	र
ai	=	ऐ	**ṭha**	=	ठ	**la**	=	ल
o	=	ओ	**ḍa**	=	ड	**va**	=	व
au	=	औ	**ḍha**	=	ढ	**śa**	=	श
m	=	अं	**ṇa**	=	ण	**ṣa**	=	ष
ḥ	=	अः	**ta**	=	त	**ha**	=	ह
ka	=	क	**tha**	=	थ	**kṣa**	=	क्ष
kha	=	ख	**da**	=	द	**tra**	=	त्र
ga	=	ग	**dha**	=	ध	**jña**	=	ज्ञ
gha	=	घ	**na**	=	न			

3.1.1 BACKGROUND AND SCOPE

Yoga is both, the goal as well as the means to achieve a state of perfect harmony. Yoga is a state of complete absorption, union (*Yoga sthiti*) with absolute Reality i.e., Universal Consciousness. The word Yoga comes from the Sanskrit root word *'Yuj'* which means integration, or a meeting with the true Self (Apte, 1992). Yoga is also an art of living and a systematic process to reach the state of *Mokśa,* endowed with perfect silence, knowledge, power and bliss (Nagendra, Nagrathana, 2001).

The world that we perceive and experience (around and within us) is one reflected by our own minds. If that 'mirror' is covered with dust or dirt [of ignorance, wrong values in from of *vāsanas* (tendencies), and *sasṁskāras* (impressions)] the reflection from it is distorted. However if one cleanses and polishes the mirror of the mind, it reflects the Reality, the true nature of Self, which is God. This cleansing is accomplished by the practice of yogic disciplines and austerities, which includes the control of the senses and the various forms of meditations. Yoga is to purify, control (*nirodha*) and slowdown (*praśamana*) the mind and its modifications (*vṛttis*) by skill (*kauśala*) and knowledge (*viveka*).

Indian tradition offers different disciplines to arrive at this state of absolute freedom according to different predispositions, temperaments (*guṇas*) and abilities of people. One can reach *Mokśa* by psychic control (*Raja* yoga), by intellectual analysis *(Jñana* yoga), by surrender and devotion (*Bhakti* yoga), by selfless service (*Karma* yoga), or by combination of all (Vivekananda, 2001).

The theoretical basis and techniques of yoga have been described in ancient Yoga texts. These observations were based on the actual experiences of the ancient sages, who studied what was taking place within them. Around 900 BC the Sage Patanjali compiled the principles of yoga in the form of yoga aphorisms *(yoga-sutrās)* and offered an eight fold path of practices called *Aṣṭāṅga Yoga*. The *aṣṭāṅga yoga* has eight limbs: *yama* (restraints), *niyama* (observances of discipline), *āsanās* (postures), *prānāyāma* (regulation of breathing) *pratyahāra* (withdrawal of senses), *dhāraṇa* (focusing), *dhyāna* (meditation) and *samādhi* (a state complete absorption) (Taimini, 1961, Ch: 2 V: 29).

While moving along this path one gets benefits such as good physical health, a peaceful mind, balanced emotions and in consequence harmonious relations with others and greater efficiency in action. Hence the popularity and awareness about yoga is growing. However, sometimes people practice yoga only to achieve these benefits forgetting the main objective and purpose of yoga. As a result many types of meditation techniques have become prevalent today. Several books and descriptions have been written about these meditation techniques. In spite of this, their basis and the principles involved remain vague. The present compilation aims at attempting to clarify the theoretical basis of meditation according to ancient texts.

3.1.2 AIMS AND OBJECTIVES

The present review was conducted to:

i) Compile authentic information on meditation from classical yogic and spiritual literature.

ii) Study the basic principles and theory of meditation based on traditional literature.

iii) Describe in brief the different methods of meditation and commonalities between them.

iv) Define and present concept of a specific technique i.e., cyclic meditation.

3.1.3 MATERIALS AND METHODS

3.1.3.A Source material

The traditional yogic and spiritual literature was reviewed. The sources for the present literary search included:

A) Classical yoga texts: (i) Patanjali yoga sūtrās, Vyāsa bhaṣyā on Patanjali yoga sūtrās (iii) Bhagavad gīta, (iv) Hatha yoga pradīpikā, (v) Gheranda saṁhītā and (vi) Shiva saṁhītā

B) Major Upaniṣads: (i) Īśāvāsya 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

C) Prakharaṇa Granthās like Atma bodha and Vivekacūdamaṇi

D) Texts written by persons recognized as spiritual leaders and visionaries like Sri Ramkrishṇa Pramahansa, Swami Vivekananda and Swami Adhīśwarānanda

3.1.3.B Methods

The verses and relevant information about different aspects of meditation, from the above mentioned sources were first systematically complied and then were sorted according to the defined structure of the sections. The relevant references are cited in the body of the text as well as in the reference section.

3.1.4 CONCEPT OF MEDITATION

3.1.4.A Definition of meditation

The English word meditation comes from the Latin root word *meditari*, which derives from the same root as the word meaning ‘to heal’. The practice of meditation sets in motion, a process that leads to the restoration of one’s - physical, mental, and spiritual well-being. The English connotation of the word ‘meditation’ is therefore more associated with healing and relaxation (Adiswarananda, 2004). Meditation is also defined as concentration (continuous thinking) and some times as contemplation (repetitive thinking). Whereas in yogic understanding meditation is not mere concentration but it is more than concentration. Therefore it is essential to distinguish the meaning of meditation.

3.1.4.A1 Concentration (Ekāgratā):

Meditation is generally understood as deep concentration on any object. In that sense, everyone meditates, because concentration is indispensable not only for survival but also for success in any walk of life. It is through concentration one can see, hear, work or understand anything. Concentration is the way to gain knowledge about any subject. Through concentration the mind acquires the quality of a lens and can penetrate deeply into an object, external or internal, and perceive its’ real nature. However, practically it is observed and experienced that concentration is tiring, it drains the energy. One cannot concentrate for long. After some time spent in concentration one feels fatigue and stressed because concentration involves intense effort.

In Sanskrit, *ekāgratā* (moving in one direction) means concentration (Apte 1992), the channelizing of all the mental energies in a single direction. Normally our mind exists in the state of *cancalatā* (continuously moving) wherein it moves in all directions, jumps (as it were) from one object to another object randomly. The mind in this phase is unstable, turbulent and restless (Chinmayananda, 2001, Ch: 6 V: 34). It flows in all directions according to its likes and dislikes and its patterns. The haphazard flow of thoughts is called as *cancalatā.* Streamlining these scattered energies of the mind in one direction is *ekāgratā*. However this process requires voluntary control and effort. For example, reading a book, watching a movie, driving a car all require different degrees of effort. Thus in concentration mind is directed on a single subject or direction, but there exist multiple thoughts. All these thoughts are interconnected to one another to form a meaningful or logical chain.

3.1.4.A2 Dhāraṇā:

Dhāraṇā is a continuation of the process of sensory inhibition or withdrawal called as *pratyahāra*. *Dhāraṇā* is the 'holding of the mind in a motionless state', as the *Tri-śikhi-Brahmaṇa- upaniṣat* defines this advanced practice (Feuerstein, 2001). *Dhāraṇā* the fifth limb of the Patanjali's eightfold path is focusing of attention to a given locus (*deśa*), which may be a particular part of the body (such as *cakra*) or an external object that is internalized (such as the image of a deity).

The Sanskrit word *dhāraṇā* stems from the verbal root *dhri* (Apte, 1992), meaning 'to hold, to fix'. What is being held is one's attention, which is fixed on an internalized object and the underlying process is called *dhāraṇā*. According to sage Patanjali,

देशबन्धश्चित्तस्य धारणा ॥

Deśabandhaścittasya dhāraṇā.

Fixing of mind on a specific object (or a spot, internal or external) is *dhāraṇā* (Prabhavananda, 2002, Ch: 1 V: 3).

देशे नाभिचक्रनासाग्रादौ चित्तस्य बन्धो विषयान्तरपरिहारेण
यत् स्थिरीकरणं सा चित्तस्य धारणा इत्युच्यते ।

Deśe nābhicakranāsāgrādau cittasya bandho viṣayāntaraparihāreṇa
yat sthirīkaraṇaṁ sā cittasya dhāraṇā ityucyate.

The mental flux could be halted on navel center, tip of the nose or any place as sanctioned by scriptures. Stabilizing the mental flux without disturbance from any corner is termed as *dhāraṇā* (Sukhanandanatha, 1992).

मैत्र्यादिचित्तपरिकर्मवासितान्तः करणेन यमनियमवता चितासनेन परिह्वतप्राणविक्षेपेण
प्रत्याह्वतेन्द्रियग्रामेण निर्वाधे प्रदेशे ऋजुकायेन जितद्वन्देन योगिना नसाग्रादौ सम्यज्ञातस्य समाधेः
अभ्यासाय चेतसः स्थिरीकरणम् कर्तव्यम् इति ॥
यमादिगुणसंयुक्ते मनसः स्थितिरात्मनि । धारणा प्रोच्यते सदिः योगशास्त्रविशारदैः ॥
तस्मात्समस्तशक्तिनाम् आधारे तत्र चेतसः । कुर्वीत संस्थितिं सा तु विज्ञेया शुद्धधारणा ॥

Maitryādicintapari karmavāsitāntaḥ karaṇena yamaniyamavatā citāsanena parihrataprāṇavikṣepeṇa pratyāhratendriyagrāmeṇa nirvādhe pradeśe rjukāyena jitadvandena yoginā nasāgrādau samyajñātasya samādheḥ abhyāsāya cetasaḥ sthirīkaraṇam kartavyam iti. Yamādiguṇsaṁyukte manasaḥ sthitirātmani. Dhāraṇā procyate sadiḥ yogaśāstraviśāradaiḥ. Tasmātsamastaśaktinām ādhāre tatra cetasaḥ|Kurvīta saṁsthitiṁ sā tu vijñeyā śuddhadhāraṇā. - Viṣṇupurāṇam

This (*dhāraṇā)* is supposed to be practiced by the yogi, who has gone through the previous five limbs, and desirious of attaining *Samādhi.* Hence directing or stabilizing all mental forces on a particular base or object is known as *śuddha-dhāraṇā*. – Viṣṇupurāṇam (Sukhanandanatha, 1992).

Thus *dhāraṇā* not only involves concentration but takes to the next step of focused attention. *Dhāraṇā* consists of focusing on a relevant thing and withdrawal from irrelevant. In the process of perception, mind not only aligns with external sense organs (*jñānendriyās*) but also tunes with earlier experiences. Hence *dhāraṇā* also involves a component of remembering i.e., repeated continuous recollection of the object and not allowing the mind to get distracted (Nagendra, Swami, & Mohan, 2003). Thus in *dhāraṇā* mind is confined (*bandha*) to a single object with single thought. Hence *dhāraṇā* requires voluntary control, persistent effort and training (*abhyāsa*).

3.1.4.A3 Dhyāna

The Sanskrit word *dhyāna* means continuous dwelling of mind on a single object. When *dhāraṇā* becomes effortless and continuous it takes the form of *dhyāna*. Often this is translated as meditation. Nevertheless, the word meditation is also used to denote concentration and *dhāraṇā*. In this thesis, meditation means *dhyāna*.

तत्र प्रत्ययैकतानता ध्यानम् ॥

Tatra pratyayaikatānatā dhyānam.

'Meditation is uninterrupted, spontaneous flow of the mind towards the chosen object' (Taimini, 1961, Ch: 3 V: 2).

Dhāraṇā naturally leads to the state of meditative absorption, in which the internalized object or locus fills the entire space of consciousness. Just as the one-pointed-ness of attention is the mechanism of *dhāraṇā*, 'one-flowing-ness' (*ekatānatā*) is the underlying process of meditation accompanied by a peaceful, calm disposition. There is no loss of lucidity, but on the contrary, the sense of wakefulness is intensified, even though there is no or little awareness of the external environment.

The psychology of meditation is to cultivate a single thought. A restless mind is like a lake, constantly agitated by the winds of desires, creating thought –waves of diverse intensities. Because of this constant agitation, our true Self at the bottom of the lake cannot be perceived. When, to counter all those many thought –waves, a single thought is consciously cultivated by the repeated and uninterrupted practice of meditation, it develops into a huge wave that swallows up all the diverse ripples and makes the mind transparent and calm. The mind in meditation takes the form of this single thought - wave. The five characteristic features of meditation (*dhyāna)* are (i) single thought, (ii) effortlessness, (iii) awareness, (iv) slowness and (v) expansiveness. This can be called as defocusing. Meditation is a fine method for learning the secrets of the outer and inner worlds. Meditation is a technique of withdrawing the mind so that it receives rest and rejuvenation. The initial purpose of meditation is to intercept the flux of ordinary mental activity (*citta vṛuti*), which is cause for *cancalatā* (Feuerstein, 2001).

3.1.4.B Steps in meditation

The process of meditation thus encompasses *ekāgratā, dhāraṇā and dhyāna*, where *ekāgratā* and *dhāraṇā* are the preliminary steps. All types of meditation techniques whether traditional or modern comprise these steps in varying duration.

Steps	Process	Key features	Experience
Ekāgratā Concentration	Channelizing the multiple thoughts in one direction	- Voluntary control - Intense effort	alertness, fatigue
Dhāraṇā Focusing	Fixing the mind on one single object with single thought	- Confined repetitions - Withdrawal from irrelevant	Sustained attention, tiredness
Dhyāna Meditation	Continuous and spontaneous dwelling of mind on a single object	- Effortless awareness - Slow expansion	Awareness Silence Peace Happiness
Samādhi	Absorption of subject, object and the process	- Expansion - Powers	Knowledge Bliss

Swami Vivekananda in his book (Vivekananda, 2001) on Raja yoga says, when the mind is focused on a specific object uninterruptedly for twelve seconds, one achieves one unit of *dhāraṇā.* Twelve such successive units of *dhāraṇā* make one unit of *dhyāna*, and twelve such successive units of meditation, lead to *Samādhi. Samādhi* is a state of complete absorption. Sage Patanjali says:

तदेवार्थमात्रनिर्भासं स्वरूपशून्यमिव समाधिः ॥

Tadevārthamātranirbhāsaṁ svarūpaśūnyamiva samādhiḥ.

The same (contemplation) when there is consciousness only the object of meditation and not of itself (the mind) is *Samädhi* (Taimini, 1961, Ch: 3 V: 3).

The absorption is attained when meditation becomes constant and continuous, and the mind merges in the object of meditation. There exits no *triputi*. *Samādhi* is a quantum jump into next level of consciousness, the realm of knowledge, power and bliss (Nagendra, Swami, & Mohan, 2003).

3.1.4.B1 Objects of meditation

Meditation involves three factors (*triputi)* i.e., meditator, the object of meditation and the process of meditation. The object of focus is generally sacred and can be personal or neutral, concrete or abstract, a word or an idea, an image or a symbol, a divine form or personality.

The *Yoga sutrās* of Patanjali mention the following as the possible objects of meditation: (i) the effulgent or radiant light which is beyond all sorrow (*jyotiṣmati*), (ii) the heart of an illuminated being (*vītrāgi*) who is free from all passion and attachment (iii) the subtler dimensions and knowledge of sleep and dream state or (iv) anything (*yathābhimata*) that is spiritually uplifting. Such a thing may be a place, some scenery, an idea or any other thing that would evoke concentration of mind (Adiswarananda, 2004).

The texts on Hatha yoga say the object of concentration can be out side the body like a *jyoti* or *bindu* in case of *trāṭaka,* sun *(surya)* and moon *(candra)* or can be inside the body like breath, movement of prana, sensations of processes in the body, various *cakras* or even the mind (genesis of thoughts) itself (Muktibodhananada, 2003).

According to the tradition of Vedanta following objects are preferred for meditation: (i) a divine form, (ii) an Incarnation of God, (iii) the divine Lord as inmost Self of Supreme Teacher, (iv) *viraṭa puruṣa* or the Cosmic Personality, (v) the sacred word *AUM*, (vi) *Gāyatri mantra*, or the sacred prayer of the Vedas (vii) the meaning of any of the four *mahāvākyas*, or great Vedic saying or (Viii) the meaning of a sacred text, word or mystic syllable (Adiswarananda, 2004).

3.1.4.B2 Requisites of meditation

Posture: The perfect posture for meditation is that in which the spine, the head, the chest, and the neck are kept erect and there is no movement of the body, and the mind remains in a state of equilibrium (Madhusudhan, & Gambhiranada, 1998, Ch: 6 V: 35). However meditation can also be practiced while body is in slow actions or motion.

Time: Although there is no fixed time for the practice of meditation, the sacred texts mention 'four timings' that are most favorable and auspicious. The first of them is time between three and five in the morning (*brahmamuhurta*). The second is midday, when nature has a tendency to return to calmness and rest. The third is the hour of dusk (*godhuli*), when day merges into night and nature becomes tranquil. And the fourth is midnight, when a deep silence pervades all of nature. Experienced teacher advocate that the time for meditation once chosen, must be observed every day, because there is a cycle or rhythm in the movement of forces, spiritual as well as material (Mokshadananda, 1997).

Place: The *Vyasa Sutrās* state "There is no law of place; wherever the mind is concentrated, meditation should be practiced" (Adiswarananda, 2004). According to sacred texts of Vedanta, a mountain, a riverbank, a temple, a place where the practice of meditation has been successfully carried out by many spiritual seekers (*tapobhumi*) and a solitary place free from distractions (Vivekananda, 1971).

Direction: The meditator is advised to sit facing the east, because the earth's daily rotation is from west to east. By facing the east, one faces the direction of motion (Adiswarananda, 2004).

3.1.4.C The states of mind

Generally mind is defined as a flow of thoughts. The conglomeration of thoughts is mind (Nagendra, 2001). This process of thoughts is always ongoing and is related with the information and inputs given by the external organs of perception and the feedback obtained from the earlier memories and impressions. In yogic understanding, the mind has four functional facets i.e., *manas, buddhi, citta* and *ahaṅkāra* together called as *antaḥkaraṇa* (internal instrument).

निगद्यतेऽन्तःकरणं मनोधीरहंकृतिश्चित्तमिति स्ववृत्तिभिः ।
मनस्तु संकल्पविकल्पनादिर्बुद्धिः पदार्थाध्यवसायधर्मतः ॥९३ ॥
अत्राभिमानादहमित्यहंकृतिः । स्वार्थानुसन्धानगुणेन चित्तम् ॥९४ ॥

Nigadyate'ntaḥkaraṇaṁ manodhīrahaṅkṛtiścittamiti svavṛttibhiḥ.
Manastu saṅkalpavikalpanādirbuddhiḥ padārthādhyavasāyadharmataḥ.
Atrābhimānādahamityahaṅkṛtiḥ. Svārthānusandhānaguṇena cittam.

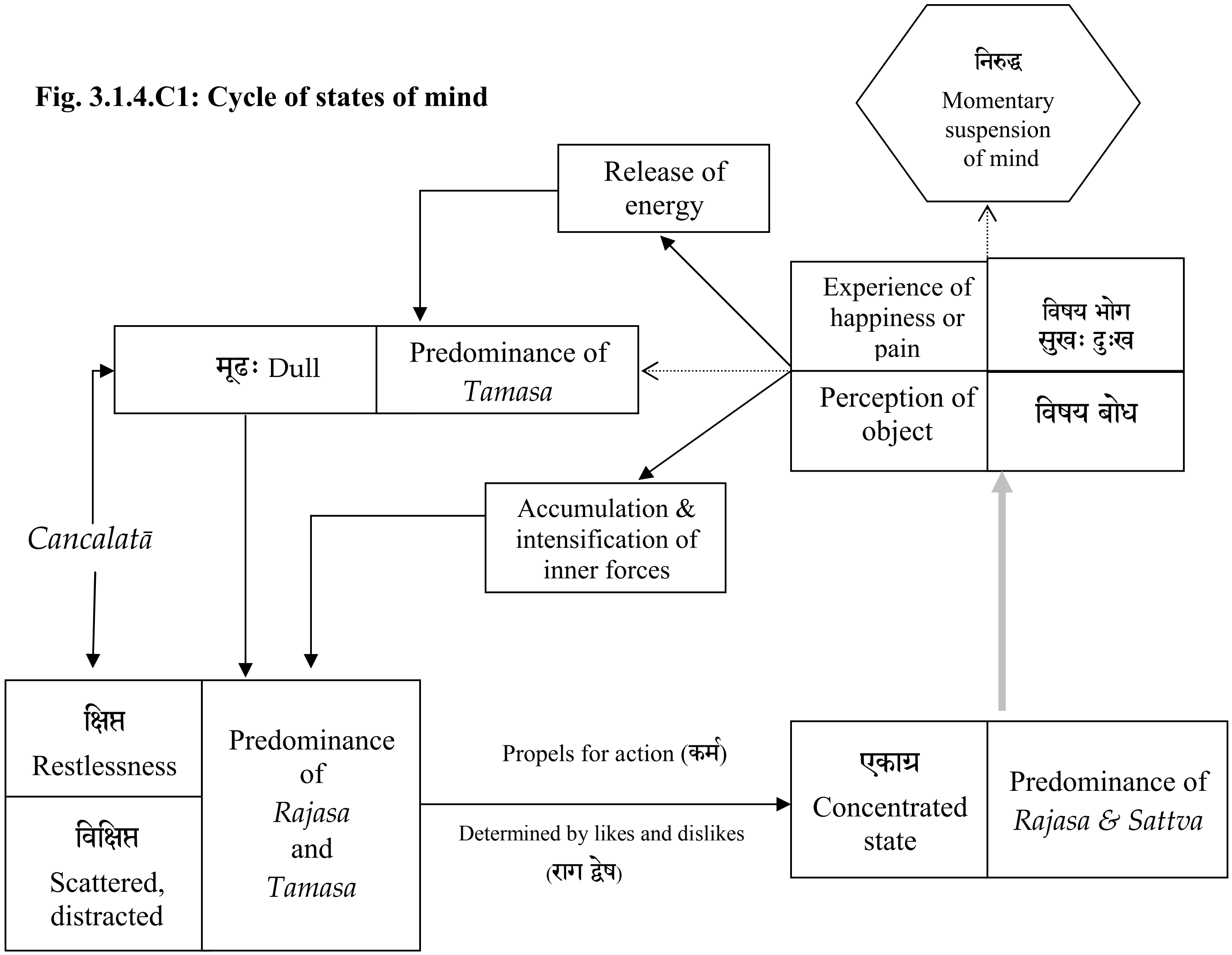
The oscillating nature of thoughts is *manas* (*saṅkalpavikalpatmika*), discriminative ability is *buddhi* (*niścayātmikā*), stored impressions and patterns is *citta* (*anusandhānātmikā*) and feeling of 'I' ness, the ego is *ahaṅkāra* (Chinmayanada, 2002a, V: 93, 94). This mind oscillates between any of the following five states:

क्षिप्तं मूढं विक्षिप्तमेकाग्रं निरुद्धमिति चित्तभूमयः ।

Kṣiptaṁ mūḍhaṁ vikṣiptamekāgraṁ niruddhamiti cittabhūmayaḥ.

Mind often functions in restless or turbulent way (*kṣipta*), sometimes becomes dull and stupefied (*mūḍha*), sometimes becomes distracted and divided (*vikṣipta*), sometimes becomes concentrated and one pointed (*ekāgra*) and rarely becomes restrained and suspended (*niruddha*). These are different grounds or fields of functioning of the mind (c*ittabhūmayaḥ*) (Bangali Baba, 2002). This is presented schematically in Fig. 3.1.4.C1.

Fig. 3.1.4.C1: Cycle of states of mind



The *Bhagavad Gīta* describes the mind by four epithets: restless, turbulent, powerful, and obstinate (Chinmayananda, 2001, Ch: 6 V: 34). An ancient proverb depicts the restless mind addicted to the pleasures of the senses as a mad elephant, while Swami Vivekananda has compared the restless mind to a monkey that not only is drunk with the wine of desire but simultaneously stung by the scorpion of jealousy and overtaken by the demon of pride. The restless mind is like a monster that can make life a nightmare - but that same mind, when subdued and controlled, becomes a most trusted friend and helper, guaranteeing peace and happiness. The strong likes (attachments) and dislikes (repulsions) make mind restless and induce desires. To pamper whatever desires arise in the mind would be counterproductive, leading only to greater restlessness. In Bhagavad Gīta it is described as..

ध्यायतो विषयान् पुंसः सङ्गस्तेषूपजायते । सङ्गात् सञ्जायते कामः कामात् क्रोधोऽभिजायते ॥२.६२ ॥
क्रोधाद् भवति संमोहः संमोहात् स्मृतिविभ्रमः । स्म्रृतिभ्रंशाद् बुद्धिनाशो बुद्धिनाशात् प्रणश्यति ॥२.६३ ॥

Dhyāyato viṣayān puṁsaḥ saṅgasteṣūpajāyate. Saṅgāt sañjāyate kāmaḥ kāmāt krodho'bhijāyate. Krodhād bhavati sammohaḥ sammohāt smṛtivibhramaḥ. Smrṛtibhraṁśād buddhināśo buddhināśāt praṇaśyati.

Brooding on the objects of senses, man develops attachment to them; from attachment comes desire; from desire anger sprouts forth. From anger proceeds delusion; from delusion, confused memory; confused memory ruins the ability of discrimination; and due to that finally he perishes (Chinmayananda, 2001, Ch: 2 V: 62, 63).

Desire leads to generation of more thoughts; repetition of thoughts and experience makes deeper impressions converting them in to emotions. Punishing the mind through self-torture and mortification would merely repress the desires, driving them underground (subconscious). Trying to transform the mind by changing our environment would be futile because wherever we go, our mind with all its habitual tendencies goes with us. The mind never becomes controlled automatically; it must be controlled consciously. The only alternative, according to the *Bhagavad Gīta*, is to slowdown the mind (sublimation) and face it by control and regulation.

शनैः शनैरूपरमेद् बुद्धया धृतिगृहीतया । आत्मसंस्थं मनः कृत्वा न किञ्चिदपि चिन्तयेत् ॥६.२५॥

Śanaiḥ śanairūparamed buddhyā dhṛtigṛhītayā Ātmasaṁsthaṁ manaḥ kṛtvā na kiñcidapi cintayet.

With intellect set in firmness, attain quietitude little by little (step by step); with the mind fixed on the Self, do not think of anything (Chinmayananda, 2001, Ch: 6 V: 25).

The methodology of yoga is to control and purify the subconscious (region of *vāsanas* and *sasṁskāras*) with the help of conscious effort. Restlessness of body is to be overcome by slow and mindful practice of postures (*āsanas*). Irregular breath, an indicator of mental restlessness, is to be made regular by smooth and rhythmic breathing (*prānāyāma*).The out going thoughts and improper tendencies of the mind must be substituted by cultivating of moral and ethical virtues. Meditation helps to gain this control and constant awareness. Meditation begins with concentration and intense focusing on the chosen object and *dhyāna* happens only when mind becomes effortlessly and continuously one-pointed like the flow of oil poured from one vessel into another. Sage Patanjali says "meditation is uninterrupted flow of mind on its object. This itself turns into *samādhi* when the object alone shines and the thought of meditation (and of the meditator) is lost, as it were" (Usharbudh, 1986). That state of mind is *niruddha* where thoughts do not exist. Meditation is only possible in wakeful state of consciousness. How mind exists in different states of consciousness and can be evolved higher is schematically depicted in Fig. 3.1.4.C2.

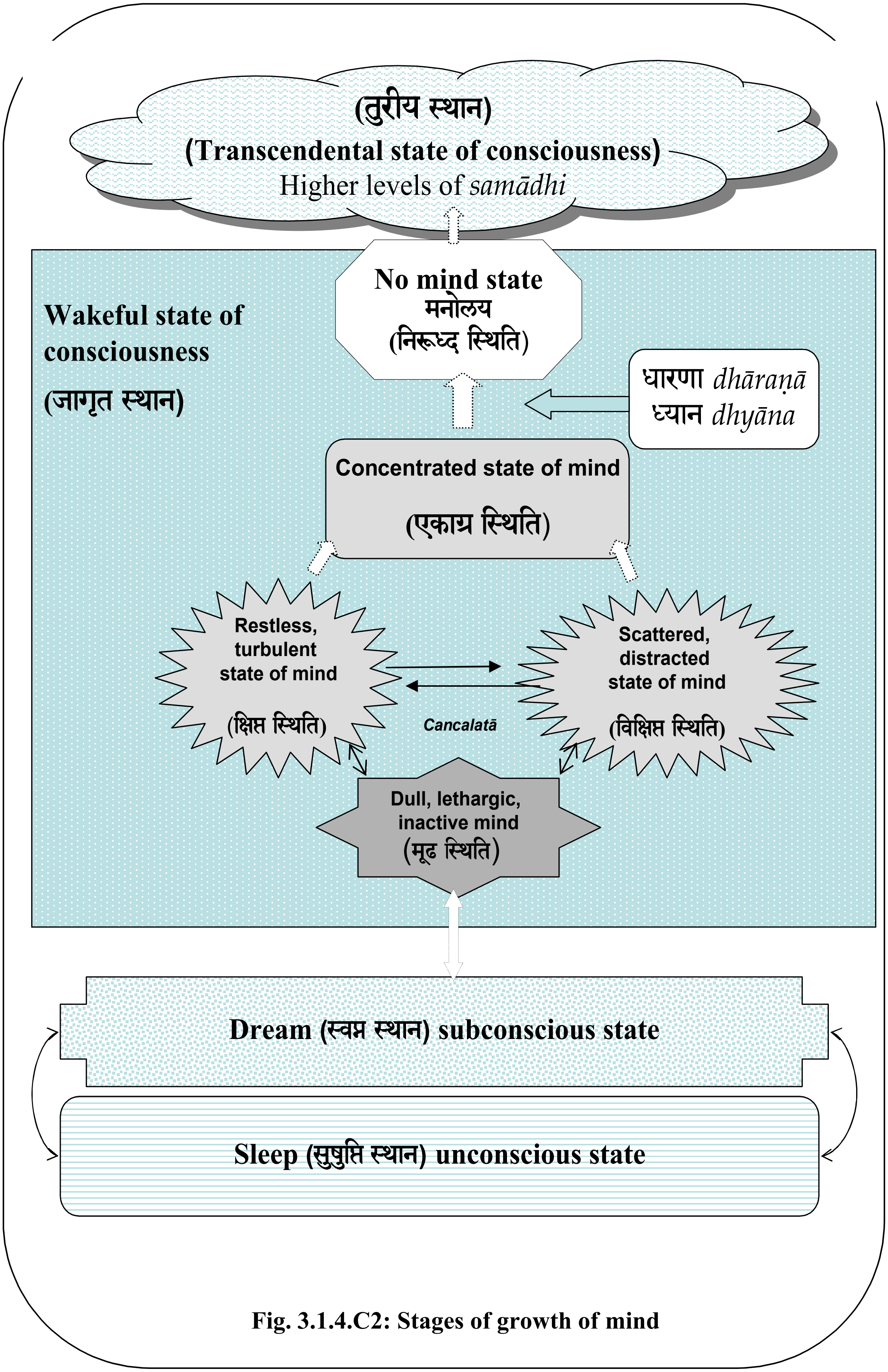


Fig. 3.1.4.C2: Stages of growth of mind

3.1.4.D Goal of meditation

The goal of meditation is complete absorption in the object of meditation (*Samādhi*), finally leading to communion or union with the Ultimate Reality. Different systems of thoughts and philosophies call it by different names: liberation - *Mokśa*, beatific vision of divine – *nirvana*, awakening, enlightment – *Kaivalya*, Self knowledge or knowledge of *Brahman*, attaining the Kingdom of Heaven within. Longing for this goal distinguishes a human individual from the subhuman beings says Sri Ramakrishna (Mumukhsnanda, 1998).

The goal of meditation is the cessation of all miseries through the realization of the indwelling Self, or *Puruśā*, which is Pure Consciousness. The yoga system maintains that the cause of all miseries is ignorance, which deludes the Self, and entangles It in the world of matter. This entanglement is essentially of the mind, and the remedy lies in disentangling the Self from the world of matter and the world of mind. This is only possible through the knowledge of Reality. The aim of meditation is to find the Reality. Meditation leads to Self realization (Satyananda, 1992).

The seers of the Vedas mention four goals of life: knowledge of the right and wrong (*dharma*), worldly prosperity (*artha*), fulfillment of legitimate desires (*kama*) and Self –Knowledge (*mokśa*). Self-knowledge is the consummation of all the other goals. According to *Upaniṣads* in this state, the dualities of subject and object, knower and known, seer and seen, all merge in the indescribable expanse of the Absolute. Consciousness of time and space obliterate, and the fetters of causality broken for forever. No sacrifice is too great to achieve this goal; no effort in this venture is ever lost or wasted. All scriptures of Yoga and Vedanta emphasize on this goal which is the goal of all goals in human life.

3.1.4.E Process of Meditation

The system of Yoga contends that the world of matter and the world of mind are not two different worlds. Material world is part of the world of mind. Matter is grossified form of mind. When the real nature of the mind is known, it no longer deludes the Self. Then the Self alone shines in Its own glory. The mind gets illuminated by that shine – pure to the core. The regular practice of meditation causes calmness of mind, slowness in the flow of thoughts and further leads to purification of mind by release of all knots and blocks in the subtle layers of mind. Meditation helps to address all the unresolved patterns, issues, fears and phobias deep within the subconscious field (Satyananda, 1992). In this technique, willpower plays an important role. Through the exercise of willpower, the mind consciously and deliberately cultivates a single thought to the exclusion of all other thoughts. Meditation begins with concentration on single object and culminates in absorption in that object. Absorption reveals the subtle nature of the object. By knowing it one is able to know the reality of subtle entities in the universe. This is schematically presented in Fig. 3.1.4.E.

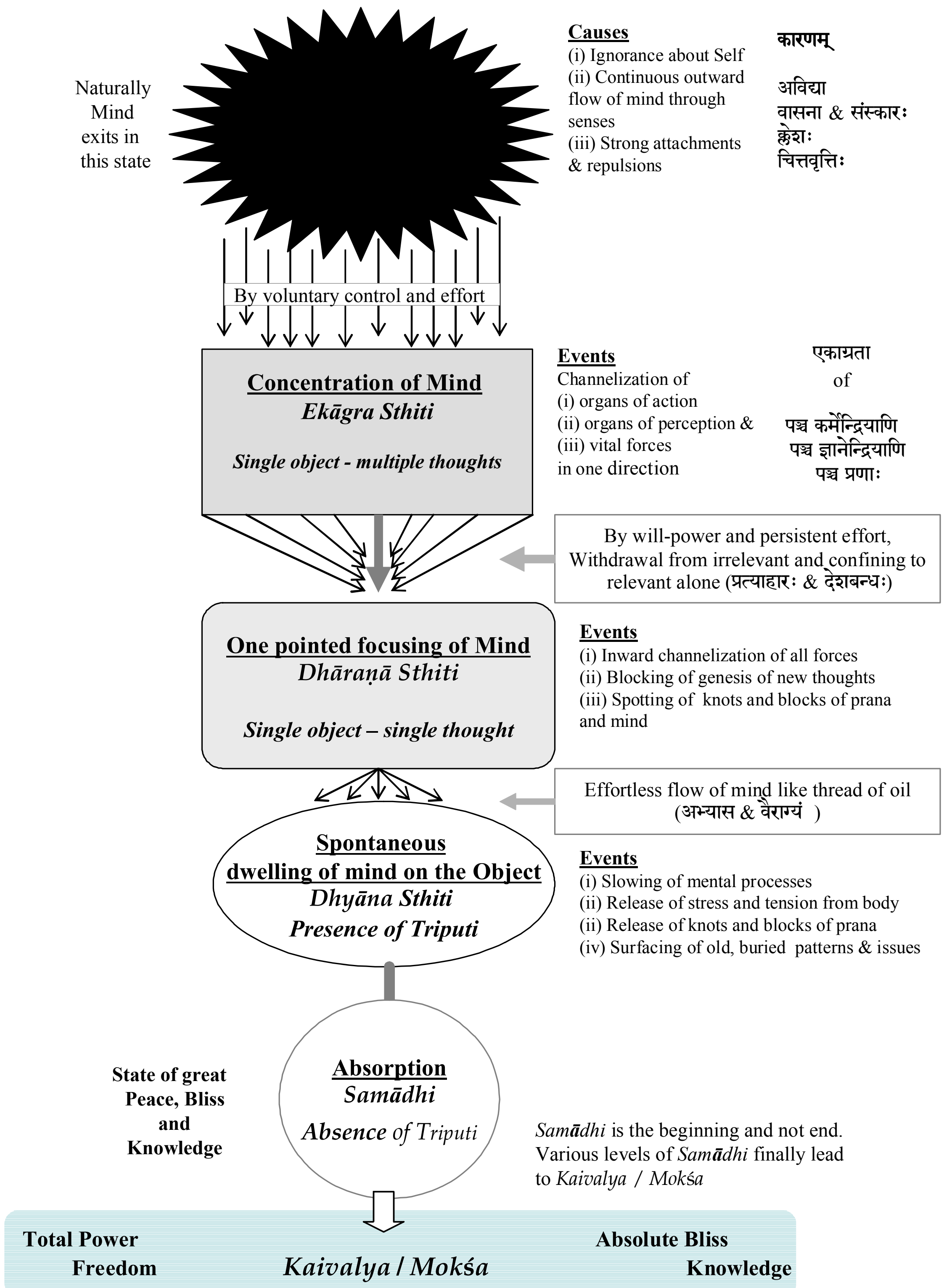


Fig. 3.1.4.E: Mechanism of process of meditation

3.1.4.F Benefits of meditation

The benefits of meditation are threefold: physical, psychological and spiritual. Meditation enables the physical and psychic energies to flow into creative, constructive channels instead of burning out in destructive forms. Mind gains the poise, peace, naturalness, serenity, stability of emotions, conservation of energy, and a capacity to bear the frustrations and the ups and downs of the life. Meditation addresses all the unresolved issues and notions of subconscious. Meditation brings about complete behavioral transformation. A new worldview induces a new quality of consciousness, which leads to change in interpersonal relationships. Meditation teaches to act and not to react (Chao Khun, 1968).

Meditation awakens the dormant powers of the mind. Just as a vast amount of energy is hidden in an atom, so too is there a vast reservoir of energy hidden in the depths of our psyche. The sacred texts of Yoga call this sleeping power of the mind *kundalīni* (Muktibodhananada, 2003). Life becomes blessed when the *kundalīni* is awakened. Practitioner attains certain powers known as *siddhis* (Taimini, 1961). Using the power of the mind, human beings have been able to achieve great wonders in the realm of science and technology. It is the same power of the mind that makes impossible things possible in the realm of spirituality. The story of the evolution of life is the story of the manifestation of mental powers. The mind being clear and free from conflicts becomes more effective and efficient. Meditation brings spiritual illumination which liberates the Self from the trappings of the body-mind complex. Meditation is the only way to Self-Knowledge, and Self-Knowledge can put an end to all the sorrows and sufferings of the life.

A large number of scientific studies have shown positive development in self-actualization, creativity, empathy, reaction time, memory and intelligence, concentration and attention, improved performance in perceptual and motor skills, cognitive abilities following meditation. It is also observed that the experienced meditators have un-agitated voice, relaxed and kindly appearance, a tension-free gait, grace and charm in all actions. In the words of *Śvetāśvatara Upaniṣat*, "The first signs of entering in yoga and meditation are lightness, health, absence of desire, a good complexion, a beautiful voice, a fragrance of the body, and less excretions" (Gamabhiranada, 1986). Swami Vivekananda says, "Such is the power of yoga and meditation that even the least of it will bring a great amount of benefit. It will not hurt anyone but will benefit everyone. It will calm down the nervous excitement, bring peace, enables to see things more clearly" (Vivekananda, 2001).

3.1.5 TECHNIQUES OF MEDITATION

There are different techniques of meditation depending upon the object and the strategy chosen. Despite the difference in objects of focus and techniques of meditation, three key factors have to be present in the practice of any kind of meditation. Those three factors are (i) the object of meditation (locus of focus), (ii) the centre of consciousness (point of awareness) where the mind is held during meditation, and (iii) the method employed to invoke concentration (Adiswarananda, 2004).

The object of meditation can be anything as described earlier, internal or external, stable or dynamic. The sacred texts of Yoga and Vedanta maintain that the object of meditation must not be frequently changed. The object of meditation is generally held within at a particular center, such as the heart, the forehead, the tip of the nose, or the crown of the head. Or the seeker may place it outside his body, in-front of him on the ideal. However in some meditation techniques the object of concentration and the center of consciousness (awareness) where the mind is held are same. The method employed to invoke concentration is either selected by the seeker or prescribed by the teacher (*Guru*), and it also must not be changed.

In Buddhist forms of mindfulness meditation technique the locus of focus and the center of awareness remain same and is dynamic, continually moves with the changing processes or phenomena (Chao Khun, 1968). In cyclic meditation as well the locus of awareness keeps on changing along with the slow movements of the body (Nagendra, & Nagrathana, 2001).

3.1.5.A Traditional techniques of meditation

While the goal of all meditation techniques remains the same, the types of mediation vary because of the different approaches used by different systems of thought. The meditation techniques mentioned in different traditional scriptures could be broadly classified (Sukhanandanatha, 1992) as [1] Meditation on concrete (*dhyāna* on *sākāra saguṇa vastu* object): (i) Meditation on sound (*śabda*) i.e. on certain *mantra, bija akṣara* (syllable in seed form) in form of *japā* meditation (silent repetition of *mantra*) or meditation on inner sounds (*nāda*), (ii) Meditation on form (*rupā*) i.e., on specific ideal or image of deity (*iṣṭadevatā*), tantric codified shapes called *yantrās* or neutral symbol like flame or light (*jyoti*), and (iii) Meditation on inner objects like breath, movement of *pranā, chakras,* genesis of thoughts, or sense of 'I'. [2] Meditation on abstract (*dhyāna* on *nirākāra nirguṇa* object or idea): (i) Meditation on meaning of *upaniṣadic* statements of universal truths called as *mahāvākyas* like अहं ब्रह्मास्मि (ahaṁ brahmāsmi), तत्त्वमसि (tattvamasi), अयमात्मा ब्रह्म (ayamātmā brahma) and प्रज्ञानं ब्रह्म (prajñānaṁ brahma).

The scriptural texts of yoga and spirituality mention following statements about meditation.

The Yajur Veda:

ॐ क्रतो स्मर

Om kṛto smarā

O' devout worshipper, meditate on '*Om*'

The Upaniṣads:

अरा इव रथनाभौ संहता यत्र नाड्यः स एषोऽन्तश्चरते बहुधा जायमानः

ओम् इत्य् एवं ध्यायथात्मानं स्वस्ति वः पाराय तमसः परस्तात्।

Arā iva rathanābhau saṁhatā yatra nāḍyaḥ sa eṣo'ntaścarate bahudhā jāyamānaḥ.

Aumityevaṁ dhyāyatha ātmānam svasti vaḥ parāya tamasaḥ parastāt.

Where the arteries of the body are brought together like the spokes in the center of a wheel , within it (this self, moves about) becoming manifold. Meditate on *Om* as the Self . May you be successful in crossing over to the farther shore of darkness.

Muṇḍaka upaniṣat- (Gamabhiranada, 1995, Ch: 2 V:2.6)

एष सर्वेषु भूतेषु गूढोऽऽत्मा न प्रकाशते।

दृश्यते त्वग्रया बुद्ध्या सूक्ष्मया सूक्ष्मदर्शिभिः॥

Eṣa sarveṣu bhūteṣu gūḍho''tmā na prakāśate.

Dṛśyate tvagrayayā buddhyā sūkṣmayā sūkṣmadarśibhiḥ.

That Self hidden in all beings does not shine forth; but
It is seen by subtle seers through their one- pointed and subtle intellects.

Katha upaniṣat - (Chinmayanada, 2002, Ch: 1 V: 3.12)

तं दुर्दर्शं गूढमनुप्रविष्टं गुहाहितं गह्वरेष्ठं पुराणम्।

अध्यात्मयोगाधिगमेन देवं मत्वा धीरो हर्षशोकौ जहाति॥

Taṁ durdarśaṁ gūḍhamanupraviṣṭhaṁ guhāhitaṁ gahvareṣṭaṁ purāṇam.

Adhyatmayogādhigamena devaṁmatvā dhīro harṣaśokau jahāti.

The wise man who, by means of concentration on the Self, realizes that ancient, effulgent One, who is hard to be seen, un-manifest, hidden, and who dwells in the *buddhi* and rests in the body – he, indeed, leaves joy and sorrow far behind.

Katha upaniṣat - (Chinmayanada, 2002, Ch: 1 V: 2.12)

त्रिरून्नतं स्थाप्य समं शरीरं हृदीन्द्रियाणी मनसा सन्निवेश्य।

ब्रह्मोदृपेन प्रतरेत विद्वान् श्रोतांसि सर्वाणि भयावहानि॥

Trirūnnataṁ sthāpya samaṁ śarīraṁ hrudīndriyāṇī manasā sanniveśya.

Brahmodṛpena pratareta vidvān śrotāṁsi sarvāṇi bhayāvahāni.

The wise man should hold his body steady, with the three (upper) parts erect, turn his senses, with the help of the mind, toward the heart, and by means of the raft of *Brahman;* cross the fearful torrents of the world.

Śvetāśvatara upaniṣat - (Gamabhiranada, 1986, Ch: 2 V: 8)

समे शुचौ शर्करावह्निवालुका विवर्जिते शब्दजलाश्रयादिभिः।

मनिनुकूले न तु चक्षुपीडने गुहानिवाताश्रयणे प्रयोजयेत्॥

Same śucau śarkarāvahnivālukā vivarjite śabdajalāśrayādibhiḥ.

Maninukūle na tu cakṣupīḍane guhānivātāśrayaṇe prayojayet.

Let yoga (meditation) be practiced within a cave protected from the high wind, or in a place which is level, pure, and free from pebbles, gravel, and fire, undisturbed by the noise of water or of market –booths, and which is delightful to the mind and not offensive to the eye.

Śvetāśvatara upaniṣat - (Gamabhiranada, 1986, Ch: 2 V: 10)

बृहच्च तद्दिव्यमचिन्त्यरूपं सूक्ष्माच्च तत्सूक्ष्मतरं विभाति।

दूरात्सुदूरे तदिहान्तिके च पश्यत्स्विहैव निहितं गुहायाम्॥

Bṛhacca taddhiavyamacintyarūpaṁ sūkṣmācca tatsūkṣmataraṁ vibhāti.

Dūrātsudūre tadihāntike ca paśyatsvihaiva nihitaṁ guhāyām.

That *Brahman* shines forth, vast, self-luminous, inconceivable, and subtler than the subtle. He is far beyond what is far and yet here very near at hand. Verily, He is seen here, dwelling in the cave of the heart of conscious beings.

Muṇḍaka upaniṣat- (Gamabhiranada, 1995, Ch: 3 V: 1.7)

सर्वं खल्विदं ब्रह्म तज्जलानिति शान्त उपासीत।

अथ खलु क्रतुमयः पुरूषो यथाक्रतुरस्मल्लोके पुरूषो भवति तथेतः प्रेत्य भवति स क्रतुं कुर्वीत॥

Sarvaṁ khalvidaṁ brahma tajjalāniti śānta upāsīta.

Atha khalu kratumayaḥ purūṣo yathākraturasmalloke purūṣo bhavati tathetaḥ pretya bhavati sa kratuṁ kurvīta.

All this is *Brahman*. From It the universe comes forth, in It the universe merges, and in It the universe breathes. Therefore a man should meditate on *Brahman* with a calm mind. *Chāndogya upaniṣat*- (Swami Swahanada, 1984, Ch: 3 V: 14.1)

Let one meditate That as adoration ; desires pay adoration to him. Let one contemplate That as the supreme, he becomes possessed of the supreme. Let one contemplate That as Brahman's destructive agent, one's hateful rivals perish as also those rivals whom he does not like . He who is here in the person and he who is yonder in the Sun, he is one.

Ṭaittirīya upaniṣat – (Gamabhiranada, 1998, Ch: 2 V:1)

Though a man may perform penance standing on one leg for a thousand years, it will not, in the least, be equal to one- sixteenth part of concentrated meditation.

- *Pingalā upaniṣat* - Ch: 4 V: 15 (Adiswarananda, 2004)

Bhagavad Gīta:

शुचौ देशे प्रतिष्ठाप्य स्थिरमासनमात्मनः।

नात्युच्छ्रितं नातिनीचं चैलाजिनकुशोत्तरम् ॥६.११॥

Śucau deśe pratiṣṭhāpya sthiramāsanamātmanaḥ.

Nātyucchitram nātinīcam cailājinakuśottaram.

On a clean and pure place neither too high nor too low
he spreads kusagrass, a deerskin and a cloth (Tpasyaananda, 2002, Ch: 6 V: 11).

तत्रैकाग्रं मनः कृत्वा यतचित्तेन्द्रियक्रियः।

उपविश्यासने युञ्ज्याद्योगमात्मविशुद्धये ॥ ६.१२ ॥

Tatraikāgram manaḥ kṛtvā yatacittendriyakriyaḥ.

Upaviśyāsane yuñjyādyogamātmaviśuddhaye.

Sitting on that seat he should concentrate the mind, control the senses and
thoughts, and practise yoga for self-purification (Tpasyaananda, 2002, Ch: 6 V: 12).

समं कायशिरोग्रीवं धारयन्नचलं स्थिरः।

सम्प्रेक्ष्य नासिकाग्रं स्वं दिशश्चानवलोकयन् ॥६.१३॥

Samaṁ kāyaśirogrīvaṁ dhārayannacalaṁ sthiraḥ.

Samprekṣya nāsikāgraṁ svaṁ diśaścānavalokayan.

Keeping the trunk, head and neck straight and steady sitting firmly,
one should look at the tip of the nose, without looking in other directions
(Tpasyaananda, 2002, Ch: 6 V: 13).

प्रशान्तात्मा विगतभीर्ब्रह्मचारिव्रते स्थितः।

मनः संयम्य मच्चित्तो युक्त आसीत मत्परः ॥६.१४॥

Praśāntātmā vigatabhīrbrahma cārivrate sthitaḥ.

Manaḥ saṁyamya maccitto yukta āsīta matparaḥ.

A majestically calm, fearless, and a confirmed celebate should
withdraw his senses and sit carefully fixing his mind upon Me
(Tpasyaananda, 2002, Ch: 6 V: 14).

युञ्जन्नेवं सदात्मानं योगी नियतमानसः।

शान्तिं निर्वाणपरमां मत्संस्थामधिगच्छति ॥६.१५॥

Yuñjannevaṁ sadātmānaṁ yogī niyatamānasaḥ.

Śāntiṁ nirvāṇaparamāṁ matsaṁsthāmadhigacchati.

In this manner, constantly meditating with controlled mind,
the yogi, emancipated and eternally peaceful,attains Me
(Tpasyaananda, 2002, Ch: 6 V: 15).

Patanjali Yoga Sutras:

Dhāraṇā is the holding of the mind to some particular object. (When the mind holds on to some object, either in the body or outside the body, and keeps itself in that state, it has attained *dhāraṇā* concentration). An unbroken flow of knowledge about that object is *dhyanā*. When the mind tries to think of one object, to hold itself to one particular spot, such as the top of the head, or the heart, and succeeds in receiving sensations only through that part of the body, and no other part, it has attained *dhāraṇā*: and when the mind succeeds in keeping itself in that state for some time, it has attained *dhyāna,* meditation.

ध्यानहेयास्तद्वृत्तयः ॥

Dhyāaheyāstadvṛtayaḥ.

The modifications of the *kleṣas* are reducible through meditation
(Taimini, 1986, Ch: 2 V: 11).

तत्र प्रत्ययैकतानता ध्यानम् ॥

Tatra pratyayaikatānatā dhyānam.

An uninterrupted stream of the content of consciousness is *dhyāna*
(Taimini, 1986, Ch: 3 V: 2).

Śaṅkhya Yoga (Bahadur, 1988):

Cessation of desire is meditation.

It has been stated that knowledge alone can confer liberation. The author goes on to say how such knowledge can be obtained. When by meditation the mind is untarnished by external objects the impediments in the way of knowledge are removed.

Meditation is perfected by repelling the modifications of the mind.

The modifications are real cognition, unreal cognition, imagination, deep sleep and memory. Meditation is accomplished by restraining them. When this is achieved there takes place the immediate intuition of the object of meditation.

Meditation is accomplished by dhāraṇā, āsana and svadharma.

The author mentions how meditation is accomplished. This is by holding the mind in a particular part of the body (*dhāraṇā*), adopting the needful posture (*āsana*), and by performance of the *varṇa* duties (*svadharma*), i.e., duties belonging to the stage of life in which one is placed.

Yoga Vāsiṣṭha:

मनः प्रशमनोपायः योगः इत्यभिदीयते ॥

Yoga is the trick to calm down the mind.

तदभ्यासेन निर्वाणम् इत्यभ्यासो महोदयः।

षम्भा ष्यैवम् निशायाम् ते निर्विकल्प समाधिना ॥

Tadabhyāsena nirvāṇam ityabhyāso mahodayaḥ.
ṣambhā ṣyaivam niśāyām te nirvikalpa samādhinā.

बभूवतुः चिदाकशरूपिण्यौ व्योमगाकृती।

डुरात् दूरम् अभिप्लुत्य ततो ब्रह्माण्डमडतत् ॥

Babhūvatuḥ cidākaśarūpiṇyau vyomagākṛtī.
Ḍurāt dūram abhiplutya tato brahmāṇḍamaḍatat.

Since liberation is (attained) by such practice, the practice (itself) is the supreme fulfillment. Conversing thus in the night, they two (Leela and Goddess) became of the form of the space of consciousness by *Nirvikalpa Samadhi* (or yogic state of absolute consciousness transcending the differentiation of the knower, knowledge and the known and possessed of the bodily form of heavenly beings) (Atreya, 1993, Ch: 5 V: 40, 41).

*Śrīmad Bhāgavata Mahāpurāṇa (*Tapayananda, 1982):

"Do you restrain by all means your fickle mind; my son by your superior intelligence set steady on Me. This is the sum and substance of all yoga." So spoke the Lord to Uddhava" (11.23.61). "The mind that dwells on sense objects gets stuck in them. The mind that remembers Me constantly gets dissolved in Me" says Lord Kṛiṣṇa to Uddahava. That is the mode of meditation advocated by the *Bhāgavat*. (11.14). Further from verses numbers 31 to 46 of *Bhāgavat Mahāpurāṇa (*chapter 14 of sub-chapter 11) it is mentioned, how the devotees should meditate on Lord Kṛiṣṇa's personal and impersonal form and with what attributes one should meditate, when asked by Uddhava.

Haṭha Yoga Text (Muktibodhananada, 2003):

In *Haṭha* yoga meditation, more specifically *kuṇḍalīni* meditation, the divine power that lies dormant in every human being is aroused and pulled upward through the *cakras*, the psychic centers of the body. At the top of the head, the seat of the highest consciousness the union of the individual and absolute consciousness takes place. This is expressed symbolically as the union of *Śakti* or *kuṇḍalīni* with Lord *Śiva*. During meditation each *cakra* is visualized as a lotus with a certain number of petals. The *mūlādhāra*, *svadhiṣṭhāna*, *maṇipura*, *anāhata*, *viśuddhi* and *ājña cakras* have four, six, ten, twelve, sixteen and two petals respectively, while *sahasrāra* has one thousand. The number of petals is determined by the number and position of *nāḍis* that emanate from the *cakras* and give it the appearance of a lotus. Hanging downward when *kuṇḍalīni* is dormant, the *nāḍīs* turn upward with its ascendance. The *cakras* may be focused upon by chanting of *Om*, the all inclusive universal sound vibration, in different pitches. When *kuṇḍalīni* is awakened it does not proceed directly to the *sahasrāra* unless one is an exceptionally pure yogi. It must be moved up from one *cakra* to another and a great of concentration and patience is required. When the *kuṇḍalīni* finally rises from the *ājña* to the *sahasrāra* union take place and this is called liberation. In summary, Hatha yoga itself (by practicing preliminary practices called *āsanas, prāṇāyāmas, kriyas, banḍhas mudras*) leads to stages of meditation, while it also prepares one's body and mind for the practice of meditation.

Prakaraṇa Grantha:

Meditate on the Atman, which resides in thee, which is devoid of all limiting adjuncts, the Existence – Knowledge – Bliss – Absolute, the One without a second, and thou shall no more come under the round of births and deaths - *Vivekacuḍāmaṇi* (Chinmayanada, 2002a, V: 288).

Mahābharata (Ramgopalachari, 1958):

In the *Śantiparva* of *Mahābharata* there are references on meditation by Manu, Vyasa, and Vasishtha. Manu says: Since the mind is always stimulated by sense-objects, it is not possible for the ordinary mind to attain to the attribute-less *Brahman*. It becomes possible only when the senses are merged in the mind, and the mind in the intellect, through uninterrupted concentration. Vyasa says: The process of withdrawing the intellect, the mind and the senses from external objects and merging them in the all-pervading *Paramātman* leads to the Supreme knowledge. An aspirant of such Knowledge must with deep concentration of mind practice the merging of the mind into the intellect twice a day, both at dawn and dusk. Vasishtha says: Meditation is the greatest power of the yogis. The wise men describe meditation as concentration of mind. Through concentration of mind, he sifts the *jīvātman* from the twenty-four cosmic principles and tries to merge it in the *Paramātman*. The moment this unity of *jīvātman* and *Paramātman* is established, a man becomes *jīvanamukta.*

3.1.5.B Popular techniques of meditation

3.1.5.B1 'Om' Meditation

Yogic teachings consider the syllable *'Om'* to be the force behind all thoughts. Either chanting or thinking about *'Om'* is supposed to cause a quiet mental state. *Om* is the primordial sound from which all other sounds and creation emerge. In *Om* meditation the meditator first concentrates on an *Om* picture and then mentally chants *mantra* '*Om'* effortlessly and finally expands to an all-pervasive level and goes for blissful silence.

3.1.5.B2 Transcendental Meditation (TM)

Transcendental meditation (TM) is based on the traditional yogic principles. In TM the meditator sits in a comfortable position silently closing the eyes and repeats a specific *mantra* mentally from time to time to go beyond thought level**.** This technique is preached and practiced by Maharshi Mahesh Yogi. This is less rigorous and demanding discipline, apparently easily learned, and hence widely practiced. The TM is defined as 'turning the attention inwards towards the subtler levels of a thought until the mind transcends the experience of the subtle state of thought and arrives at the source of the thought'.

3.1.5.B3 Tantric meditation

In this technique the meditator has to repeat a sacred *mantra* given by the *guru*, with intense concentration. This meditation is practiced and propagated by the Ananda Marga organization. The technique consist two important steps. First, the meditators sit in comfortable relaxed position and withdraw the attention inwards by ignoring the external stimuli and paying attention to their breathing. Then they silently repeat the two lettered personal *mantra* with their breathing.

3.1.5.B4 Brahmakumaris Raja yoga meditation

This meditation technique is preached and practiced by Brahmakumaris Ishawariya Vishwavidyalaya. During this meditation, aspirants sit in a comfortable position with their eyes open, and with effortless gaze fixed on a *jyoti* (light – representing supreme consciousness). At same time they actively generate positive thoughts about the Universal force pervading all over, as light and peace.

3.1.5.B5 Zen Meditation

Zazen- Zen meditation is a fundamental part of both the Soto and Rinzai Sects of Zen Buddhism. The aim in this form of meditation is the ultimate state of enlightenment called *Satori.* This technique involves concentration. There are three types in this type of meditation. In the first type, the meditator concentrates on his breathing, counting the breaths or without counting. In second type of meditation the meditator has to solve koans or say non-logical riddles. In third type of meditation the meditator just sits and breathes in a prescribed manner without any aids or concentrating on his breath.

3.1.5.B6 Vipassanā Meditation

Vipassanā, which means to see things as they really are, is one of the ancient techniques of meditation. It was rediscovered by Gotama Buddha more than 2500 years ago. In *vipassanā* meditation the meditator, sitting in a comfortable position, initially observes his own breathing and thereafter observes sensations and feelings in various part of the body with an attitude of witness. *Vipassanā* is a way of self-transformation through self-observation. It focuses on the subtle interconnection between mind and body, which can be experienced directly by disciplined attention to the physical sensations that form the life of the body, and that continuously interconnect and condition the life of the mind. It is this observation-based, self-exploratory journey to the common root of mind and body that dissolves mental impurity, resulting in a balanced mind full of love and compassion.

3.1.5.B7 Prekṣā Meditation

This is also an ancient meditation technique practiced in Jainism. *Prekṣā* means to perceive and realize the subtlest aspects of ones own self, 'to see the Self'. *Prekṣā* is derived from the Sanskrit word *"Pra + iksha"* which means to observe carefully. Basically it sums up the perception of body, psychic centers, breath and observation of mind. In *Prekṣā dhyana* no thought is forcefully stopped. Instead the art of merely observing the thought process without forming any reaction or attachment is developed. By doing so, thoughts themselves cease to appear.

3.1.5.B8 Yoga nidra

Yoga-nidra (yogic psychic sleep) is a meditative technique, derived from ancient *Tantra* popularized by Bihar School of Yoga (BSY). Yoga-nidra is described as a systematic method of inducing complete physical, mental and emotional relaxation, while maintaining awareness at deeper levels. Yoga-nidra is performed in *Savasana* and it consists of progressive relaxation and rotation of awareness all over body, resolve, and visualization of some images of nature and *tantric* abstract symbols.

3.1.5.C Modern techniques of meditation

The modern way of life poses several hassles and stress to every body whether the person is an overworked executive in an office or a farmer tilling the field under hot sun. The modern man takes up to meditation not for Self realization but approaches these systems with objective of achieving (i) good physical relaxation (ii) holistic health (iii) peace of mind (iv) stress management (v) balance of emotions (vi) control of mind (vii) development of personality (Viii) improvement in interpersonal relationships and (ix) efficiency in performance at work.

Today various types of meditation and relaxation techniques are popular world over by different names. Most of these are tailor made techniques and are practiced with guided instruction on audiovisual aids. These techniques could be broadly classified as: (i) Relaxation meditation: these types of meditation techniques comprise the instructions to sequentially relax the all body part by part, slowing of breath and imageries. (ii) Concentration meditations: these types of meditations consists techniques to develop focused attention like gazing at fine points, listening to distant sounds, slow walking etc. (iii) Expansive meditation: these types of meditation techniques comprise the instructions to expand the awareness with infinite objects in nature like sky, ocean, mountains, flow of river, flight of birds etc. (iv) Value based meditation: in these type of meditation techniques after inducing the deep relaxation firm instructions are given to remove fear and anxiety and resolves are given to imbibe moral values like love, patience, compassion, trust and positive attitude etc.

3.1.6 CYCLIC MEDITATION

3.1.6.A Definition

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 *Māndukya Upaniṣat* (Chinmayananda, 1984) and *Yoga Sutrās* of Patanjali. This technique is developed and propagated by Swami Vivekananda Yoga Anusandhana Samsthana 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.

3.1.6.B Principles and basis of CM

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 Gaudapada's (Chinmayananda, 1984, Ch:3 V: 44) *Māndukya Upaniṣat Karika:*

लये सम्बोधयेत् चित्तं विक्षिप्तं शमयेत् पुनः।

Laye sambodhayet cittaṁ vikṣiptaṁ śamayet punaḥ.

सकषायं विजानियात् समप्राप्तं न चालयेत्।

Sakaṣāyaṁ vijñāniyāt samaprāptaṁ na cālayet.

"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"

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 (*sadhanā*) practices. The solution given by Sage Gaudapada 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 to be 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)* phases with unbroken (*tailā 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 banḍha*) 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 *dharana* (pointed awareness) and *dhyana* (pervasive awareness) finally stabilizing in the effortless expansive meditative state. When mind settles in the state of balanced equipoise, one must understand the possibilities of mind again getting distracted and hence should not move from that state. Sage Gaudapada further says in *Māndukya Upaniṣat Karika* (Chinmayananda, 1984, Ch:3 V: 47) that:

यदा न लियते चित्तं न च विक्षिप्यते पुनः।
Yadā na liyate cittaṁ na ca vikṣipyate punaḥ.
अनिङ्गनमनाभासं निष्पन्नं ब्रह्म तत्तदा ॥४६॥
Aniṅganamanābhāsaṁ niṣpannaṁ brahma tattadā.

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 (*anābhāsaṁ)*; then it gets absorbed and becomes pure expansive Counciouness (*niṣpannaṁ brahma).*

3.1.6.C Technique of CM

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 observing 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 practiced in such a way that it sets a slow cyclic rhythm in the body, *prana* (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 CM 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 *Patanjali Yoga Sutra* (Taimini, 1961, Ch: 2 V: 46, 47, 48):

स्थिरसुखमासनम्॥ *Sthirasukhamāsanam.*
प्रयत्नशैथिल्यानन्तसमापत्तिभ्याम्॥ *Prayatnaśaithilyānantasamāpattibhyām.*
ततो द्वन्द्वानभिघातः॥ *Tato dvandvānabhighātaḥ.*

The postures are practiced slowly according to ones 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. 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 CM by *Jnāna Yoga* brings about cognitional transformation to resolve the subtle intellectual conflicts. Hence CM is considered as a holistic tool with other practices of the yoga powered by comprehensive knowledge base. The pictorial description of the postures in cyclic meditation is given in Plate 3.1.6.C.

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 *Māndukya Upaniṣad* 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 CM have been designed. The basic version consists four standing postures (*tāḍāsana, arḍakaticakrāsana, pādahastāsana and arḍacakrāsana)* interspersed with IRT and DRT. In present study this basic version of CM was interspersed. In advanced version four standing and two sitting postures (*śaśankāsana and ūṣtrāsana*) are interspersed with IRT, QRT and DRT.

Plate 3.1.6.C: Postures in Cyclic Meditation (CM)

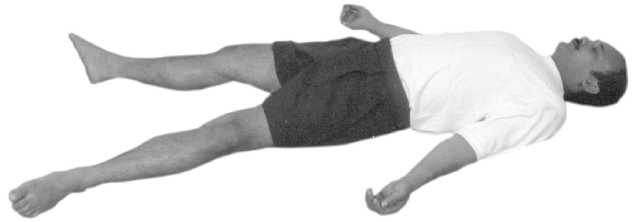
Tāḍāsana

Arḍakaticakrāsana (Right side)

Arḍakaticakrāsana (Left side)

Pādahastāsana

Arḍacakrāsana



Supine posture for IRT, QRT and DRT

3.1.7 CONCLUSION

Yoga is an ancient Indian Science and way of Life. It offers various techniques to reach the ultimate goal of perfection, endowed with knowledge, power and bliss. Meditation is one such technique that helps to purify, control (*nirodha*) and slowdown (*praśamana*) the mind and its modifications (*vṛttis*) by skill (*kauśala*) and regular practice (*abhyāsa*). The process of meditation begins with concentration (*ekāgratā)* and focused attention (*dhāraṇā)* on the chosen object and *dhyāna* happens only when mind becomes effortlessly and continuously one-pointed like the flow of oil poured from one vessel in to another. Sage Patanjali says "*dhyāna* is an uninterrupted, spontaneous flow of mind on its object. This itself turns into *samādhi* when the object alone shines and the thought of meditation (and of the meditator) is lost, as it were". The five characteristic features of meditation (*dhyāna)* are (i) single thought, (ii) effortlessness, (iii) awareness, (iv) slowness and (v) expansiveness (defocusing). Meditation involves three factors i.e., meditator, the object of meditation and the process of meditation (*triputi)*. The object of focus is generally sacred and can be personal or neutral, stable or dynamic, concrete or abstract, a word or an idea, an image or a symbol, a divine form or personality. Meditative styles can be usefully classified into two types - *mindfulness and concentrative*, which differ in the way attentional processes are directed. Most meditative techniques lie somewhere on a continuum between the poles of these two general methods.

Mindfulness practices involve allowing any thoughts, feelings, or sensations to arise, while maintaining a witnessing awareness without judgment or analysis. Examples include Zen, Vipassana meditation. Concentrative meditation techniques involve focusing on specific mental or sensory activity: a repeated sound, an image, or specific body sensations such as the breath. Examples include forms of Transcendental Meditation (TM) and Tantric meditation.

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 Gaudapada 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 to be 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 practiced with unbroken (*tailā 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 *dharana* (pointed awareness) and *dhyana* (pervasive awareness) finally stabilizing in the effortless expansive meditative state.

3.2.1 STUDIES ON MEDITATION

The scientific studies of yoga and other forms of contemplative experience have recently become a subject of interest for researchers. In 1925 early scientific studies were reported by Swami Kuvalayananda of Lonavala in a quarterly journal *Yoga Mimāmsā*. These studies helped to initiate interest in yoga research by showing that the physiological effects of yoga could be examined in the laboratory. This was followed by a number studies which reported that yogis could exert voluntary control over the cardiovascular system and reduce their metabolic rate at will. Around 1960, as Transcendental Meditation (TM) became popular, a number of scientific studies were conducted on meditation. The studies which are most relevant to the present research are mentioned below, and have also been summarized in Table T 3.2.

Dhyāna is the generic Sanskrit term for meditation, which in the Patanjali *yoga sutrās* is referred to as an uninterrupted flow of the mind towards the chosen object. It is the intermediate state between mere continuous attention to an object (*dhārana*) and complete absorption in it (*samādhi*) (Taimini, 1961). Depending upon the object and the strategy chosen, there are different techniques of meditations.

3.2.1.A Studies on Transcendental Meditation

Transcendental meditation (TM) is based on traditional yogic principles. A large number of scientific studies have been reported on TM. In 1970, R.K. Wallace reported the physiological effects of TM in fifteen normal college students (Wallace, 1971). There was a pre control period; five minutes eyes open and fifteen minutes with eyes closed. This was followed by thirty minutes of meditation, after which the subjects sat with eyes closed for ten minutes, and then with eyes open for five minutes. Oxygen consumption was measured in nine subjects by either the open or closed circuit methods. The mean decrease in oxygen consumption was about 45 cm^3/minute or 20% compared to the pre-control period. There was a mean decrease in total ventilation during meditation of about 1 liter/minutes. Skin resistance increased at the onset of meditation and decreased to the resting value after meditation. The heart rate of each subject decreased during meditation, with a mean decrease of five beats per minute. The most notable change in EEG pattern during TM was an increase in the alpha wave amplitude and regularity, with occasional slow alpha and low voltage theta. 'Alpha blocking' to sound and light was present, and did not show habituation.

In a later study, Wallace, Benson and Wilson (1971) reported their observations on 36 subjects (28 males and 8 females). The subjects acted as their own controls. The pre-control period consisted of 10-30 minutes with eyes closed and eyes open for a similar duration. After 20-30 minutes of meditation they were asked to stop meditating and sit with their eyes closed for 10 minutes, then with their eyes open for the same time. They reported a decrease in oxygen consumption (an average decrease of 17%) from a mean of 251.2 ml/minutes before meditation to 211.4 ml/minutes during meditation and gradually increasing after meditation to 242.1 ml/minutes. Minute ventilation decreased by about one liter/minute and respiratory rate decreased about three breaths/minute during meditation, though neither were statistically significant. The mean lactate concentration decreased from a pre-control level of 11.4 mg, to 8.0 mg/100 ml. The average heart rate decreased during meditation by three beats per minute. Rectal temperature remained fairly constant during meditation. The skin resistance increased markedly at the onset of meditation and decreased after meditation but remained higher than before meditation. Based on the EEG findings along with those of other variables TM came to be described as ‘wakeful hypometabolic state’.

Orme-Johnson (1973) reported a study on 16 subjects, 8 of them were meditators and 8 were controls. The meditators 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. The mean rate of spontaneous GSR fluctuations was 6.14 in 10 minutes compared to 18 - 25 in 10 minutes meditation Vs pre-control periods. The meditators had 8.7 responses in 10 minutes during rest compared to 21.0 in 10 minutes for non-meditators.

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.

Later, Wilson, Jevning, and Guich (1987) studied oxygen consumption, carbon dioxide production and acid/base changes in 62 subjects during two hypo-metabolic states (35 during transcendental mediation and 27 during un-stylized rest). The results indicated that during these hypo-metabolic states, arterial-venous carbon dioxide content difference declined, and that during Transcendental Meditation, arterial-venous carbon dioxide content difference briefly disappeared. This change was thought due to both an increase in arterial carbon dioxide content and a decrease of venous carbon dioxide content. Similar, but opposite and smaller, changes occurred in arterial and venous oxygen content. The respiratory quotient was low at all times and decreased during the hypo-metabolic states. Subsequently 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.

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.

Recently, 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.

3.2.1.B **Studies on Zen Meditation**

In 1960 Hirai found changes in the breathing during Zen meditation. The breath rate decreased to 4 - 5 breaths per minute. The same study reported an acceleration of the pulse rate during meditation to a rate between 80 and 100 beats/minute. A further study on Zen meditators, demonstrated an alpha suppression response, a sudden attenuation of alpha waves in response to a stimulus, which did not habituate to repeated click stimuli during Zen meditation whereas controls habituated after the fifth or sixth click (Kasamatsu, & Hirai,1966). This was taken to reflect a 'hypersensitivity' of attention during Zen meditation.

In another study on experienced Zazen meditators, a decrease in spontaneous skin conductance responses during Zazen was reported (Akishige, 1968). The same study also showed that there was a decrease in oxygen consumption and rate of respiration, associated with Zen meditation. Sugi and Akutsu (1968) observed a 20% decrease in oxygen consumption associated with meditation in 10 Zen monks with many years of experience. Goyeche, Chihara and Shimizu (1972) compared Zen meditation with relaxation in 8 subjects. There was reduction in breath and heart rate during Zen meditation. Becker and Shapiro (1981) studied 5 groups of subjects: Zen meditators, TM subjects, Yoga subjects and 2 groups of non-meditators. The subjects were given click stimuli and they all demonstrated alpha suppression and subsequently habituation, with no differences among groups.

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 Fm theta activities were provoked (6 men, 6 women, 48% of the total subjects), peripheral autonomic activities were evaluated during the appearance of Fm 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 22 healthy subjects to evaluate the effect of Zen meditation on EEG coherance and heart rate varibility (HRV) in relation to trait anxiety scores, there was an increase in slow alpha interhemispheric EEG coherance 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.

3.2.1.C Studies on Tantric Meditation

Elson, Hauri and Cunis (1977) studied Ananda Marga meditators; both amateur and experienced practitioners (average experience was 1.8 years). They found an increase in alpha and theta activity during meditation. There was a decrease in skin conductance and rate of respiration. In another study Corby and others investigated 2 groups of 10 meditators each (Corby, Roth, Zarcone, & Kopell, 1978). One group had an average experience of 4.4 years. All the subjects were very committed to the practice of meditation and practiced for a minimum of three hours per day. There was also a control group. Meditators showed a statistically significant increase in alpha and theta activity compared to the control group. This study also reported changes in autonomic variables. There was an increase in skin conductance (i.e., lowered skin resistance) and absence of a deceleratory heart rate orienting response. Heart rate and respiratory rate changes were not significant within the group. During meditation there was a trend for heart rate to decrease relative to the control group. One of the subjects had a near *samādhi* experience, and they recorded an increase in heart rate, respiratory rate and a marked decrease in skin resistance.

3.2.1.D Studies on *'OM'* Meditation

In an early study on evoked potentials during *Om* meditation Telles and Desiraju (1993) used, for the first time two important modifications in the research design for yoga research. The 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. Auditory middle latency evoked potentials were recorded during the practice of meditation. This study highlighted two points, (i) meditation is best described as a physiological state of 'alertful rest', and (ii) considerable physiological variations were seen both intra- and inter-individually. Similar results were seen when autonomic and respiratory variables were studied in *Om* meditators (Telles, Nagarathna, & Nagendra, 1995). When repetition of *'Om'* was compared with the repetition of 'One', there was a difference in the autonomic and respiratory responses (Telles, Nagarathna, & Nagendra, 1998). Both types of sessions resulted in a decrease in the heart and breath rates, but repetition of *Om* alone reduced the skin resistance, suggesting a subtle change in the mental state, related to the significance of the syllable. These results were reinforced by a study of similar design, in which the variable recorded was the auditory middle latency evoked response during both *'Om'* and 'One' sessions (Telles, Nagarathna, Nagendra, & Desiraju, 1994). Based on changes in the evoked potentials it was described that repetition of *'Om'* resulted in significant changes in sensory relay at a neural center (i.e., the thalamus), with more neurons being (i.e., higher amplitude) recruited and information processing was facilitated (i.e., latency that was reduced). In persons who had over 5 years of meditation experience the changes in auditory middle latency evoked potentials, suggested that changes occurred at more complex brain areas corresponding to auditory association cortices (Telles, & Desiraju, 1993). Another recent report has described differences between the physiological states in sleep and in meditation (Naveen, & Telles, 2003).

3.2.1.E Studies on Brahmakumaris Raja yoga Meditation

Eighteen male 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. The heart rate during the meditation period was increased compared to 'baseline' as well as compared to during the non-meditation period of control sessions. In contrast there was no significant change during meditation, for the group as a whole, in GSR, respiratory rate and finger plethysmogram amplitude. The individual level analysis revealed that changes in autonomic variables suggestive of both activation and relaxation occurred simultaneously in different subdivisions of the autonomic nervous system in a meditator. Apart from this, there were differences in patterns of change among the persons who practiced the same meditation (Telles, & Desiraju, 1993a).

In an another study conducted on eleven experienced practitioners of Brahmakumaris Raja Yoga meditation, meditators while participating in a functional magnetic resonance imaging (fMRI) study, were able to reach a deep meditative state (suggested by pulse rate and breath rate changes), while in the 'loud' scanner environment (Khushu, Telles, Kumaran, Naveen, & Tripathi, 2000). All subjects reported vivid visual images related to the content of the meditation after the session. One subject showed significant activation in the primary visual cortex. Recently, it has been shown that Brahmakumaris Raja Yoga meditation produces changes at the level of the mesencephalon – diencephalon (i.e., possibly thalamic level) (Telles, & Naveen, 2004).

3.2.1.F Studies on Tai Chi Chuan Meditation

Tai Chi Chuan (TCC) is a traditional Oriental 'moving' mediation technique based on Taoist philosophical principles of Yin and Yang (the opposite forces) and breathing techniques. 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. Since ancient times 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). According to Qu there are two major reasons for these experiences (Yan, 1995). First, participants have to be very focused and concentrated when practicing, and by doing so they exclude other distractions and stressors and experience an inner peacefulness. Second, the nature of the art, with smooth, slow and rhythmic movements, facilitates muscular relaxation and flexibility.

Jin (1989) assessed psychological and physiological changes following Tai Chi practice in 33 beginners and 33 practitioners. Using a three-way factorial design, the subjects were divided into groups on the basis of experience, time of practice, and phase (before, during, or after Tai Chi intervention). Participants filled out the Profile of Mood States (POMS) and Trait Anxiety Inventory form before and after testing, and their heart rate, noradrenaline excretions, and cortisol concentrations were measured pre-testing and post-testing. Compared to baseline, practice of Tai Chi raised heart rate, increased noradrenaline-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% of VO_2 max, (indicating a low workload). Subjects reported less tension, depression, anger, fatigue, confusion and state-anxiety, they felt more vigorous, and in general they had less total mood disturbance after Tai Chi practice. Mood improved significantly during Tai Chi, and remained positive one 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 (VO_2) equivalent to the mean TCC - VO_2. Six experienced (group mean 8.3 years) male TCC practitioners served as subjects and the data were collected during the ‘Cloud H and movement of the TCC’ exercise. Lower responses for ventilatory frequency (Vf) (11.3 and 15.7 breaths/minute), ventilatory equivalent (V_E/VO_2) (23.47 and 27.41), and the ratio of dead space ventilation to tidal volume (V_D/V_T) (20 and 270c) were found in TCC in comparison to cycle ergometry. The percentage of minute ventilation used for alveolar ventilation was significantly higher during TCC than cycle ergometry, with mean values of 81 and 73 liters respectively. 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.

Similarly, 15 men aged between 26 to 56 (group mean $\pm$ SD, 39.9 $\pm$ 9.5) years were studied 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 $\pm$ 2.4 years). Blood lactate was measured before and immediately after TCC practice. Additionally, breath-by-breath measurement of cardiorespiratory 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 were compared to determine the exercise intensity of TCC. While performing TCC, the mean HR of subjects was 140 $\pm$10 beats per minute, and the mean oxygen consumption was 21.4 $\pm$ 1.5 ml/kg/min. Compared with the data of the exercise test, the HR during TCC practice was 58% of the heart rate range. The oxygen consumption during TCC practice was 55% 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.

In another study Jin (1991) examined Tai Chi, as a moving meditation, for its efficacy in post stressor recovery in 48 adult male and 48 adult female Tai Chi practitioners, who were randomly assigned to 4 treatment groups: Tai Chi, brisk walking, meditation, and neutral reading. A "blind" experimenter who 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 and 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 noradrenaline, 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 16 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 (C), moderate intensity walking group (MW), low intensity walking group (LW), low intensity walking plus relaxation response group (LWR), or mindful exercise (ME) group - a Tai Chi type program. Women in the ME group experienced reductions in mood disturbance (tension, depression, anger, confusion, and total mood disturbance) and an improvement in general mood. Women in the MW group noted greater satisfaction with physical attributes (body cathexis), and men in MW reported increased positive affect. 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 "tranquility" than all other exercise groups. Further, they reported lower psychological distress, fatigue, and exhaustion as compared to the martial arts group.

Recently it was reported that a three month intervention of Tai Chi given to college students brought about a significant improvement in general health, vitality, bodily pain, perception of mental health and emotional stability (Wang, Taylor, Pearl, & Chang, 2004).

3.2.2 STUDIES ON YOGIC RELAXATION TECHNIQUES

3.2.2.A Studies on Śavāsana

Lying flat on the ground with the face upwards, in the manner of a corpse, is *śavāsana.* It reduces fatigue and enables the mind and body to relax (Mukatibodhananda, 2001). *Śavāsana* is the corpse pose. *Shava* means 'corpse'. It is also known as the pose of relaxation and it is essentially practiced in between other *asanas* or after a hectic day.

A randomized controlled trial was conducted on twenty five patients of essential hypertension using *śavāsana* therapy (Sundar, Agrawal, Singh, Bhattacharya, Udupa, & Vaish, 1984). *Śavāsana* therapy was continued for six months. There was significant reduction in both mean systolic and diastolic blood pressure and antihypertensive drugs score in yoga groups. In 65 % of patients of yoga, blood pressure was controlled with *śavāsana* alone without any drug. In another study the efficacy of meditation and śavāsana in promoting self-actualization and changes in self-reported stress was studied among 62 college students (Janowiak, & Hackman, 1994). Two groups were given *mantra* meditation and a yogic relaxation technique referred to as *śavāsana*. Pre and post test measures were taken on the Personal Orientation Inventory and the Behavioral Relaxation Scale. Both groups showed significant increases in scores on self-actualization; however, no differences were found between groups. Meditation training was associated with larger gains in scores on measures of systematic relaxed behavior than of the relaxation training.

In another study śavāsana was found effective in coping with stress manifestations (Bera, Gore, & Oak, 1998). The recovery from induced physiological stress in *śavāsana* and two other postures (resting in chair and resting supine) was compared. Thirty one males and six females (age 21-30 yrs) were allowed to rest in one of the above postures immediately after completing the scheduled treadmill running. The recovery was assessed in terms of heart rate (HR) and blood pressure (BP). HR and BP were measured before and every two minutes after the treadmill running till they returned to the initial level. These results revealed that the effect of stress was reversed in a significantly shorter time in *śavāsana*, compared to resting in a chair and a supine posture.

The yoga based relaxation technique has also shown to reduce physiological signs of arousal (Vempati, & Telles, 2002). 35 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 15 subjects, before, during, and after the practices, whereas oxygen consumption and breath volume were recorded for 25 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.

In 10 normal adults RR interval variation (RRIV), deep breathing difference (DBD), and heart rate, blood pressure and rate-pressure-product (RPP) response to a cold pressor test (CPT) were measured before and immediately after śavāsana (Madanmohan, Udupa, Bhavanani, Krishnamurthy, & Pal, 2002). *Śavāsana* produced a significant increase in DBD and an appreciable but statistically insignificant increase in RRIV suggesting an enhanced parasympathetic activity. Significant blunting of cold pressor-induced increase in heart rate, blood pressure and RPP by *śavāsana* was seen during and even five minutes after CPT suggesting that *śavāsana* reduces the load on the heart by blunting the sympathetic response. It was concluded that *śavāsana* can enhance the ability to withstand stress induced by CPT and this ability can be achieved even with seven days of *śavāsana* training.

Recently 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 medical students (n = 50) during routine activities and prior to their examination. 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. A significant reduction in number of failures in yoga group as compared to the control group was also observed. The feedback scores indicated improvement in various variables such as better sense of well being, feeling of relaxation, improved concentration, self confidence, improved efficiency, good interpersonal relationship, increased attentiveness, lowered irritability levels, and an optimistic outlook in life.

3.2.2.B Studies on yoga based isometric relaxation

A study was conducted on yoga based isometric relaxation technique. Forty male volunteers with ages ranging from 16 to 46 years were studied in two sessions; yoga based isometric relaxation technique (IRT) and supine rest (SR) (Telles, & Vempati, 1999). Assessments of autonomic variables were made in 15 subjects, before and after the practices, whereas oxygen consumption, breath rate, breath-volume were recorded in 25 subjects, before and after IRT and SR. A significant decrease in breath rate after IRT and finger plethyasmogram was recorded after SR. This indicated that yoga based IRT is useful in reducing the physiological signs of anxiety and stress and not every person is able to relax in supine rest.

3.2.2.C Studies on *Śānti kriyā*

Śānti kriyā is a mixture of combined yogic practices of breathing and relaxation (Satyanarayana, Rajeswari, Rani, Krishna, & Rao, 1992). Eight healthy male volunteers (age group 25.9 $\pm$ 3 years) were subjected to *śānti kriyā* practice daily for 50 minutes for 30 days. The body weight, blood pressure, oral temperature, pulse rate, respiration, ECG and EEG were recorded before and after the practice on the 1st day and subsequently on 10th, 20th and 30th day of their practice. They were also given a perceptual acuity test to know their cognitive level on the 1st day and also at the end of the study (day 30). Results indicated a gradual and significant decrease in the body weight from day 1 to day 30 and an increase in alpha activity of the brain during the course of 30 days. Also there was increased oral temperature by 3^0F and decreased respiratory on all practice days. Increase of alpha activity both in occipital and pre-frontal areas of both the hemispheres of the brain denoted an increase of calmness.

3.2.2.D Studies on *Yoganidra*

Global cerebral blood flow (CBF) distribution (with the 150 – H2O PET technique) and spectral EEG analysis was done in nine young adults, who were highly experienced yoga teachers, during the yoganidra relaxation meditation, and during the resting state. 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. 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 thought to support an executive attentional network (Lou, Kjaer, Friberg, Wildschiodtz, Holm, & Nowak, 1999).

Another study on *yoganidra* 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 *yoganidra* meditation. Participants underwent two 11C- raclopride PET scans: one while attending to speech with eyes closed, and one during active meditation. During *yoganidra* meditation 11C- raclopride binding in ventral stream decreased by 7.9%. This corresponded to a 65 % 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.

3.2.2.E Studies on yoga stretching and relaxation

In a study the effects of three different procedures, relaxation, visualization and yogic stretch and yogic breathing (*prāṇāyāma)* on perceptions of physical and mental energy and on positive and negative mood states was assessed in a group of normal volunteers (n = 71, age range 21-76) (Wood, 1993). Yogic stretch and yogic breathing produced a significantly greater increase in perceptions of mental and physical energy and feelings of alertness and enthusiasm than the other two procedures. Relaxation made subjects more sleepy and sluggish immediately after the session than yogic stretch and yogic breathing. Visualization made them more sluggish but less content than yogic breathing and more upset than relaxation after the second session. Thus, a 30 minutes program of yogic stretch and breathing exercises which is simple to learn and which can be practiced even by the elderly had a markedly 'invigorating' effect on perceptions of both mental and physical energy and increased high positive mood.

Another study investigated the psychological and physical effects of training of body awareness and slow stretching on persons with chronic toxic encephalopathy (CTE) (Engel, & Andersen, 2000). The body-mind training consisted a guided relaxation technique combined with meditative stretching. Eight subjects with CTE, 48.5 years, were trained for 8 weeks. Outcome measures were percentage alpha brain waves (alpha %), electromyography (EMG) on the frontalis muscle, state-trait anxiety (STAI), creativity (RAT), and mood measured as anxiousness, humour and mental fatigue. The mean alpha increased 52% during the training period and the EMG decreased 31%. State anxiety decreased 22% during the training period, but no changes were observed in trait anxiety and in the creativity score. The level of anxiousness and fatigue before a training session decreased during the training period. The results suggested an improved ability for physical and mental relaxation as indicated from the lower EMG, the higher alpha percentage and the decrease in state anxiety following the meditative stretching.

3.2.3 STUDIES ON GENERAL RELAXATION TECHNIQUES

3.2.3.A Studies on progressive muscle relaxation

Thirty six volunteer subjects 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 5 week period, they were tested for psychophysiological 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). Later on 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. 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 waiting 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. The meditation groups had a 78% compliance rate at 5.5 months with treatment effect seen whether subjects practiced their techniques frequently or occasionally. The safe and inexpensive semi-automated meditation training has considerable value for stress-management programs in organizational settings.

Oxygen consumption, tidal volume, respiratory rate, heart rate, systolic and diastolic blood pressure were measured before the subjects (n=39) learned Transcendental Meditation (TM: n = 21) or Jacobson's Progressive Relaxation (PR: 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, RR, diastolic blood pressure and HR) during TM or PR. However the TM group displayed more significant decreases during meditation and during activity than did the PR group. The more significant and comprehensive results for mediators were explained primarily in terms of the greater amount of time the TM group spent on their technique, plus the differences in the two techniques themselves (Throll, 1982).

3.2.3.B Studies on relaxation training

A study was conducted on attentional capacity in 25 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.

The effect of supine floating (SF) relaxation on heart rate, blood pressure and cardiac autonomic nervous activity in ten male subjects (n = 10, mean age: 22.4 years) was studied (Nishimura, & Onodera, 2000). Cardiac autonomic nerve activity was estimated with the power spectrum analysis of heart rate variability (HRV) by using the Fast Fourier Transformation (FFT). HF during SF condition was significantly increased; LF/HF, heart rate and blood pressure were significantly decreased. These data indicated that cardiac vagal activity is enhanced and sympathetic nervous activity is suppressed by reciprocal response.

3.2.4 STUDIES ON CYCLIC MEDITATION

Cyclic meditation has the unique feature of combining simple yogic postures (stretching) practiced with very slow, mindful body movements, rhythmic breathing, expansive awareness and chanting and relaxation in supine position.

A study was conducted to compare the effect of cyclic meditation (a calming and stimulating technique) on oxygen consumption with that of *śavāsana* (a calming technique) (Telles, Reddy, & Nagendra, 2000). The oxygen consumption, breath rate, and breath volume of 40 male volunteers (group mean $\pm$ SD, 27.0 $\pm$ 5.7 years) were assessed before and after sessions of cyclic meditation (CM) and before and after sessions of *śavāsana* (SH). These assessments were done while breathing oxygen through a closed circuit Benedict-Roth apparatus. The two sessions (CM, SH) were one day apart. Cyclic meditation included the practice of yoga postures interspersed with periods of supine relaxation. During SH the subject remained in supine position throughout the practice. There was a significant decrease in the amount of oxygen consumed and in breath rate and an increase in breath volume after both types of sessions. However, the magnitude of change on all three measures was greater after CM: (i) Oxygen consumption decreased 32.1% after CM compared with 10.1% after SH; (ii) breath rate decreased 3.6 cpm after CM and 1.9 cpm after SH; and (iii) breath volume increased 28.8% after CM and 15.9% after SH. These results supported the idea that a combination of yoga postures interspersed with relaxation reduces arousal more than relaxation alone. The increase in depth of respiration with reduction in breath frequency, suggested physiological relaxation.

The above studies have described the psycho-physiological changes during different meditation and relaxation techniques, including cyclic meditation. However there have not been reports of simultaneous recording of (i) indices of psycho-physiological arousal and (ii) those of attention. This was attempted to be done in the present study in which the meditation technique selected was cyclic meditation which has already been shown to reduce psycho-physiological arousal.

Abbreviations used in Table T 3.2

AEP	:	Auditory Evoked Potentials
BMR	:	Basal Metabolic Rate
BOC	:	Basal Oxygen Consumption
BP	:	Blood Pressure
CNV	:	Contingent Negative Variation
d	:	day
EC	:	Eyes Closed
EO	:	Eyes Open
Exp	:	Expiration
Expt	:	Experiment
EKG, ECG	:	Electrocardiogram
EEG	:	Electroencephalogram
EMG	:	Electro-myogram
EOG	:	Electro-oculogram
Gps	:	Groups
GSR	:	Galvanic Skin Resistance
HR	:	Heart Rate
HRV	:	Heart Rate Variability
HF	:	High frequency
5-HIAA	:	5- Hydroxy Indole Acetic Acid
Insp	:	Inspiration
Ld	:	Lead (as in standard leads of ECG)
LF	:	Low frequency
m	:	months
Medtn	:	Meditation
Min	:	Minute
MMN	:	Mismatch Negativity (auditory)
n	:	number of subjects/patients
OC	:	Oxygen Consumption
PaCO2	:	Partial pressure of Carbon dioxide in arterial blood
PaO2	:	Partial pressure of oxygen in arterial blood
RR	:	Respiratory Rate
RT	:	Reaction time
S	:	Subjects
ss	:	subjects
SC	:	Skin conductance
sec	:	second
Temp	:	Temperature
VE	:	Pulmonary Ventilation
Vs	:	Versus
Symbols used	:	↑ Increase, ↓ Decrease, < Less than, > Greater than, → followed by, * Original article not referred to, information obtained from citation in other articles. ^ Original article not referred to, abstract consulted.

CHAPTER - II

R E V I E W O F L I T R A T U R E

[A] CONCEPTS OF MEDITATION IN TRADITIONAL YOGIC AND SPIRITUAL LITERATURE

'He who sees the entire world of animate and inanimate objects
in himself and also sees himself in all animate and inanimate objects
because of this does not hate any'
is a Yogi

-

Iśāvāsya Upaniṣat

1.0 BACKGROUND AND SCOPE

Yoga is both the goal as well as the means to achieve a state of perfect harmony. Yoga is a state of complete absorption, union (*Yoga sthiti*) with absolute Reality i.e., Universal Consciousness. The word Yoga comes from the Sanskrit root word *'Yuj'* which means integration, or a meeting with the true Self (Apte, 1992). Yoga is also an art of living and a systematic process to reach the state of *Mokśa,* endowed with perfect silence, knowledge, power and bliss (Nagendra, Nagrathana, 2001).

The world that we perceive and experience (around and within us) is one reflected by our own minds. If that 'mirror' is covered with dust or dirt (of ignorance, wrong values in from of *vāsanas*, and *sasṁskāras*) the reflection from it is distorted. However if one cleanses and polishes the mirror of the mind, it reflects the Reality, the true nature of Self, which is God. This cleansing is accomplished by the practice of yogic disciplines and austerities, which includes the control of the senses and the various forms of meditations. Yoga is to purify, control (*nirodha*) and slowdown (*praśamana*) the mind and its modifications (*vṛttis*) by skill (*kauśala*) and knowledge (*viveka*).

Indian tradition offers different disciplines to arrive at this state of absolute freedom according to different predispositions, temperaments (*guṇas*) and abilities of people. One can reach *Mokśa* by psychic control (*Raja* yoga), by intellectual analysis *(Jñana* yoga), by surrender and devotion (*Bhakti* yoga), by selfless service (*Karma* yoga), or by combination of all (Vivekananda, 2001).

The theoretical basis and techniques of yoga have been described in ancient Yoga texts. These observations were based on the actual experiences of the ancient sages, who studied what was taking place within them. Around 900 BC the Sage Patanjali, compiled the principles of yoga in the form of yoga aphorisms *(yoga-sutrās)* and offered an eight fold path of practices called *Aṣṭāṅga Yoga*. The *aṣṭāṅga yoga* has eight limbs: *yama* (restraints), *niyama* (observances of discipline), *āsanās* (postures), *prāṇāyāma* (regulation of breathing) *pratyahāra* (withdrawal of senses), *dhāraṇa* (focusing), *dhyāna* (meditation) and *samādhi* (a state complete absorption) (Taimini, 1996, Ch: 2, V: 29).

While moving along this path one gets benefits such as good physical health, a peaceful mind, balanced emotions and in consequence harmonious relations with others and greater efficiency in action. Hence the popularity and awareness about yoga is growing. However, sometimes people practice yoga only to achieve these benefits forgetting the main objective and purpose of yoga. As a result many types of meditation techniques have become prevalent today. Several books and descriptions have been written about these meditation techniques. In spite of this their basis and the principles involved remain vague. The present compilation aims at attempting to clarify the theoretical basis of meditation according to ancient texts.

2.0 AIMS AND OBJECTIVES

The present review was conducted to:

v) Compile authentic information on meditation from classical yogic and spiritual literature.

vi) Study the basic principles and theory of meditation based on traditional literature.

vii) Describe in brief the different methods of meditation and commonalities between them.

viii) Define and present concept of a specific technique i.e., cyclic meditation.

3.0 MATERIALS AND METHODS

3.1 Source material

The traditional yogic and spiritual literature was reviewed. The sources for the present literary search included:

E) Classical yoga texts: (i) Patanjali yoga sūtrās, Vyāsa bhaṣyā on Patanjali yoga sūtrās (iii) Bhagavad gīta, (iv) Hatha yoga pradīpikā, (v) Gheranda saṁhītā and (vi) Shiva saṁhītā

F) Major Upaniṣads: (i) īśāvāsya Upaniṣat (ii) Kena Upaniṣat (iii) Kaṭha Upaniṣat (iv) Muṇḍaka Upaniṣat (v) Māṇḍūkya Upaniṣat (vi) Aitareya Upaniṣat (vii) TaittirīyaUpaniṣat (viii) Praśna Upaniṣat (ix) Chāndogya Upaniṣat (x) Bṛhadāraṇyaka Upaniṣat (xi) Śvetāśvatara Upaniṣat

G) Prakharaṇa Granthās like Atma bodha and Vivekacūdamaṇi

H) Texts written by persons recognized as spiritual leaders and visionaries like Sri Ramkrishṇa Pramahansa, Swami Vivekananda and Swami Adhīśwarānanda

3.2 Methods

The verses and relevant information about different aspects of meditation, from the above mentioned sources were first systematically complied and then were sorted according to the defined structure of the sections. The relevant references are cited in the body of the text as well as in the reference section.

4.0 CONCEPT OF MEDITATION

4.1 Definition of meditation

The English word meditation comes from the Latin root word *meditari*, which derives from the same root as the word meaning ‘to heal’. The practice of meditation sets in motion, a process that leads to the restoration of one’s - physical, mental, and spiritual well-being. The English connotation of the word ‘meditation’ is therefore more associated with healing and relaxation (Adiswarananda, 2004). Meditation is also defined as concentration (continuous thinking) and some times as contemplation (repetitive thinking). Whereas in yogic understanding meditation is not mere concentration but it is more than concentration. Therefore it is essential to distinguish the meaning of meditation.

4.1a Concentration (Ekāgratā):

Meditation is generally understood as deep concentration on any object. In that sense, everyone meditates, because concentration is indispensable not only for survival but also for success in any walk of life. It is through concentration one can see, hear, work or understand anything. Concentration is the way to gain knowledge about any subject. Through concentration the mind acquires the quality of a lens and can penetrate deeply into an object, external or internal, and perceive its’ real nature. However, practically it is observed and experienced that concentration is tiring, it drains the energy. One cannot concentrate for long. After some time spent in concentration one feels fatigue and stressed because concentration involves intense effort.

In Sanskrit, *ekāgratā* (moving in one direction) means concentration[1], the channelizing of all the mental energies in a single direction. Normally our mind exists in the state of *cancalatā* (continuously moving) wherein it moves in all directions, jumps (as it were) from one object to another object randomly. The mind in this phase is unstable, turbulent and restless (Chinmayananda, 2001, Ch: 6 V: 34). It flows in all directions according to its likes and dislikes and its patterns. The haphazard flow of thoughts is called as *cancalatā.* Streamlining these scattered energies of the mind in one direction is *ekāgratā*. However this process requires voluntary control and effort. For example, reading a book, watching a movie, driving a car all require different degrees of effort. Thus in concentration mind is directed on a single subject or direction, but there exist multiple thoughts. All these thoughts are interconnected to one another to form a meaningful or logical chain.

4.1b Dhāraṇā:

Dhāraṇā is a continuation of the process of sensory inhibition or withdrawal called as *pratyahāra*. *Dhāraṇā* is the 'holding of the mind in a motionless state', as the *Tri-śikhi-Brahmaṇa- upaniṣat* defines this advanced practice (Feuerstein, 2001). *Dhāraṇā* the fifth limb of the Patanjali's eightfold path is focusing of attention to a given locus (*deśa*), which may be a particular part of the body (such as *cakra*) or an external object that is internalized (such as the image of a deity).

The Sanskrit word *dhāraṇā* stems from the verbal root *dhri* (Apte, 1992), meaning 'to hold, to fix'. What is being held is one's attention, which is fixed on an internalized object and the underlying process is called *dhāraṇā*. According to sage Patanjali,

देशबन्धश्चित्तस्य धारणा ॥

Deśabandhaścittasya dhāraṇā.

Fixing of mind on a specific object (or a spot, internal or external) is dhāraṇā (Prabhavananda, 2002, Ch: 1 V: 3).

देशे नाभिचक्रनासाग्रादौ चित्तस्य बन्धो विषयान्तरपरिहारेण
यत् स्थिरीकरणं सा चित्तस्य धारणा इत्युच्यते ।

Deśe nābhicakranāsāgrādau cittasya bandho viṣayāntaraparihāreṇa
yat sthirīkaraṇaṁ sā cittasya dhāraṇā ityucyate.

The mental flux could be halted on navel center, tip of the nose or any place as sanctioned by scriptures. Stabilizing the mental flux without disturbance from any corner is termed as *dhāraṇā* (Sukhanandanatha, 1992).

मैत्र्यादिचित्तपरिकर्मवासितान्तः करणेन यमनियमवता चितासनेन परिहृतप्राणविक्षेपेण
प्रत्याहृतेन्द्रियग्रामेण निर्वाधे प्रदेशे ऋजुकायेन जितद्वन्देन योगिना नसाग्रादौ सम्यज्ञातस्य समाधेः
अभ्यासाय चेतसः स्थिरीकरणम् कर्तव्यम् इति ॥
यमादिगुणसंयुक्ते मनसः स्थितिरात्मनि । धारणा प्रोच्यते सदिः योगशास्त्रविशारदैः ॥
तस्मात्समस्तशक्तिनाम् आधारे तत्र चेतसः । कुर्वीत संस्थितिं सा तु विज्ञेया शुद्धधारणा ॥

Maitryādicintapari karmavāsitāntaḥ karaṇena yamaniyamavatā citāsanena parihrataprāṇavikṣepeṇa pratyāhratendriyagrāmeṇa nirvādhe pradeśe rjukāyena jitadvandena yoginā nasāgrādau samyajñātasya samādheḥ abhyāsāya cetasaḥ sthirīkaraṇam kartavyam iti. Yamādiguṇsaṁyukte manasaḥ sthitirātmani. Dhāraṇā procyate sadiḥ yogaśāstraviśāradaiḥ. Tasmātsamastaśaktinām ādhāre tatra cetasaḥ|Kurvīta saṁsthitiṁ sā tu vijñeyā śuddhadhāraṇā. - Viṣṇupurāṇam

This is supposed to be practiced by the yogi, who has gone through the previous five limbs, and desirious of attaining *Samādhi.* Hence directing or stabilizing all mental forces on a particular base or object is known as *śuddha-dhāraṇā*. – Viṣṇupurāṇam (Sukhanandanatha, 1992).

Thus *dhāraṇā* not only involves concentration but takes to the next step of focused attention. *Dhāraṇā* consists of focusing on a relevant thing and withdrawal from irrelevant. In the process of perception, mind not only aligns with external sense organs (*jñānendriyās*) but also tunes with earlier experiences. Hence *dhāraṇā* also involves a component of remembering i.e., repeated continuous recollection of the object and not allowing the mind to get distracted (Nagendra, Swami, & Mohan, 2003). Thus in *dhāraṇā* mind is confined (*bandha*) to a single object with single thought. Hence *dhāraṇā* requires voluntary control, persistent effort and training (*abhyāsa*).

4.1c Dhyāna

The Sanskrit word *dhyāna* means continuous dwelling of mind on a single object. When *dhāraṇā* becomes effortless and continuous it takes the form of *dhyāna*. Often this is translated as meditation. Nevertheless, the word meditation is also used to denote concentration and *dhāraṇā*. In this thesis, meditation means *dhyāna*.

तत्र प्रत्ययैकतानता ध्यानम् ॥

Tatra pratyayaikatānatā dhyānam.

'Meditation is uninterrupted, spontaneous flow of the mind towards the chosen object' (Taimini, 1986, Ch: 3 V: 2).

Dhāraṇā naturally leads to the state of meditative absorption, in which the internalized object or locus fills the entire space of consciousness. Just as the one-pointed-ness of attention is the mechanism of *dhāraṇā*, 'one-flowing-ness' (*ekatānatā*) is the underlying process of meditation accompanied by a peaceful, calm disposition. There is no loss of lucidity, but on the contrary, the sense of wakefulness is intensified, even though there is no or little awareness of the external environment.

The psychology of meditation is to cultivate a single thought. A restless mind is like a lake, constantly agitated by the winds of desires, creating thought –waves of diverse intensities. Because of this constant agitation, our true Self at the bottom of the lake cannot be perceived. When, to counter all those many thought –waves, a single thought is consciously cultivated by the repeated and uninterrupted practice of meditation, it develops into a huge wave that swallows up all the diverse ripples and makes the mind transparent and calm. The mind in meditation takes the form of this single thought- wave. The five characteristic features of meditation (*dhyāna)* are (i) single thought, (ii) effortlessness, (iii) awareness, (iv) slowness and (v) expansiveness. This can be called as defocusing. Meditation is a fine method for learning the secrets of the outer and inner worlds. Meditation is a technique of withdrawing the mind so that it receives rest and rejuvenation. The initial purpose of meditation is to intercept the flux of ordinary mental activity (*citta vṛuti*), which is cause for *cancalatā* (Feuerstein, 2001).

4.2 Steps in meditation

The process of meditation thus encompasses *ekāgratā, dhāraṇā and dhyāna*, where *ekāgratā* and *dhāraṇā* are the preliminary steps. All types of meditation techniques whether traditional or modern comprise these steps in varying duration.

Steps	Process	Key features	Experience
Ekāgratā Concentration	Channelizing the multiple thoughts in one direction	- Voluntary control - Intense effort	Focusing, fatigue
Dhāraṇā Focusing	Fixing the mind on one single object with single thought	- Confined repetitions - Withdrawal from irrelevant	Sustained attention, tiredness
Dhyāna Meditation	Continuous and spontaneous dwelling of mind on a single object	- Effortless awareness - Slow expansion	Awareness Silence Peace Happiness
Samādhi	Absorption of subject, object and the process	- Expansion - Powers	Knowledge Bliss

Swami Vivekananda in his book (Vivekananda, 2001) on Raja yoga says, when the mind is focused on a specific object uninterruptedly for twelve seconds, one achieves one unit of *dhāraṇā.* Twelve such successive units of *dhāraṇā* make one unit of *dhyāna*, and twelve such successive units of meditation, lead to *Samādhi. Samādhi* is a state of complete absorption. Patanjali says

तदेवार्थमात्रनिर्भासं स्वरूपशून्यमिव समाधिः ॥

Tadevārthamātranirbhāsaṁ svarūpaśūnyamiva samādhiḥ.

The same (contemplation) when there is consciousness only the object of meditation and not of itself (the mind) is *Samädhi* (Taimini, 1986, Ch: 3 V: 3).

The absorption is attained when meditation becomes constant and continuous, and the mind merges in the object of meditation. There exits no *triputi*. *Samādhi* is a quantum jump into next level of consciousness, the realm of knowledge, power and bliss (Nagendra, Swami, & Mohan, 2003).

4.2a Objects of meditation

Meditation involves three factors i.e., meditator, the object of meditation and the process of meditation (*triputi)*. The object of focus is generally sacred and can be personal or neutral, concrete or abstract, a word or an idea, an image or a symbol, a divine form or personality.

The *Yoga sutrās* of Patanjali mention the following as the possible objects of meditation: (i) the effulgent or radiant light which is beyond all sorrow (*jyotiṣmati*), (ii) the heart of an illuminated being (*vītrāgi*) who is free from all passion and attachment (iii) the subtler dimensions and knowledge of sleep and dream state or (iv) anything (*yathābhimata*) that is spiritually uplifting. Such a thing may be a place, some scenery, an idea or any other thing that would evoke concentration of mind (Adiswarananda, 2004).

The texts on Hatha yoga say on the object of concentration can be out side the body like a *jyoti* or *bindu* in case of *trāṭaka,* sun *(surya)* and moon *(candra)* or can be inside the body like breath, movement of prana, sensations of processes in the body, various *cakra* or even the mind (genesis of thoughts) itself (Muktibodhananada, 2003).

According to the tradition of Vedanta following objects are preferred for meditation: (i) a divine form, (ii) an Incarnation of God, (iii) the divine Lord as inmost Self of Supreme Teacher, (iv) *viraṭa puruṣa* or the Cosmic Personality, (v) the sacred word *Om*, (vi) *Gāyatri mantra*, or the sacred prayer of the Vedas (vii) the meaning of any of the four *mahāvākyas*, or great Vedic saying or (Viii) the meaning of a sacred text, word or mystic syllable (Adiswarananda, 2004).

4.2b Requisites of meditation

Posture: The perfect posture for meditation is that in which the spine, the head, the chest, and the neck are kept erect and there is no movement of the body, and the mind remains in a state of equilibrium (Madhusudhan, & Gambhiranada, 1998, Ch: 6 V: 35). However meditation can also be practiced while body being in slow actions or motion.

Time: Although there is no fixed time for the practice of meditation, the sacred texts mention four times that are most favorable and auspicious. The first of them is time between three and five in the morning (*brahmamuhurta*). The second is midday, when nature has a tendency to return to calmness and rest. The third is the hour of dusk (*godhuli*), when day merges into night and nature becomes tranquil. And the fourth is midnight, when a deep silence pervades all of nature. Experienced teacher advocate that the time for meditation once chosen, must be observed every day, because there is a cycle or rhythm in the movement of forces, spiritual as well as material (Mokshadananda, 1997).

Place: The *Vyasa Sutrās* state "There is no low of place; wherever the mind is concentrated, meditation should be practiced" (Adiswarananda, 2004). According to sacred texts of Vedanta, a mountain, a riverbank, a temple, a place where the practice of meditation has been successfully carried out by many spiritual seekers (*tapobhumi*) and a solitary place free from distractions (Vivekananda, 1971).

Direction: The meditator is advised to sit facing the east, because the earth's daily rotation is from west to east. By facing the east, one faces the direction of motion (Adiswarananda, 2004).

4.3 The states of mind

Generally mind is defined as a flow of thoughts. The conglomeration of thoughts is mind (Nagendra, 2001). This process of thoughts is always ongoing and is related with the information and inputs given by the external organs of perception and the feedback obtained from the earlier memories and impressions. In yogic understanding, the mind has four functional facets i.e., *manas, buddhi, citta* and *ahaṅkāra* together called as *antaḥkaraṇa* (internal instrument).

निगद्यतेऽन्तःकरणं मनोधीरहंकृतिश्चित्तमिति स्ववृत्तिभिः।
मनस्तु संकल्पविकल्पनादिर्बुद्धिः पदार्थाध्यवसायधर्मतः॥९३॥
अत्राभिमानादहमित्यहंकृतिः। स्वार्थानुसन्धानगुणेन चित्तम्॥९४॥

Nigadyate'ntaḥkaraṇaṁ manodhīrahaṅkṛtiścittamiti svavṛttibhiḥ.
Manastu saṅkalpavikalpanādirbuddhiḥ padārthādhyavasāyadharmataḥ.
Atrābhimānādahamityahaṅkṛtiḥ. Svārthānusandhānaguṇena cittam.

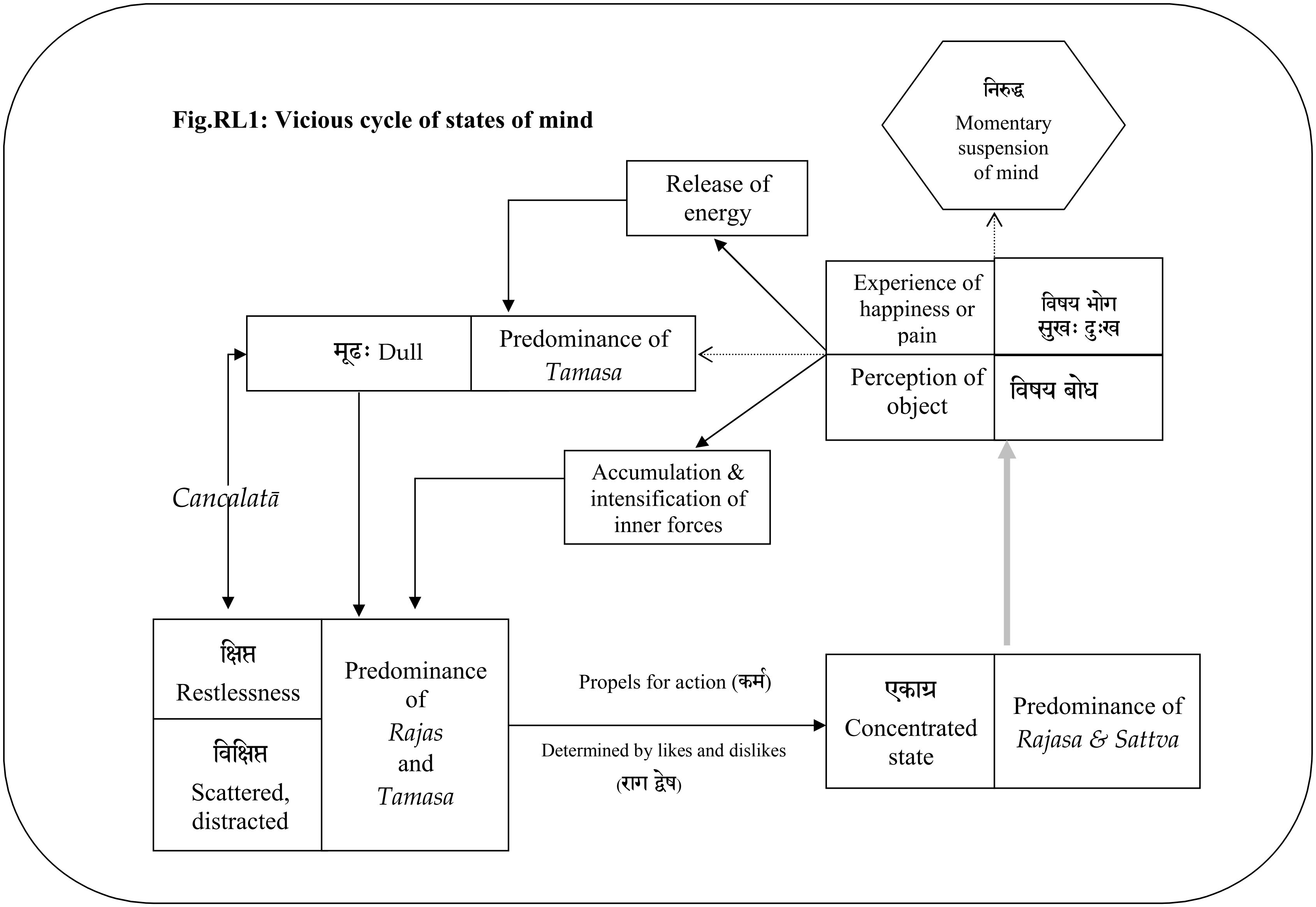
The oscillating nature of thoughts is *manas* (*saṅkalpavikalpatmika*), discriminative ability is *buddhi* (*niścayātmikā*), stored impressions and patterns is *citta* (*anusandhānātmikā*) and feeling of 'I' ness, the ego is *ahaṅkāra* (Chinmayanada, 2002, V: 93, 94). This mind oscillates between any of the following five states

क्षिप्तं मूढं विक्षिप्तमेकाग्रं निरुद्धमिति चित्तभूमयः।

Kṣiptaṁ mūḍhaṁ vikṣiptamekāgraṁ niruddhamiti cittabhūmayaḥ.

Mind often functions in restless or turbulent way (*kṣipta*), sometimes becomes dull and stupefied (*mūḍha*), sometimes becomes distracted and divided (*vikṣipta*), sometimes becomes concentrated and one pointed (*ekāgra*) and rarely becomes restrained and suspended (*niruddha*). These are different grounds or fields of functioning of the mind (*cittabhūmayaḥ*) (Bangali Baba, 2002). This is presented schematically in Fig. RL1.

Fig.RL1: Vicious cycle of states of mind



The *Bhagavad Gīta* describes the mind by four epithets: restless, turbulent, powerful, and obstinate (Chinmayananda, 2001, Ch: 6 V: 34). An ancient proverb depicts the restless mind addicted to the pleasures of the senses as a mad elephant, while Swami Vivekananda has compared the restless mind to a monkey that not only is drunk with the wine of desire but simultaneously stung by the scorpion of jealousy and overtaken by the demon of pride. The restless mind is like a monster that can make life a nightmare - but that same mind, when subdued and controlled, becomes a most trusted friend and helper, guaranteeing peace and happiness. The strong likes (attachments) and dislikes (repulsions) make mind restless and induce desires. To pamper whatever desires arise in the mind would be counterproductive, leading only to greater restlessness. In *Bhagavad Gīta* it is described as..

ध्यायतो विषयान् पुंसः सङ्गस्तेषूपजायते । सङ्गात् सञ्जायते कामः कामात् क्रोधोऽभिजायते ॥२.६२ ॥
क्रोधाद् भवति संमोहः संमोहात् स्मृतिविभ्रमः । स्म्रृतिभ्रंशाद् बुद्धिनाशो बुद्धिनाशात् प्रणश्यति ॥२.६३ ॥

Dhyāyato viṣayān puṁsaḥ saṅgasteṣūpajāyate. Saṅgāt sañjāyate kāmaḥ kāmāt krodho'bhijāyate. Krodhād bhavati sammohaḥ sammohāt smṛtivibhramaḥ. Smrṛtibhraṁśād buddhināśo buddhināśāt praṇaśyati.

Brooding on the objects of senses, man develops attachment to them; from attachment comes desire; from desire anger sprouts forth. From anger proceeds delusion; from delusion, confused memory; confused memory ruins the ability of discrimination; and due to that finally he perishes (Chinmayananda, 2001, Ch: 2 V: 62, 63).

Desire leads to generation of more thoughts; repetition of thoughts and experience makes deeper impressions converting them in to emotions. Punishing the mind through self-torture and mortification would merely repress the desires, driving them underground (subconscious). Trying to transform the mind by changing our environment would be futile because wherever we go, our mind with all its habitual tendencies goes with us. The mind never becomes controlled automatically; it must be controlled consciously. The only alternative, according to the *Bhagavad Gīta*, is to slowdown the mind (sublimation) and face it by control and regulation.

शनैः शनैरूपरमेद् बुद्ध्या धृतिगृहीतया । आत्मसंस्थं मनः कृत्वा न किञ्चिदपि चिन्तयेत् ॥६.२५ ॥

Śanaiḥ śanairūparamed buddhyā dhṛtigṛhītayā Ātmasaṁsthaṁ manaḥ kṛtvā na kiñcidapi cintayet.

With intellect set in firmness, attain quietitude little by little (step by step); with the mind fixed on the Self, do not think of anything (Chinmayananda, 2001, Ch: 6 V: 25).

The methodology of yoga is to control and purify the subconscious (region of *vāsanas* and *sasṁskāras*) with the help of conscious effort. Restlessness of body is to be overcome by slow and mindful practice of postures (*āsanas*). Irregular breath, an indicator of mental restlessness, is to be made regular by smooth and rhythmic breathing (*prāṇāyāma*).The out going thoughts and improper tendencies of the mind must be substituted by cultivating of moral and ethical virtues. Meditation helps to gain this control and constant awareness. Meditation begins with concentration and intense focusing on the chosen object and *dhyāna* happens only when mind becomes effortlessly and continuously one-pointed like the flow of oil poured from one vessel in to another. Sage Patanjali says "meditation is uninterrupted flow of mind on its object. This itself turns into *samādhi* when the object alone shines and the thought of meditation (and of the meditator) is lost, as it were" (Usharbudh, 1986). That state of mind is *niruddha* where thoughts do not exist. Meditation is only possible in wakeful state of consciousness. How mind exists in different states of consciousness and can be evolved higher is schematically depicted in Fig. RL2.

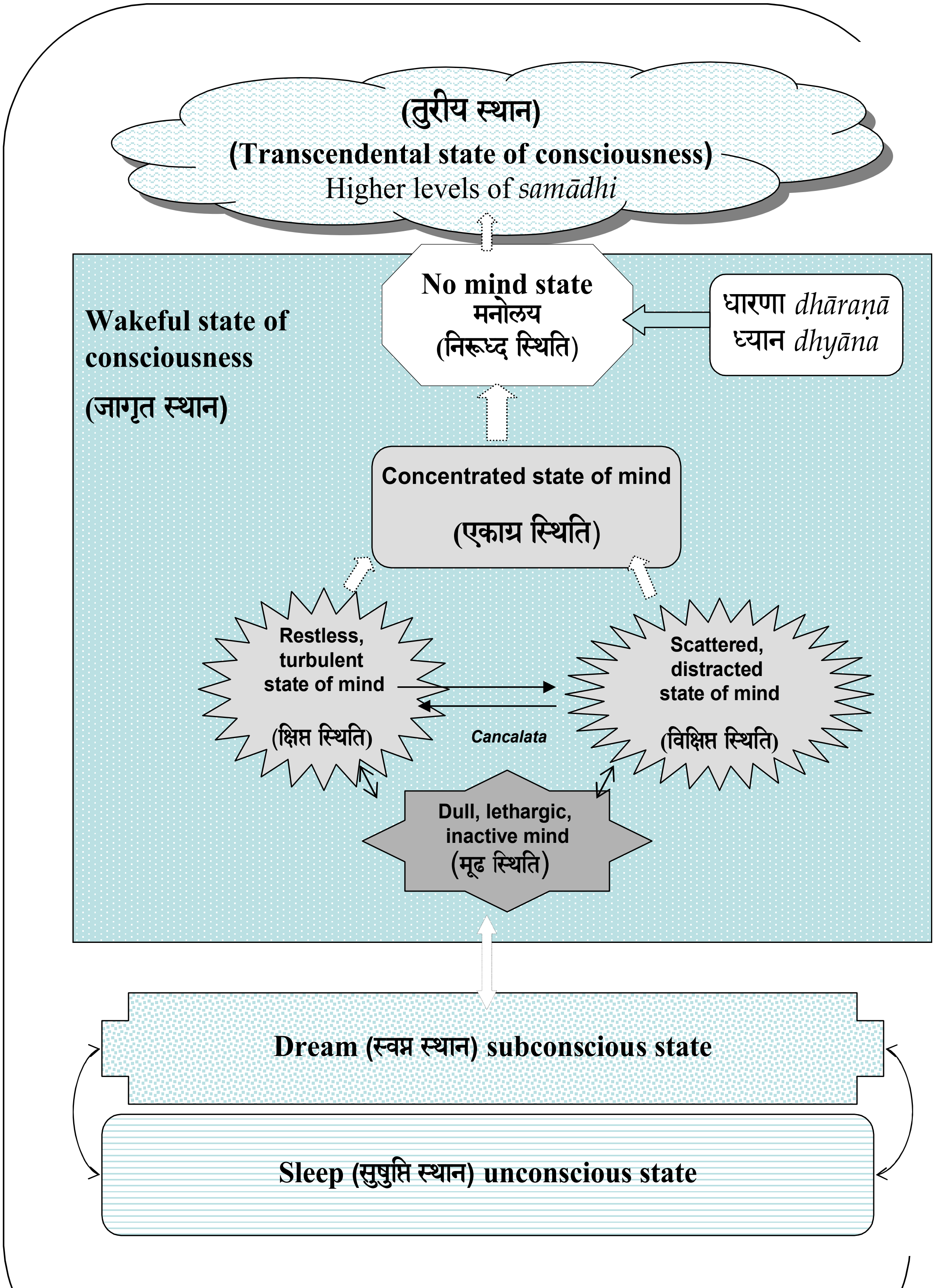


Fig. RL2 Stages of growth of mind

4.4 Goal o

The goal of meditation is complete absorption in the object of meditation (*Samādhi*), finally leading to communion or union with the Ultimate Reality. Different systems of thoughts and philosophies call it by different names: liberation - *Mokśa*, beatific vision of divine – *nirvana*, awakening, enlightment – *Kaivalya*, Self knowledge or knowledge of *Brahman*, attaining the Kingdom of Heaven within. Longing for this goal distinguishes a human individual from the subhuman beings says Sri Ramakrishna (Mumukhsnanda, 1998).

The goal of meditation is the cessation of all miseries through the realization of the indwelling Self, or *Puruśā*, which is Pure Consciousness. The yoga system maintains that the cause of all miseries is ignorance, which deludes the Self, and entangles It in the world of matter. This entanglement is essentially of the mind, and the remedy lies in disentangling the Self from the world of matter and the world of mind. This is only possible through the knowledge of Reality. The aim of meditation is to find the Reality. Meditation leads to Self realization (Satyananda, 1992).

The seers of the Vedas mention four goals of life: knowledge of the right and wrong (*dharma*), worldly prosperity (*artha*), fulfillment of legitimate desires (*kama*) and Self – Knowledge (*mokśa*). Self-knowledge is the consummation of all the other goals. According to *Upaniṣads* in this state, the dualities of subject and object, knower and known, seer and seen, all merge in the indescribable expanse of the Absolute. Consciousness of time and space obliterate, and the fetters of causality broken for forever. No sacrifice is too great to achieve this goal; no effort in this venture is ever lost or wasted. All scriptures of Yoga and Vedanta emphasize on this goal which is the goal of all goals in human life.

4.5 Process of Meditation

The system of Yoga contends that the world of matter and the world of mind are not two different worlds. Material world is part of the world of mind. Matter is grossified form of mind. When the real nature of the mind is known, it no longer deludes the Self. Then the Self alone shines in Its own glory. The mind gets illuminated by that shine – pure to the core. The regular practice of meditation causes calmness of mind, slowness in the flow of thoughts and further leads to purification of mind by release of all knots and blocks in the subtle layers of mind. Meditation helps to address all the unresolved patterns, issues, fears and phobias deep within the subconscious field (Satyananda, 1992). In this technique, willpower plays an important role. Through the exercise of willpower, the mind consciously and deliberately cultivates a single thought to the exclusion of all other thoughts. Meditation begins with concentration on single object and culminates in absorption in that object. Absorption reveals the subtle nature of the object. By knowing it one is able to know the reality of subtle entities in the universe. This is schematically presented in Fig.RL3.

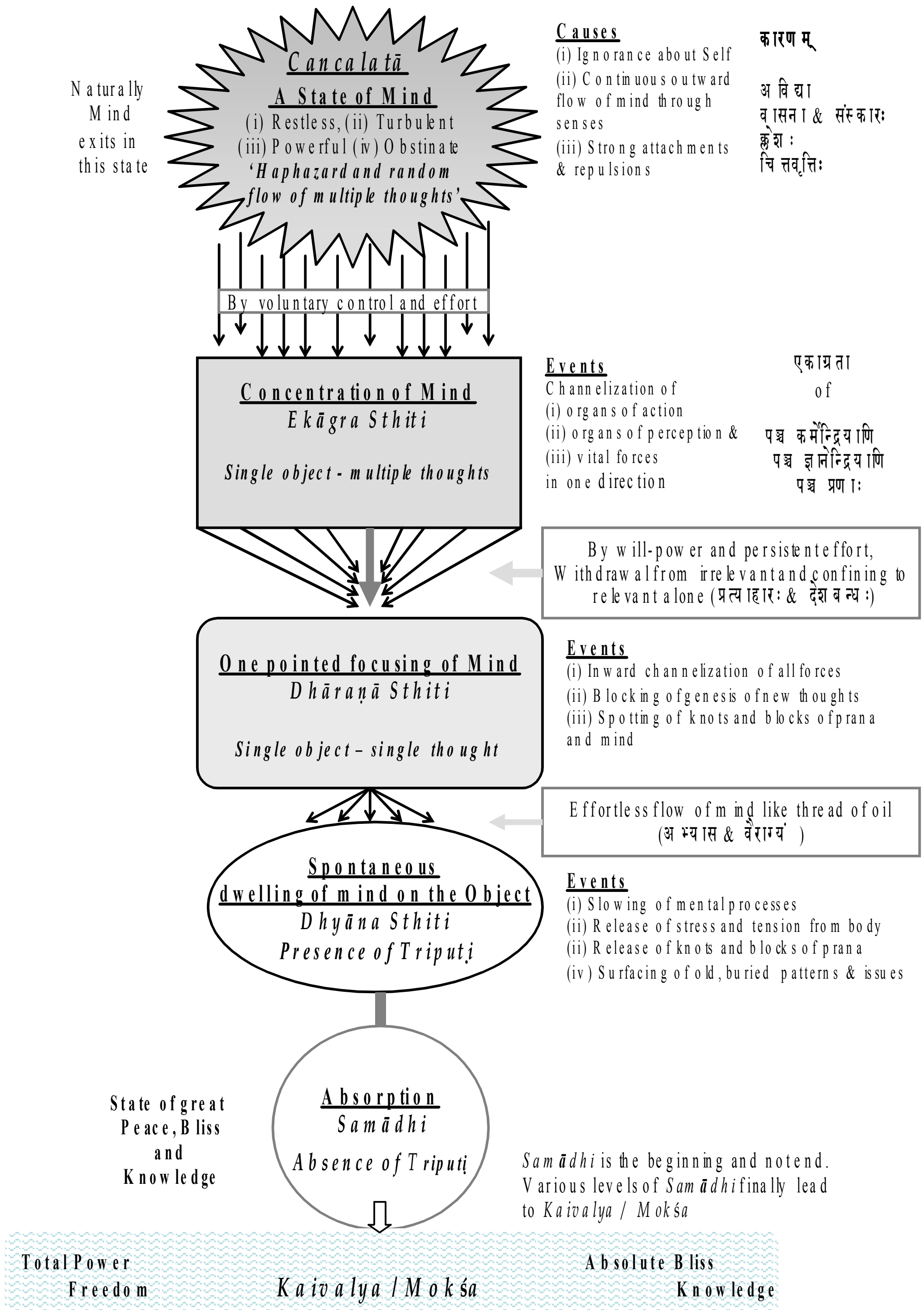


Fig. RL3: Mechanism of process of meditation

4.6 Benefits of meditation

The benefits of meditation are threefold: physical, psychological and spiritual. Meditation enables the physical and psychic energies to flow into creative, constructive channels instead of burning out in destructive forms. Mind gains the poise, peace, naturalness, serenity, stability of emotions, conservation of energy, and a capacity to bear the frustrations and the ups and downs of the life. Meditation addresses all the unresolved issues and notions of subconscious. Meditation brings about complete behavioral transformation. A new worldview induces a new quality of consciousness, which leads to change in interpersonal relationships. Meditation teaches to act and not to react (Chao Khun, 1968).

Meditation awakens the dormant powers of the mind. Just as a vast amount of energy is hidden in an atom, so too is there a vast reservoir of energy hidden in the depths of our psyche. The sacred texts of Yoga call this sleeping power of the mind *kundalīni* (Muktibodhananada, 2003). Life becomes blessed when the *kundalīni* is awakened. Practitioner attains certain powers known as *siddhis* (Taimini, 1986). Using the power of the mind, human beings have been able to achieve great wonders in the realm of science and technology. It is the same power of the mind that makes impossible things possible in the realm of spirituality. The story of the evolution of life is the story of the manifestation of mental powers. The mind being clear and free from conflicts becomes more effective and efficient. Meditation brings spiritual illumination which liberates the Self from the trappings of the body-mind complex. Meditation is the only way to Self-Knowledge, and Self-Knowledge can put an end to all the sorrows and sufferings of the life.

A large number of scientific studies have shown positive development in self-actualization, creativity, empathy, reaction time, memory and intelligence, concentration and attention, improved performance in perceptual and motor skills, cognitive abilities following meditation. It is also observed that the experienced meditators have un-agitated voice, relaxed and kindly appearance, a tension-free gait, grace and charm in all actions. In the words of *Śvetāśvatara Upaniṣat*, "The first signs of entering in yoga and meditation are lightness, health, absence of desire, a good complexion, a beautiful voice, a fragrance of the body, and less excretions" (Gamabhiranada, 1986). Swami Vivekananda says, "Such is the power of yoga and meditation that even the least of it will bring a great amount of benefit. It will not hurt anyone but will benefit everyone. It will calm down the nervous excitement, bring peace, enables to see things more clearly" (Vivekananda, 2001).

5.0 TECHNIQUES OF MEDITATION

There are different techniques of meditation depending upon the object and the strategy chosen. Despite the difference in objects of focus and techniques of meditation, three key factors have to be present in the practice of any kind of meditation. Those three factors are (i) the object of meditation (locus of focus), (ii) the centre of consciousness (point of awareness) where the mind is held during meditation, and (iii) the method employed to invoke concentration (Adiswarananda, 2004).

The object of meditation can be anything as described earlier, internal or external, stable or dynamic. The sacred texts of Yoga and Vedanta maintain that the object of meditation must not be frequently changed. The object of meditation is generally held within at a particular center, such as the heart, the forehead, the tip of the nose, or the crown of the head. Or the seeker may place it outside his body, in-front of him on the ideal. However in some meditation techniques the object of concentration and the center of consciousness (awareness) where the mind is held are same. The method employed to invoke concentration is either selected by the seeker or prescribed by the teacher (*Guru*), and it also must not be changed.

In Buddhist forms of mindfulness meditation technique the locus of focus and the center of awareness remain same and is dynamic, continually moves with the changing processes or phenomena (Chao Khun, 1968). In cyclic meditation as well the locus of awareness keeps on changing along with the slow movements of the body (Nagendra, & Nagrathana, 2001).

5.1 Traditional techniques of meditation

While the goal of all meditation techniques remains the same, the types of mediation vary because of the different approaches used by different systems of thought. The meditation techniques mentioned in different traditional scriptures could be broadly classified (Sukhanandanatha, 1992) as [1] Meditation on concrete (*dhyāna* on *sākāra saguṇa vastu* object): (i) Meditation on sound (*śabda*) i.e. on certain *mantra, bija akṣara* (syllable in seed form) in form of *japā* meditation (silent repetition of *mantra*) or meditation on inner sounds (*nāda*), (ii) Meditation on form (*rupā*) i.e., on specific ideal or image of deity (*iṣṭadevatā*), tantric codified shapes called *yantrās* or neutral symbol like flame or light (*jyoti*), and (iii) Meditation on inner objects like breath, movement of *pranā, chakras,* genesis of thoughts, or sense of 'I'. [2] Meditation on abstract (*dhyāna* on *nirākāra nirguṇa* object or idea): (i) Meditation on meaning of *upaniṣadic* statements of universal truths called as *mahāvākyas* like अहं ब्रह्मास्मि (ahaṁ brahmāsmi), तत्त्वमसि (tattvamasi), अयमात्मा ब्रह्म (ayamātmā brahma) and प्रज्ञानं ब्रह्म (prajñānaṁ brahma).

The scriptural texts of yoga and spirituality mention following statements about meditation.

5.1a The Yajur Veda

ॐ क्रतो स्मर

Om kṛto smarā

O' devout worshipper, meditate on '*Om*'

5.1b The Upaniṣads

अरा इव रथनाभौ संहता यत्र नाड्यः स एषोऽन्तश्चरते बहुधा जायमानः

ओम् इत्य् एवं ध्यायथात्मानं स्वस्ति वः पाराय तमसः परस्तात्।

Arā iva rathanābhau saṁhatā yatra nāḍyaḥ sa eṣo'ntaścarate bahudhā jāyamānaḥ.

Aumityevaṁ dhyāyatha ātmānam svasti vaḥ parāya tamasaḥ parastāt.

Where the arteries of the body are brought together like the spokes in the center of a wheel , within it (this self, moves about) becoming manifold. Meditate on *Om* as the Self . May you be successful in crossing over to the farther shore of darkness.

Muṇḍaka upaniṣat- (Gamabhiranada, 1995, Ch: 2 V:2.6)

एष सर्वेषु भूतेषु गूढोऽऽत्मा न प्रकाशते।

दृश्यते त्वग्रया बुद्ध्या सूक्ष्मया सूक्ष्मदर्शिभिः॥

Eṣa sarveṣu bhūteṣu gūḍho''tmā na prakāśate.

Dṛśyate tvagrayayā buddhyā sūkṣmayā sūkṣmadarśibhiḥ.

That Self hidden in all beings does not shine forth; but
It is seen by subtle seers through their one- pointed and subtle intellects.
Katha upaniṣat - (Chinmayanada, 2002, Ch: 1 V: 3.12)

तं दुर्दर्शं गूढमनुप्रविष्टं गुहाहितं गह्वरेष्ठं पुराणम् ।
अध्यात्मयोगाधिगमेन देवं मत्वा धीरो हर्षशोकौ जहाति ॥

Taṁ durdarśaṁ gūḍhamanupraviṣṭhaṁ guhāhitaṁ gahvareṣṭaṁ purāṇam.
Adhyatmayogādhigamena devaṁmatvā dhīro harṣaśokau jahāti.
The wise man who, by means of concentration on the Self, realizes that ancient, effulgent One, who is hard to be seen, un-manifest, hidden, and who dwells in the *buddhi* and rests in the body –he, indeed, leaves joy and sorrow far behind.
Katha upaniṣat - (Chinmayanada, 2002, Ch: 1 V: 2.12)

त्रिरून्नतं स्थाप्य समं शरीरं हृदीन्द्रियाणी मनसा सन्निवेश्य ।
ब्रह्मोद्दपेन प्रतरेत विद्वान् श्रोतांसि सर्वाणि भयावहानि ॥

Trirūnnataṁ sthāpya samaṁ śarīraṁ hrudīndriyāṇī manasā sanniveśya.
Brahmodṛpena pratareta vidvān śrotāṁsi sarvāṇi bhayāvahāni.
The wise man should hold his body steady, with the three (upper) parts erect, turn his senses, with the help of the mind, toward the heart, and by means of the raft of *Brahman;* cross the fearful torrents of the world.
Śvetāśvatara upaniṣat - (Gamabhiranada, 1986, Ch: 2 V: 8)

समे शुचौ शर्करावह्निवालुका विवर्जिते शब्दजलाश्रयादिभिः ।
मनिनुकूले न तु चक्षुपीडने गुहानिवाताश्रयणे प्रयोजयेत् ॥

Same śucau śarkarāvahnivālukā vivarjite śabdajalāśrayādibhiḥ.
Maninukūle na tu cakṣupīḍane guhānivātāśrayaṇe prayojayet.
Let yoga (meditation) be practiced within a cave protected from the high wind, or in a place which is level, pure, and free from pebbles, gravel, and fire, undisturbed by the noise of water or of market –booths, and which is delightful to the mind and not offensive to the eye.
Śvetāśvatara upaniṣat - (Gamabhiranada, 1986, Ch: 2 V: 10)

बृहच्च तद्दिव्यमचिन्त्यरूपं सूक्ष्माच्च तत्सूक्ष्मतरं विभाति ।
दूरात्सुदूरे तदिहान्तिके च पश्यत्स्विहैव निहितं गुहायाम् ॥

Bṛhacca taddhiavyamacintyarūpaṁ sūkṣmācca tatsūkṣmataraṁ vibhāti.
Dūrātsudūre tadihāntike ca paśyatsvihaiva nihitaṁ guhāyām.
That *Brahman* shines forth, vast, self-luminous, inconceivable, and subtler than the subtle. He is far beyond what is far and yet here very near at hand. Verily, He is seen here, dwelling in the cave of the heart of conscious beings.

Muṇḍaka upaniṣat- (Gamabhiranada, 1995, Ch: 3 V: 1.7)

सर्वं खल्विदं ब्रह्म तज्जलानिति शान्त उपासीत।

अथ खलु क्रतुमयः पुरूषो यथाक्रतुरस्मल्लोके पुरूषो भवति तथेतः प्रेत्य भवति स क्रतुं कुर्वीत॥

Sarvaṁ khalvidaṁ brahma tajjalāniti śānta upāsīta.
Atha khalu kratumayaḥ purūṣo yathākraturasmalloke purūṣo bhavati tathetaḥ pretya bhavati sa kratuṁ kurvīta.

All this is *Brahman*. From It the universe comes forth, in It the universe merges, and in It the universe breathes. Therefore a man should meditate on *Brahman* with a calm mind.

Chāndogya upaniṣat- (Swami Swahanada, 1984, Ch: 3 V: 14.1)

Let one meditate That as adoration ; desires pay adoration to him. Let one contemplate That as the supreme, he becomes possessed of the supreme. Let one contemplate That as Brahman's destructive agent, one's hateful rivals perish as also those rivals whom he does not like . He who is here in the person and he who is yonder in the Sun, he is one.

Ṭaittirīya upaniṣat – (Gamabhiranada, 1998, Ch: 2 V:1)

Though a man may perform penance standing on one leg for a thousand years, it will not, in the least, be equal to one- sixteenth part of concentrated meditation.

\- *Pingalā upaniṣat* - Ch: 4 V: 15 (Adiswarananda, 2004)

5.1c Bhagavad Gīta

शुचौ देशे प्रतिष्ठाप्य स्थिरमासनमात्मनः।

नात्युच्छ्रितं नातिनीचं चैलाजिनकुशोत्तरम्॥६.११॥

Śucau deśe pratiṣṭhāpya sthiramāsanamātmanaḥ.
Nātyucchitram nātinīcam cailājinakuśottaram.

On a clean and pure place neither too high nor too low
he spreads kusagrass, a deerskin and a cloth (Tpasyaananda, 2002, Ch: 6 V: 11).

तत्रैकाग्रं मनः कृत्वा यतचित्तेन्द्रियक्रियः।

उपविश्यासने युञ्ज्याद्योगमात्मविशुद्धये॥ ६.१२॥

Tatraikāgram manaḥ kṛtvā yatacittendriyakriyaḥ.
Upaviśyāsane yuñjyādyogamātmaviśuddhaye.

Sitting on that seat he should concentrate the mind, control the senses and
thoughts, and practise yoga for self-purification (Tpasyaananda, 2002, Ch: 6 V: 12).

समं कायशिरोग्रीवं धारयन्नचलं स्थिरः।

सम्प्रेक्ष्य नासिकाग्रं स्वं दिशश्चानवलोकयन्॥६.१३॥

Samaṁ kāyaśirogrīvaṁ dhārayannacalaṁ sthiraḥ.
Samprekṣya nāsikāgraṁ svaṁ diśaścānavalokayan.

Keeping the trunk , head and neck straight and steady sitting firmly,
one should look at the tip of the nose, without looking in other directions (Tpasyaananda, 2002, Ch: 6 V: 13).

प्रशान्तात्मा विगतभीर्ब्रह्मचारिव्रते स्थितः ।

मनः संयम्य मच्चित्तो युक्त आसीत मत्परः ॥६.१४ ॥

Praśāntātmā vigatabhīrbrahma cārivrate sthitaḥ.
Manaḥ saṁyamya maccitto yukta āsīta matparaḥ.
A majestically calm, fearless, and a confirmed celebate should
withdraw his senses and sit carefully fixing his mind upon Me
(Tpasyaananda, 2002, Ch: 6 V: 14).

युञ्जन्नेवं सदात्मानं योगी नियतमानसः ।

शान्तिं निर्वाणपरमां मत्संस्थामधिगच्छति ॥६.१५ ॥

Yuñjannevaṁ sadātmānaṁ yogī niyatamānasaḥ.
Śāntiṁ nirvāṇaparamāṁ matsaṁsthāmadhigacchati.
In this manner, constantly meditating with controlled mind,
the yogi, emancipated and eternally peaceful,attains Me
(Tpasyaananda, 2002, Ch: 6 V: 15).

5.1d Patanjali Yoga Sutras

Dhāraṇā is the holding of the mind to some particular object. (When the mind holds on to some object, either in the body or outside the body, and keeps itself in that state, it has attained *dhāraṇā* concentration). An unbroken flow of knowledge about that object is dhyana. When the mind tries to think of one object, to hold itself to one particular spot, such as the top of the head, or the heart, and succeeds in receiving sensations only through that part of the body, and no other part, it has attained *dhāraṇā*: and when the mind succeeds in keeping itself in that state for some time, it has attained *dhyāna,* meditation.

ध्यानहेयास्तद्वृत्तयः ॥

Dhyāaheyāstadvṛtayaḥ.
The modifications of the *kleṣas* are reducible through meditation
(Taimini, 1986, Ch: 2 V: 11).

तत्र प्रत्ययैकतानता ध्यानम् ॥

Tatra pratyayaikatānatā dhyānam.
An uninterrupted stream of the content of consciousness is *dhyāna*

(Taimini, 1986, Ch: 3 V: 2).

5.1e Śaṅkhya Yoga (Bahadur, 1988)

Cessation of desire is meditation.

It has been stated that knowledge alone can confer liberation. The author goes on to say how such knowledge can be obtained. When by meditation the mind is untarnished by external objects the impediments in the way of knowledge are removed.

Meditation is perfected by repelling the modifications of the mind.

The modifications are real cognition, unreal cognition, imagination, deep sleep and memory. Meditation is accomplished by restraining them. When this is achieved there takes place the immediate intuition of the object of meditation.

Meditation is accomplished by dhāraṇā, āsana and svadharma.

The author mentions how meditation is accomplished. This is by holding the mind in a particular part of the body (*dhāraṇā*), adopting the needful posture (*āsana*), and by performance of the *varṇa* duties (*svadharma*), i.e., duties belonging to the stage of life in which one is placed.

5.1f Yoga Vāsiṣṭha

मनः प्रशमनोपायः योगः इत्यभिदीयते ॥

Yoga is the trick to calm down the mind.

तदभ्यासेन निर्वाणम् इत्यभ्यासो महोदयः ।

षम्भा ष्यैवम् निशायाम् ते निर्विकल्प समाधिना ॥

Tadabhyāsena nirvāṇam ityabhyāso mahodayaḥ.
ṣambhā ṣyaivam niśāyām te nirvikalpa samādhinā.

बभूवतुः चिदाकशरूपिण्यौ व्योमगाकृती ।

डुरात् दूरम् अभिप्लुत्य ततो ब्रह्माण्डमडतत् ॥

Babhūvatuḥ cidākaśarūpiṇyau vyomagākṛtī.
Ḍurāt dūram abhiplutya tato brahmāṇḍamaḍatat.

Since liberation is (attained) by such practice, the practice (itself) is the supreme fulfillment. Conversing thus in the night, they two (Leela and Goddess) became of the form of the space of consciousness by *Nirvikalpa Samadhi* (or yogic state of absolute consciousness transcending the differentiation of the knower, knowledge and the known and possessed of the bodily form of heavenly beings)
(Atreya, 1993, Ch: 5 V: 40, 41).

5.1g *Śrīmad Bhāgavata Mahāpurāṇa* (Tapayananda, 1982)

"Do you restrain by all means your fickle mind; my son by your superior intelligence set steady on Me. This is the sum and substance of all yoga." So spoke the Lord to Uddhava" (11.23.61). "The mind that dwells on sense objects gets stuck in them. The mind that remembers Me constantly gets dissolved in Me" says Lord Kṛiṣṇa to Uddahava. That is the mode of meditation advocated by the *Bhāgavat*. (11.14). Further from verses numbers 31 to 46 of *Bhāgavat Mahāpurāṇa (*chapter 14 of sub-chapter 11) it is mentioned, how the devotees should meditate on Lord Kṛiṣṇa's personal and impersonal form and with what attributes one should meditate, when asked by Uddhava.

5.1h Haṭha Yoga Text (Muktibodhananada, 2003)

In *Haṭha* yoga meditation, more specifically *kuṇḍalīni* meditation, the divine power that lies dormant in every human being is aroused and pulled upward through the *cakras*, the psychic centers of the body. At the top of the head, the seat of the highest consciousness the union of the individual and absolute consciousness takes place. This is expressed symbolically as the union of *Śakti* or *kuṇḍalīni* with Lord *Śiva*. During meditation each *cakra* is visualized as a lotus with a certain number of petals. The *mūlādhāra*, *svadhiṣṭhāna*, *maṇipura*, *anāhata*, *viśuddhi* and *ājña cakras* have four, six, ten, twelve, sixteen and two petals respectively, while *sahasrāra* has one thousand. The number of petals is determined by the number and position of *nāḍis* that emanate from the *cakras* and give it the appearance of a lotus. Hanging downward when *kuṇḍalīni* is dormant, the *nāḍīs* turn upward with its ascendance. The *cakras* may be focused upon by chanting of *Om*, the all inclusive universal sound vibration, in different pitches. When *kuṇḍalīni* is awakened it does not proceed directly to the *sahasrāra* unless one is an exceptionally pure yogi.

It must be moved up from one *cakra* to another and a great of concentration and patience is required. When the *kuṇḍalīni* finally rises from the *ājña* to the *sahasrāra* union take place and this is called liberation. In summary, Hatha yoga itself (by practicing preliminary practices called *āsanas, prāṇāyāmas, kriyas, banḍhas mudras*) leads to stages of meditation, while it also prepares one's body and mind for the practice of meditation.

5.1i Prakaraṇa Grantha

Meditate on the Atman, which resides in thee, which is devoid of all limiting adjuncts, the Existence – Knowledge – Bliss – Absolute, the One without a second, and thou shall no more come under the round of births and deaths -*Vivekacuḍāmaṇi* (Chinmayanada, 2002, V: 288).

5.1j Mahābharata (Ramgopalachari, 1958)

In the *Śantiparva* of *Mahābharata* there are references on meditation by Manu, Vyasa, and Vasishtha. Manu says: Since the mind is always stimulated by sense-objects, it is not possible for the ordinary mind to attain to the attribute-less *Brahman*. It becomes possible only when the senses are merged in the mind, and the mind in the intellect, through uninterrupted concentration. Vyasa says: The process of withdrawing the intellect, the mind and the senses from external objects and merging them in the all-pervading *Paramātman* leads to the Supreme knowledge. An aspirant of such Knowledge must with deep concentration of mind practice the merging of the mind into the intellect twice a day, both at dawn and dusk. Vasishtha says: Meditation is the greatest power of the yogis. The wise men describe meditation as concentration of mind. Through concentration of mind, he sifts the *jīvātman* from the twenty-four cosmic principles and tries to merge it in the *Paramātman*. The moment this unity of *jīvātman* and *Paramātman* is established, a man becomes *jīvanamukta.*

5.2 Popular techniques of meditation:

5.2a'Om' Meditation

Yogic teachings consider the syllable *'Om'* to be the force behind all thoughts. Either chanting or thinking about *'Om'* is supposed to cause a quiet mental state. *Om* is the primordial sound from which all other sounds and creation emerge. In *Om* meditation the meditator first concentrates on an *Om* picture and then mentally chants *mantra* '*Om'* effortlessly and finally expands to an all-pervasive level and goes for blissful silence.

5.2b Transcendental Meditation (TM)

Transcendental meditation (TM) is based on the traditional yogic principles. In TM the meditator sits in a comfortable position silently closing the eyes and repeats a specific *mantra* mentally from time to time to go beyond thought level**.** This technique is preached and practiced by Maharshi Mahesh Yogi. This is less rigorous and demanding discipline, apparently easily learned, and hence widely practiced. The TM is defined as 'turning the attention inwards towards the subtler levels of a thought until the mind transcends the experience of the subtle state of thought and arrives at the source of the thought'.

5.2c Tantric meditation

In this technique the meditator has to repeat a sacred *mantra* given by the *guru*, with intense concentration. This meditation is practiced and propagated by the Ananda Marga organization. The technique consist two important steps. First, the meditators sit in comfortable relaxed position and withdraw the attention inwards by ignoring the external stimuli and paying attention to their breathing. Then they silently repeat the two lettered personal *mantra* with their breathing.

5.2d Brahmakumaris Raja yoga meditation

This meditation technique is preached and practiced by Brahmakumaris Ishawariya Vishwavidyalaya. During this meditation, aspirants sit in a comfortable position with their eyes open, and with effortless gaze fixed on a *jyoti* (light – representing supreme consciousness). At same time they actively generate positive thoughts about the Universal force pervading all over, as light and peace.

5.2e Zen Meditation

Zazen- Zen meditation is a fundamental part of both the Soto and Rinzai Sects of Zen Buddhism. The aim in this form of meditation is the ultimate state of enlightenment called *Satori.* This technique involves concentration. There are three types in this type of meditation. In the first type, the meditator concentrates on his breathing, counting the breaths or without counting. In second type of meditation the meditator has to solve koans or say non-logical riddles. In third type of meditation the meditator just sits and breathes in a prescribed manner without any aids or concentrating on his breath.

5.2f Vipassanā Meditation

Vipassanā, which means to see things as they really are, is one of the ancient techniques of meditation. It was rediscovered by Gotama Buddha more than 2500 years ago. In *vipassanā* meditation the meditator, sitting in a comfortable position, initially observes his own breathing and thereafter observes sensations and feelings in various part of the body with an attitude of witness. *Vipassanā* is a way of self-transformation through self-observation. It focuses on the subtle interconnection between mind and body, which can be experienced directly by disciplined attention to the physical sensations that form the life of the body, and that continuously interconnect and condition the life of the mind. It is this observation-based, self-exploratory journey to the common root of mind and body that dissolves mental impurity, resulting in a balanced mind full of love and compassion.

5.2g Prekṣā Meditation

This is also an ancient meditation technique practiced in Jainism. *Prekṣā* means to perceive and realize the subtlest aspects of ones own self, 'to see the Self'. *Prekṣā* is derived from the Sanskrit word *"Pra + iksha"* which means to observe carefully. Basically it sums up the perception of body, psychic centers, breath and observation of mind. In *Prekṣā dhyana* no thought is forcefully stopped. Instead the art of merely observing the thought process without forming any reaction or attachment is developed. By doing so thoughts themselves cease to appear.

5.2h Yoga nidra

Yoga-nidra (yogic psychic sleep) is a meditative technique, derived from ancient *Tantra* popularized by Bihar School of Yoga (BSY). Yoga-nidra is described as a systematic method of inducing complete physical, mental and emotional relaxation, while maintaining awareness at deeper levels. Yoga-nidra is performed in *Savasana* and it consists of progressive relaxation and rotation of awareness all over body, resolve, and visualization of some images of nature and *tantric* abstract symbols.

5.3 Modern techniques of meditation

The modern way of life poses several hassles and stress to every body whether the person is an overworked executive in an office or a farmer tilling the field under hot sun. The modern man takes up to meditation not for Self realization but approaches these systems with objective of achieving (i) good physical relaxation (ii) holistic health (iii) peace of mind (iv) stress management (v) balance of emotions (vi) control of mind (vii) development of personality (Viii) improvement in interpersonal relationships and (ix) efficiency in performance at work.

Today various types of meditation and relaxation techniques are popular world over by different names. Most of these are tailor made techniques and are practiced with guided instruction on audiovisual aids. These techniques could be broadly classified as: (i) Relaxation meditation: these types of meditation techniques comprise the instructions to sequentially relax the all body part by part, slowing of breath and imageries. (ii) Concentration mediations: these types of meditations consists techniques to develop focused attention like gazing at fine points, listening to distant sounds, slow walking etc. (iii) Expansive meditation: these types of meditation techniques comprise the instructions to expand the awareness with infinite objects in nature like sky, ocean, mountains, flow of river, flight of birds etc. (iv) Value based meditation: in these type of meditation techniques after inducing the deep relaxation firm instructions are given to remove fear and anxiety and resolves are given to imbibe moral values like love, patience, compassion, trust and positive attitude etc.

6.0 CYCLIC MEDITATION

6.1 Definition

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 *Māndukya Upaniṣat* (Chinmayananda, 1984) and *Yoga Sutrās* of Patanjali. This technique is developed and propagated by Swami Vivekananda Yoga Anusandhana Samsthana 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.

6.2 Principles and basis of CM

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 Gaudapada's (Chinmayananda, 1984, Ch:3 V: 44) *Māndukya Upaniṣat Karika..*

लये सम्बोधयेत् चित्तं विक्षिप्तं शमयेत् पुनः।

Laye sambodhayet cittaṁ vikṣiptaṁ śamayet punaḥ.

सकषायं विजानियात् समप्राप्तं न चालयेत्।

Sakaṣāyaṁ vijñāniyāt samaprāptaṁ na cālayet.

"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"

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 (*sadhanā*) practices. The solution given by Gaudapada 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 to be 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)* phases with unbroken (*tailā 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 banḍha*) 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 *dharana* (pointed awareness) and *dhyana* (pervasive awareness) finally stabilizing in the effortless expansive meditative state. When mind settles in the state of balanced equipoise, one must understand the possibilities of mind again getting distracted and hence should not move from that state. Sage Gaudapada further says in *Māndukya Upaniṣat Karika* (Chinmayananda, 1984, Ch:3 V: 47) that..

यदा न लियते चित्तं न च विक्षिप्यते पुनः।
Yadā na liyate cittaṁ na ca vikṣipyate punaḥ.
अनिङ्गनमनाभासं निष्पन्नं ब्रह्म तत्तदा ॥४६॥
Aniṅganamanābhāsaṁ niṣpannaṁ brahma tattadā.

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 (*anābhāsaṁ)*; then it gets absorbed and becomes pure expansive Counciouness (*niṣpannaṁ brahma).*

6.3 Technique of CM

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 observing 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 practiced in such a way that it sets a slow cyclic rhythm in the body, *prana* (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 CM 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 *Patanjali Yoga Sutra* (Taimini, 1986, Ch: 2 V: 46, 47, 48).

स्थिरसुखमासनम् ॥ *Sthirasukhamāsanam.*

प्रयत्नशैथिल्यानन्तसमापत्तिभ्याम् ॥ *Prayatnaśaithilyānantasamāpattibhyām.*

ततो द्वन्द्वानभिघातः ॥ *Tato dvandvānabhighātaḥ.*

The postures are practiced slowly according to ones 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. 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 CM by *Jnāna Yoga* brings about cognitional transformation to resolve the subtle intellectual conflicts. Hence CM is considered as a holistic tool with other practices of the yoga powered by comprehensive knowledge base. The pictorial description of the postures in cyclic meditation is given in Plate RL 1.

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 *Māndukya Upaniṣad* the syllables 'A' 'U' and 'M' constitute the perimordial sound *'Om'*, which is at the base of all creations.

Depending upon the applied needs, different versions of CM have been designed. The basic version consists four standing postures (*tāḍāsana, arḍakaticakrāsana, pādahastāsana and arḍacakrāsana)* interperresd with IRT and DRT. In present study this basic version of CM was investigated. In advanced version four standing and two sitting postures (*śaśankāsana and ūṣṭrāsana*) are inertespersed with IRT, QRT and DRT.

Plate RL1: Postures in Cyclic Meditation (CM)

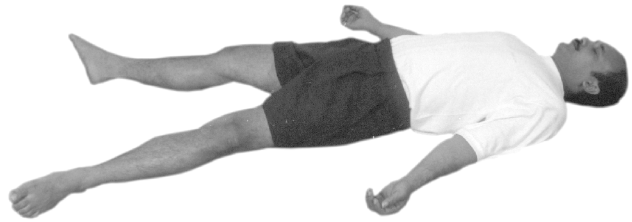
Tāḍāsana

Arḍakaticakrāsana (Right side)

Arḍakaticakrāsana (Left side)

Pādahastāsana

Arḍacakrāsana



Supine posture for IRT, QRT and DRT

7.0 CONCLUSION

Yoga is an ancient Indian Science and way of Life. It offers various techniques to reach the ultimate goal of perfection, endowed with knowledge, power and bliss. Meditation is one such technique that helps to purify, control (*nirodha*) and slowdown (*praśamana*) the mind and its modifications (*vṛttis*) by skill (*kauśala*) and regular practice (*abhyāsa*). The process of meditation begins with concentration (*ekāgratā)* and focused attention (*dhāraṇā)* on the chosen object and *dhyāna* happens only when mind becomes effortlessly and continuously one-pointed like the flow of oil poured from one vessel in to another. Sage Patanjali says "*dhyāna* is an uninterrupted, spontaneous flow of mind on its object. This itself turns into *samādhi* when the object alone shines and the thought of meditation (and of the meditator) is lost, as it were". The five characteristic features of meditation (*dhyāna)* are (i) single thought, (ii) effortlessness, (iii) awareness, (iv) slowness and (v) expansiveness (defocusing). Meditation involves three factors i.e., meditator, the object of meditation and the process of meditation (*triputi)*. The object of focus is generally sacred and can be personal or neutral, stable or dynamic, concrete or abstract, a word or an idea, an image or a symbol, a divine form or personality. Meditative styles can be usefully classified into two types - *mindfulness and concentrative*, which differ in the way attentional processes are directed. Most meditative techniques lie somewhere on a continuum between the poles of these two general methods.

Mindfulness practices involve allowing any thoughts, feelings, or sensations to arise, while maintaining a witnessing awareness without judgment or analysis. Examples include Zen, Vipassana meditation. Concentrative meditation techniques involve focusing on specific mental or sensory activity: a repeated sound, an image, or specific body sensations such as the breath. Examples include forms of Transcendental Meditation (TM) and Tantric meditation.

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 Gaudapada 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 to be 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 practiced with unbroken (*tailā 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 *dharana* (pointed awareness) and *dhyana* (pervasive awareness) finally stabilizing in the effortless expansive meditative state.

3.2 A REVIEW OF THE SCIENTIFIC LITERATURE ON MEDITATION

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

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Albert Einstein (1879 - 1955)

"Science, Philosophy and Religion: a Symposium", 1941

3.2.1 STUDIES ON MEDITATION

The scientific studies of yoga and other forms of contemplative experience have recently become a subject of interest for researchers. In 1925 early scientific studies were reported by Swami Kuvalayananda of Lonavala in a quarterly journal *Yoga Mimāmsā*. These studies helped to initiate interest in yoga research by showing that the physiological effects of yoga could be examined in the laboratory. This was followed by a number studies which reported that yogis could exert voluntary control over the cardiovascular system and reduce their metabolic rate at will. Around 1960, as Transcendental Meditation (TM) became popular, a number of scientific studies were conducted on meditation. The studies which are most relevant to the present research are mentioned below, and have also been summarized in Table T 3.2.

Dhyāna is the generic Sanskrit term for meditation, which in the Patanjali *yoga sutrās* is referred to as an uninterrupted flow of the mind towards the chosen object. It is the intermediate state between mere continuous attention to an object (*dhārana*) and complete absorption in it (*samādhi*) (Taimini, 1961). Depending upon the object and the strategy chosen, there are different techniques of meditations.

3.2.1.A Studies on Transcendental Meditation

Transcendental meditation (TM) is based on traditional yogic principles. A large number of scientific studies have been reported on TM. In 1970, R.K. Wallace reported the physiological effects of TM in 15 normal college students (Wallace, 1971). There was a pre control period; 5 minutes eyes open and 15 minutes with eyes closed. This was followed by 30 minutes of meditation, after which the subjects sat with eyes closed for 10 minutes, and then with eyes open for 5 minutes. Oxygen consumption was measured in nine subjects by either the open or closed circuit methods. The mean decrease in oxygen consumption was about 45 cm^3/minute or 20% compared to the pre-control period. There was a mean decrease in total ventilation during meditation of about 1 liter/minutes. Skin resistance increased at the onset of meditation and decreased to the resting value after meditation. The heart rate of each subject decreased during meditation, with a mean decrease of 5 beats per minute. The most notable change in EEG pattern during TM was an increase in the alpha wave amplitude and regularity, with occasional slow alpha and low voltage theta. 'Alpha blocking' to sound and light was present, and did not show habituation.

In a later study, Wallace, Benson and Wilson (1971) reported their observations on 36 subjects (28 males and 8 females). The subjects acted as their own controls. The pre-control period consisted of 10-30 minutes with eyes closed and eyes open for a similar duration. After 20-30 minutes of meditation they were asked to stop meditating and sit with their eyes closed for 10 minutes, then with their eyes open for the same time. They reported a decrease in oxygen consumption (an average decrease of 17%) from a mean of 251.2 ml/minutes before meditation to 211.4 ml/minutes during meditation and gradually increasing after meditation to 242.1 ml/minutes. Minute ventilation decreased by about 1 liter/minutes and respiratory rate decreased about 3 breaths/min during meditation, though neither were statistically significant. The mean lactate concentration decreased from a pre-control level of

11.4 mg, to 8.0 mg/100 ml. The average heart rate decreased during meditation by 3 beats per minute. Rectal temperature remained fairly constant during meditation. The skin resistance increased markedly at the onset of meditation and decreased after meditation but remained higher than before meditation. Based on the EEG findings along with those of other variables TM came to be described as ‘wakeful hypometabolic state’.

Orme-Johnson (1973) reported a study on 16 subjects, 8 of them were meditators and 8 were controls. The meditators had a mean experience of 15 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. The mean rate of spontaneous GSR fluctuations was 6.14 in 10 minutes compared to 18 - 25 in 10 minutes meditation Vs pre-control periods. The meditators had 8.7 responses in 10 minutes during rest compared to 21.0 in 10 minutes for non-meditators.

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 2 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.

Later, Wilson, Jevning and Guich (1987) studied oxygen consumption, carbon dioxide production and acid/base changes in 62 subjects during two hypo-metabolic states (35 during transcendental mediation and 27 during un-stylized rest). The results indicated that during these hypo-metabolic states, arterial-venous carbon dioxide content difference declined, and that during Transcendental Meditation, arterial-venous carbon dioxide content difference briefly disappeared. This change was thought due to both an increase in arterial carbon dioxide content and a decrease of venous carbon dioxide content. Similar, but opposite and smaller, changes occurred in arterial and venous oxygen content. The respiratory quotient was low at all times and decreased during the hypo-metabolic states. Subsequently there have been reports of other studies on TM indicating it's clinical applications and usefulness in enhancing the cognitive performance and perceptual and motor skills.

TM practice was studied using a passive auditory paradigm listening trial with variable inter-stimulus intervals (1-4 s) 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.

Recently, 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.

3.2.1.B **Studies on Zen Meditation**

In1960 Hirai found changes in the breathing during Zen meditation. The breath rate decreased to 4 - 5 breaths per minute. The same study reported an acceleration of the pulse rate during meditation to a rate between 80 and 100 beats/minute. A further study on Zen meditators, demonstrated an alpha suppression response, a sudden attenuation of alpha waves in response to a stimulus, which did not habituate to repeated click stimuli during Zen meditation whereas controls habituated after the fifth or sixth click (Kasamatsu, & Hirai,1966). This was taken to reflect a ‘hypersensitivity’ of attention during Zen meditation.

In another study on experienced Zazen meditators, a decrease in spontaneous skin conductance responses during Zazen was reported (Akishige, 1968). The same study also showed that there was a decrease in oxygen consumption and rate of respiration, associated with Zen meditation. Sugi and Akutsu (1968) observed a 20% decrease in oxygen consumption associated with meditation in 10 Zen monks with many years of experience. Goyeche, Chihara and Shimizu (1972) compared Zen meditation with relaxation in 8 subjects. There was reduction in breath and heart rate during Zen meditation. Becker and Shapiro (1981) studied 5 groups of subjects: Zen meditators, TM subjects, Yoga subjects and 2 groups of non-meditators. The subjects were given click stimuli and they all demonstrated alpha suppression and subsequently habituation, with no differences among groups.

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 Fm theta activities were provoked (6 men, 6 women, 48% of the total subjects), peripheral autonomic activities were evaluated during the appearance of Fm 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 22 healthy subjects to evaluate the effect of Zen meditation on EEG coherance and heart rate varibility (HRV) in relation to trait anxiety scores, there was an increase in slow alpha interhemispheric EEG coherance 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.

3.2.1.C Studies on Tantric Meditation

Elson, Hauri and Cunis (1977) studied Ananda Marga meditators; both amateur and experienced practitioners (average experience was 1.8 years). They found an increase in alpha and theta activity during meditation. There was a decrease in skin conductance and rate of respiration. In another study Corby and others investigated 2 groups of 10 meditators each (Corby, Roth, Zarcone, & Kopell, 1978). One group had an average experience of 4.4 years. All the subjects were very committed to the practice of meditation and practiced for a minimum of 3 hours per day. There was also a control group. Meditators showed a statistically significant increase in alpha and theta activity compared to the control group. This study also reported changes in autonomic variables. There was an increase in skin conductance (i.e., lowered skin resistance) and absence of a deceleratory heart rate orienting response. Heart rate and respiratory rate changes were not significant within the group. During meditation there was a trend for heart rate to decrease relative to the control group. One of the subjects had a near *samādhi* experience, and they recorded an increase in heart rate, respiratory rate and a marked decrease in skin resistance.

3.2.1.D Studies on *'OM'* Meditation

In an early study on evoked potentials during *Om* meditation Telles and Desiraju (1993) used, for the first time two important modifications in the research design for yoga research. The 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. Auditory middle latency evoked potentials were recorded during the practice of meditation. This study highlighted two points, (i) meditation is best described as a physiological state of 'alertful rest', and (ii) considerable physiological variations were seen both intra- and inter-individually. Similar results were seen when autonomic and respiratory variables were studied in *Om* meditators (Telles, Nagarathna, & Nagendra, 1995). When repetition of *'Om'* was compared with the repetition of 'One', there was a difference in the autonomic and respiratory responses (Telles, Nagarathna, & Nagendra, 1998). Both types of sessions resulted in a decrease in the heart and breath rates, but repetition of *Om* alone reduced the skin resistance, suggesting a subtle change in the mental state, related to the significance of the syllable. These results were reinforced by a study of similar design, in which the variable recorded was the auditory middle latency evoked response during both *'Om'* and 'One' sessions (Telles, Nagarathna, Nagendra, & Desiraju, 1994). Based on changes in the evoked potentials it was described that repetition of *'Om'* resulted in significant changes in sensory relay at a neural center (i.e., the thalamus), with more neurons being (i.e., higher amplitude) recruited and information processing was facilitated (i.e., latency that was reduced). In persons who had over 5 years of meditation experience the changes in auditory middle latency evoked potentials, suggested that changes occurred at more complex brain areas corresponding to auditory association cortices (Telles, & Desiraju, 1993). Another recent report has described differences between the physiological states in sleep and in meditation (Naveen, & Telles, 2003).

3.2.1.E Studies on Brahmakumaris Raja yoga Meditation

Eighteen male 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. The heart rate during the meditation period was increased compared to 'baseline' as well as compared to during the non-meditation period of control sessions. In contrast there was no significant change during meditation, for the group as a whole, in GSR, respiratory rate and finger plethysmogram amplitude. The individual level analysis revealed that changes in autonomic variables suggestive of both activation and relaxation occurred simultaneously in different subdivisions of the autonomic nervous system in a meditator. Apart from this, there were differences in patterns of change among the persons who practiced the same meditation (Telles, & Desiraju, 1993a).

In an another study conducted on eleven experienced practitioners of Brahmakumaris Raja Yoga meditation, meditators while participating in a functional magnetic resonance imaging (fMRI) study, were able to reach a deep meditative state (suggested by pulse rate and breath rate changes), while in the 'loud' scanner environment (Khushu, Telles, Kumaran, Naveen, & Tripathi, 2000). All subjects reported vivid visual images related to the content of the meditation after the session. One subject showed significant activation in the primary visual cortex. Recently, it has been shown that Brahmakumaris Raja Yoga meditation produces changes at the level of the mesencephalon – diencephalon (i.e., possibly thalamic level) (Telles, & Naveen, 2004).

3.2.1.F Studies on Tai Chi Chuan Meditation

Tai Chi Chuan (TCC) is a traditional Oriental 'moving' mediation technique based on Taoist philosophical principles of Yin and Yang (the opposite forces) and breathing techniques. 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. Since ancient times 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). According to Qu there are two major reasons for these experiences (Yan, 1995). First, participants have to be very focused and concentrated when practicing, and by doing so they exclude other distractions and stressors and experience an inner peacefulness. Second, the nature of the art, with smooth, slow and rhythmic movements, facilitates muscular relaxation and flexibility.

Jin (1989) assessed psychological and physiological changes following Tai Chi practice in 33 beginners and 33 practitioners. Using a three-way factorial design, the subjects were divided into groups on the basis of experience, time of practice, and phase (before, during, or after Tai Chi intervention). Participants filled out the Profile of Mood States (POMS) and Trait Anxiety Inventory form before and after testing, and their heart rate, noradrenaline excretions, and cortisol concentrations were measured pre-testing and post-testing. Compared to baseline, practice of Tai Chi raised heart rate, increased noradrenaline-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% of VO_2 max, (indicating a low workload). Subjects reported less tension, depression, anger, fatigue, confusion and state-anxiety, they felt more vigorous, and in general they had less total mood disturbance after Tai Chi practice. Mood improved significantly during Tai Chi, and remained positive one 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 (VO_2) equivalent to the mean TCC - VO_2. Six experienced (group mean 8.3 years) male TCC practitioners served as subjects and the data were collected during the 'Cloud H and movement of the TCC' exercise. Lower responses for ventilatory frequency (Vf) (11.3 and 15.7 breaths/minute), ventilatory equivalent

(V_E/VO_2) (23.47 and 27.41), and the ratio of dead space ventilation to tidal volume (V_D/V_T) (20 and 270c) were found in TCC in comparison to cycle ergometry. The percentage of minute ventilation used for alveolar ventilation was significantly higher during TCC than cycle ergometry, with mean values of 81 and 73 liters respectively. 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.

Similarly, 15 men aged between 26 to 56 (group mean $\pm$ SD, 39.9 $\pm$ 9.5) years were studied 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 $\pm$ 2.4 years). Blood lactate was measured before and immediately after TCC practice. Additionally, breath-by-breath measurement of cardiorespiratory 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 were compared to determine the exercise intensity of TCC. While performing TCC, the mean HR of subjects was 140 $\pm$10 beats per minute, and the mean oxygen consumption was 21.4 $\pm$ 1.5 ml/kg/min. Compared with the data of the exercise test, the HR during TCC practice was 58% of the heart rate range. The oxygen consumption during TCC practice was 55% 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.

In another study Jin (1991) examined Tai Chi, as a moving meditation, for its efficacy in post stressor recovery in 48 adult male and 48 adult female Tai Chi practitioners, who were randomly assigned to 4 treatment groups: Tai Chi, brisk walking, meditation, and neutral reading. A "blind" experimenter who 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 and 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 noradrenaline, 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 16 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 (C), moderate intensity walking group (MW), low intensity walking group (LW), low intensity walking plus relaxation response group (LWR), or mindful exercise (ME) group - a Tai Chi type program. Women in the ME group experienced reductions in mood disturbance (tension, depression, anger, confusion, and total mood disturbance) and an improvement in general mood. Women in the MW group noted greater satisfaction with physical attributes (body cathexis), and men in MW reported increased positive affect. 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.

Recently it was reported that a three month intervention of Tai Chi given to college students brought about a significant improvement in general health, vitality, bodily pain, perception of mental health and emotional stability (Wang, Taylor, Pearl, & Chang, 2004).

3.2.2 STUDIES ON YOGIC RELAXATION TECHNIQUES

3.2.2.A Studies on Śavāsana

Lying flat on the ground with the face upwards, in the manner of a corpse, is *śavāsana.* It reduces fatigue and enables the mind and body to relax (Mukatibodhananda, 2001). *Śavāsana* is the corpse pose. *Shava* means 'corpse'. It is also known as the pose of relaxation and it is essentially practiced in between other *asanas* or after a hectic day.

A randomized controlled trial was conducted on twenty five patients of essential hypertension using *śavāsana* therapy (Sundar, Agrawal, Singh, Bhattacharya, Udupa, & Vaish, 1984). *Śavāsana* therapy was continued for six months. There was significant reduction in both mean systolic and diastolic blood pressure and antihypertensive drugs score in yoga groups. In 65 % of patients of yoga, blood pressure was controlled with *śavāsana* alone without any drug. In another study the efficacy of meditation and śavāsana in promoting self-actualization and changes in self-reported stress was studied among 62 college students (Janowiak, & Hackman, 1994). Two groups were given *mantra* meditation and a yogic relaxation technique referred to as *śavāsana*. Pre and post test measures were taken on the Personal Orientation Inventory and the Behavioral Relaxation Scale. Both groups showed significant increases in scores on self-actualization; however, no differences were found between groups. Meditation training was associated with larger gains in scores on measures of systematic relaxed behavior than of the relaxation training.

In another study śavāsana was found effective in coping with stress manifestations (Bera, Gore, & Oak, 1998). The recovery from induced physiological stress in *śavāsana* and two other postures (resting in chair and resting supine) was compared. 31 males and 6 females (age 21-30 yrs) were allowed to rest in one of the above postures immediately after completing the scheduled treadmill running. The recovery was assessed in terms of heart rate (HR) and blood pressure (BP). HR and BP were measured before and every two minutes after the treadmill running till they returned to the initial level. These results revealed that the effect of stress was reversed in a significantly shorter time in *śavāsana*, compared to resting in a chair and a supine posture.

The yoga based relaxation technique has also shown to reduce physiological signs of arousal (Vempati, & Telles, 2002). 35 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 15 subjects, before, during, and after the practices, whereas oxygen consumption and breath volume were recorded for 25 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.

In 10 normal adults RR interval variation (RRIV), deep breathing difference (DBD), and heart rate, blood pressure and rate-pressure-product (RPP) response to a cold pressor test (CPT) were measured before and immediately after śavāsana (Madanmohan, Udupa, Bhavanani, Krishnamurthy, & Pal, 2002). *Śavāsana* produced a significant increase in DBD and an appreciable but statistically insignificant increase in RRIV suggesting an enhanced parasympathetic activity. Significant blunting of cold pressor-induced increase in heart rate, blood pressure and RPP by *śavāsana* was seen during and even five minutes after CPT suggesting that ś*avāsana* reduces the load on the heart by blunting the sympathetic response. It was concluded that *śavāsana* can enhance the ability to withstand stress induced by CPT and this ability can be achieved even with seven days of *śavāsana* training.

Recently 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 medical students (n = 50) during routine activities and prior to their examination. 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. A significant reduction in number of failures in yoga group as compared to the control group was also observed. The feedback scores indicated improvement in various variables such as better sense of well being, feeling of relaxation, improved concentration, self confidence, improved efficiency, good interpersonal relationship, increased attentiveness, lowered irritability levels, and an optimistic outlook in life.

3.2.2.B Studies on yoga based isometric relaxation

A study was conducted on yoga based isometric relaxation technique. Forty male volunteers with ages ranging from 16 to 46 years were studied in two sessions; yoga based isometric relaxation technique (IRT) and supine rest (SR) (Telles, & Vempati, 1999). Assessments of autonomic variables were made in 15 subjects, before and after the practices, whereas oxygen consumption, breath rate, breath-volume were recorded in 25 subjects, before and after IRT and SR. A significant decrease in breath rate after IRT and finger plethyasmogram was recorded after SR. This indicated that yoga based IRT is useful in reducing the physiological signs of anxiety and stress and not every person is able to relax in supine rest.

3.2.2.C Studies on *Śānti kriyā*

Śānti kriyā is a mixture of combined yogic practices of breathing and relaxation (Satyanarayana, Rajeswari, Rani, Krishna, & Rao, 1992). Eight healthy male volunteers (age group 25.9 $\pm$ 3 years) were subjected to *śānti kriyā* practice daily for 50 minutes for 30 days. The body weight, blood pressure, oral temperature, pulse rate, respiration, ECG and EEG were recorded before and after the practice on the 1st day and subsequently on 10th, 20th and 30th day of their practice. They were also given a perceptual acuity test to know their cognitive level on the 1st day and also at the end of the study (day 30). Results indicated a gradual and significant decrease in the body weight from day 1 to day 30 and an increase in alpha activity of the brain during the course of 30 days. Also there was increased oral temperature by 3^0F and decreased respiratory on all practice days. Increase of alpha activity both in occipital and pre-frontal areas of both the hemispheres of the brain denoted an increase of calmness.

3.2.2.D Studies on *Yoganidra*

Global cerebral blood flow (CBF) distribution (with the 150 – H2O PET technique) and spectral EEG analysis was done in nine young adults, who were highly experienced yoga teachers, during the yoganidra relaxation meditation, and during the resting state. 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. 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 thought to support an executive attentional network (Lou, Kjaer, Friberg, Wildschiodtz, Holm, & Nowak, 1999).

Another study on *yoganidra* 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 yoga-nidra meditation. Participants underwent two 11C- raclopride PET scans: one while attending to speech with eyes closed, and one during active meditation. During yoga-nidra meditation 11C- raclopride binding in ventral stream decreased by 7.9%. This corresponded to a 65 % 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.

3.2.2.E Studies on yoga stretching and relaxation

In a study the effects of three different procedures, relaxation, visualization and yogic stretch and yogic breathing (*prāṇāyāma)* on perceptions of physical and mental energy and on positive and negative mood states was assessed in a group of normal volunteers (n=71, age range 21-76) (Wood, 1993). Yogic stretch and yogic breathing produced a significantly greater increase in perceptions of mental and physical energy and feelings of alertness and enthusiasm than the other two procedures. Relaxation made subjects more sleepy and sluggish immediately after the session than yogic stretch and yogic breathing. Visualization made them more sluggish but less content than yogic breathing and more upset than relaxation after the second session. Thus, a 30 minutes program of yogic stretch and breathing exercises which is simple to learn and which can be practiced even by the elderly had a markedly 'invigorating' effect on perceptions of both mental and physical energy and increased high positive mood.

Another study investigated the psychological and physical effects of training of body awareness and slow stretching on persons with chronic toxic encephalopathy (CTE) (Engel, & Andersen, 2000). The body-mind training consisted a guided relaxation technique combined with meditative stretching. Eight subjects with CTE, 48.5 years, were trained for 8 weeks. Outcome measures were percentage alpha brain waves (alpha %), electromyography (EMG) on the frontalis muscle, state-trait anxiety (STAI), creativity (RAT), and mood measured as anxiousness, humour and mental fatigue. The mean alpha increased 52% during the training period and the EMG decreased 31%. State anxiety decreased 22% during the training period, but no changes were observed in trait anxiety and in the creativity score. The level of anxiousness and fatigue before a training session decreased during the training period. The results suggested an improved ability for physical and mental relaxation as indicated from the lower EMG, the higher alpha percentage and the decrease in state anxiety following the meditative stretching.

3.2.3 STUDIES ON GENERAL RELAXATION TECHNIQUES

3.2.3.A Studies on progressive muscle relaxation

Thirty six volunteer subjects 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 5 week period, they were tested for psychophysiological 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). Later on 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. 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 waiting 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. The meditation groups had a 78% compliance rate at 5.5 months with treatment effect seen whether subjects practiced their techniques frequently or occasionally. The safe and inexpensive semi-automated meditation training has considerable value for stress-management programs in organizational settings.

Oxygen consumption, tidal volume, respiratory rate, heart rate, systolic and diastolic blood pressure were measured before the subjects (n=39) learned Transcendental Meditation (TM: n = 21) or Jacobson's Progressive Relaxation (PR: 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, RR, diastolic blood pressure and HR) during TM or PR. However the TM group displayed more significant decreases during meditation and during activity than did the PR group. The more significant and comprehensive results for mediators were explained primarily in terms of the greater amount of time the TM group spent on their technique, plus the differences in the two techniques themselves (Throll, 1982).

3.2.3.B Studies on relaxation training

A study was conducted on attentional capacity in 25 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 neuroanatomy of how cognitive states are integrated with bodily responses.

The effect of supine floating (SF) relaxation on heart rate, blood pressure and cardiac autonomic nervous activity in ten male subjects (n=10, mean age: 22.4 yrs) was studied (Nishimura, & Onodera, 2000). Cardiac autonomic nerve activity was estimated with the power spectrum analysis of heart rate variability (HRV) by using the Fast Fourier Transformation (FFT). HF during SF condition was significantly increased; LF/HF, heart rate and blood pressure were significantly decreased. These data indicated that cardiac vagal activity is enhanced and sympathetic nervous activity is suppressed by reciprocal response.

3.2.4 STUDIES ON CYCLIC MEDITATION

Cyclic meditation has the unique feature of combining simple yogic postures (stretching) practiced with very slow, mindful body movements, rhythmic breathing, expansive awareness and chanting and relaxation in supine position.

A study was conducted to compare the effect of cyclic meditation (a calming and stimulating technique) on oxygen consumption with that of *śavāsana* (a calming technique) (Telles, Reddy, & Nagendra, 2000). The oxygen consumption, breath rate, and breath volume of 40 male volunteers (group mean $\pm$ SD, 27.0 $\pm$ 5.7 years) were assessed before and after sessions of cyclic meditation (CM) and before and after sessions of *śavāsana* (SH). These assessments were done while breathing oxygen through a closed circuit Benedict-Roth apparatus. The two sessions (CM, SH) were one day apart. Cyclic meditation included the practice of yoga postures interspersed with periods of supine relaxation. During SH the subject remained in supine position throughout the practice. There was a significant decrease in the amount of oxygen consumed and in breath rate and an increase in breath volume after both types of sessions. However, the magnitude of change on all three measures was greater after CM: (i) Oxygen consumption decreased 32.1% after CM compared with 10.1% after SH; (ii) breath rate decreased 3.6 cpm after CM and 1.9 cpm after SH; and (iii) breath volume increased 28.8% after CM and 15.9% after SH. These results supported the idea that a combination of yoga postures interspersed with relaxation reduces arousal more than relaxation alone. The increase in depth of respiration with reduction in breath frequency, suggested physiological relaxation.

The above studies have described the psycho-physiological changes during different meditation and relaxation techniques, including cyclic meditation. However there have not been reports of simultaneous recording of (i) indices of psycho-physiological arousal and (ii) those of attention. This was attempted to be done in the present study in which the meditation technique selected was cyclic meditation which has already been shown to reduce psycho-physiological arousal.

Abbreviations used in Table T 3.2

AEP	:	Auditory Evoked Potentials
BMR	:	Basal Metabolic Rate
BOC	:	Basal Oxygen Consumption
BP	:	Blood Pressure
CNV	:	Contingent Negative Variation
d	:	day
EC	:	Eyes Closed
EO	:	Eyes Open
Exp	:	Expiration
Expt	:	Experiment
EKG, ECG	:	Electrocardiogram
EEG	:	Electroencephalogram
EMG	:	Electro-myogram
EOG	:	Electro-oculogram
Gp	:	Group
Gps	:	Groups
GSR	:	Galvanic Skin Resistance
HR	:	Heart Rate
HRV	:	Heart Rate Variability
HF	:	High frequency
5-HIAA	:	5- Hydroxy Indole Acetic Acid
Insp	:	Inspiration
Ld	:	Lead (as in standard leads of ECG)
LF	:	Low frequency
m	:	months
Medtn	:	Meditation
Min	:	Minute
MMN	:	Mismatch Negativity (auditory)
n	:	number of subjects/patients
OC	:	Oxygen Consumption
PaCO2	:	Partial pressure of Carbon dioxide in arterial blood
PaO2	:	Partial pressure of oxygen in arterial blood
RR	:	Respiratory Rate
RT	:	Reaction time
S	:	Subjects
ss	:	subjects
SC	:	Skin conductance
sec	:	second
Temp	:	Temperature
VE	:	Pulmonary Ventilation
Vs	:	Versus
Symbols used	:	↑ Increase, ↓ Decrease, < Less than, > Greater than, → followed by, * Original article not referred to, information obtained from citation in other articles. ^ Original article not referred to, abstract consulted.

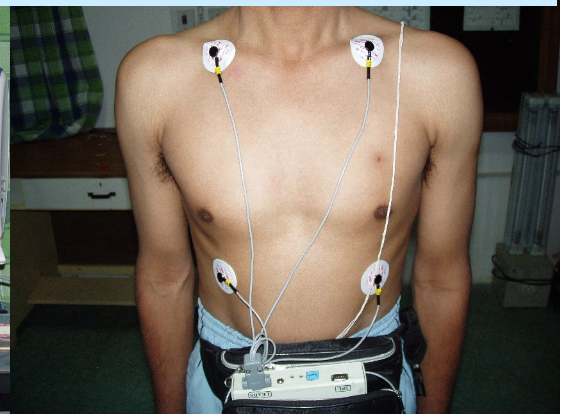
Plate 4.2.1: Oxycon Pro System Jaeger, Germany

Oxycon Pro system with cylinder

Triple 'V' sensor with breathing mask

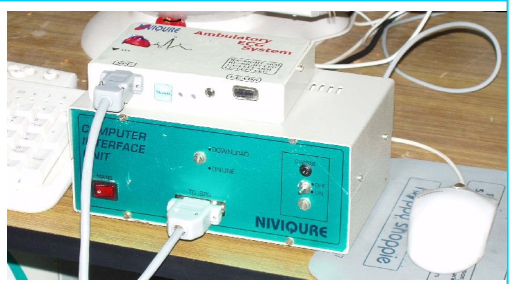
Subject in air conditioned room wearing breathing mask connected to O_2 analyzer through twin tube

Plate 4.2.2: Ambulatory ECG System for HRV, Niviqure, India



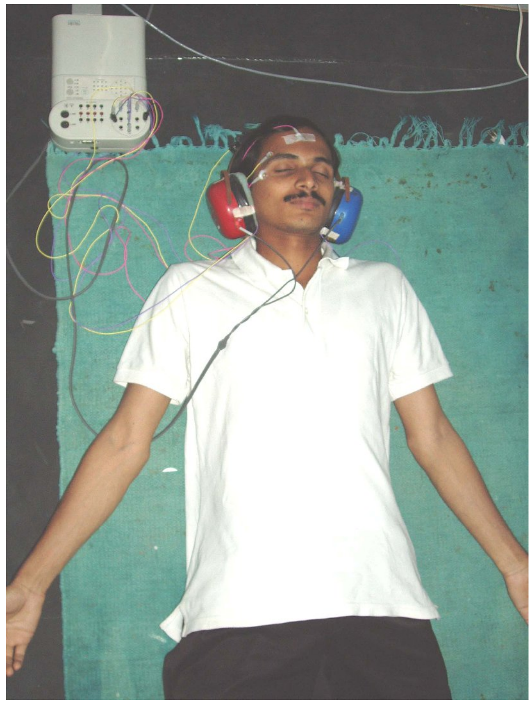
Pentium computer with ambulatory system **ECG electrode positions**

Signal processing unit and interface unit →



Subject in a recording room with ambulatory ECG unit connected to adhesive electrodes

Plate 4.2.3: Bravo EP System (Nicolet, USA)



The Bravo EP - 4 channels amplifier and Closed circuit TV

Subject in supine position with electrode connections and earphone

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The recording cabin with acoustically shielded earphone (Amplivox, UK) used to deliver the 'frequent' and 'rare' stimuli, and a head-box for electrode connections with LED electrode impedance panel.

2.1 AIMS OF THE STUDY

The present study was intended to obtain a greater understanding of the technique, cyclic meditation, measuring indicators of psycho-physiological arousal and those of levels of attention. Hence changes in following variables were compared following (or during) cyclic meditation as compared to a comparable period of supine rest; (i) oxygen consumption and related variables while breathing atmospheric air through an open circuit apparatus, (ii) the autonomic balance assessed through heart rate variability (HRV), (iii) P300 (auditory oddball paradigm) recorded at Fz, Cz and Pz, and (iv) performance in a letter cancellation task.

2.1 RELEVANCE OF THE STUDY

In several previous studies meditation practice has been shown to reduce physiological arousal (in terms of metabolism and sympathetic activity). 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 reduced. Indeed, this is often looked upon as a possible drawback of practicing meditation. That is, that one may become hypo-aroused but also less alert. Hence the present study was planned to measure variables indicative of the level of psycho-physiological arousal (i.e., oxygen consumption and HRV) as well those of attention (i.e., the P300 and performance in a cancellation task). This was considered important to get a comprehensive model of the technique, in this case cyclic meditation.

In this thesis the changes in (i) respiratory and metabolic variables (e.g., V_{O2}, V_{CO2}, RR, end tidal gases) (ii) heat rate variability (HRV) (iii) P300 (based on the auditory oddball paradigm), and (iv) a paper and pencil letter cancellation test were evaluated in normal volunteers related to two yoga relaxation techniques viz. cyclic meditation and supine rest.

4.1 SUBJECTS

4.1.1 Sample size: A sample of 53 subjects was studied. The actual sample size required was 40, which was based on the effect-size obtained in previous study of changes in cyclic meditation (Telles, Reddy, & Nagendra, 2000). It was calculated using G-power software, University of Duesseldorf, Germany; http://www.psycho.uni-duesseldorf.de /aap/projects/gpower where the α power was set at 0.05.

4.1.2 Inclusion criteria: (i) The subjects were healthy volunteers with age range from 18 to 48 years (group mean age $\pm$ S.D., 27.1 $\pm$ 6.3) (ii) Male subjects alone were studied as oxygen consumption, autonomic variables and auditory evoked responses have been shown to vary with the phases of the menstrual cycles in females (Das, & Jana, 1999; Yildirir, Kabakci, Akgul, Tokgozoglu, & Oto, 2002; Yadav, Tandon, & Vaney, 2002). (iii) All subjects had experience of practice of both yoga relaxation techniques ranging from 3 to 60 months (group mean experience $\pm$ S.D., 15.3 $\pm$ 13.3 months). They were regular in practice. Also the study was conducted following two months of supervised practice of cyclic meditation and supine rest for about 30 minutes on alternate days as a 'refresher course'. The details of each subject have been given in the Table 4.1.2 (see Appendix - 4).

4.1.3 Exclusion Criteria: The following criteria were used to exclude the volunteers. (i) The presence of cognitive and/or neurological and/or metabolic disorders based on a medical history and routine clinical examination (ii) in take of medication, which is known to influence cognitive, autonomic and metabolic functions (iii) smoking or alcoholism which may have influenced the respiratory and metabolic variables and (iv) any hearing deficit.

4.1.4 Source: The subjects were residential students at Swami Vivekananda Yoga Anusandhana Samsthana, Deemed University, Prashanti Kutiram, Bangalore. They had all enrolled for graduate and post graduate study programs.

4.1.5 Ethical considerations: The subjects were told about the aims and methods of the study and the informed consent was signed by all subjects (a sample copy is enclosed in Appendix-1). An approval was obtained from the Institutional Ethical Committee as all tests are essentially noninvasive in nature.

4.2 ASSESSMENTS

4.2.1 Respiratory and metabolic variables

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 present thesis the term ‘variable’ has been used to describe the assessments studied.

4.2.1.A Selection of respiratory and metabolic variables:

Respiratory and metabolic variables were measured in order to assess changes throughout the practice of cyclic meditation and supine rest by using a computerized open circuit system (Oxycon Pro, Model 2001, No. SN 808323, Jaeger, Germany) (Plate 4.2.1).

4.2.1.B Principle and specifications of Oxycon Pro system:

The measurement principle underlying the Oxycon Pro System: Dynamic "breath by breath" measurement is done using an open circuit system. The volume is measured via the bidirectional digital volume sensor "Triple V" which works on the paramagnetic principle. The gas exchange measurement is done via the extremely fast O_2 and CO_2 analyzers at the speed of 10ms with breathing level up to 80 breaths per minute (Jaerger Toennies Medizintechnik Mit System, 2001).

The Oxycon Pro system has following technical specifications:

(1) Measurement	Range	
(i) Ventilation (V_E)	0 to 300 liters/min	
(ii) O2 uptake (V_{O2})	0 to 7 liters/min	
(iii) CO_2 output (V_{CO2})	0.6 to 2.0	
(2) Volume sensor		
(i) Volume	0 to10 liters	
(ii) Resolution	0.3 liters	
(iii) Flow	0 to 15 liters/s	
(iv) Resistance	<0.1 kPa at 15 liters/s	
(3) O_2 analyzer (high – speed analyzer based on the differential – paramagnetic principle)		
	Range 1	Range 2
(i) Range	0 to25%	0 to 60%
(ii) Resolution	0.01%	0.02%
(iii) Stability	0.02%/h	
(iv) Min. rise time	$T_{10\text{-}90}$, 40 ms	
(4) CO_2 analyzer (high – speed analyzer based on the infrared absorption principle)		
(i) Range	0 to15%	

(ii) Resolution	0.01%
(iii) Stability	0.02%/h
(iv) Min. rise time	$T_{10\text{-}90}$, 40 ms

Plate 4.2.1: Oxycon Pro System Jaeger, Germany

Oxycon Pro system with cylinder

Triple 'V' sensor with breathing mask

Subject in air conditioned room wearing breathing mask connected to O_2 analyzer through twin tube

***4.2.1.C Familiarization of the subject with the laboratory environment and with the study*:**

As the recordings were made under basal conditions (i.e., at as complete mental and physical rest as possible and 10 -12 hours after last meal) all subjects were asked to consume fixed quantity of food i.e., 1069.1 Kcal (calculated using Annapurna 2003, Version 1.0 software, Annapurna Associates, Bangalore) on the night previous to recordings (Ganong,1987). They were requested to sleep in the laboratory for 3 consecutive nights, where the first day was to make them acclimatized to the laboratory environment. The next two days were meant for actual recordings. The subjective experience of the quality of sleep was noted by a visual analogue scale. In the morning, recordings were made between 5 a.m. to 7 a.m. Each subject was instructed to restrict activity to using the rest room. This was necessary to minimize physical activity and avoid arousal. Following this, the recordings were carried out.

4.2.1.D Recording conditions:

The subjects were studied in an air conditioned, sound attenuated room with dim lighting. The temperature of the recording room was maintained between 20 - 25^0 Celsius, the humidity was between 65 to 75 min/max and the barometric pressure was between 650 to 685 mmHg.

4.2.1.E Calibration of the equipment:

Every day prior to assessment, the following calibrations were performed.

(i) Ambient conditions: As ambient data are the basis for determination of important correction factors for calculating recorded values, the ambient data were checked at regular intervals. The barometric pressure, temperature and humidity were automatically recorded by the sensors built in the system.

(ii) Volume calibration: The measuring system consisting of the Triple V volume sensor was calibrated every day. A clear Triple V (digital volume sensor) is very important for an accurate flow and volume measurement.

(iii) Gas calibration: The gas analyzers (O_2/CO_2) integrated in the system were calibrated once a day, after a warming-up time of 30 minutes. The O_2 / CO_2 calibration was carried out using the certified gases (BOC, UK) from the calibration gas cylinder (containing mixture 5.2% of CO_2 and Nitrogen) connected to the system. The calibration program runs automatically and is divided into three phases (a) flushing the tube system (b) determination of delay time and (c) gain settings. At the end of calibration the calculated parameters were saved.

4.2.1.F Recording procedure:

The steps followed for recordings were

(i) Subject data: Before taking measurements, details such as the age, gender, height and weight were entered in the system. The height was measured by a standard scale in centimeters and the weight was measured with clothing using a digital weighing machine (Essae – Digi, Model No. DI-20, Essae-Teraoka Pvt. Ltd., Bangaolre, India). (ii) The breathing mask, designed to form an airtight cover over the subject's nose and mouth was fixed by straps (mask for adults with dead space of 70 ml) and care was taken that the air did not leak out from the sides of the mask. (iii) The Triple V sensor (Plate 4.2.1) was connected to the breathing mask at one end and at the other end to the integrated gas analyzer system in the compact housing through the twin tubes. (iv) Specific workload protocol was loaded according to the design of the recording session and selected to run during the experiment**.** The recorded data was stored in the hard disc of the PC (Pentium III).

4.2.1.G Variables measured:

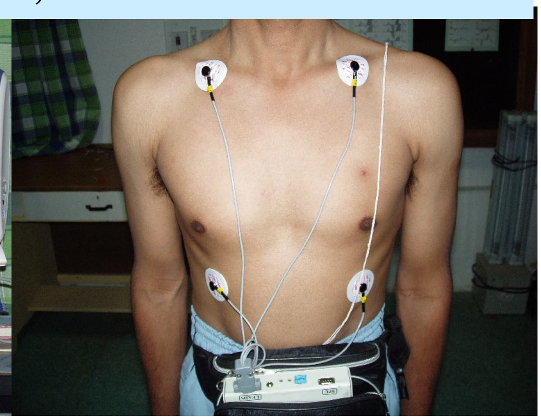
The following variables were measured: (i) V_E: Minute or total ventilation is the amount of air moved in or out of the lungs per minute. Conventionally, minute ventilation is always measured on an expired sample and symbolized $V_{E.}$ The minute ventilation includes alveolar and dead space ventilation ($V_E = V_A + V_D$), and is recorded in liters per minute (l/min) corrected to BTPS (Body Temperature and Pressure Saturated with water vapor). Normally, in healthy adults V_E ranges from 5 to 10 l/min. (ii) V_T: The volume of air inspired or expired during each respiratory cycle is tidal volume. It is usually measured in liters or milliliters, BTPS. Generally, the volume expired is expressed as V_T. Average V_T for healthy adults ranges between 400 and 700 ml. (iii) RR: The respiratory rate is the number of breaths per unit of time, usually per minute. The normal respiratory rate ranges from 10 to 20 breaths per minute (c/min). (iv) V_{O2}: Oxygen consumption is the volume of oxygen taken up by body tissues while resting (or exercising) in liters, or milliliters per minute (ml/min), converted into STPD [Standard Temperature (0^o C), standard Pressure (760 mm Hg) and Dry (no water vapor)]. V_{O2} is also commonly reported in milliliters per kilogram of body weight (ml/kg). In healthy adults at rest the V_{O2} is approximately 250 ml/min (STPD), or approximately 3.5 ml O_2/min/kg. (v) V_{CO2}: Carbon dioxide output is the volume of carbon dioxide produced by body tissues in liters, or milliliters per minute (ml/min), STPD. In healthy adults at rest the V_{CO2} is approximately 200 ml/min (STPD). (vi) PA_{CO2} is the partial pressure of carbon dioxide in alveoli. It is measured in both kilopascal (kPa) and mm Hg (1 mm Hg = 1 kPa/0.1333). Normally it ranges between 4.65 and 5.30 kPa (i.e., 35 to 40 mm Hg). Clinically, PA_{CO2} is considered approximately same as Pa_{CO2} (Partial pressure of carbon dioxide in arterial blood). (vii) PET_{CO2} is partial pressure of end tidal carbon dioxide. End tidal carbon dioxide is the carbon dioxide present in the airways at the end of expiration. It is measured in both kilopascal (kPa) and mm Hg. (viii) PET_{O2} is partial pressure of end tidal oxygen. It is also measured in both kilopascal (kPa) and mm Hg. (ix) EE: Energy expenditure is derived from oxygen consumption and is measured in kilocalories (kcal/day). The calorie (cal) is defined as the amount of heat energy necessary to raise the temperature of 1 gram of water by one degree centigrade.

4.2.2 Heart rate variability (HRV)

Heart rate variability (HRV) describes the variations between consecutive heartbeats. The regulation mechanisms of HRV originate from the sympathetic and parasympathetic nervous systems in addition to other controls and hence, HRV is used as a quantitative marker of the autonomic control over the heart (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, Heart Rate Variability: standards of measurement, physiological interpretation, and clinical use, 1996). The electrocardiogram (ECG) for HRV spectrum was acquired using an ambulatory ECG system (Niviqure, Bangalore, India) (Plate 4.2.2).

Plate 4.2.2: Ambulatory ECG System for HRV, Niviqure, India

Pentium computer with ambulatory system



ECG electrode positions

Signal processing unit and interface unit →

Subject in a recording room with ambulatory ECG unit connected to adhesive electrodes

4.2.2.A Recording conditions:

The subjects were studied in an air conditioned, sound attenuated room with dim lighting and the temperature ranging from 20 to 25 ^{0} Celsius.

4.2.2.B Specifications of Niviqure system:

Niviqure ambulatory system is a computerized ECG recording system that allows to acquire, analyze and store ECG data over long hours. The data is acquired and stored in flash memory for later downloading and analysis. The data transfer from the memory module (main unit) to the computer is through an interface RS232C-compatible module. The ECG viewing on the computer monitor screen includes multi-lead ECG viewing, beat-to-beat analysis and detection of heart rate. The biological signal is isolated from AC mains and ground. The system consist (i) computer interface unit, (ii) signal processing unit with bio-amplifier and (iii) bio-amplifier circuit with gain, low-pass and high-pass filters adjusted for ECG signal acquisition. Gain is set at 1 mV/ division (Y-axis) as 'default' for ECG signal processing with frequency band: 0.5 to 100 Hz (Niviqure Meditech Pvt. Ltd., 2003). Data can be translated into BIN, ASCII formats. This permits to analyze the data using any standard software.

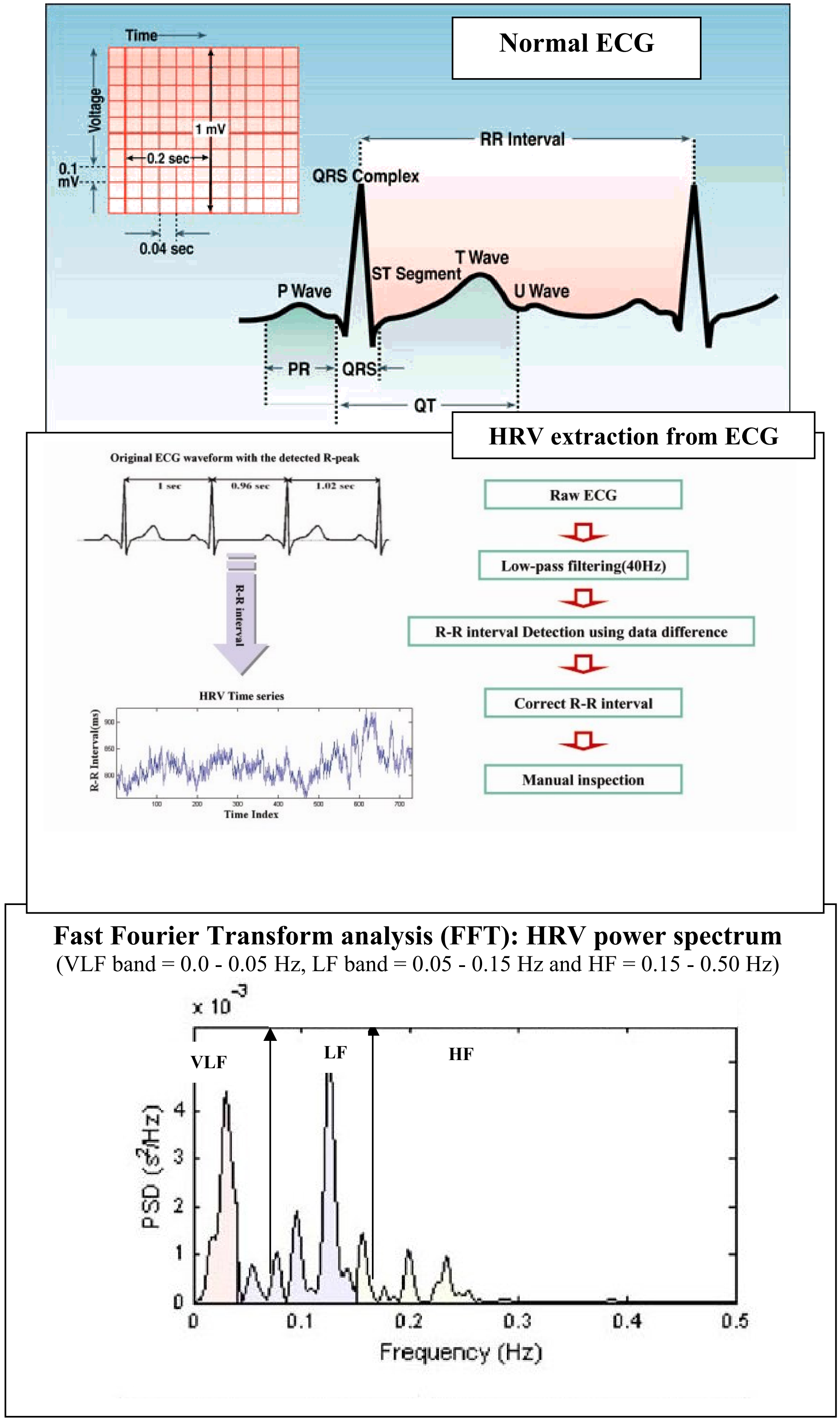
4.2.2.C Testing procedure:

The ECG was recorded throughout the practice of cyclic meditation and supine rest using Ag/AgCl solid adhesive pre-gelled electrodes (Bio Protech Inc. Korea) affixed on either side of clavicular prominence and on the lower ribs to simulate limb lead I and II configuration. These electrode positions were selected as it was found that (i) placing the electrodes in the standard limb lead position led to artifacts and (ii) the recordings made with electrodes in these positions were free from movement artifact. The ECG was acquired using an ambulatory ECG system (Niviqure, Bangalore, India) (Plate 4.2.2) at the sampling rate of 1024 Hz and was stored on the hard disc of a PC (Pentium IV) for analysis. The R waves were detected to obtain a point event series of successive R-R intervals, from which the beat to beat heart series were computed (Fig. 4.2.2). The data recorded was visually inspected off-line and noise free data were included for the analysis.

4.2.2.D Variables measured:

The following variables were measured (i) LF: Low frequency power of HRV spectrum is known to correspond to sympathetic modulation when expressed in normalized units. Low frequency band ranges between 0.05 - 0.15 Hz. (ii) HF: High frequency power (normalized units) of HRV spectrum ranges between 0.15 – 0.4 Hz. The efferent vegal activity is a major contributor to the HF component. (iii) Ratio of low and high frequency powers (LF/HF ratio) is correlated with the sympathovagal balance. (iv) HR: Heart rate is number of beats of per minute (b/min). Normally, heart rate ranges between 70 and 80 b/min.

Fig. 4.2.2: Heart rate variability spectrum (HRV)



4.2.3 Computer averaged P300 auditory evoked potentials

The P300 event related brain potentials (ERP) reflect fundamental cognitive events requiring attentional and immediate memory processes. The P300 component is often elicited with a simple discrimination task known as the ‘oddball’ paradigm, since two stimuli are presented in a random series such that one of them occurs relatively infrequently i.e. the odd ball (Polich, 1999). The P300 generation occurs from the interaction between frontal lobe and hippocampal and temporoparietal functions (Halgren, Marinkovic, & Chauvel, 1998). The P300 event related potentials were recorded using Nicolet Bravo System (USA) (Plate 4.2.3).

4.2.3.A 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 Evoked Potentials (AEP), Somatosensory Evoked Potentials (SEP), Visual Evoked Potentials (VEP) and P300 Event Related Potentials (ERP). The Bravo EP amplifier has 4 acquisition channels, a headbox for electrode connections and a LED electrode impedance panel. To perform AEP tests, acoustically shielded earphone (TDH-39, Amplivox, UK) 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). 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).

Plate 4.2.3: Bravo EP System (Nicolet, USA)

The Bravo EP - 4 channels amplifier and Closed circuit TV

Subject in supine position with electrode connections and earphone

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The recording cabin with acoustically shielded earphone (Amplivox, UK) used to deliver the ‘frequent’ and ‘rare’ stimuli, and a head-box for electrode connections with LED electrode impedance panel.

4.2.3.B Selection of auditory oddball P300 evoked potentials:

Previous studies have shown improvement in P300 evoked responses following Brahmakumaris Raja yoga meditation and Transcendental meditation (Joseph, Ram Shankar, Kulkarni, Ramchandra, Narasimhalu, Desiraju, 1987). However no study has been done on event related potentials following cyclic meditation.

4.2.3.C Recording conditions:

The subjects were individually assessed in a sound attenuated and dimly lit cabin. The recording leads were led out of the cabin, and connected to the Nicolet Bravo System (USA). The subjects were observed on a closed circuit TV and instructions were given through an intercom, so that subjects could remain undisturbed during a session.

4.2.3.D Electrode positions:

Ag/AgCl disk electrodes were affixed with electrode gel (Ten 20 conductive EEG paste, D.O. Weaver and Co. USA) at the Fz (frontal), Cz (central) and Pz (parietal) scalp sites, referred to linked earlobes (A1-A2) with a forehead ground (FPz); according to the International 10-20 system (Jasper, 1958). The electro-ocular activity (EOG) was recorded with a bipolar derivation from electrodes placed at 1 cm above and 1 cm below outer canthus of the right eye (Fig.M2). The electrode impendence was kept below 5 kΩ at all the scalp sites.

4.2.3.E Amplifier settings:

The electroencephalographic (EEG) activity was amplified with a sensitivity of 100μV. The low pass filter was kept at 0.01 Hz and the high pass filter was kept at 30 Hz. The P300 ERPs were computer averaged in 300 trial sweeps, in the 75 -750 ms range. The pre-stimulus delay was kept at 75 ms and the level of artifact rejection was set at 90%.

4.2.3.F Stimulus characteristics:

Binaural tone stimuli of alternating polarity delivered at 0.9 ms with a frequency of 1 KHz (50 cycles for the plateau, 10 cycles for the ramp) for the standard stimuli and 2 KHz (10 cycles for the plateau, 20 cycles for the ramp) for the target stimuli were used to trigger online averaging of the EEG. The percent of standard stimuli was set at 80 and for the target stimuli at 20. The stimulus intensity was kept at 70 dB SPL.

4.2.3.G Recording procedure:

The subjects 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. A trial session was given to rule out any hearing deficit. The P300 evoked potentials were recorded in the eyes closed supine position. The ‘standard’ and ‘target’ auditory stimuli were delivered through close fitting earphones (TDH-39, Amplivox, UK) (Plate 4.2.3). The subjects were asked to distinguish between the two tones by mentally counting the ‘target’ stimuli. The P300 responses were recorded before and immediately after the intervention.

4.2.3.H Variables measured:

The following variables were measured

1. Peak latencies (ms) of P300 responses at (i) Fz (frontal electrode site), (ii) Cz (vertex electrode site) and (iii) Pz (parietal electrode site).
2. Peak amplitudes (μV) of P300 responces at (i) Fz (frontal electrode site), (ii) Cz (vertex electrode site) and (iii) Pz (parietal electrode site).

4.2.4 Six letter cancellation test (SLT)

Cancellation tests require visual selectivity and a repetitive motor response. A six letter cancellation test (SLET) was administered to assess functions such as selective and focused attention, visual scanning, and the activation and inhibition of rapid responses. The six letter cancellation test has been used in similar type of design on Indian population (Natu, & Agarawal, 1997). A sample worksheet of six letter cancellation test is given in Appendix-2.

4.2.4.A Testing procedure:

The test worksheet consisted of three parts (i) instructions (ii) the six target letters to be cancelled and (iii) the working section which consisted of letters of the English alphabets arranged randomly in 22 rows and 14 columns. The subjects were asked to cancel as many target letters as possible in the specified time i.e., 90 seconds. 90 seconds has been selected as normally it is unlikely to complete the task in 90 seconds. The letter cancellation can be undertaken following a horizontal, vertical or randomized path by selecting any target alphabet mentioned. In the present study the subjects were asked to follow a randomize path. The total number of cancellations and wrong cancellations were scored and the net scores were calculated by deducting wrong cancellations from the total cancellations attempted. As this test was administered before and immediately after the intervention, to avoid the test – retest effect of memory, parallel worksheets were prepared by changing the target letters and the sequence of letters in the working section (Agarwal, Kalra, Natu, Dadich, & Deswal, 2002). This method (i.e., changing the target letters and the sequence of letters) was found to be appropriate for making parallel worksheets. Hence 50% of the subjects received one set of worksheets before a session, which the other 50% received a parallel worksheet before the session. Accordingly the subjects received the appropriate worksheet after the session. Similarly there were separate worksheets for the second session. This is the ‘counter balancing’ effect.

4.2.4.B Reliability and validity:

Reliability refers to the precision or accuracy of measurement. It suggests the consistency of measurement which is reflected in the reproducibility of the scores. The six letter cancellation test 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 pilot data (unpublished) collected in twenty male healthy volunteers ‘without any intervention’. The correlation was made for the data collected before and after 23 minutes during which the subjects were given no specific intervention (Spearman’s correlation coefficient). The variable for which the correlation was made (i.e., the net score) demonstrated the temporal stability ($r = 0.781$, $P = 0.002$). Since the six letter cancellation test 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 six letter cancellation test is directly related to the attention of the person being examined. Cancellation tests require visual selectivity and a repetitive motor response. These tests assess many functions such as sustained attention, visual scanning, and the activation and inhibition of rapid responses

(Lezak, 1995). Hence it may be said that the content validity of this test is adequate for the purpose for which it is intended.

4.2.5 Visual analogue scale (VAS):

Visual analog scales were measured to test the qualitative subjective experiences like the quality of practice, level of relaxation, level of awareness and quality of sleep during the preceding night after each recording session. A visual analog scale is a measurement scale that is used to measure a characteristic or attitude which is believed to range across a continuum of values and cannot easily be directly measured. It consists of a horizontal line, 10 cm in length, anchored by word descriptions at each end (Wewers, & Lowe, 1990). A sample worksheet of visual analogue scale (VAS) is given in Appendix-3.

4.2.5.A Testing procedure:

The subjects were asked to mark the line at the point that they felt represented their perception of their current state. The VAS score was determined by measuring in millimeters from the left-hand end of the line to the point that the subject marked. There are no standard data available as this scale was used for the first time to understand these types of subjective experiences; however these types of scales are used in measurement of clinical phenomena like pain (Wewers, & Lowe, 1990).

4.2.5.B Variables measured:

Visual analogue scale (VAS) for (i) quality of practice (QOP), (ii) quality of sleep (QOS), (iii) level of relaxation (LOR) and (iv) level of awareness (LOA).

4.3 DESIGN

4.3.1 Structure of sessions

Each subject was assessed in 6 sessions. They underwent three cyclic meditation sessions separately while (i) recording respiratory and metabolic variables, and heart rate variability (HRV) simultaneously, (ii) recording P300 event related potentials and (iii) recording the letter cancellation test (this test was administered to the group at a time). Similarly each subject underwent three supine rest sessions separately while (i) recording respiratory and metabolic variables, and heart rate variability (HRV) simultaneously, (ii) recording of P300 event related potentials and (iii) recording the letter cancellation test (this test was administered to the group at a time). The supine rest was considered as control session for CM because (i) supine posture is best known position for relaxation and (ii) in earlier study, CM was compared to supine rest in corpse posture (*śavāsana*) (Telles, Reddy, & Nagendra, 2000).

4.3.2 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.

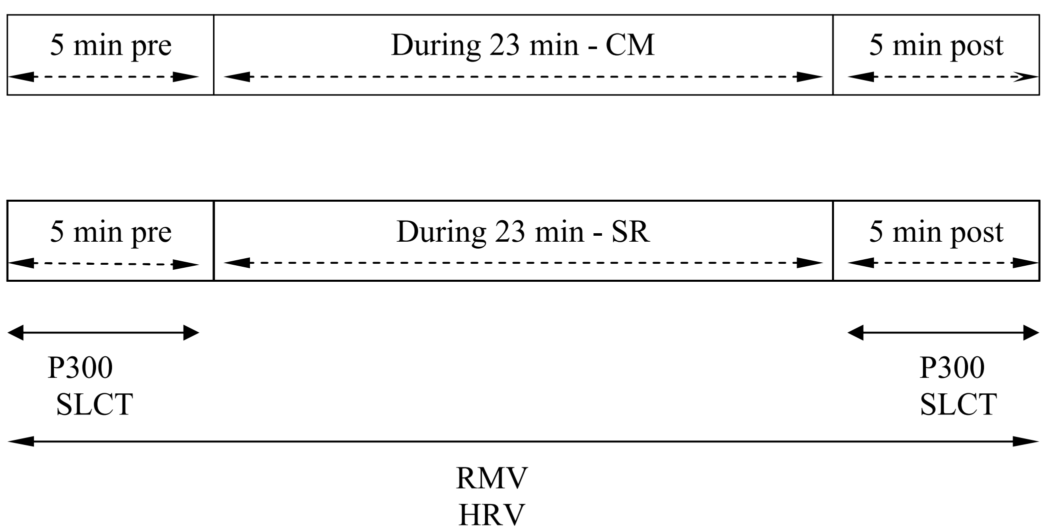
4.3.3 Time allocation within the sessions

The respiratory and metabolic variables, and ECG for heart rate variability were recorded through out the intervention in three states i.e., pre, during and post.

The P300 event related potentials and the letter cancellation tests were performed in two states i.e., pre and post.

4.3.3.A Cyclic meditation session: the first 5 minutes of the 'pre' cyclic meditation period was in the supine position, followed by 23 minutes of the 'during' period, where subjects were given cyclic meditation practice using taped instructions. This was followed by 5 minutes of the 'post' cyclic meditation period of supine rest.

4.3.3B Supine rest session: the first 5 minutes of the 'pre' supine rest period was in the supine position, followed by 23 minutes of the 'during' period, where subjects were given supine rest without instructions. This was followed by 5 minutes of the 'post' supine rest period of supine rest. The time breakup has been given below.



CM = Cyclic Meditation

SR = Supine rest

P300 = P300 event related potentials

RMV = Respiratory and metabolic variables

SLCT = Six letter cancellation test

HRV = Heart rate variability

4.4 INTERVENTIONS

4.4.1 Cyclic Meditation

Throughout the practice of cyclic meditation subjects kept their eyes closed, and followed taped instructions with ear phones. The instructions emphasized carrying out the practice slowly, with awareness and relaxation. The practice began by repeating a verse from the yoga text, the *Māṇḍukya Upaniṣat* (40 seconds); followed by isometric contraction of the muscles of the body ending with supine rest (1 minute): standing at ease (called *tāḍāsana*) and 'balancing' the weight on both feet (2 minutes): then the first actual posture, bending to the right (*arḍakaticakrāsana,* 1 minute 20 seconds); a gap of 1 minute 10 seconds with instructions about relaxation and awareness; bending to the left (1 minute 20 seconds); a gap as before (1 minute 10 seconds); forward bending (*pādahastāsana,* 1 minute 20 seconds); another gap (1 minute 10 seconds); backward bending *(arḍacakrāsana*, 1 minute 20 seconds); supine rest with instructions to relax different parts of the body in sequence (10 minutes). The pictorial description of these postures in cyclic meditation is given in Plate 3.1.6.C. The postures were practiced slowly, with awareness of all the sensations that are felt. The total duration of the practice was 23 minutes (Nagendra, & Nagarathna, 2003). 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 chapter 'Review of Literature' 3.1.6.C section.

4.4.2 Supine rest

During supine rest session, the subjects were lying supine with legs apart and arms away from the sides of the body and with their eyes closed. The duration of the practice was 23 minutes.

4.5 DATA EXTRACTION

4.5.1 Respiratory and metabolic variables

The data were converted to the format that is compatible with Microsoft Excel program. The contiguous breath-by-breath data were then averaged for different states (i.e., pre, during and post) of each recording session. The data of the 'during' state were divided into 4 sub-phases for further analysis (Table 4.5.1).

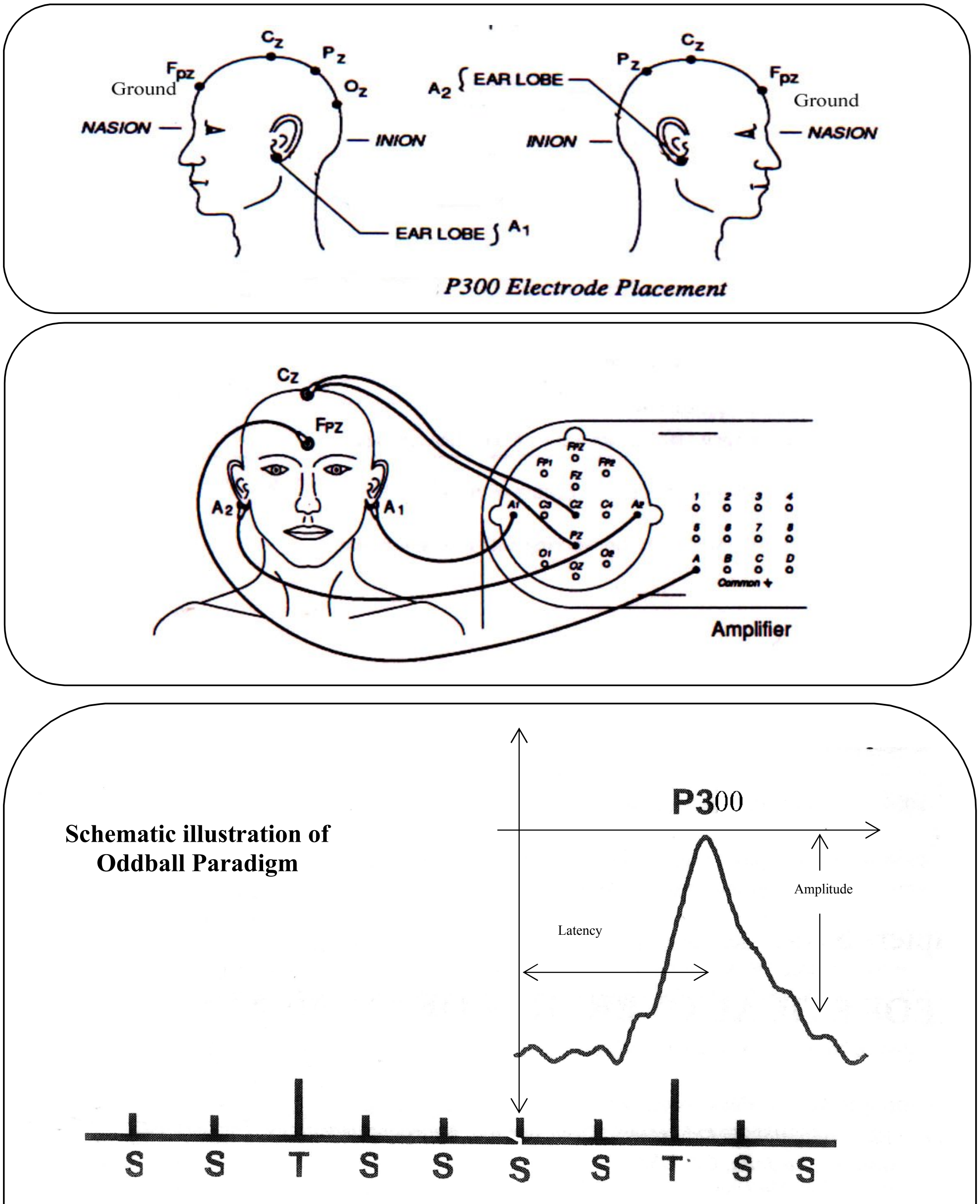
4.5.2 Heart rate variability (HRV)

The data were continuously acquired throughout the recording session; hence it was divided into 7 phases of 5 minutes for analysis (Table 4.5.2). The data small episodes of artifacts were shredded and were included for analysis. Data were analyzed with an "advanced HRV analysis software" program developed by Biomedical Signal Analysis Group, University of Kuopia, Finland (Niskanen, Tarvainen, Ranta-aho, & Karjalainen, 2004). To recover an evenly sampled signal from the irregularly sampled event series, a cubic interpolation was applied and the HRV power spectrum was obtained using Fast Fourier Transform analysis (FFT) (Fig. 4.2.2). The power in the HRV series of the following specific bands was studied, viz., the very low frequency component (0.0 - 0.04 Hz), low frequency component (0.05 - 0.15 Hz), and high frequency component (0.15 - 0.50 Hz). The low frequency and high frequency values were expressed as normalized units, which represent the relative of each power component in proportion to the total power minus VLF component [LF norm = LF / (total power-VLF) × 100; HF norm = HF / (total power – VLF) ×100)] (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, Heart Rate Variability: standards of measurement, physiological interpretation, and clinical use, 1996).

4.5.3 Computer averaged P300 auditory evoked potentials

The peak amplitude and peak latency of the P300 was measured at the three electrode sites; i.e., Fz, Cz and Pz. Peak amplitude (in μV) was defined as the voltage difference between a pre-stimulus baseline and the largest positive-going peak of the ERP waveform within 250-500 ms latency (Polich, 1999). The latency (ms) was defined as the time from stimulus onset to the point of maximum positive amplitude within the latency window. The waveforms were visually inspected off-line for artifacts and the latency and the peak amplitude were obtained by selection with the cursor. The selection was performed by the experimenter (Fig. 4.5.3.A). A sample record of P300 responses using Nicolet Bravo EP system (USA) in presented in Fig. 4.5.3.B.

Fig. 4.5.3.A: Latency and amplitude of P300 responses



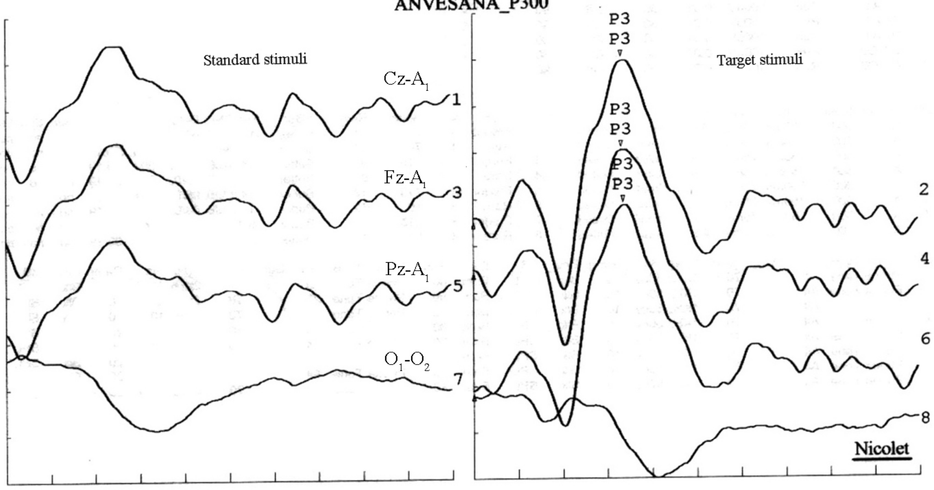
The oddball task presents two different stimuli in a random sequence, with one occurring less frequently than the other (T = target, S = standard)

Nicolet Biomedical Inc.
5225 Verona Rd.
Madison, WI 53711
(608) 441-2000

Code Name: SS	First: PostCM	Gender: M
Med ID:	Birthdate:	
Date: 08/03/2004	Examiner: Sarang	

Case History:
Notes/Impressions:

ANVESANA_P300



Sensitivity and Sweep Time Per Division

1	5.00 uV	75.0 ms	2	5.00 uV	75.0 ms	3	5.00 uV	75.0 ms	4	5.00 uV	75.0 ms
5	5.00 uV	75.0 ms	6	5.00 uV	75.0 ms	*7	5.00 uV	75.0 ms	8	5.00 uV	75.0 ms

P300

	Cz-A_1		Fz-A_1		Pz-A_1	
N1		N1		N1		
N1		N1		N1		
P2		P2		P2		
P2		P2		P2		
N2		N2		N2		
N2		N2		N2		
P3	324.00ms	P3	324.00ms	P3	327.00ms	
P3	17.00uV	P3	12.77uV	P3	19.87uV	

P	Elect	Mode	Sns	Lff	Hff	Notch	Artifact	REM	Remarks
	Cz-A1	Run	100uV	0.01	30	Off	90	1	
	Cz-A1	Run	100uV	0.01	30	Off	90	2	
	Fz-A1	Run	100uV	0.01	30	Off	90	3	
	Fz-A1	Run	100uV	0.01	30	Off	90	4	
	Pz-A1	Run	100uV	0.01	30	Off	90	5	
	Pz-A1	Run	100uV	0.01	30	Off	90	6	
	O1-O2	Run	100uV	0.01	30	Off	90	7	
	O1-O2	Run	100uV	0.01	30	Off	90	8	

Q	Comm	Sweep	Time	Delay	Rate	Trigger	Stim	MISC	Type	Ch#	Accept	Reject	Filter	Fsp/SNR	Date	Time	Add	Sub	Inv	Filter	Smooth
	A	300	750ms	75ms	0.9	Inter	Gated	1	Freqnt	1	216	11	Butter	-14.79dB	08/02/2004	05:19	no	no	no	no	no
	A	300	750ms	75ms	0.9	Inter	Gated	2	Rare	1	78	11	Butter	-14.79dB	08/02/2004	05:19	no	no	no	no	no
	A	300	750ms	75ms	0.9	Inter	Gated	3	Freqnt	2	218	9	Butter	-14.52dB	08/02/2004	05:19	no	no	no	no	no
	A	300	750ms	75ms	0.9	Inter	Gated	4	Rare	2	78	9	Butter	-14.52dB	08/02/2004	05:19	no	no	no	no	no
	A	300	750ms	75ms	0.9	Inter	Gated	5	Freqnt	3	213	12	Butter	-14.83dB	08/02/2004	05:19	no	no	no	no	no
	A	300	750ms	75ms	0.9	Inter	Gated	6	Rare	3	80	12	Butter	-14.83dB	08/02/2004	05:19	no	no	no	no	no
	A	300	750ms	75ms	0.9	Inter	Gated	7	Freqnt	4	218	1	Butter	-9.25dB	08/02/2004	05:19	no	no	no	no	no
	A	300	750ms	75ms	0.9	Inter	Gated	8	Rare	4	82	1	Butter	-9.25dB	08/02/2004	05:19	no	no	no	no	no

M	Trans	Type	Pol	Dur	Level	Freq	Pla	Ramp	Env	dB	Ear	Prcnt	Trans	Type	Pol	Dur	Level	Freq	Pla	Ramp	Env	dB	Ear	Prcnt
	Phone	Tone	Alt		70	1KHz	50cy	10	Blk	SPL	Both	80	Phone	Tone	Alt		70	2KHz	10cy	20	Blk	SPL	Both	20
	Phone	Tone	Alt		70	1KHz	50cy	10	Blk	SPL	Both	80	Phone	Tone	Alt		70	2KHz	10cy	20	Blk	SPL	Both	20
	Phone	Tone	Alt		70	1KHz	50cy	10	Blk	SPL	Both	80	Phone	Tone	Alt		70	2KHz	10cy	20	Blk	SPL	Both	20
	Phone	Tone	Alt		70	1KHz	50cy	10	Blk	SPL	Both	80	Phone	Tone	Alt		70	2KHz	10cy	20	Blk	SPL	Both	20
	Phone	Tone	Alt		70	1KHz	50cy	10	Blk	SPL	Both	80	Phone	Tone	Alt		70	2KHz	10cy	20	Blk	SPL	Both	20
	Phone	Tone	Alt		70	1KHz	50cy	10	Blk	SPL	Both	80	Phone	Tone	Alt		70	2KHz	10cy	20	Blk	SPL	Both	20
	Phone	Tone	Alt		70	1KHz	50cy	10	Blk	SPL	Both	80	Phone	Tone	Alt		70	2KHz	10cy	20	Blk	SPL	Both	20
	Phone	Tone	Alt		70	1KHz	50cy	10	Blk	SPL	Both	80	Phone	Tone	Alt		70	2KHz	10cy	20	Blk	SPL	Both	20

Fig. 4.5.3.B: Sample record of P300 responses measured using Nicolet Bravo EP system (USA)

4.6 DATA ANALYSIS

Statistical analysis was done using SPSS Version 10 after selecting the appropriate test. The raw data obtained for each subject in each recording session were tabulated separately and the methods of statistical analysis are given below:

(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) Repeated measures analyses of variance (ANOVA) were performed with two 'Within subjects' factors, i.e., Factor 1: Sessions; CM and SH and Factor 2: States; Pre, During, and Post. These repeated measures ANOVA were carried out for each variable separately.

(iii) For the normally distributed data paired t – tests were performed to compare the data of the 'during' and the 'post' periods with those of the respective 'pre' period.

For data that were found to be not normally distributed, step (ii) and (iii) were different. They have been described below as (ii)^ and (iii)^.

(ii)^ In place of the repeated measures of ANOVA described in step (ii) a Kruskal Wallis non parametric test was performed.

(iii)^ The Wilcoxon paired signed ranks test was performed to compare the data of the 'during' and the 'post' periods with those of the respective 'pre' periods.

Table 4.5.1: States of recording sessions: Respiratory and metabolic variables (RMV)

Cyclic meditation session

	Cyclic meditation (23 minutes: eyes closed)				
5 minutes	5 minutes D1	5 minutes D2	5 minutes D3	8 minutes D4	5 minutes
'Pre' Supine rest (eyes closed)	Prayer IRT Linear awareness Standing up Centering Observation of changes *Arḍakaticakrāsana* (Right side)	Observation of changes *Arḍakaticakrāsana* (Left side) Observation of changes Balance *Pādahastāsana*	Observation of changes *Arḍacakrāsana* 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 *Sukhāsana* Prayer	'Post' Supine rest (eyes closed)

Supine rest session

	Supine rest (23 minutes: eyes closed)				
5 minutes	5 minutes D1	5 minutes D2	5 minutes D3	8 minutes D4	5 minutes
'Pre' Supine rest (eyes closed)	Supine rest	Supine rest	Supine rest	Supine rest	'Post' Supine rest (eyes closed)

D1 to D4 = Phases of 'During' state, IRT = Instant relaxation technique (Journal of Indian Psychology. 2002; 17(2): 46-52).
DRT = Deep relaxation technique (Psychological Reports. 2002; 90: 487-94).

Table 4.5.2: States of recording sessions: Heart rate variability (HRV)

Cyclic meditation session

5 minutes	**Cyclic meditation** (25 minutes: eyes closed)					5 minutes
	5 minutes D2	5 minutes D2	5 minutes D3	5 minutes D4	5 minutes D5	
'Pre' Supine rest (eyes closed)	Prayer IRT Linear awareness Standing up Centering Observation of changes *Arḍakaticakrāsana* (Right side)	Observation of changes *Arḍakaticakrāsana* (Left side) Observation of changes Balance *Pādahastāsana*	Observation of changes *Arḍacakrāsana* 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	Coming up in sitting position *Sukhāsana* Prayer Again lying down in supine position	'Post' Supine rest (eyes closed)

Supine rest session

5 minutes	**Supine rest** (25 minutes: eyes closed)					5 minutes
	5 minutes D2	5 minutes D2	5 minutes D3	5 minutes D4	5 minutes D5	
'Pre' Supine rest (eyes closed)	Supine rest	Supine rest	Supine rest	Supine rest	Supine rest	'Post' Supine rest (eyes closed)

D1 to D5 = Phases of 'During' state, IRT = Instant relaxation technique (Journal of Indian Psychology. 2002; 17(2): 46-52).
DRT = Deep relaxation technique (Psychological Reports. 2002; 90: 487-94).

CHAPTER - 3

M E T H O D S

In this thesis the changes in (i) respiratory and metabolic variables (e.g., V_{O2}, V_{CO2}, RR, end tidal gases) (ii) heat rate variability (HRV) (iii) P300 (based on the auditory oddball paradigm), and (iv) a paper and pencil letter cancellation test were evaluated in normal volunteers related to two yoga relaxation techniques viz. cyclic meditation and supine rest.

1.0 SUBJECTS

1.1 Sample size: A sample of 53 subjects was studied. The actual sample size required was 40, which was based on the effect-size obtained in previous study of changes in cyclic meditation (Telles, Reddy, & Nagendra, 2000). It was calculated using G-power software, University of Duesseldorf, Germany; http://www.psycho.uni-duesseldorf.de /aap/projects/gpower where the α power was set at 0.05.

1.2 Inclusion criteria: (i) The subjects were healthy volunteers with age range from 18 to 48 years (avg. age ± SD, 27.13 ± 6.33) (ii) Male subjects alone were studied as oxygen consumption, autonomic variables and auditory evoked responses have been shown to vary with the phases of the menstrual cycles in females (Das, & Jana, 1999; Yildirir, Kabakci, Akgul, Tokgozoglu, & Oto, 2002; Yadav, Tandon, & Vaney, 2002). (iii) All subjects had experience of practice of both yoga relaxation techniques ranging from 3 to 60 months (avg. experience ± SD, 15.30 ± 13.30 months). They were regular in practice. Also the study was conducted following two months of supervised practice of cyclic meditation and supine rest for about 30 min on alternate days as a 'refresher course'. The details of each subject have been given in the Table 4.1.2.

1.3 Exclusion Criteria: The following criteria were used to screen the volunteers. (i) The presence of cognitive and/or neurological and/or metabolic disorders based on a medical history and routine clinical examination (ii) in take of medication, which is known to influence cognitive, autonomic and metabolic functions (iii) smoking or alcoholism which may have influenced the respiratory and metabolic variables and (iv) any hearing deficit.

1.4 Source: The subjects were residential students at Swami Vivekananda Yoga Anusandhana Samsthana, Deemed University, Prashanti Kutiram, Bangalore. They had all enrolled for graduate and post graduate study programs.

1.5 Ethical considerations: The subjects were told about the aims and methods of the study and the informed consent was signed by all subjects (a sample copy is enclosed in Appendix-1). An approval was obtained from the Institutional Ethical Committee as all tests are essentially noninvasive in nature.

2.0 ASSESSMENTS

2.1 Respiratory and metabolic variables

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 present thesis the term 'variable' has been used to describe the assessments studied.

2.1a Selection of respiratory and metabolic variables:

Respiratory and metabolic variables were measured in order to assess changes throughout the practice of cyclic meditation and supine rest by using a computerized open circuit system (Oxycon Pro, Model 2001, No. SN 808323, Jaeger, Germany) (Plate M1).

2.1b Principle and specifications of Oxycon Pro system:

The measurement principle underlying the Oxycon Pro System: Dynamic "breath by breath" measurement is done using an open circuit system. The volume is measured via the bidirectional digital volume sensor "Triple V" which works on the paramagnetic principle. The gas exchange measurement is done via the extremely fast O_2 and CO_2 analyzers at the speed of 10ms with breathing level up to 80 breaths per minute.

The Oxycon Pro system has following technical specifications:

(1) Measurement	Range	Accuracy
(i) Ventilation (V_E)	0 to 300 liters/min	2% or 0.5 l/min
(ii) O2 uptake (V_{O2})	0 to 7 liters/min	3% or 0.05 l/min
(iii) CO_2 output (V_{CO2})	0.6 to 2.0	4%
(2) Volume sensor		
(i) Volume	0 to10 liters	
(ii) Accuracy	2 % or 0.15 liters	
(iii) Resolution	0.3 liters	
(iv) Flow	0 to 15 liters/s	
(v) Accuracy	3% 0r 0.70 liters/s	
(vi) Resistance	<0.1 kPa at 15 liters/s	
(3) O_2 analyzer (high – speed analyzer based on the differential – paramagnetic principle)		
	Range 1	Range 2
(i) Range	0 to25%	0 to 60%
(ii) Accuracy	0.05%	0.2%
(iii) Resolution	0.01%	0.02%
(iv) Stability	0.02%/h	
(v) Min. rise time	$T_{10\text{-}90}$, 40 ms	
(4) CO_2 analyzer (high – speed analyzer based on the infrared absorption principle)		
(i) Range	0 to15%	
(ii) Accuracy	0.05%	

(iii) Resolution	0.01%
(iv) Stability	0.02%/h
(v) Min. rise time	T $_{10\text{-}90}$, 40 ms

***2.1c Familiarization of the subject with the laboratory environment and with the study*:**

As the recordings were made under basal conditions (i.e., at as complete mental and physical rest as possible and 10 -12 hours after last meal) all subjects were asked to consume fixed quantity of food i.e., 1069.1Kcal (calculated using Annapurna 2003, Version 1.0 software, Annapurna Associates, Bangalore) on the night previous to recordings (Ganong,1987). They were requested to sleep in the laboratory for 3 consecutive nights, where the first day was to make them acclimatized to the laboratory environment. The next two days were meant for actual recordings. The subjective experience of the quality of sleep was noted by a visual analogue scale. In the morning, recordings were made between 5 a.m. to 7 a.m. Each subject was instructed to restrict activity to using the rest room. This was necessary to minimize physical activity and avoid arousal. Following this, the recordings were carried out.

2.1d Recording conditions:

The subjects were studied in an air conditioned, sound attenuated room with dim lighting. The temperature of the recording room was maintained between 20 - 25^0 Celsius, the humidity was between 65 to 75 min/max and the barometric pressure was between 650 to 685 mmHg.

2.1e Calibration of the equipment:

Every day prior to assessment, the following calibrations were performed.

(i) Ambient conditions: As ambient data are the basis for determination of important correction factors for calculating recorded values, the ambient data were checked at regular intervals. The barometric pressure, temperature and humidity were automatically recorded by the sensors built in the system.

(ii) Volume calibration: The measuring system consisting of the Triple V volume sensor was calibrated every day. A clear Triple V (digital volume sensor) is very important for an accurate flow and volume measurement.

(iii) Gas calibration: The gas analyzers (O_2/CO_2) integrated in the system were calibrated once a day, after a warming-up time of 30 minutes. The O_2 / CO_2 calibration was carried out using the certified gases (BOC, UK) from the calibration gas cylinder (containing mixture 5.2% of CO_2 and Nitrogen) connected to the system. The calibration program runs automatically and is divided into three phases (a) flushing the tube system (b) determination of delay time and (c) gain settings. At the end of calibration the calculated parameters were saved.

2.1f Recording procedure:

The steps followed for recordings were

(i) Subject data: Before taking measurements, details such as the age, gender, height and weight were entered in the system. The height was measured by a standard scale in centimeters and the weight was measured with clothing using a digital weighing machine (Essae – Digi, Model No. DI-20, Essae-Teraoka Pvt. Ltd., Bangaolre, India). (ii) The breathing mask, designed to form an airtight cover over the subject's nose and mouth was fixed by straps (mask for adults with dead space of 70 ml) and care was taken that the air did not leak out from the sides of the mask. (iii) The TripleV sensor (Plate M1) was connected to the breathing mask at one end and at the other end to the integrated gas analyzer system in the compact housing through the twin tubes. (iv) Specific workload protocol was loaded according to the design of the recording session and selected to run during the experiment. The recorded data was stored in the hard disc of the PC (Pentium III).

2.1g Variables measured:

The following variables were measured

1. V_E (l/min) Total ventilation
2. V_T (l) Tidal volume
3. RR (c/min) Respiratory rate
4. V_{O2} (ml/min) Oxygen consumption (STPD)
5. V_{CO2} (ml/min) Carbon dioxide output (STPD)
6. PA_{CO2} (kPa) Partial pressure of carbon dioxide in alveoli
7. PET_{CO2} (kPa) Partial pressure of end tidal carbon dioxide
8. PET_{O2} (kPa) Partial pressure of end tidal oxygen
9. EE (kcal/day) Energy expenditure (EE was derived using the following formula. $EE = 1.59 \times V_{CO2} + 5.68 \times V_{O2} - 2.17 \times UN$ (Values at normal breathing: (i) V_{CO2} = 350 ml/min/kg, (ii) V_{O2} = 280 ml/min/kg, (iii) UN = patient-dependent (presetting: 15 g/day), (iii) EE = 1.59 ×350 + 5.68 × 280 - 217 × 15 and (iv) EE = 2113 g/day) (Oxycon Instruction Manual, 2001).

2.2 Heart rate variability (HRV)

Heart rate variability (HRV) describes the variations between consecutive heartbeats. The regulation mechanisms of HRV originate from the sympathetic and parasympathetic nervous systems in addition to other controls and hence, HRV is used as a quantitative marker of the autonomic control over the heart (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, Heart Rate Variability: standards of measurement, physiological interpretation, and clinical use, 1996). The ECG for HRV spectrum was acquired using an ambulatory ECG system (Niviqure, Bangalore, India).

2.2a Recording conditions:

The subjects were studied in an air conditioned, sound attenuated room with dim lighting and the temperature ranging from 20 to 25 ^{0} Celsius.

2.2b Specifications of Niviqure system:

Niviqure ambulatory system is a computerized ECG recording system that allows to acquire, analyze and store ECG data over long hours. The data is acquired and stored in flash memory for later downloading and analysis. The data transfer from the memory module (main unit) to the computer is through an interface RS232C-compatible module. The ECG viewing on the computer monitor screen includes multi-lead ECG viewing, beat-to-beat analysis and detection of heart rate. The biological signal is isolated from AC mains and ground. The system consist (i) computer interface unit, (ii) signal processing unit with bio-amplifier and (iii) bio-amplifier circuit with gain, low-pass and high-pass filters adjusted for ECG signal acquisition. Gain is set at 1 mV/ div (Y-axis) as ‘default’ for ECG signal processing with frequency band: 0.5 to 100 Hz (Niviqure ambulatory ECG system: Instruction Manual, 2003). Data translations into BIN, ASCII formats is possible. This permits to analyze the data using any standard software.

2.2c Testing procedure:

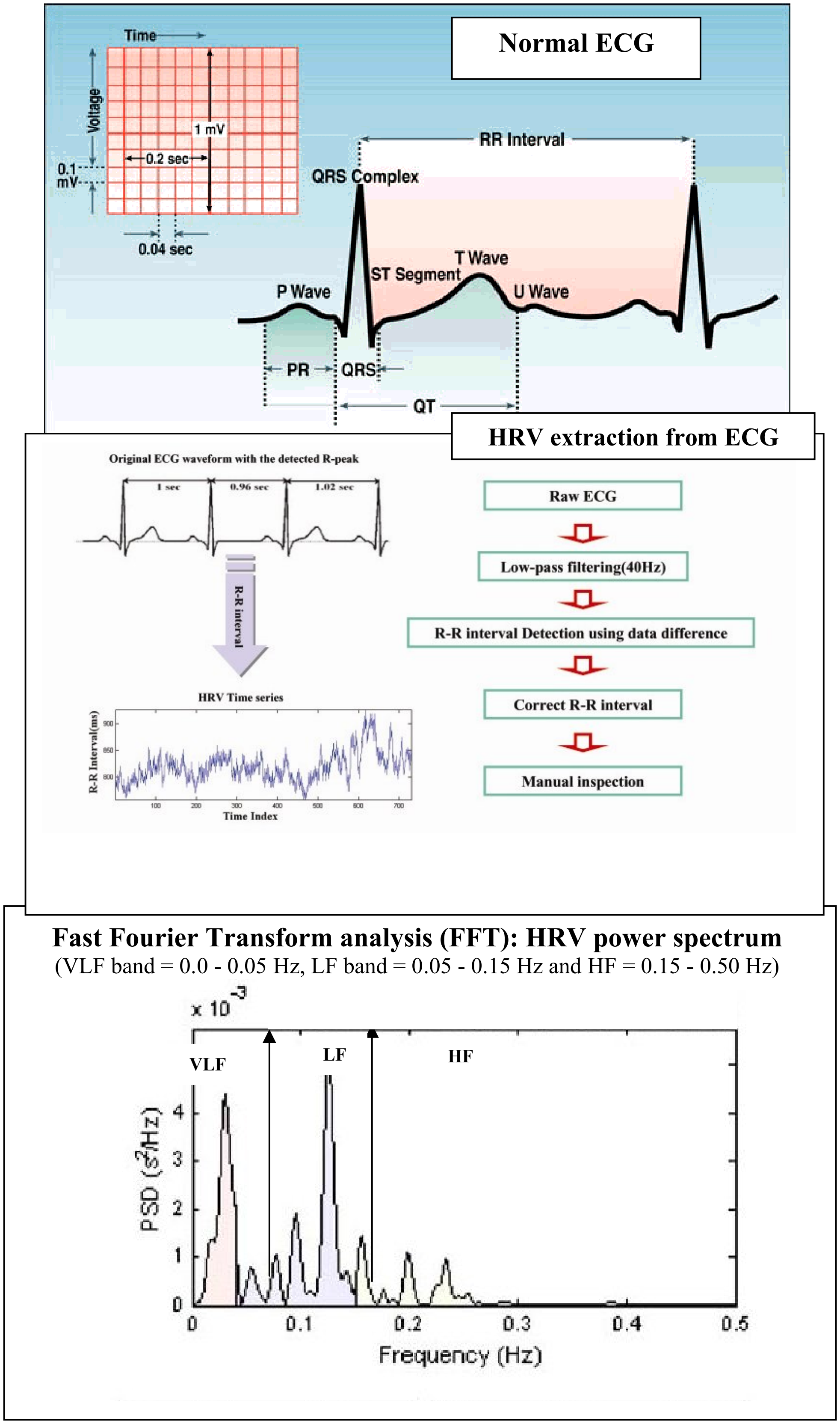
The ECG was recorded throughout the practice of cyclic meditation and supine rest using Ag/AgCl solid adhesive pre-gelled electrodes (Bio Protech Inc. Korea) affixed on either side of clavicular prominence and on the lower ribs to simulate limb lead I and II configuration. These electrode positions were selected as it was found that (i) placing the electrodes in the standard limb lead position led to artifacts and (ii) the recordings made with electrodes in these positions were free from movement artifact. The ECG was acquired using an ambulatory ECG system (Niviqure, Bangalore, India) (Plate M2) at the sampling rate of 1024 Hz and was stored on the hard disc of a PC (Pentium IV) for analysis. The R waves were detected to obtain a point event series of successive R-R intervals, from which the beat to beat heart series were computed. (Fig M1). The data recorded was visually inspected off-line and noise free data were included for the analysis.

2.2d Variables measured:

The following variables were measured

1.	LF	(normalized units)	Low frequency power of HRV spectrum
2.	HF	(normalized units)	High frequency power of HRV spectrum
3.	LF/HF		Ratio of low and high frequency powers
4.	HR	(b/min)	Heart rate

Fig. M1: Heart rate variability spectrum (HRV)



2.3 Computer averaged P300 auditory evoked potentials

The P300 event related brain potentials (ERP) reflect fundamental cognitive events requiring attentional and immediate memory processes. The P300 component is often elicited with a simple discrimination task known as the 'oddball' paradigm, since two stimuli are presented in a random series such that one of them occurs relatively infrequently i.e. the odd ball (Polich, 1999). The P300 event related potentials were recorded using Nicolet Bravo System (USA).

2.3a Specifications of Nicolet Bravo System:

The Bravo EP (Nicolet, USA) is a 4 channel evoked potential acquisition and review system. This system acquires and analyses data using easy-to-use Windows™ NT base interface. The Bravo EP has options of performing wide variety of tests such as Auditory Evoked Potentials (AEP), Somatosensory Evoked Potentials (SEP), Visual Evoked Potentials (VEP) and P300 Event Related Potentials (ERP). The Bravo EP amplifier has 4 acquisition channels, a headbox for electrode connections and a LED electrode impedance panel. To perform AEP tests, the system has the options of using different auditory transducers such as earphones, tubal insert phones or bone vibrators. Acoustically shielded earphone (TDH-39, Amplivox, UK) is being 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). 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 (Bravo EP Users Guide, 1998).

2.3b Selection of auditory oddball P300 evoked potentials:

Previous studies have shown improvement in P300 evoked responses following Brahmakumaris Raja yoga meditation and Transcendental meditation (Joseph, Ram Shankar, Kulkarni, Ramchandra, Narasimhalu, Desiraju, 1987). However no study has been done on event related potentials following cyclic meditation.

2.3c Recording conditions:

The subjects were individually assessed in a sound attenuated and dimly lit cabin. The recording leads were led out of the cabin, and connected to the Nicolet Bravo System (USA). The subjects were observed on a closed circuit TV and instructions were given through an intercom, so that subjects could remain undisturbed during a session (Plate M3).

2.3d Electrode positions:

Ag/AgCl disk electrodes were affixed with electrode gel (Ten 20 conductive EEG paste, D.O. Weaver and Co. USA) at the Fz (frontal), Cz (central) and Pz (parietal) scalp sites, referred to linked earlobes (A1-A2) with a forehead ground (FPz); according to the International 10-20 system (Jasper, 1958). The electro-ocular activity (EOG) was recorded with a bipolar derivation from electrodes placed at 1 cm above and 1 cm below outer canthus of the right eye (Fig.M2). The electrode impendence was kept below 5 kΩ at all the scalp sites.

2.3e Amplifier settings:

The electroencephalographic (EEG) activity was amplified with a sensitivity of 100μV. The low pass filter was kept at 0.01 Hz and the high pass filter was kept at 30 Hz. The P300 ERPs were computer averaged in 300 trial sweeps, in the 75 -750 ms range. The pre-stimulus delay was kept at 75 ms and the level of artifact rejection was set at 90%.

2.3f Stimulus characteristics:

Binaural tone stimuli of alternating polarity delivered at 0.9 ms with a frequency of 1 KHz (50cycles for the plateau, 10cycles for the ramp) for the standard stimuli and 2 KHz (10 cycles for the plateau, 20 cycles for the ramp) for the target stimuli were used to trigger online averaging of the EEG. The percent of standard stimuli was set at 80 and for the target stimuli at 20. The stimulus intensity was kept at 70 dB SPL.

2.3g Recording procedure:

The subjects 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. A trial session was given to rule out any hearing deficit. The P300 evoked potentials were recorded in the eyes closed supine position. The ‘standard’ and ‘target’ auditory stimuli were delivered through close fitting earphones (TDH-39, Amplivox, UK). The subjects were asked to distinguish between the two tones by mentally counting the ‘target’ stimuli. The P300 responses were recorded before and immediately after the intervention.

2.3c Variables measured:

The following variables were measured

1. Peak latencies (ms) of P300 responses at (i) Fz (frontal electrode site), (ii) Cz (vertex electrode site) and (iii) Pz (parietal electrode site).
2. Peak amplitudes (μV) of P300 responces at (i) Fz (frontal electrode site), (ii) Cz (vertex electrode site) and (iii) Pz (parietal electrode site).

2.4 Six letter cancellation test (SLT)

Cancellation tests require visual selectivity and a repetitive motor response. A six letter cancellation test (SLET) was administered to assess functions such as selective and focused attention, visual scanning, and the activation and inhibition of rapid responses. This test has been used in similar type of design on Indian population (Natu, & Agarawal, 1997). A sample worksheet of six letter cancellation test is given in Appendix-2.

2.4a Testing procedure:

The test worksheet consisted of three parts (i) instructions (ii) the six target letters to be cancelled and (iii) the working section which consisted of letters of the English alphabets arranged randomly in 22 rows and 14 columns. The subjects were asked to cancel as many target letters as possible in the specified time i.e., 90 seconds. 90 seconds has been selected as normally it is unlikely to complete the task in 90 seconds. The letter cancellation can be undertaken following a horizontal, vertical or randomized path by selecting any target alphabet mentioned. In the present study the randomized path was chosen. The total number of cancellations and wrong cancellations were scored and the net scores were calculated by deducting wrong cancellations from the total cancellations attempted. As this test was administered before and immediately after the intervention, to avoid the test – retest effect of memory, parallel worksheets were prepared by changing the target letters and the sequence of letters in the working section (Agarwal, Kalra, Natu, Dadich, & Deswal, 2002). This method (i.e., changing the target letters and the sequence of letters) was found to be appropriate for making parallel worksheets. Hence 50% of the subjects received one set of worksheets before a session, which the other 50% received a parallel worksheet before the session. Accordingly the subjects received the appropriate worksheet after the session. Similarly there were separate worksheets for the second session. This is the ‘counter balancing’ effect.

2.4b Reliability and validity:

<u>**2.5 Visual analogue scale (VAS):**</u>

Visual analog scales were measured to test the qualitative subjective experiences like the quality of practice, level of relaxation, level of awareness and quality of sleep during the preceding night after each recording session. A visual analog scale is a measurement scale that is used to measure a characteristic or attitude which is believed to range across a continuum of values and cannot easily be directly measured. It consists of a horizontal line, 10 cm in length, anchored by word descriptions at each end (Wewers, & Lowe, 1990). A sample worksheet of visual analogue scale (VAS) is given in appendix-ii.

2.5a Testing procedure:

The subjects were asked to mark the line at the point that they felt represented their perception of their current state. The VAS score was determined by measuring in millimeters from the left-hand end of the line to the point that the subject marked. There are no standard data available as this scale was used for the first time to understand these types of subjective experiences; however these types of scales are used in measurement of clinical phenomena like pain (Wewers, & Lowe, 1990).

2.5b Variables measured:

Visual analogue scale (VAS) for (i) quality of practice (QOP), (ii) quality of sleep (QOS), (iii) level of relaxation (LOR) and (iv) level of awareness (LOA).

3.0 DESIGN

3.1 Structure of sessions

Each subject was assessed in 6 sessions. They underwent three cyclic meditation sessions separately while (i) recording respiratory and metabolic variables, and heart rate variability (HRV) simultaneously, (ii) recording P300 event related potentials and (iii) recording the letter cancellation test (this test was administered to the group at a time). Similarly each subject underwent three supine rest sessions separately while (i) recording respiratory and metabolic variables, and heart rate variability (HRV) simultaneously, (ii) recording of P300 event related potentials and (iii) recording the letter cancellation test (this test was administered to the group at a time). The supine rest was considered as control session for CM because (i) supine posture is best known position for relaxation and (ii) in earlier study, CM was compared to supine rest in corpse posture (*śavāsana*) (Telles, Reddy, & Nagendra, 2000).

3.2 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.

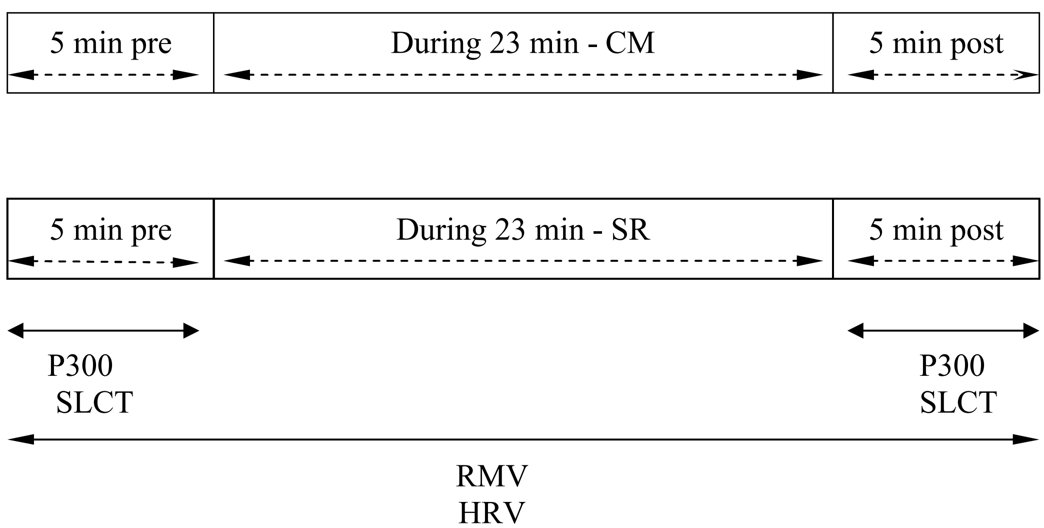
3.3 Time allocation within the sessions

The respiratory and metabolic variables, and ECG for heart rate variability were recorded through out the intervention in three states i.e., pre, during and post.

The P300 event related potentials and the letter cancellation tests were performed in two states i.e., pre and post.

3.3a Cyclic meditation session: the first 5 minutes of the 'pre' cyclic meditation period was in the supine position, followed by 23 minutes of the 'during' period, where subjects were given cyclic meditation practice using taped instructions. This was followed by 5 minutes of the 'post' cyclic meditation period of supine rest.

3.3b Supine rest session: the first 5 minutes of the 'pre' supine rest period was in the supine position, followed by 23 minutes of the 'during' period, where subjects were given supine rest without instructions. This was followed by 5 minutes of the 'post' supine rest period of supine rest. The time breakup has been given below.



CM = Cyclic Meditation

SR = Supine rest

P300 = P300 event related potentials

RMV = Respiratory and metabolic variables

SLCT = Six letter cancellation test

HRV = Heart rate variability

4.0 INTERVENTIONS

4.1 Cyclic Meditation

Throughout the practice of cyclic meditation subjects kept their eyes closed, and followed taped instructions with ear phones. The instructions emphasized carrying out the practice slowly, with awareness and relaxation. The practice began by repeating a verse from the yoga text, the *Māṇḍukya Upaniṣat* (40 seconds); followed by isometric contraction of the muscles of the body ending with supine rest (1 minute): standing at ease (called *tāḍāsana*) and 'balancing' the weight on both feet (2 minutes): then the first actual posture, bending to the right (*arḍakaticakrāsana,* 1 minute 20 seconds); a gap of 1 minute 10 seconds with instructions about relaxation and awareness; bending to the left (1 minute 20 seconds); a gap as before (1 minute 10 seconds); forward bending (*pādahastāsana,* 1 minute 20 seconds); another gap (1 minute 10 seconds); backward bending *(arḍacakrāsana*, 1 minute 20 seconds); supine rest with instructions to relax different parts of the body in sequence (10 minutes). The pictorial description of these postures in CM is given in Plate RL1. The postures were practiced slowly, with awareness of all the sensations that are felt. The total duration of the practice was 23 minutes (Nagendra, & Nagarathna, 2003). The basis of CM and its practical details are elaborated in Review of Literature **(2.2.6.1XX).**

4.2 Supine rest

During supine rest session, the subjects were lying supine with legs apart and arms away from the sides of the body and eyes closed. The duration of the practice was 23 minutes.

5.0 DATA EXTRACTION

5.1 Respiratory and metabolic variables

The data were converted to the format that is compatible with Microsoft Excel program. The contiguous breath-by-breath data were then averaged for different states (i.e., pre, during and post) of each recording session. The data of the 'during' state were divided into 4 sub-phases for further analysis (Table 4.5.1).

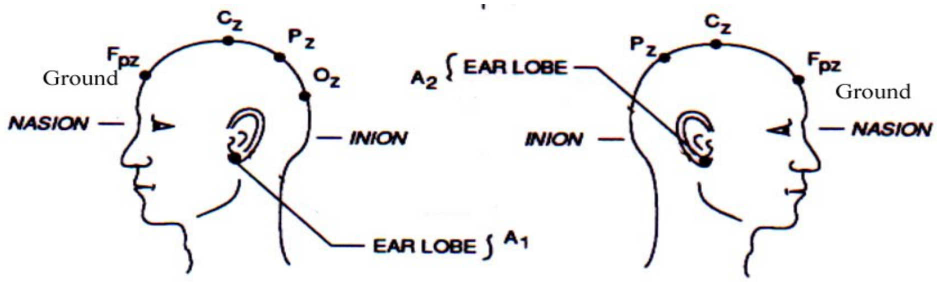
5.2 Heart rate variability (HRV)

The data were continuously acquired throughout the recording session; hence it was divided into 7 phases of 5 minutes for analysis (Table 4.5.2). The data small episodes of artifacts were shredded and were included for analysis. Data were analyzed with an "advanced HRV analysis software" program developed by Biomedical Signal Analysis Group, University of Kuopia, Finland (Niskanen, Tarvainen, Ranta-aho, & Karjalainen, 2004). To recover an evenly sampled signal from the irregularly sampled event series, a cubic interpolation was applied and the HRV power spectrum was obtained using Fast Fourier Transform analysis (FFT) (Fig. M1). The power in the HRV series of the following specific bands was studied, viz., the very low frequency component (0.0 - 0.05 Hz), low frequency component (0.05 - 0.15 Hz), and high frequency component (0.15 - 0.50 Hz). The low frequency and high frequency values were expressed as normalized units, which represent the relative of each power component in proportion to the total power minus VLF component [LF norm = LF / (total power-VLF) × 100; HF norm = HF / (total power – VLF) ×100)] (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, Heart Rate Variability: standards of measurement, physiological interpretation, and clinical use, 1996).

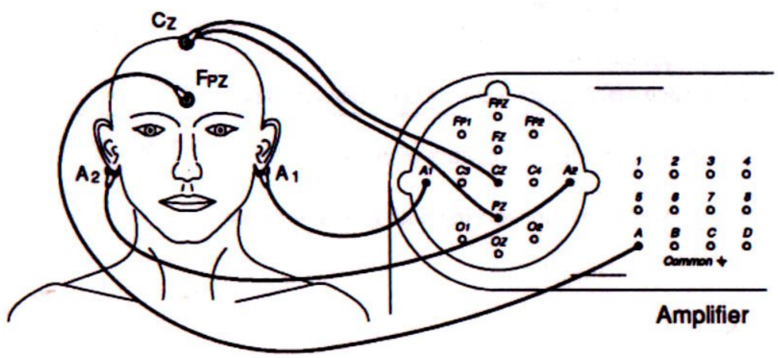
5.3 Computer averaged P300 auditory evoked potentials

The peak amplitude and peak latency of the P300 was measured at the three electrode sites; i.e., Fz, Cz and Pz. Peak amplitude (in μV) was defined as the voltage difference between a pre-stimulus baseline and the largest positive-going peak of the ERP waveform within 250-500ms latency (Polich, 1999). The latency (ms) was defined as the time from stimulus onset to the point of maximum positive amplitude within the latency window. The waveforms were visually inspected off-line for artifacts and the latency and the peak amplitude were obtained by selection with the cursor. The selection was performed by the experimenter. (Fig. M2). A sample record of P300 responses using Nicolet Bravo EP system (USA) in presented in Fig. M3.

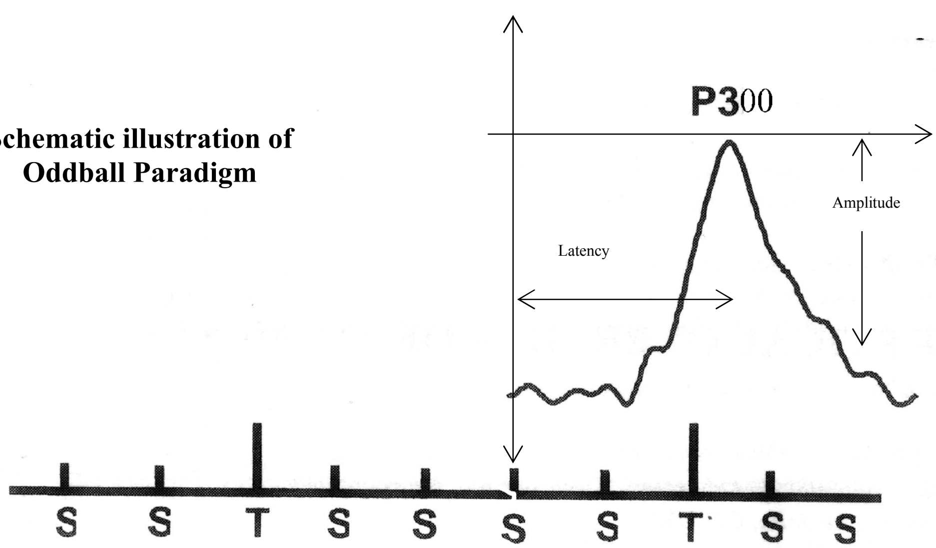
Fig. M2: Latency and amplitude of P300 responses



P300 Electrode Placement



Schematic illustration of Oddball Paradigm



The oddball task presents two different stimuli in a random sequence, with one occurring less frequently than the other (T = target, S = standard)

Nicolet Biomedical Inc.
5225 Verona Rd.
Madison, WI 53711
(608) 441-2000

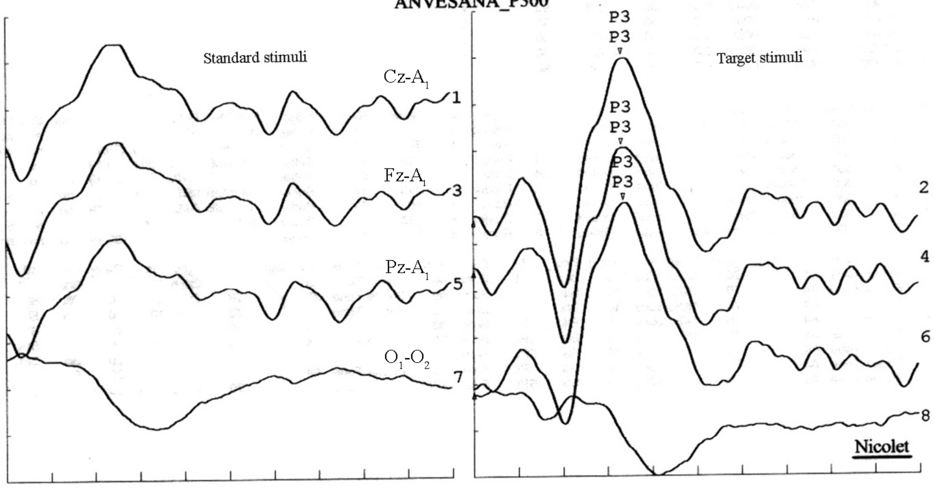
Code Name: SS
Med ID:
Date: 08/03/2004

First: PostCM
Birthdate:
Examiner: Sarang

Gender: M

Case History:
Notes/Impressions:

ANVESANA_P300



Sensitivity and Sweep Time Per Division

1	5.00 uV	75.0 ms	2	5.00 uV	75.0 ms	3	5.00 uV	75.0 ms	4	5.00 uV	75.0 ms
5	5.00 uV	75.0 ms	6	5.00 uV	75.0 ms	*7	5.00 uV	75.0 ms	8	5.00 uV	75.0 ms

P300

N1		N1		N1		
N1	$Cz-A_1$	N1	$Fz-A_1$	N1	$Pz-A_1$	
P2		P2		P2		
P2		P2		P2		
N2		N2		N2		
N2		N2		N2		
P3	324.00ms	P3	324.00ms	P3	327.00ms	
P3	17.00uV	P3	12.77uV	P3	19.87uV	

P	Elect	Mode	Sns	Lff	Hff	Notch	Artifact	REM	Remarks
	Cz-A1	Run	100uV	0.01	30	Off	90	1	
	Cz-A1	Run	100uV	0.01	30	Off	90	2	
	Fz-A1	Run	100uV	0.01	30	Off	90	3	
	Fz-A1	Run	100uV	0.01	30	Off	90	4	
	Pz-A1	Run	100uV	0.01	30	Off	90	5	
	Pz-A1	Run	100uV	0.01	30	Off	90	6	
	O1-O2	Run	100uV	0.01	30	Off	90	7	
	O1-O2	Run	100uV	0.01	30	Off	90	8	

Q	Comm	Sweep	Time	Delay	Rate	Trigger	Stim	MISC	Type	Ch#	Accept	Reject	Filter	Fsp/SNR	Date	Time	Add	Sub	Inv	Filter	Smooth
	A	300	750ms	75ms	0.9	Inter	Gated	1	Freqnt	1	216	11	Butter	-14.79dB	08/02/2004	05:19	no	no	no	no	no
	A	300	750ms	75ms	0.9	Inter	Gated	2	Rare	1	78	11	Butter	-14.79dB	08/02/2004	05:19	no	no	no	no	no
	A	300	750ms	75ms	0.9	Inter	Gated	3	Freqnt	2	218	9	Butter	-14.52dB	08/02/2004	05:19	no	no	no	no	no
	A	300	750ms	75ms	0.9	Inter	Gated	4	Rare	2	78	9	Butter	-14.52dB	08/02/2004	05:19	no	no	no	no	no
	A	300	750ms	75ms	0.9	Inter	Gated	5	Freqnt	3	213	12	Butter	-14.83dB	08/02/2004	05:19	no	no	no	no	no
	A	300	750ms	75ms	0.9	Inter	Gated	6	Rare	3	80	12	Butter	-14.83dB	08/02/2004	05:19	no	no	no	no	no
	A	300	750ms	75ms	0.9	Inter	Gated	7	Freqnt	4	218	1	Butter	-9.25dB	08/02/2004	05:19	no	no	no	no	no
	A	300	750ms	75ms	0.9	Inter	Gated	8	Rare	4	82	1	Butter	-9.25dB	08/02/2004	05:19	no	no	no	no	no

M	Trans	Type	Pol	Dur	Level	Freq	Pla	Ramp	Env	dB	Ear	Prcnt	Trans	Type	Pol	Dur	Level	Freq	Pla	Ramp	Env	dB	Ear	Prcnt
	Phone	Tone	Alt		70	1KHz	50cy	10	Blk	SPL	Both	80	Phone	Tone	Alt		70	2KHz	10cy	20	Blk	SPL	Both	20
	Phone	Tone	Alt		70	1KHz	50cy	10	Blk	SPL	Both	80	Phone	Tone	Alt		70	2KHz	10cy	20	Blk	SPL	Both	20
	Phone	Tone	Alt		70	1KHz	50cy	10	Blk	SPL	Both	80	Phone	Tone	Alt		70	2KHz	10cy	20	Blk	SPL	Both	20
	Phone	Tone	Alt		70	1KHz	50cy	10	Blk	SPL	Both	80	Phone	Tone	Alt		70	2KHz	10cy	20	Blk	SPL	Both	20
	Phone	Tone	Alt		70	1KHz	50cy	10	Blk	SPL	Both	80	Phone	Tone	Alt		70	2KHz	10cy	20	Blk	SPL	Both	20
	Phone	Tone	Alt		70	1KHz	50cy	10	Blk	SPL	Both	80	Phone	Tone	Alt		70	2KHz	10cy	20	Blk	SPL	Both	20
	Phone	Tone	Alt		70	1KHz	50cy	10	Blk	SPL	Both	80	Phone	Tone	Alt		70	2KHz	10cy	20	Blk	SPL	Both	20
	Phone	Tone	Alt		70	1KHz	50cy	10	Blk	SPL	Both	80	Phone	Tone	Alt		70	2KHz	10cy	20	Blk	SPL	Both	20

Fig. M3: Sample record of P300 responses measured using Nicolet Bravo EP system (USA)

6.0 DATA ANALYSIS

Statistical analysis was done using SPSS Version 10 after selecting the appropriate test. The raw data obtained for each subject in each recording session were tabulated separately and the methods of statistical analysis are given below:

(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) Repeated measures analyses of variance (ANOVA) were performed with two 'Within subjects' factors, i.e., Factor 1: Sessions; CM and SH and Factor 2: States; Pre, During, and Post. These repeated measures ANOVA were carried out for each variable separately.

(iii) For the normally distributed data paired t – tests were performed to compare the data of the 'during' and the 'post' periods with those of the respective 'pre' period.

For data that were found to be not normally distributed, step (ii) and (iii) were different. They have been described below as (ii)^ and (iii)^.

(ii)^ In place of the repeated measures of ANOVA described in step (ii) a Kruskal Wallis non parametric test was performed.

(iii)^ The Wilcoxon paired signed ranks test was performed to compare the data of the 'during' and the 'post' periods with those of the respective 'pre' periods.

Table T 4.5.1: States of recording sessions: Respiratory and metabolic variables (RMV)

Cyclic meditation session

5 minutes	**Cyclic meditation** (23 minutes: eyes closed)				5 minutes
	5 minutes D1	5 minutes D2	5 minutes D3	8 minutes D4	
'Pre' Supine rest (eyes closed)	Prayer IRT Linear awareness Standing up Centering Observation of changes *Arḍakaticakrāsana* (Right side)	Observation of changes *Arḍakaticakrāsana* (Left side) Observation of changes Balance *Pādahastāsana*	Observation of changes *Arḍacakrāsana* 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 *Sukhāsana* Prayer	'Post' Supine rest (eyes closed)

Supine rest session

5 minutes (eyes closed)	**Supine rest** (23 minutes: eyes closed)				5 minutes (eyes closed)
	5 minutes D1	5 minutes D2	5 minutes D3	8 minutes D4	
'Pre' Supine rest	Supine rest	Supine rest	Supine rest	Supine rest	'Post' Supine rest

D1 to D4 = Phases of 'During' state, IRT = Instant relaxation technique (Journal of Indian Psychology. 2002; 17(2): 46-52).
DRT = Deep relaxation technique (Psychological Reports. 2002; 90: 487-94).

Table T4.5.2: States of recording sessions: Heart rate variability (HRV)

Cyclic meditation session

5 minutes	**Cyclic meditation** (25 minutes: eyes closed)					5 minutes
	5 minutes D2	5 minutes D2	5 minutes D3	5 minutes D4	5 minutes D5	
'Pre' Supine rest (eyes closed)	Prayer IRT Linear awareness Standing up Centering Observation of changes *Arḍakaticakrāsana* (Right side)	Observation of changes *Arḍakaticakrāsana* (Left side) Observation of changes Balance *Pādahastāsana*	Observation of changes *Arḍacakrāsana* 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	Coming up in sitting position *Sukhāsana* Prayer Again lying down in supine position	'Post' Supine rest (eyes closed)

Supine rest session

5 minutes (eyes closed)	**Supine rest** (25 minutes: eyes closed)					5 minutes (eyes closed)
	5 minutes D2	5 minutes D2	5 minutes D3	5 minutes D4	5 minutes D5	
'Pre' Supine rest	Supine rest	Supine rest	Supine rest	Supine rest	Supine rest	'Post' Supine rest

D1 to D5 = Phases of 'During' state, IRT = Instant relaxation technique (Journal of Indian Psychology. 2002; 17 (2): 46-52).
DRT = Deep relaxation technique (Psychological Reports. 2002; 90: 487-94).

The most pertinent results detailed in the previous section are discussed under the two main categories of variables (i) measures of physiological arousal i.e., respiratory and metabolic variables, and heart rate variability measured through out (pre, during and post states) the recording sessions and (ii) measures of attention viz., P300 auditory event related potentials and performance in a letter cancellation task measured before (pre) and after (post) the sessions.

6.1 Respiratory and metabolic variables:

In the CM session the respiratory rate (cycles/min) increased during the first phase 'during' i.e., D1 (0.5 cycles/min), the second phase 'during' i.e., D2 (3 cycles/min) and the third phase 'during' i.e., D3 (3.14 cycles/min) (activating phases) of CM and returned towards baseline in the fourth phase 'during' i.e., D4 phase (claming phase) and further reduced by 1.12 cycles/min after CM. The total minute ventilation (l/min) increased during D1 (1.32 l/min), D2 (2.31 l/min) and D3 (3.51 l/min) phases of CM and returned towards baseline in D4 phase and further decreased 0.88 l/min *after* CM. Similarly the tidal volume also increased during D1 (15%), D2 (10%) and D3 (24%) phases of CM and returned to baseline during D4 phase and reduced by 13% *after* CM. In the supine rest session no change was observed in respiratory rate however a slight but significant reduction in minute ventilation and tidal volume was observed during the initial phases and not after supine rest.

There was 16%, 23% and 55% increase in oxygen consumption (ml/min) during D1, D2 and D3 phases of CM respectively. In D4 phase oxygen consumption returned to baseline values and reduced further by 19% *after* cyclic meditation. The carbon dioxide elimination (ml/min) also increased by 18%, 20% and 48% during D1, D2 and D3 phases of supine rest respectively and during D4 phase returned to baseline values, and reduced by 19% *after* cyclic meditation. Similar changes were observed in energy expenditure. In the CM session the energy expenditure (Kcal/day) increased by 16%, 24% and 55% in D1, D2 and D3 phases of 'during' state respectively and decreased by 20% *after* CM compared with the baseline. In supine rest session as well, there was a reduction in the oxygen consumption, carbon dioxide output and energy expenditure by 6 to 7% during D1 to D4 phases, which remained lower by 5% after supine rest.

There was a 9% and a 12% decrease in the partial pressure of alveolar carbon dioxide (kPa) during the D2 and D3 phases of CM, respectively. The partial pressure of end tidal carbon dioxide (kPa) also decreased by 5%, 12%, 8% and 2% in D1, D2, D3 and D4 phases of the 'during' state respectively and remained lower by 2% after cyclic meditation. The partial pressure of end tidal oxygen (kPa) increased during D1, D2, D3 and D4 phases of CM by 3%, 4%, 2% and 1% respectively and remained elevated by 1% *after* cyclic meditation. In contrast there was no significant change in PA_{CO2}, PET_{CO2} and PET_{O2} in the supine rest session.

In a previous study on the CM the oxygen consumption, breath rate, and tidal volume of forty male volunteers were assessed before and after sessions of CM and supine rest (Telles, Reddy, & Nagendra, 2000). There was a significant decrease in the amount of oxygen consumed and breath rate, and an increase in breath volume after both types of sessions. The magnitude of change on all three measures was greater after CM: (i) oxygen consumption decreased by 32.1% after CM compared with 10.1% decrease after SR; (ii) breath rate decreased by 18.0% after CM and 15.2% after SR; and (iii) breath volume increased by 28.8% after CM and 15.9% after SR. However (i) these findings were based on post versus pre comparisons and (ii) the assessments were made while breathing oxygen through a closed circuit apparatus (Benedicts-Roth, INCO, Ambala) (Mountcastle, 1980).

The magnitude of change in oxygen consumption that was observed in the earlier cited study on CM is greater than the changes observed in the present study i.e., 19% after CM and 7% after supine rest. This variation could be due to the technique used for measurement of these variables. In the closed circuit systems the subject breathes from a reservoir of 100% oxygen which creates an artificial situation (AARC Clinical Practice Guidelines for metabolic measurement using indirect calorimetry during mechanical ventilation, 1994). During exercise, it is difficult to measure oxygen uptake with closed circuit spirometry. The breathing resistance is increased, inspiratory time is prolonged, and the work of breathing may be increased as much as 10% in closed systems (Branson, 1990). In contrast in open circuit systems the subject breathes in ambient room air, and hence it does not increase the work of breathing. Generally an open circuit system is regarded as a more accurate measure than closed circuit as it is less prone to error, especially during exercise (Matarese, 1997).

The first three phases (D1, D2 and D3) of CM consisted of the slow practice of four standing postures (*yogāsanās*) and the fourth phase (D4) consisted of yoga based relaxation in a supine posture. In the present study, the increase in RR, V_E, V_T, V_{O2}, V_{CO2} and EE during the first three phases of cyclic meditation suggests that there was physiological activation and these postures provide a form of mild exercise. The results of the first three phases of cyclic meditation (but not the fourth phase) are consistent with earlier findings reported during the practice of Tai Chi Chun (TCC) meditation (Lan, Chen, Lai, & Wong, 2001). These findings indicated that though TCC involves slow body movements it provides moderate aerobic exercise. These results were also based on the measurements made while breathing atmospheric air through an open circuit apparatus. However it is important to note that TCC does not involve a combination of guided relaxation in supine posture with slow body movements as in cyclic meditation. A study has reported 25.2% reduction in oxygen consumption, and sympathetic activity after 10 minute practice of yoga based guided relaxation in a supine posture (Vempati, & Telles, 2002).

The respiratory rate, minute ventilation and tidal volume all are highly sensitive to phasic changes in the psychological state (Lorig, & Schwartz, 1990). Theoretical models of pulmonary responses have tended to identify a single variable, typically the metabolic rate and to attribute the majority of changes in pulmonary response to that variable. For example, early studies on Transcendental Meditation reported that the observed reduction in metabolic rate (and hence in the need of oxygen) during meditation was reflected in a decrease, essentially involuntary, in the rate of respiration and the volume of air breathed (Wallace, Benson, & Wilson, 1971). The greater reduction in oxygen consumption, decrease in respiratory rate, minute ventilation and tidal volume after CM, may have a similar explanation.

The greater reduction in oxygen consumption after CM and the similar changes in other variables suggest that the slow cyclic practice of yoga postures followed by rest in a supine posture induces deeper relaxation than supine rest alone. The importance of interspersing exercise with periods of rest had been described (Falk, 1995). Intermittent exercise was described as more likely to enhance enjoyment and improve compliance with the exercise plan. Yoga postures have been shown to serve as a form of mild exercise (Rai, & Ram, 1993). The yoga posture practiced in CM may have served as physically more activating than supine rest. A guided relaxation technique combined with meditative stretching (body-mind training) brought about a 31% reduction in electromyogram (EMG) of the frontalis muscle, 22% reduction in state anxiety and in fatigue. This suggested that meditative stretching combined with guided relaxation induces deeper muscular relaxation (Engel, & Andersen, 2000). Because the stress reducing effects of noncompetitive, moderate exercise are well known (Shephard, 1997) it may be indirectly inferred that the relatively higher level of physical activity in CM as compare to SR, may explain the respiratory changes following CM.

During CM, subjects are given instructions to relax and maintain that mental state. It has already been shown that exercise plus cognitive strategy programs are more effective in promoting psychological benefits compared with exercise programs lacking a structured cognitive component (Brown, Wang, Ward, Ebbeling, Fortage, Puleo, Benson, & Rippe, 1995). Hence both cognitive and psychological factors may contribute to the greater reduction in oxygen consumption and other respiratory changes following CM as compared with supine rest.

6.2 Heart Rate Variability (HRV):

The variables of the heart rate variability spectrum (i.e., LF, HF, LF/HF ratio and HR) were recorded in forty one subjects during CM and supine rest sessions. A significant increase in LF power (13%) and LF/HF ratio (55%) was observed in the 'D2' phase of CM; which returned to the baseline level in the 'D5' phase and was significantly reduced by 6% and further by 15% *after* the practice of CM. The HF power in contrast significantly reduced in 'D2' phase of CM (27%) and increased *after* the practice of CM (11%). The heart rate showed a significant increase by 11.4, 22.1 and 18 b/min in 'D1', 'D2' and 'D3' phases of CM and significantly reduced in 'D4' phase by 1.4 b/min and further reduced by 2.37 b/min *after* the practice of CM. No significant change was observed in the LF, HF power and LF/HF ratio during and after the SR. However a slight but significant increase (1.91 b/min) in heart rate was noted in the 'D5' phase of during and after (1.62 b/min) periods of supine rest.

The LF band of HRV is thought to correspond to sympathetic modulation when expressed in normalized units as opposed to absolute units (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, Heart Rate Variability: standards of measurement, physiological interpretation, and clinical use, 1996), and the efferent vagal activity is major contributor to the HF band. The LF/HF ratio is correlated with the sympathovagal balance (Malliani, Pagani, Lombardi, & Cerutti, 1991). Cyclic meditation is a 'moving meditation' technique in which physical postures are interspersed with relaxation. The 'D2' phase of CM consisted of a lateral bending posture (*arḍakaticakrāsana)* and a forward bending posture (*pādahastāsana).* The increase in LF power and LF/HF ratio and reduction in HF power during this phase of CM suggested sympathetic activation and increased cardiac vagal activity. These results are similar to the changes observed during the practice of the yogic headstand known as *sirśāsana* (Manjunath, & Telles, 2003).

A study conducted on twenty two healthy subjects to evaluate the effect of Zen meditation on heart rate varibility reported 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). In the present study the recovery in the LF and HF power and LF/HF ratio to the respective baselines in the last phase of CM and a further significant reduction in LF power and LF/HF ratio and an increase in HF power after the practice of CM suggested deeper relaxation.

The increase in heart rate during the slow practice of postures in CM reflect the physiological arousal. The reduction in heart rate in relaxation phase (D4) of CM and further decrease in HR after the practice of CM indicate a rested state. The changes in the heart rate during yogic practices is well known (Telles, Joshi, Dash, Raghuraj, Naveen, & Nagendra, 2004). A slight but significant increase in heart rate in the last phase and after the supine rest could be due to lying in supine posture for a longer period (35 min) without any instructions. The studies on guided relaxation have shown that relaxation with instructions is more effective than mere supine rest (Sakakibara, Takwuchi, & Hayano, 1994). Also after exercise the heart rate and blood pressure returned to the baseline levels sooner when subjects practiced guided relaxation compared with recovery after supine rest (Bera, Gore, & Oak, 1998).

However some reports have shown that not every person is able to relax in supine position (Vempati, & Telles, 2002).

The present results of reduction in physiological arousal after the practice of CM are similar to the present and earlier study on CM which showed reduction in respiratory rate and oxygen consumption immediately after the practice of CM (Telles, Reddy, & Nagendra, 2000). These finding are in keeping with concept of CM stated in *Māndukya Upaniṣat*.

6.3 Computer averaged P300 event related potentials

The P300 auditory evoked potentials (peak latency and peak amplitude) were recorded in 42 subjects in CM and supine rest sessions from Fz, Cz and Pz electrode sites referenced to linked earlobes (A1-A2).

The group average of P300 peak latency after CM was significantly lower at Fz (35.85 ms), Cz (36.71 ms) and Pz (39.62 ms) electrode sites, than the respective baseline values. A similar trend of reduction in P300 peak latency at Fz (12.57 ms), Cz (17.79 ms) and Pz (17.03 ms) was observed after supine rest, compared to respective baseline values. The group average P300 peak amplitude after CM was significantly higher at Fz (34.42%), Cz (26.18%) and Pz (13.51%) sites compared with before cyclic meditation. In contrast no significant change was observed in the P300 peak amplitude after supine rest.

The P300 amplitude is thought to indicate amount of brain activity related to incoming information processing and it is more sensitive to the amount of attentive resources engaged during the task. P300 latency reflects the stimulus classification (cognitive) speed, is generally unrelated to the overt response, and is independent of behavioral reaction time. Because P300 latency is an index of stimulus processing rather than response generation, it is used as a motor-free measure of cognitive function. P300 peak latency has been found to be negatively correlated with mental function in normal subjects: Shorter latencies are associated with superior cognitive performance from neuro-psychologic tests of attention and immediate memory (Polich, 2004). In present study both amplitude and latency of the P300 potentials have changed following intervention.

Previous studies have shown definite changes in the P300 evoked responses following Brahmakumaris Raja yoga meditation and Transcendental meditation (Joseph, Ram Shankar, Kulkarni, Ramchandra, Narasimhalu, & Desiraju, 1987). TM practice was studied using a passive auditory paradigm listening trial with variable inter-stimulus intervals (1-4 s) between identical tone stimuli (Cranson, Goddard, & Orme-Johnson, 1990). The subjects were non-meditator controls, novices, and experienced TM meditators with mean ages of 20, 28, and 41 years, respectively. The IQ scores did not differ among the groups. The P300 latency was shorter for the two meditation groups, with the long-term meditators showing the shortest P300 latency regardless of their age. In another study an auditory oddball task was used with eyes-closed to assess experienced TM meditators at pre-test baseline, after 10 minutes of rest, or after 10 minutes 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.

Sudarshan Kriya Yoga (SKY) is a meditation system that emphasizes breathing techniques. This technique was used as an intervention to assess dysthymia, dysthymia with melancholy, and unaffected control subject groups (Naga Venkatesh Murthy, Janakiramaiah, Gangadhar, & Subbukrishna, 1998). At three months, P300 amplitude increased to control levels in the patient groups.

The neuroelectric events that underlie P300 generation stem from the interaction between frontal lobe and hippocampal and temporoparietal function (Halgren, Marinkovic, & Chauvel, 1998). The primary neural generators for the P300 components are anterior cingulate when new stimuli are processed into working memory and subsequent activation of the hippocampal formation when frontal lobe mechanisms communicate with the temporal/parietal lobe connections (Polich, 1999). In the present study P300 peak amplitude increased at Fz, Cz and Pz scalp recording sites but the greater amplitude at the Fz indicates more involvement of frontal areas required for sustained attention. Various neuroimaging studies on meditation have shown increased regional cerebral blood flow measures during meditation. These and the EEG effects from meditative practice are thought to be generated by anterior cingulate cortex and dorsolateral prefrontal areas. These findings appear to index the increased attentional demand of meditative process (Polich, 2004).

6.4 Six letter cancellation test

A six letter cancellation test was administered in forty two subjects in CM and supine rest sessions. The net scores were calculated by deducting wrong cancellations from the total cancellations attempted.

Following the practice of CM and supine rest there was a significant improvement in the performance in a cancellation task. However the magnitude of change was higher following CM (26%) than supine rest (14%).

Cancellation tasks require visual selectivity and a repetitive motor response. These tasks assess many functions such as selective and focused attention, visual scanning, and the activation and inhibition of rapid responses (Lezak, Riddle, & U'ren RC, 1986). Certain studies have shown that anxiety affects performance requiring attentional abilities.

A study was conducted on high trait-anxious subjects and low anxious subjects, who were assessed on a Stroop color-naming paradigm (Fox, 1993). This test presented neutral and threatening words in color, in conditions where the distracting (word) and target (color) information were presented both together and separately. It was observed that the high-trait-anxious subjects took longer to color-name threatening words than neutral words when compared to low anxious subjects. Also they were distracted by separate color words. This suggests that high trait-anxiety may be associated with a general inability to maintain attentional focus. In another study generalized anxiety disorder (GAD) patients, social phobia patients and normal healthy controls were assessed using a visual search task (Rinck, Becker, Kellermann, & Roth, 2003). This study showed that patients with GAD were slowed by GAD-related distractor words.

The practice of transcendental meditation (TM) has been reported to reduce physiological arousal (Wallace, Benson, & Wilson, 1971) and anxiety levels among students (Dillbeck, 1977). Practicing yoga breathing techniques (*pranayamas*) for eight weeks resulted in reduced physiological arousal as evidenced by increased skin resistance and a reduction in pulse rate, urinary catecholamine concentration and anxiety scores in patients with anxiety neurosis (Crisan, 1984). Another study was conducted on 108 school children who practiced yoga breathing techniques and showed that they performed better in spatial memory tasks than the group who practiced breath awareness (Naveen, Nagendra, Nagarathna, & Telles, 1997). These findings were attributed to the anxiety reducing effects produced by yoga breathing practices. A study on the practice of yoga based relaxation in exam going medical students showed a reduction in anxiety, improved concentration and reduction in number of failures compared to the control group (Malathi, & Damodaran, 1999). Similar mechanisms may have contributed to the results of the present study.

The basis for the present study was to determine whether CM which consists ‘calming’ and ‘stimulating’ measures with emphasis on awareness would favorably influence the performance in a six letter cancellation task compared supine rest. A study done on the effect of three different procedures- relaxation, visualization and yoga training on perception of physical and mental energy and mood, demonstrated that relaxation and visualization made subjects sleepy and sluggish immediately after the practice, whereas the yoga training consisting yogic stretch and breathing produced significantly greater increase in perception of mental and physical energy, feeling of alertness and mood of enthusiasm (Wood, 1993). Another study done on Tai Chi, a moving mindfulness meditation showed greater reduction in salivary cortisol and improvement in mood when compared to meditation and brisk walking (Jin, 1992). In the present results an improved performance in CM supports the hypothesis.

The subcortical brain area which is presumed to be involved in attentional mechanisms is the thalamus (Laberge, 1995). The thalamic circuitry is believed to be especially involved in the process of selective attention (Brunia, 1993; Laberge, & Brown, 1989). Cyclic meditation involves slow body movements with sustained attention (Nagendra, & Nagarathna, 2003). A study conducted to assess changes in middle latency auditory evoked potentials (MLAEPs) following yoga breathing showed that the early negative component of MLAEPs (i.e., the Na wave) significantly increased in peak amplitude and decreased in peak latency following the meditation on ‘OM’ (Telles, Nagarathna, Nagendra, & Desiraju, 1994). The neural generator of the Na wave of MLAEPs is believed to correspond to the mesencephalic-diencephalic (thalamic) level (Deiber, Ibañez, Fischer, Perrin, Mauguiére, 1988). Hence the study cited above suggests an enhancement in the sensory information processing at the thalamic level.

The results of the assessments made 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) Respiratory and metabolic variables, and heart rate variability recorded through out the interventions, and (ii) P300 event related potentials and letter cancellation test recorded before and after the interventions. In this chapter the tables and figures are interspersed with the text.

5.1 RESPIRATORY AND METABOLIC VARIABLES

Recapitulation: The respiratory and metabolic variables (i.e., V_E, V_T, RR, V_{O2}, V_{CO2}, PA_{CO2}, PET_{O2}, PET_{CO2} and EE) were recorded in 50 subjects during cyclic meditation and supine rest sessions. As described under Methods (data analysis), separate repeated measures ANOVAs were performed to compare the 'Pre' 'During' [During1 (D1) of 5min, During2 (D2) of 5min, During3 (D3) of 5min, During4 (D4) of 8 min] and 'Post' states of both the sessions. The events in D1 to D4 phases of 'During' state are given in Table 4.5.1. The test values of repeated measures of ANOVAs are summarized in Table 5.1.A. The paired t – tests were performed to compare the data of the 'During' and the 'Post' periods with those of the respective 'Pre' periods. In case of PA_{CO2}, as the data were not normally distributed Kruskal Wallis and Wilcoxon paired signed ranks tests were performed. The test statistics of Kruskal Wallis test are summarized in Table 5.1.B and the summary of changes in CM and SR sessions are given in Table 5.1.C and Table 5.1.D.

Table 5.1.A: Repeated Measures of ANOVA: Respiratory and metabolic variables

Variable	Repeated Measures ANOVA	SESSIONS (CM/SR)	STATES (Pre_D1_D2_D3_D4_Post)	SESSIONS^{X} STATES
V_E (l/min)	df, Error	1, 49	2.98, 146.22	2.88, 141.11
	F	117.19	142.12	180.27
	P	< 0.001***	< 0.001***	< 0.001***
V_T (l)	df, Error	1, 49	3.58, 175.41	3.81, 186.94
	F	14.86	35.53	42.58
	P	< 0.001***	< 0.001***	< 0.001***
RR (c/min)	df, Error	1, 49	3.72, 182.49	3.82, 187.26
	F	49.938	34.71	46.29
	P	< 0.001***	< 0.001***	< 0.001***
V_{O2} (ml/min)	df, Error	1, 49	2.58, 126.46	2.81, 137.71
	F	181.24	138.02	193.16
	P	< 0.001***	< 0.001***	< 0.001***
V_{Co2} (ml/min)	df, Error	1, 49	2.85, 139.99	3.06, 149.94
	F	133.05	109.33	163.41
	P	< 0.001***	< 0.001***	< 0.001***

PET_{O2} (kPa)	**df, Error**	1, 49	4.10, 200.9	3.80, 186.39
	F	14.62	21.44	21.88
	P	< 0.001***	< 0.001***	< 0.001***
PET_{Co2} (kPa)	**df, Error**	1, 49	3.94, 193.25	3.31, 162.22
	F	63.59	55.60	62.33
	P	< 0.001***	< 0.001***	< 0.001***
EE (Kcal/day)	**df, Error**	1, 49	2.60, 127.45	2.80, 139.53
	F	164.28	128.05	185.95
	P	< 0.001***	< 0.001***	< 0.001***

N=50, *** P < 0.001, ** P< 0.01, * P < 0.05

Table 5.1.B: Kruskal Wallis: Partial pressure of alveolar carbon dioxide (PA_{CO2})

	Pre (CM/SR)	**During(CM/SR)**				**Post (CM/SR)**
		D1	**D2**	**D3**	**D4**	
X^2	0.539	12.075	22.368	12.121	0.684	0.037
df	1	1	1	1	1	1
P	0.463	< 0.001***	< 0.001***	< 0.001***	0.408	0.847

N=50, *** P < 0.001, ** P< 0.01, * P < 0.05

Table 5.1.C: Respiratory and metabolic variables recorded in 'Pre', 'During' (D1 to D4) and 'Post' states of cyclic meditation and supine rest sessions. Values are group Mean + SD

Variables	Cyclic Meditation (CM)						Supine rest (SR)					
	Before	D 1	D 2	D3	D4	After	Before	D 1	D 2	D3	D4	After
V_E (l/min)	6.84 ±1.00	8.16*** ±1.26	9.15*** ±1.86	10.35*** ±1.82	7.08* ±1.10	5.96*** ±0.92	6.61 ±1.00	6.35** ±0.93	6.32** ±0.88	6.33* ±0.96	6.42 ±0.82	6.50 ±0.92
V_T (l)	0.50 ±0.10	0.57*** ±0.10	0.54** ±0.10	0.61*** ±0.10	0.50 ±0.09	0.43*** ±0.08	0.50 ±0.11	0.48* ±0.09	0.47* ±0.09	0.48 ±0.09	0.47* ±0.07	0.49 ±0.10
RR (c/min)	15.11 ±2.43	15.62* ±2.77	18.10*** ±3.32	18.25*** ±3.45	15.64 ±2.75	13.99*** ±2.68	14.39 ±2.80	13.99 ±2.67	14.26 ±2.84	14.12 ±2.77	14.51 ±2.49	14.45 ±2.66
V_{O2} (ml/min)	219.93 ±21.31	254.58*** ±42.86	271.53*** ±63.18	341.12*** ±56.81	214.55 ±31.42	177.28*** ±18.14	212.83 ±26.94	198.64*** ±25.88	197.34*** ±25.52	197.52*** ±26.91	198.72*** ±24.04	202.56*** ±23.01
V_{Co2} (ml/min)	195.12 ±20.94	229.85*** ±37.55	233.38*** ±52.84	288.45*** ±49.19	193.56 ±29.36	158.45*** ±17.44	190.56 ±24.58	179.61*** ±22.94	176.90*** ±21.90	176.65*** ±24.63	177.96*** ±21.23	182.36*** ±20.77
^PA_{Co2} (kPa)	4.92 ±0.95	4.59 ±1.39	4.46*** ±1.22	4.30*** ±1.78	5.07 ±0.68	4.97 ±1.07	5.07 ±0.76	5.33 ±1.16	5.04 ±2.19	4.98 ±2.08	4.97 ±1.23	5.35 ±1.55
PET_{O2} (kPa)	12.64 ±0.33	12.98*** ±0.31	13.15*** ±0.37	12.84*** ±0.33	12.84*** ±0.31	12.80*** ±0.35	12.70 ±0.36	12.70 ±0.36	12.70 ±0.38	12.69 ±0.38	12.72 ±0.35	12.69 ±0.39
PET_{Co2} (kPa)	4.60 ±0.31	4.35*** ±0.25	4.02*** ±0.31	4.23*** ±0.29	4.48*** ±0.27	4.52* ±0.31	4.60 ±0.30	4.64 ±0.31	4.63 ±0.30	4.62 ±0.29	4.60 ±0.30	4.63 ±0.29
EE Kcal/day	1517.87 ±147.05	1760.63*** ±289.84	1876.56*** ±438.89	2359.53*** ±394.17	1480.54 ±223.97	1215.59*** ±139.03	1472.11 187.53	1376.99*** 182.04	1367.83*** 177.65	1368.22*** 189.52	1375.73*** 167.79	1396.51*** ±175.31

N= 50, *** P < 0.001, ** P< 0.01, * P < 0.05; Paired t – test (2 tailed), ^ Wilcoxon signed ranks test, 'D1 to D4' and 'Post' compared with respective 'Pre' values

Table 5.1.D: Summary of changes in respiratory and metabolic variables recorded in 'Pre', 'During' (D1 to D4) and 'Post' states of cyclic meditation and supine rest sessions. Values are percent change or actual units as specified.

Variables	Cyclic Meditation (CM)					Supine rest (SR)				
	D 1	D 2	D3	D4	After	D 1	D 2	D3	D4	After
V_E (l/min)	↑1.32*** l/min	↑2.31*** l/min	↑3.51*** l/min	↑0.24* l/min	↓0.88*** l/min	↓0.26** l/min	↓0.29** l/min	↓0.28* l/min	NS	NS
V_T (l)	↑14.86*** (%)	↑9.57** (%)	↑24.07*** (%)	NS	↓13.00*** (%)	↓3.82* (%)	↓5.97* (%)	NS	↓6.25* (%)	NS
RR (c/min)	↑0.51* c/min	↑2.99*** c/min	↑3.14 *** c/min	NS	↓1.12 *** c/min	NS	NS	NS	NS	NS
V_{O2} (ml/min)	↑15.75*** (%)	↑23.46*** (%)	↑55.10*** (%)	NS	↓19.39*** (%)	↓6.67*** (%)	↓7.28*** (%)	↓7.20*** (%)	↓6.63*** (%)	↓4.83*** (%)
V_{Co2} (ml/min)	↑17.80*** (%)	↑19.61*** (%)	↑47.83*** (%)	NS	↓18.79*** (%)	↓5.75*** (%)	↓7.17*** (%)	↓7.30*** (%)	↓6.61*** (%)	↓4.30*** (%)
^PA_{Co2} (kPa)	NS	↓9.33* (%)	↓12.71* (%)	NS	NS	NS	NS	NS	NS	NS
PET_{O2} (kPa)	↑2.65*** (%)	↑4.00*** (%)	↑1.57*** (%)	↑1.56*** (%)	↑1.29*** (%)	NS	NS	NS	NS	NS
PET_{Co2} (kPa)	↓5.46*** (%)	↓12.47*** (%)	↓8.01*** (%)	↓2.57*** (%)	↓1.64* (%)	NS	NS	NS	NS	NS
EE Kcal/day	↑15.99*** (%)	↑23.63*** (%)	↑55.45*** (%)	NS	↓19.91*** (%)	↓6.46*** (%)	↓7.08*** (%)	↓7.06*** (%)	↓6.55*** (%)	↓5.14*** (%)

N= 50, *** $P < 0.001$, ** $P< 0.01$, * $P < 0.05$; Paired t – test (2 tailed), ^ Wilcoxon signed ranks test, 'D1 to D4' and 'Post' compared with respective 'Pre' values

5.1.1 Total minute ventilation (V_E):

The repeated measures ANOVA which consisted of the two within-subjects factors, i.e., (i) Sessions (cyclic meditation and supine rest) and (ii) States [Pre, During (D1 to D4) and Post] showed a significant difference between the Sessions (F=117.192, p<0.001, Greenhouse-Geisser epsilon=1.000), between the States (F=142.129, p<0.001, Greenhouse-Geisser epsilon=0.597), and the interactions between the Sessions and States (F = 180.276, p <0.001, Greenhouse-Geisser epsilon = 0.576).

In the cyclic meditation session the group average of total minute ventilation (l/min) significantly increased in D1, D2, D3 phases [p<0.001 (2) paired t –test] and also in D4 phase of 'during' state [p<0.05] compared to the baseline values. There was a significant reduction in total minute ventilation after (Post) the cyclic meditation from baseline (Pre) state [p <0.001]. In the supine rest session the total minute ventilation significantly reduced in D1, D2 [p <0.01] and in D3 [p <0.05] phases of 'during' state compared to baseline. There was no significant change after the supine rest (Fig. 5.1.1). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.1.1.A and Table 5.1.1.B respectively (see Appendix – 5).

5.1.2 Tidal volume (V_T):

The repeated measures ANOVA which consisted of the two within-subjects factors, i.e., (i) Sessions (cyclic meditation and supine rest) and (ii) States [Pre, During (D1 to D4) and Post] showed a significant difference between the Sessions (F = 14.864, p<0.001, Greenhouse-Geisser epsilon = 1.000), between the States (F

Fig. 5.1.1: V_E: Total minute ventilation (l/min) recorded in 'Pre', 'During' (D1 to D4) and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions.

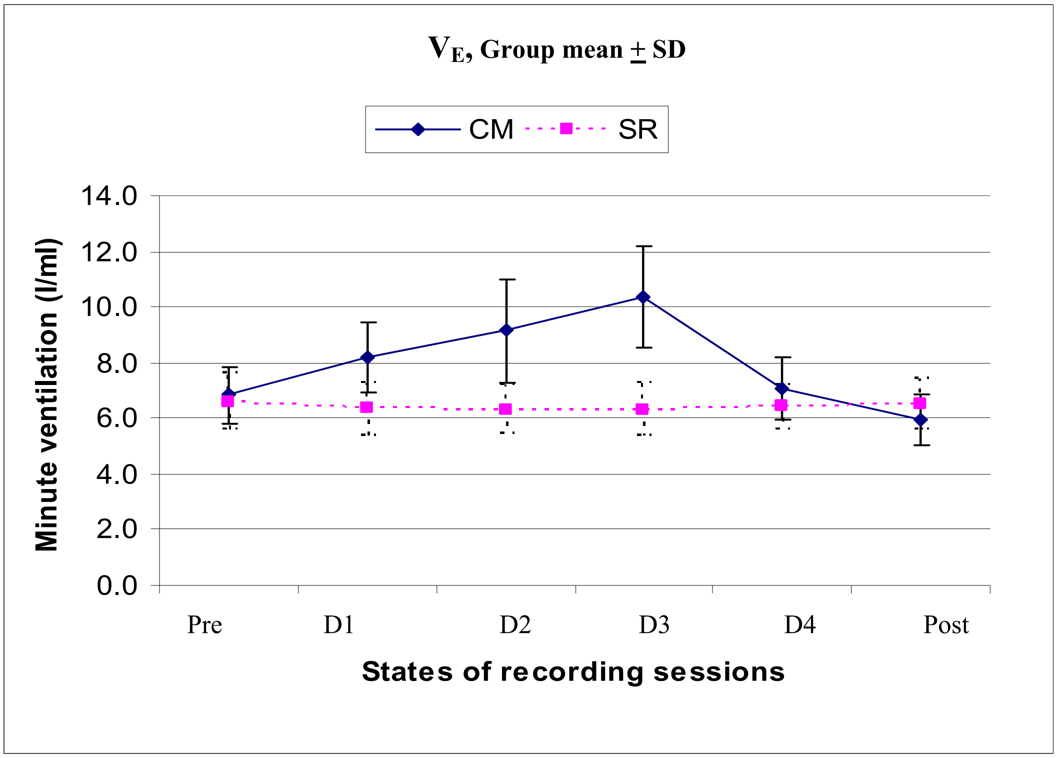
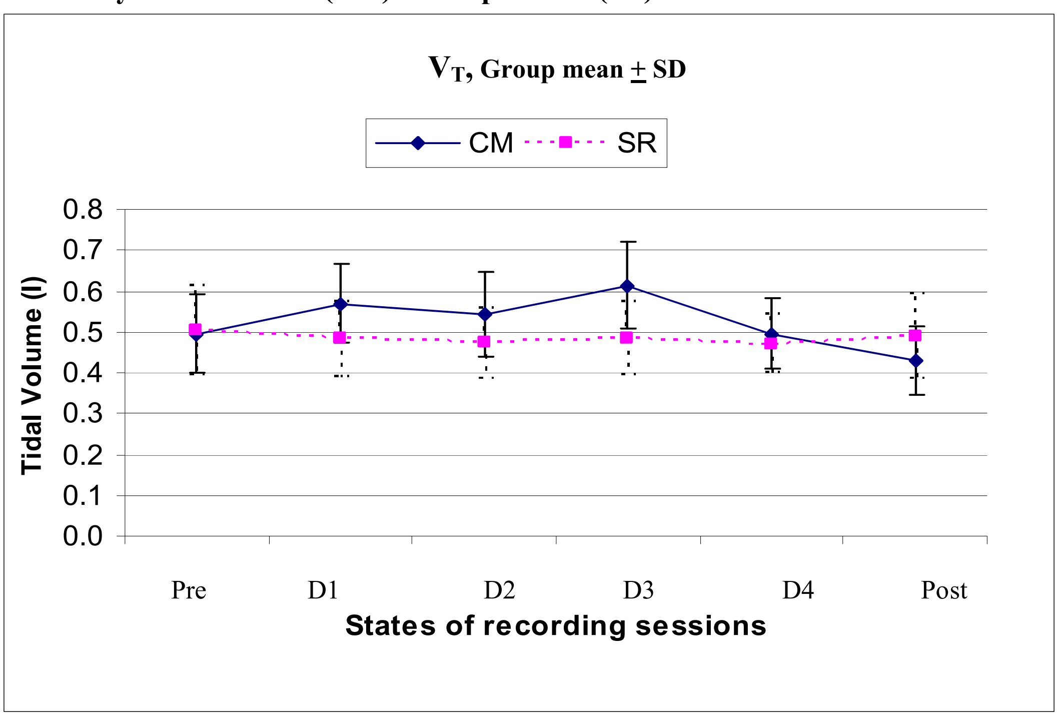


Fig. 5.1.2: V_T: Tidal volume (l) recorded in 'Pre', 'During' (D1 to D4) and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions.



N= 50, *** P < 0.001, ** P< 0.01, * P < 0.05; Paired t – test (2 tailed), 'D1 to D4' and 'Post' compared with respective 'Pre' values

= 35.539, p<0.001, Greenhouse-Geisser epsilon = 0.716), and the interactions between the Sessions and States (F = 42.587, p<0.001, Greenhouse-Geisser epsilon = 0.763).

In the cyclic meditation session the group average of tidal volume significantly increased in D1, D2 and D3 phases of 'during' state [p <0.001] compared to the baseline values. There was a significant reduction in tidal volume after (Post) cyclic meditation from baseline (Pre) state [p <0.001]. In the supine rest session the tidal volume significantly reduced in D1, D2 and D4 phases of 'during' state compared to baseline [p <0.05]. There was no significant change after the supine rest session (Fig. 5.1.2). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.1.2.A and Table 5.1.2.B respectively (see Appendix – 5).

5.1.3 Respiratory rate (RR):

The repeated measures ANOVA which consisted of the two within-subjects factors, i.e., (i) Sessions (cyclic meditation and supine rest) and (ii) States [Pre, During (D1 to D4) and Post] showed a significant difference between the Sessions (F = 49.938, p<0.001, Greenhouse-Geisser epsilon = 1.000), between the States (F = 34.718, p<0.001, Greenhouse-Geisser epsilon = 0.745), and the interactions between the Sessions and States (F = 46.291, p<0.001, Greenhouse-Geisser epsilon = 0.764).

In the cyclic meditation session the group average respiratory rate (c/min) significantly increased in D1, D2 and D3 phases of 'during' state [p <0.001 (2-tailed) paired t –test] compared to the baseline values. There was a significant reduction in respiratory rate after (Post) cyclic meditation from baseline (Pre) state [$p < 0.001$]. In the supine rest session no significant change was observed (Fig. 5.1.3). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.1.3.A and Table 5.1.3.B respectively (see Appendix – 5).

5.1.4 Oxygen consumption (V_{O2}):

The repeated measures ANOVA which consisted of the two within-subjects factors, i.e., (i) Sessions (cyclic meditation and supine rest) and (ii) States [Pre, During (D1 to D4) and Post] showed a significant difference between the Sessions ($F = 181.246$, $p<0.001$, Greenhouse-Geisser epsilon = 1.000), between the States ($F = 138.023$, $p<0.001$, Greenhouse-Geisser epsilon = 0.516), and the interactions between the Sessions and States ($F = 193.160$, $p<0.001$, Greenhouse-Geisser epsilon = 0.562).

In the cyclic meditation session the group average of oxygen consumption (ml/min - STPD) significantly increased in D1, D2, D3 phases of 'during' state [$p < 0.001$] compared to the baseline values. There was a significant reduction in oxygen consumption after (Post) the cyclic meditation from baseline (Pre) state [$p < 0.001$]. In the supine rest session the oxygen consumption significantly reduced in D1, D2, D3 and D4 phases of 'during' state and after the supine rest [$p < 0.001$] compared to baseline (Fig. 5.1.4). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.1.4.A and Table 5.1.4.B respectively (see Appendix – 5).

Fig. 5.1.3: RR: Respiratory rate (c/min) recorded in 'Pre', 'During' (D1 to D4) and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions.

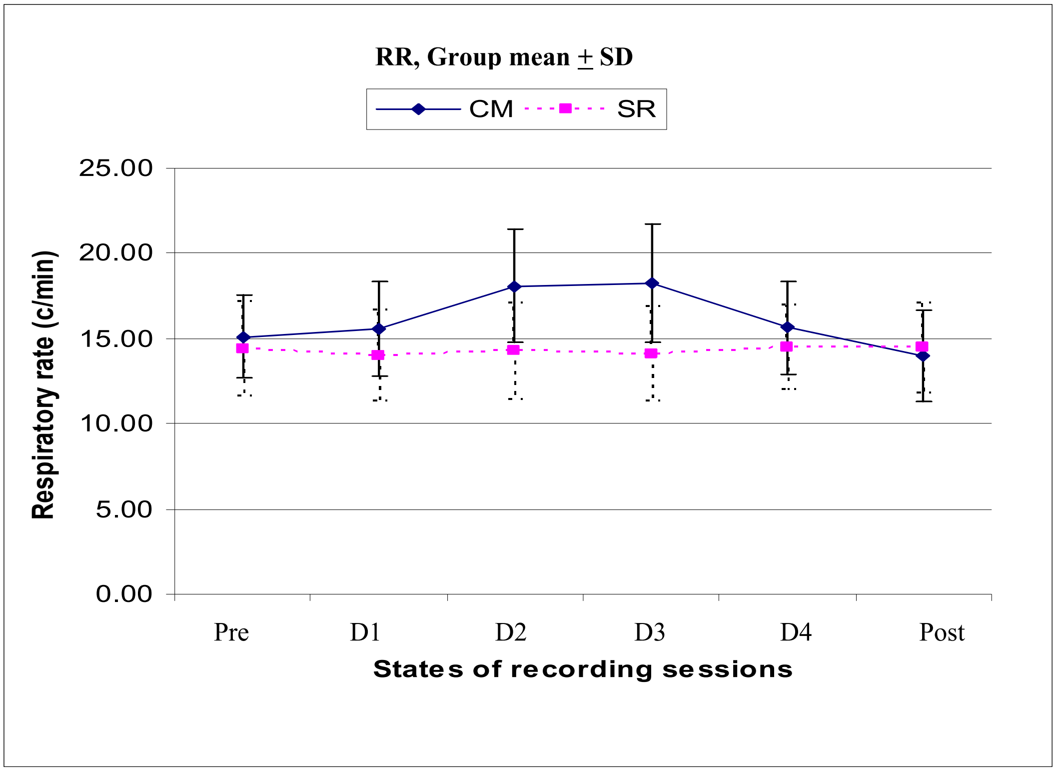
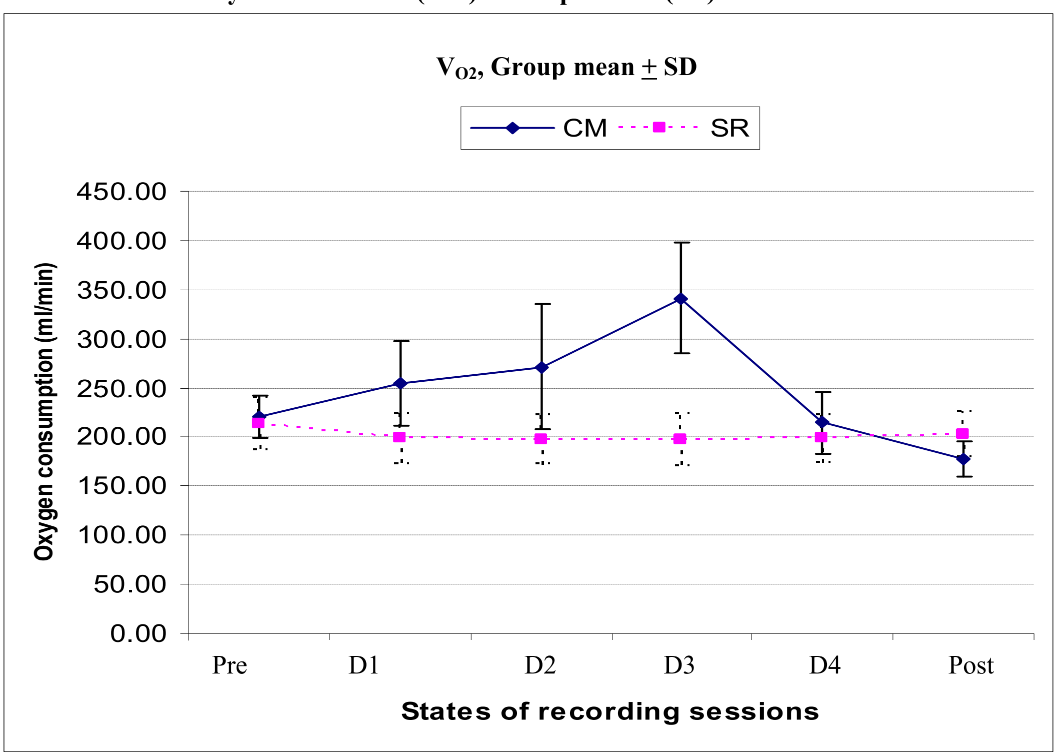


Fig. 5.1.4: V_{O2}: Oxygen consumption (ml/min_STPD) recorded in 'Pre', 'During' (D1 to D4) and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions.



N= 50, *** P < 0.001, ** P< 0.01, * P < 0.05; Paired t – test (2 tailed), 'D1 to D4' and 'Post' compared with respective 'Pre' values

5.1.5 Carbon dioxide output (V_{CO2}):

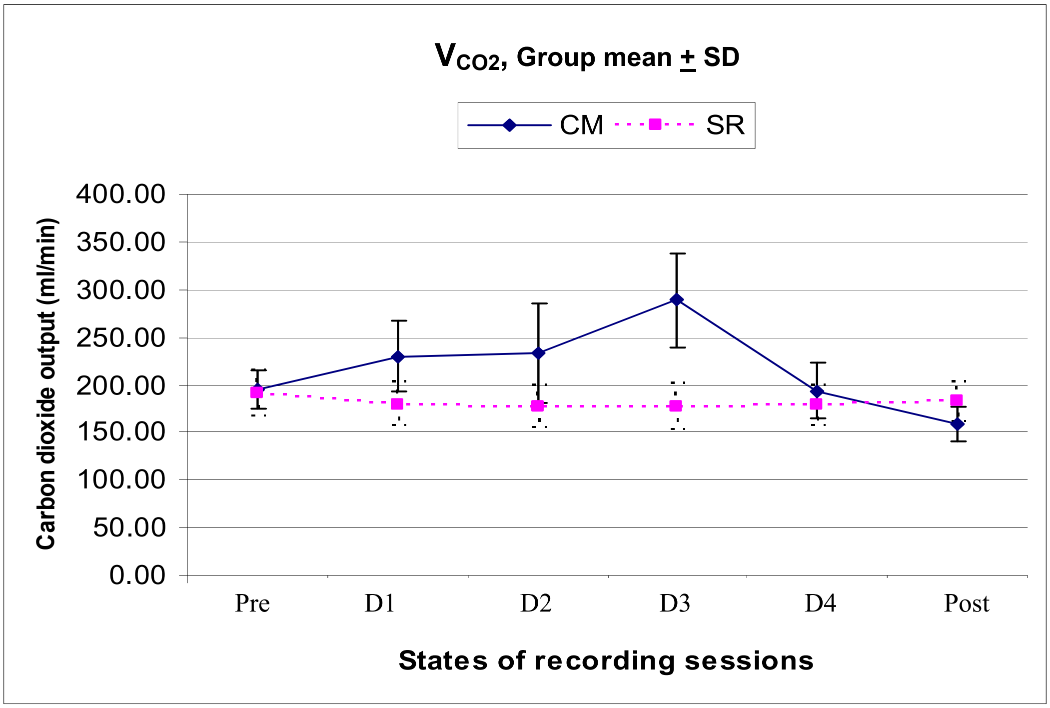
The repeated measures ANOVA which consisted of the two within-subjects factors, i.e., (i) Sessions (cyclic meditation and supine rest) and (ii) States [Pre, During (D1 to D4) and Post] showed a significant difference between the Sessions (F = 133.055, p<0.001, Greenhouse-Geisser epsilon = 1.000), between the States (F = 109.337, p<0.001, Greenhouse-Geisser epsilon = 0.202), and the interactions between the Sessions and States (F = 163.417, p <0.001, Greenhouse-Geisser epsilon = 0.201).

In the cyclic meditation session the group average of carbon dioxide out put (ml/min - STPD) significantly increased in D1, D2 and D3 phases of 'during' state [p <0.001 (2-tailed) paired t –test] compared to the baseline values. There was a significant reduction in carbon dioxide elimination after (Post) cyclic meditation from baseline (Pre) state [p <0.001]. In the supine rest session the carbon dioxide out put significantly reduced in D1, D2, D3 and D4 phases of 'during' state, and after the supine rest compared to baseline [p <0.001] (Fig. 5.1.5). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.1.5.A and Table 5.1.5.B respectively (see Appendix – 5).

5.1.6 Partial pressure of carbon dioxide in alveoli (PA_{CO2}):

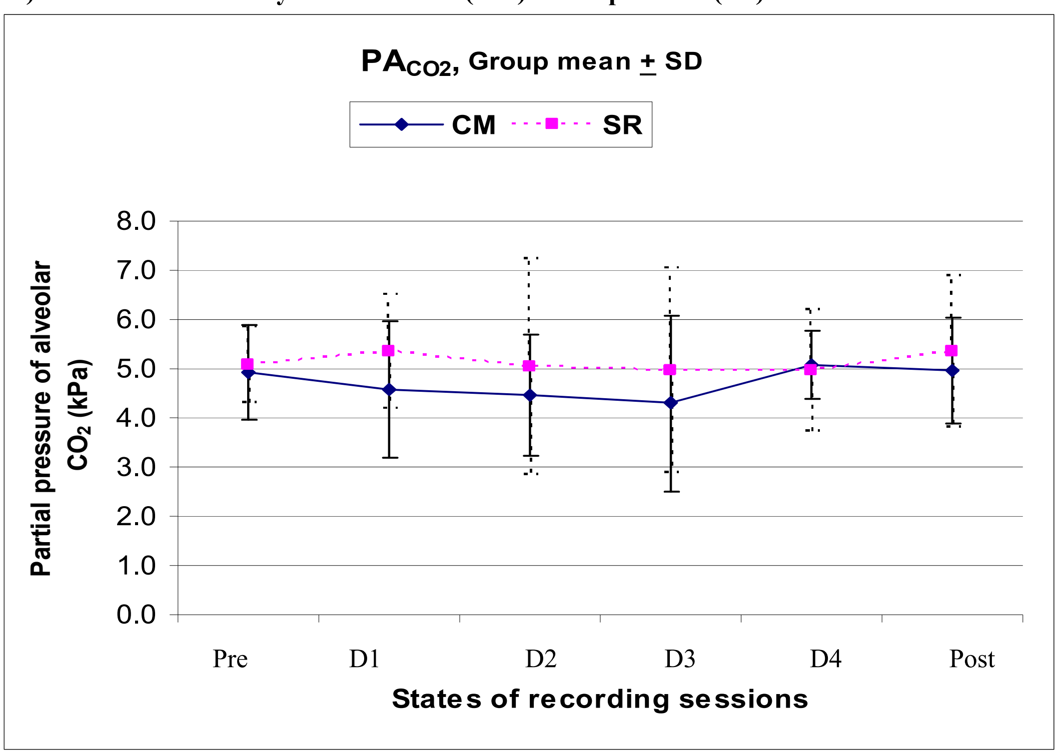
As data were not normally distributed Kruskal Wallis and Wilcoxon paired signed ranks tests were performed. The Kruskal Wallis Test which consisted two factors i.e., (i) grouping variable (CM and SR) and (ii) test variable list [Pre, During (D1 to D4) and Post] showed a significant difference between the sessions in D1 (x^2 = 12.075, df =1, p <0.001), D2 (x^2 = 22.368, df =1, p <0.001), D3 (x^2 = 12.121, df =1, p <0.001) phases of 'during' state.

Fig. 5.1.5: V_{CO2}: Carbon dioxide output (ml/min_STPD) recorded in 'Pre', 'During' (D1 to D4) and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions.



N= 50, *** P < 0.001, ** P< 0.01, * P < 0.05; Paired t – test (2 tailed), D1 to D4 and Post compared with respective 'Pre' values

Fig. 5.1.6: PA_{CO2}: Alveolar carbon dioxide pressure (kPa) recorded in 'Pre', 'During' (D1 to D4) and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions.



N= 50, *** P < 0.001, ** P< 0.01, * P < 0.05; Wilcoxon signed ranks test, 'D1 to D4' and 'Post' compared with respective 'Pre' values

In the cyclic meditation session the group average of the partial pressure of carbon dioxide in alveoli (kPa) significantly decreased and in D2 and D3 phases of 'during' state [$p < 0.001$ (2-tailed) Wilcoxon signed ranks test] compared to the baseline values. No significant change was seen in supine rest session session. (Fig.5.1.6). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.1.6.A and Table 5.1.6.B respectively (see Appendix – 5).

5.1.7 Partial pressure of end tidal carbon dioxide (PET_{CO2}):

The repeated measures ANOVA which consisted of the two within-subjects factors, i.e., (i) Sessions (cyclic meditation and supine rest) and (ii) States [Pre, During (D1 to D4) and Post] showed a significant difference between the Sessions ($F = 63.591$, $p<0.001$, Greenhouse-Geisser epsilon = 1.000), between the States ($F = 55.601$, $p<0.001$, Greenhouse-Geisser epsilon = 0.789), and the interactions between the Sessions and States ($F = 62.333$, $p<0.001$, Greenhouse-Geisser epsilon = 0.662).

In the cyclic meditation session the group average of the partial pressure of end tidal carbon dioxide (kPa) significantly decreased in D1, D2, D3 and D4 phases of 'during' state [$p < 0.001$ (2-tailed) paired t –test] compared to the baseline values. Also there was a significant reduction in PET_{CO2} after (Post) cyclic meditation from baseline (Pre) state [$p < 0.05$]. There was no significant change in the supine rest session (Fig. 5.1.7). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.1.7.A and Table 5.1.7.B respectively (see Appendix – 5).

Fig. 5.1.7: PET_{CO2}: Partial pressure of end tidal carbon dioxide (kPa) recorded in 'Pre', 'During' (D1 to D4) and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions.

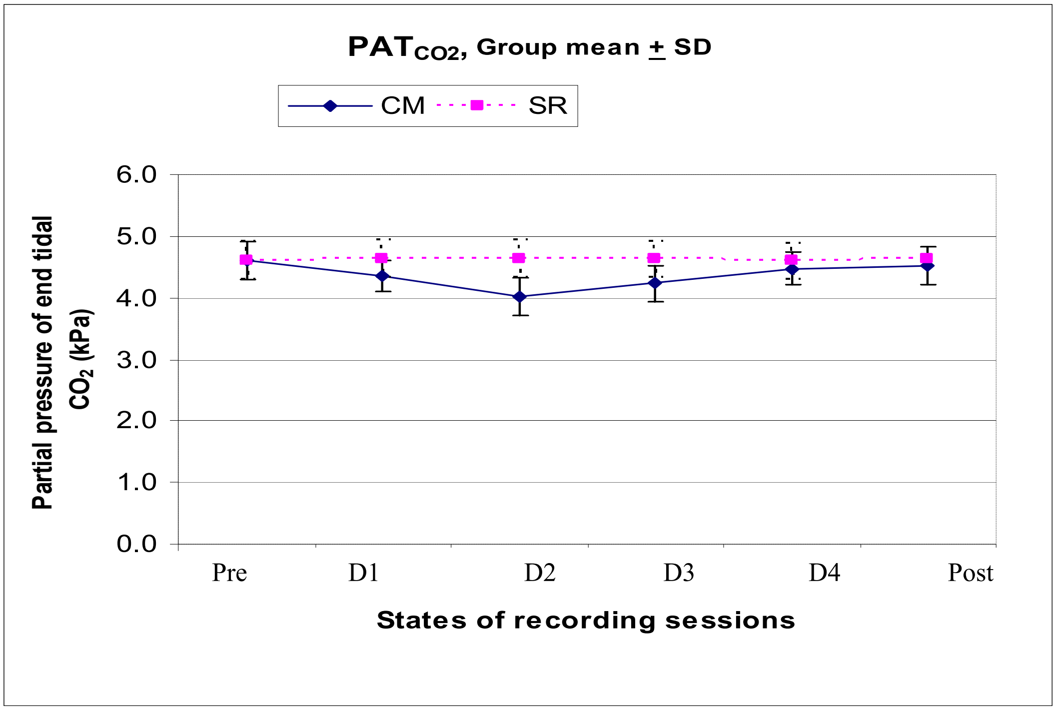
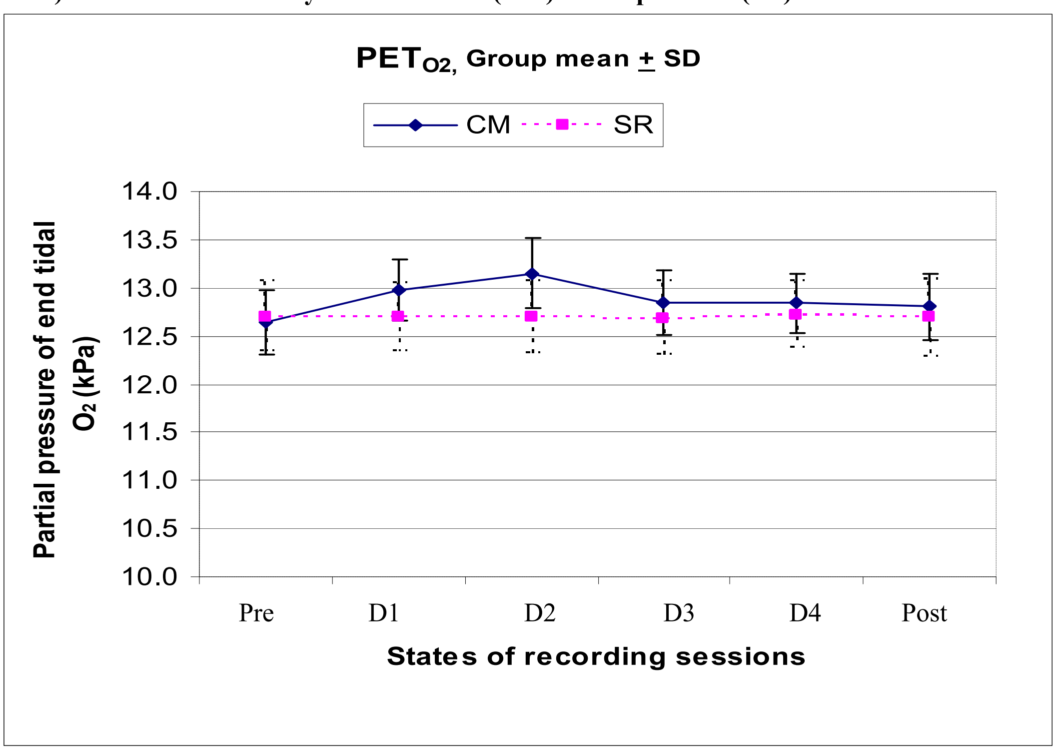


Fig. 5.1.8: PET_{O2}: Partial pressure of end tidal oxygen (kPa) recorded in 'Pre', 'During' (D1 to D4) and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions.



N= 50, *** $P < 0.001$, ** $P< 0.01$, * $P < 0.05$; Paired t – test (2 tailed), 'D1 to D4' and 'Post' compared with respective 'Pre' values

5.1.8 Partial pressure of end tidal oxygen (PET_{O2}):

The repeated measures ANOVA which consisted of the two within-subjects factors, i.e., (i) Sessions (cyclic meditation and supine rest) and (ii) States [Pre, During (D1 to D4) and Post] showed a significant difference between the Sessions ($F = 14.624$, $p<0.001$, Greenhouse-Geisser epsilon = 1.000), between the States ($F = 21.443$, $p<0.001$, Greenhouse-Geisser epsilon = 0.820), and the interactions between the Sessions and States ($F = 21.888$, $p<0.001$, Greenhouse-Geisser epsilon = 0.761).

In the cyclic meditation session the group average of the partial pressure of end tidal oxygen (kPa) significantly increased in D1, D2, D3 and D4 phases of 'during' state respectively [$p <0.001$ (2-tailed) paired t –test] compared to the baseline values. Also there was a significant increase in PET_{O2} after (Post) cyclic meditation from baseline (Pre) state [$p <0.001$]. There was no significant change in the supine rest session (Fig. 5.1.8). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.1.8.A and Table 5.1.8.B respectively (see Appendix – 5).

5.1.9 Energy Expenditure (EE):

The repeated measures ANOVA which consisted of the two within-subjects factors, i.e., (i) Sessions (cyclic meditation and supine rest) and (ii) States [Pre, During (D1 to D4) and Post] showed a significant difference between the Sessions ($F = 164.289$, $p<0.001$, Greenhouse-Geisser epsilon = 1.000), between the States ($F = 128.053$, $p<0.001$, Greenhouse-Geisser epsilon = 0.520), and the interactions between the Sessions and States ($F = 185.959$, $p <0.001$, Greenhouse-Geisser epsilon = 0.570).

In the cyclic meditation session the group average of energy expenditure (Kcal/day) significantly increased in D1, D2, D3 phases of 'during' state [$p < 0.001$ (2-tailed) paired t –test] compared to the baseline values. There was a significant reduction in oxygen consumption after (Post) the cyclic meditation from baseline (Pre) state [$p < 0.001$]. In the supine rest session the oxygen consumption significantly reduced in D1, D2, D3 and D4 phases of 'during' state, and after (Post) the supine rest session [$p < 0.001$] compared to baseline (Fig. 5.1.9). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.1.9.A and Table 5.1.9.B respectively (see Appendix – 5).

5.1.10 Visual Analogue Scale (VAS) while recording RMV:

The subjective impressions of the quality of practice, level of relaxation, level of awareness and quality of sleep during the preceding night were measured in 50 subjects after both cyclic meditation and supine rest sessions (Fig. 5.1.10). The actual scores of individual subjects after CM and SR sessions are presented with group mean ± SD in Table 5.1.10.A and Table 5.1.10.B respectively (see Appendix – 5).

The Pearson correlation coefficient was performed to correlate these scores with the percent changes in oxygen consumption. No significant correlations were observed. However a significant correlation [$p < 0.001$ (2-tailed) Pearson correlation test] was observed when quality of practice of CM was correlated with both the levels of relaxation and levels of awareness after CM. Scores of quality of practice of SR also showed a significant correlation [$p < 0.001$ (2)] with level of relaxation after SR, and no correlation with level of awareness.

Fig.5.1.9: EE: Energy expenditure (Kcal/day) recorded in 'Pre', 'During' (D1 to D4) and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions.

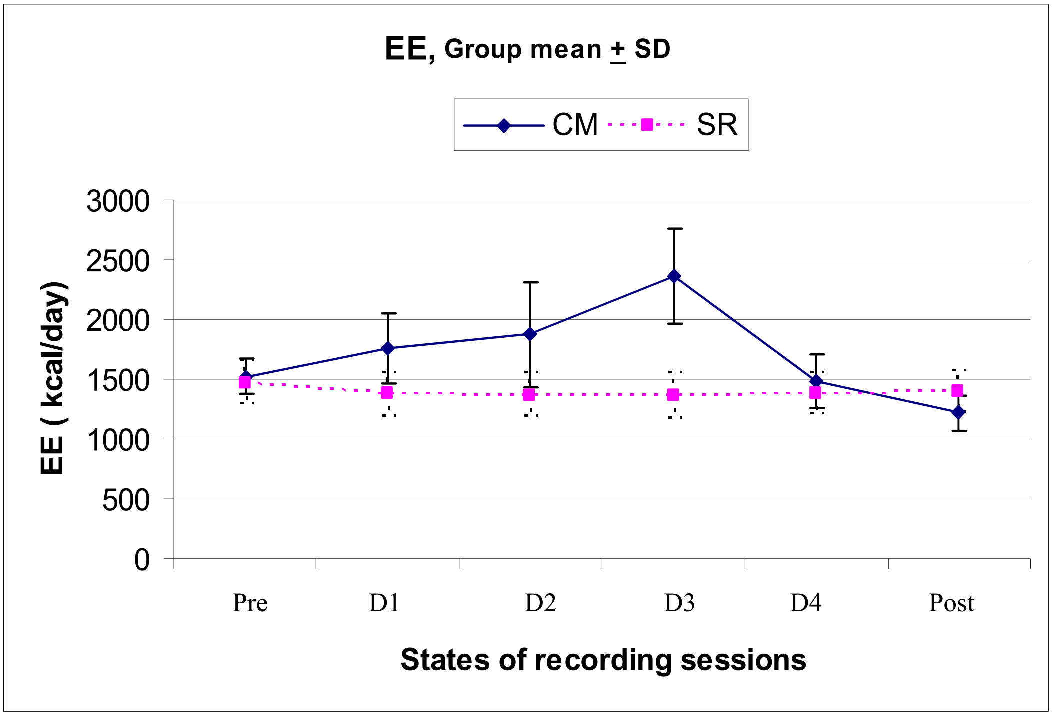
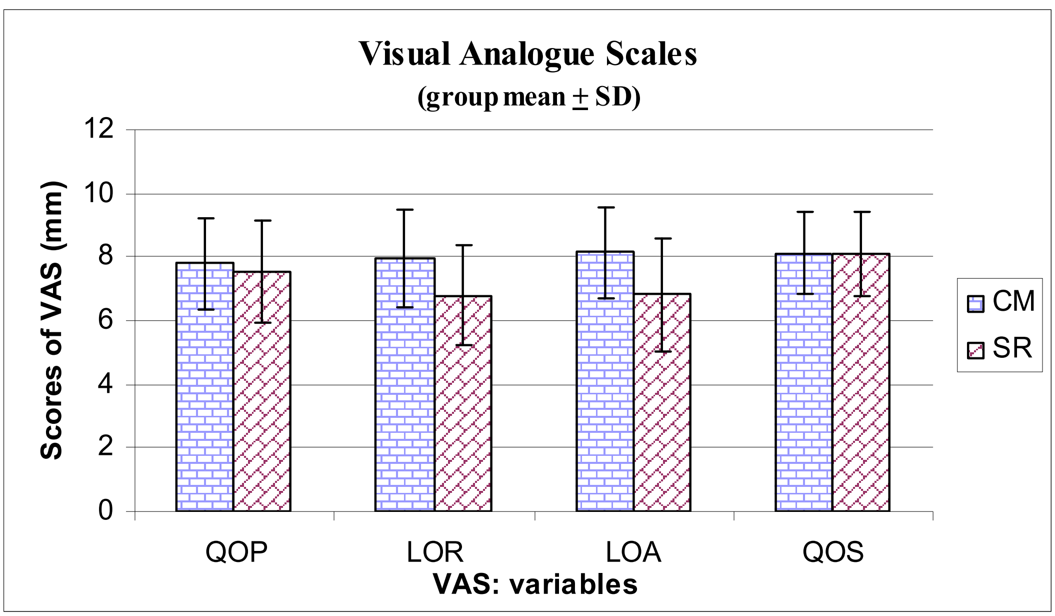


Fig. 5.1.10: Scores of visual analogue scales (VAS) measured (mm) after the RMV and HRV recording sessions of cyclic meditation (CM) and supine rest (SR).



QOP = Quality of practice, LOR = Level of relaxation, LOA = Level of awareness,
QOS = Quality of sleep

N= 50, *** P < 0.001, ** P< 0.01, * P < 0.05; Paired t – test (2 tailed), D1 to D4 and 'CM' compared with respective 'SR'.

Quality of practice and quality of sleep showed no significant difference between recording sessions of cyclic meditation and supine rest ($p > .05$, paired t-test) whereas level of relaxation and level of awareness showed a significant difference between cyclic meditation and supine rest sessions ($p < .001$, paired t-test).

5.2 HEART RATE VARIABILITY (HRV):

Recapitulation: The variables of heart rate variability spectrum (i.e., LF, HF, LF/HF ratio) and HR were recorded in 41 subjects during cyclic meditation and supine rest sessions. As described under Methods (data analysis), separate repeated measures ANOVAs were performed to compare the 'Pre', 'During' [During1 (D1) of 5min, During2 (D2) of 5min, During3 (D3) of 5min, During4 (D4) of 5 min, During5 (D5) of 5 min] and 'Post' states of both the sessions. The events in D1 to D5 phases of 'During' state are given in Table 4.5.2. The test values of repeated measures of ANOVAs are summarized in Table 5.2.A. The paired t – tests were performed to compare the data of the 'During' and the 'Post' periods with those of the respective 'Pre' period. The summary of changes in CM and SR sessions are given in Table 5.2.B and Table 5.2.C.

Table 5.2.A: Repeated Measures of ANOVA: Heart Rate Variability (HRV)

Variable	Repeated Measures ANOVA	SESSIONS (CM/SR)	STATES (Pre_D1_D2_D3_D4_D5_Post)	SESSIONS^{X} STATES
LF (n.u.)	df, Error	1, 40	3.53, 141.44	4.35, 174.36
	F	1.496	3.684	7.253
	P	0.228	0.009**	< 0.001***
HF (n.u.)	df, Error	1, 40	4.1, 163.98	5.03, 201.25
	F	2.208	7.654	7.954
	P	0.145	< 0.001***	< 0.001***
LF HF ratio	df, Error	1, 40	4.01, 160.67	4.58,183.55
	F	2.077	10.864	9.162
	P	0.157	< 0.001***	< 0.001***
HR (b/min)	df, Error	1, 40	3.28, 131.43	3.10, 124.36
	F	83.378	138.934	136.662
	P	< 0.001***	< 0.001***	< 0.001***

N= 41, *** P < 0.001, ** P< 0.01, * P < 0.05

Table 5.2.B: Frequency power of HRV spectrum (n.u.) and heart rate (b/min) recorded in 'Pre', 'During' (D1 to D5) and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions.

Values are group Mean ± SD

Variables	Cyclic Meditation (CM)							Supine rest (SR)						
	Pre	D1	D2	D3	D4	D5	Post	Pre	D1	D2	D3	D4	D5	Post
LF (n.u.)	66.71 ±9.05	66.57 ±9.54	75.70*** ±7.30	67.04 ±8.41	65.70 ±10.09	64.65 ±10.18	62.48*** ±9.95	65.06 ±12.44	64.19 ±10.9	64.79 ±12.80	66.91 ±10.80	66.39 ±10.20	64.38 ±9.99	65.25 ±11.14
HF (n.u.)	33.53 ±9.00	33.43 ±9.54	24.28*** ±7.30	32.95 ±8.41	34.30 ±10.09	35.35 ±10.18	37.30*** ±9.76	34.94 ±12.44	35.76 ±10.01	34.99 ±12.72	33.08 ±10.80	33.60 ±10.20	35.61 ±9.99	34.75 ±11.14
LF/HF Ratio	2.22 ±0.90	2.23 ±0.88	3.45*** ±1.19	2.26 ±0.93	2.19 ±1.00	2.08 ±0.94	1.88*** ±0.80	2.27 ±1.30	2.05 ±0.95	2.20 ±1.03	2.35 ±1.05	2.27 ±1.02	2.04 ±0.89	2.16 ±0.94
HR b/min	59.79 ±6.18	71.19*** ±7.97	81.95*** ±9.21	77.73*** ±7.91	58.36* ±6.40	59.32 ±5.32	57.42*** ±5.61	58.89 ±5.98	59.26 ±6.30	60.24 ±6.28	59.86 ±6.29	60.11 ±6.40	60.80** ±7.08	60.51** ±6.74

N= 41, *** $P < 0.001$, ** $P< 0.01$, * $P < 0.05$; Paired t – test (2 tailed), D1 to D5 and Post compared with respective 'Pre' values

Table 5.2.C Summary of changes in frequency power of HRV spectrum and heart rate recorded in 'Pre', 'During' (D1 to D5) and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions

Values are percent change or actual units as specified.

Variables	**Cyclic Meditation (CM)**						**Supine rest (SR)**					
	D1	**D2**	**D3**	**D4**	**D5**	**Post**	**D1**	**D2**	**D3**	**D4**	**D5**	**Post**
LF	**NS**	**↑13.47*** (%)**	**NS**	**NS**	**NS**	**↓6.35*** (%)**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
HF	**NS**	**↓27.58*** (%)**	**NS**	**NS**	**NS**	**↑11.26*** (%)**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
LF/HF Ratio	**NS**	**↑55.45*** (%)**	**NS**	**NS**	**NS**	**↓15.56*** (%)**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
HR b/min	**↑11.4 *** (b/min)**	**↑22.16*** (b/min)**	**↑17.94*** (b/min)**	**↓1.43* (b/min)**	**NS**	**↓2.37*** (b/min)**	**NS**	**NS**	**NS**	**NS**	**↑1.91** (b/min)**	**↑1.62** (b/min)**

N= 41, *** P < 0.001, ** P< 0.01, * P < 0.05; Paired t – test (2 tailed), 'D1 to D5' and 'Post' compared with respective 'Pre' values

5.2.1 Low frequency power (LF) of the Heart Rate Variability (HRV) spectrum

The repeated measures ANOVA which consisted of the two within-subjects factors, i.e., (i) Sessions (cyclic meditation and supine rest) and (ii) States [Pre, During (D1 to D5) and Post] showed no significant difference between the Sessions (F = 1.496, p = 0.228, Greenhouse-Geisser epsilon = 1.000), however there was a significant difference between the States (F = 3.684, p =0.009, Greenhouse-Geisser epsilon = 0.589), and the interactions between the Sessions and States (F = 7.253, p<0.001, Greenhouse-Geisser epsilon = 0.727). Also the comparison of baseline values of both the sessions (CM and SR) showed no significant difference (P >0.05 Paired t – test).

In the cyclic meditation session the group average LF values significantly increased in D2 phase of 'during' state [p <0.001 (2-tailed) paired t –test] compared to the baseline values. There was a significant reduction in LF values after (Post) cyclic meditation from baseline (Pre) state [p <0.001]. There was no significant change in the supine rest session (Fig. 5.2.1). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.2.1.A and Table 5.2.1.B respectively (see Appendix – 5).

5.2.2 High frequency power (HF) of the Heart Rate Variability (HRV) spectrum

The repeated measures ANOVA which consisted of the two within-subjects factors, i.e., (i) Sessions (cyclic meditation and supine rest) and (ii) States [Pre, During (D1 to D5) and Post] showed no significant difference between the Sessions (F = 2.208, p = 0.145, Greenhouse-Geisser epsilon = 1.000), however there was a significant difference between the States (F = 7.654, p <0.001,

Fig. 5.2.1: Low frequency power of HRV spectrum (n.u.) recorded in 'Pre', 'During' (D1 to D5) and 'Post' states of cyclic meditation and supine rest sessions.

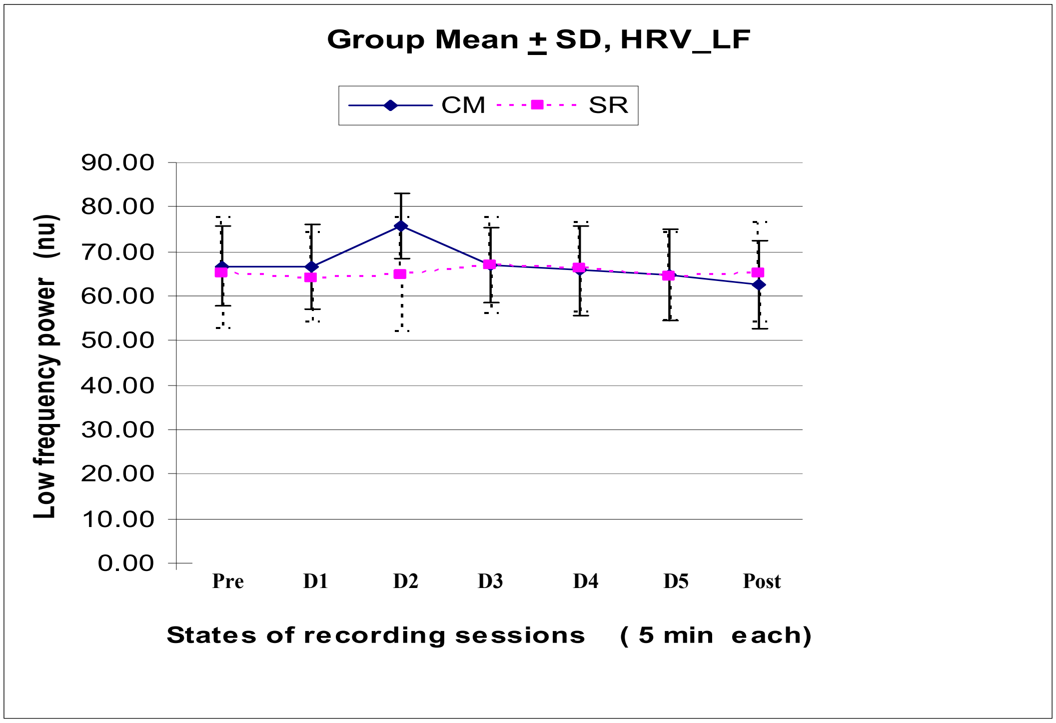
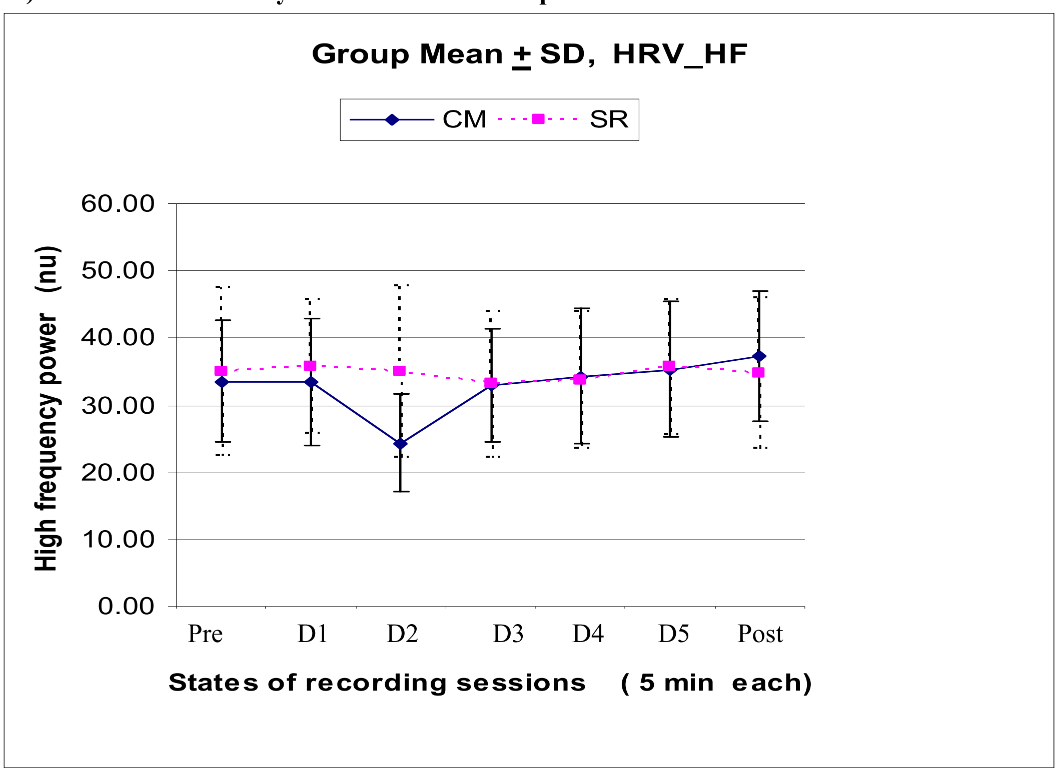


Fig. 5.2.2: High frequency power of HRV spectrum (n.u.) recorded in 'Pre', 'During' (D1 to D5) and 'Post' states of cyclic meditation and supine rest sessions.



N= 41, *** P < 0.001, ** P< 0.01, * P < 0.05; Paired t – test (2 tailed), D1 to D4 and Post compared with respective 'Pre' values

Greenhouse-Geisser epsilon = 0.683), and the interactions between the Sessions and States (F = 7.954, p<0.001, Greenhouse-Geisser epsilon = 0.839). Also the comparison of baseline values of both the sessions (CM and SR) showed no significant difference (P >0.05 Paired t – test).

In the cyclic meditation session the group average HF values significantly reduced in D2 phase of 'during' state [p <0.001 (2-tailed) paired t –test] compared to the baseline values. There was a significant increase in HF values after (Post) cyclic meditation from baseline (Pre) state [p <0.001]. There was no significant change in the supine rest session (Fig. 5.2.2). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.2.2.A and Table 5.2.2.B respectively (see Appendix – 5).

5.2.3 Ratio of LF/HF

The repeated measures ANOVA which consisted of the two within-subjects factors, i.e., (i) Sessions (cyclic meditation and supine rest) and (ii) States [Pre, During (D1 to D5) and Post] showed no significant difference between the Sessions (F = 2.077, p = 0.157, Greenhouse-Geisser epsilon = 1.000), however there was a significant difference between the States (F = 10.864, p <0.001, Greenhouse-Geisser epsilon = 0.669), and the interactions between the Sessions and States (F = 9.162, p<0.001, Greenhouse-Geisser epsilon = 0.765). Also the comparison of baseline values of both the sessions (CM and SR) showed no significant difference (P >0.05 Paired t – test).

In the cyclic meditation session the group average LF/HF ratio values significantly reduced in D2 phase of 'during' state [p <0.001 (2-tailed) paired t –test] compared to the baseline values. There was a significant reduction in LF/HF ratio values after (Post) cyclic meditation from baseline (Pre) state [$p < 0.001$]. There was no significant change in the supine rest session (Fig. 5.2.3). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.2.3.A and Table 5.2.3.B respectively (see Appendix – 5).

5.2.4 Heart Rate (HR)

The repeated measures ANOVA which consisted of the two within-subjects factors, i.e., (i) Sessions (cyclic meditation and supine rest) and (ii) States [Pre, During (D1 to D5) and Post] showed significant difference between the Sessions ($F = 83.378$, $p<0.001$, Greenhouse-Geisser epsilon = 1.000), the States ($F = 138.934$, $p < 0.001$, Greenhouse-Geisser epsilon = 0.548), and the interactions between the Sessions and States ($F = 136.662$, $p<0.001$, Greenhouse-Geisser epsilon = 0.518).

In the cyclic meditation session the group average HR significantly increased in D1, D2, D3 phases of 'during' state [$p < 0.001$ (2-tailed) paired t –test] compared to the baseline values. There was a significant reduction in HR in D4 phase of 'during' state [$p < 0.05$] and after (Post) cyclic meditation from baseline (Pre) state [$p < 0.001$]. In the supine rest session the group average HR significantly increased in D5 phase of 'during' state and after (Post) the supine rest [$p < 0.01$] compared to the baseline values (Fig. 5.2.4). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.2.4.A and Table 5.2.4.B respectively (see Appendix – 5).

Fig. 5.2.3: Ratio of LF/HF of HRV spectrum recorded in 'Pre', 'During' (D1 to D5) and 'Post' states of cyclic meditation and supine rest sessions.

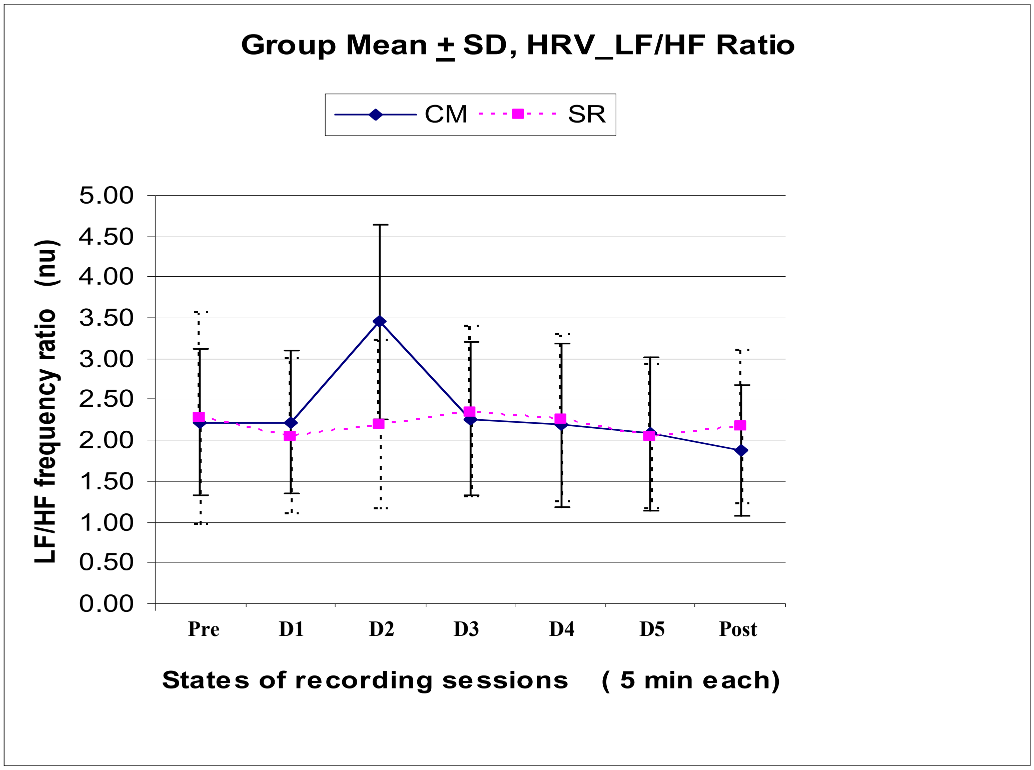
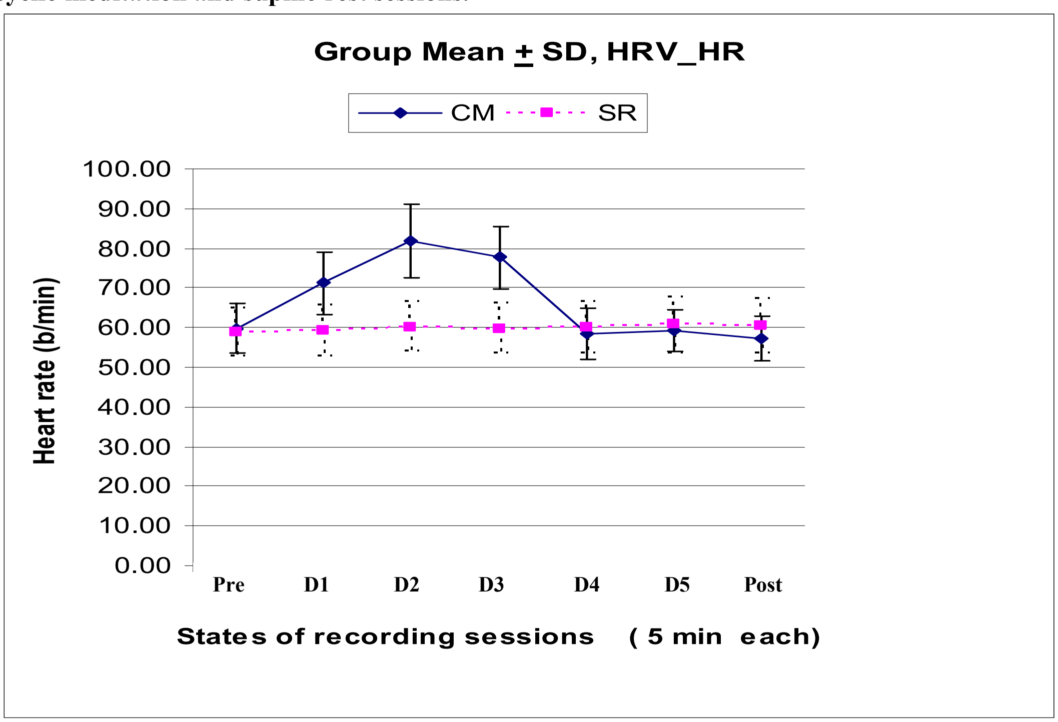


Fig. 5.2.4: Heart Rate (b/min) recorded in 'Pre', 'During' (D1 to D5) and 'Post' states of cyclic meditation and supine rest sessions.



N= 41, *** P < 0.001, ** P< 0.01, * P < 0.05; Paired t – test (2 tailed), D1 to D4 and Post compared with respective 'Pre' values

5.3 COMPUTER AVERAGED P300 EVENT RELATED POTENTIALS

Recapitulation: The P300 auditory evoked potentials (peak latency and peak amplitude) were recorded in 42 subjects in cyclic meditation and supine rest sessions from Fz, Cz and Pz electrode sites (referenced to linked earlobes). As described under Methods (data analysis), separate repeated measures ANOVAs were performed to compare the 'Pre' and 'Post' states of both the sessions. The test values of repeated measures of ANOVAs are summarized in Table 5.3.A. The paired t – tests were performed to compare the data of the 'Post' period with those of the respective 'Pre' period. The summary of changes in CM and SR sessions are given in Table 5.3.B, Table 5.3.C and Table 5.3.D.

Table 5.3.A: Repeated measures of ANOVA: Peak latency and amplitude of P300 recorded (Auditory oddball paradigm).

Electrode Site^		Latency (ms)			Amplitude (µV)		
	Repeated Measures ANOVA	SESSIONS (CM/SR)	STATES (Pre & Post)	SESSIONS* STATES	SESSIONS (CM/SR)	STATES Pre & Post)	SESSIONS^{X} STATES
Fz	df, Error	1, 41	1, 41	1, 41	1, 41	1, 41	1, 41
	F	9.526	82.990	21.53	0.426	9.723	4.944
	P	0.004 **	0.001 ***	0.001 ***	0.518 (NS)	0.003 **	0.032 *
Cz	df, Error	1, 41	1, 41	1, 41	1, 41	1, 41	1, 41
	F	22.167	92.290	16.451	1.178	8.932	6.793
	P	0.001 ***	0.001 ***	0.001 ***	0.284 (NS)	0.005 **	0.013 **
Pz	df, Error	1, 41	1, 41	1, 41	1, 41	1, 41	1, 41
	F	16.622	130.831	18.163	1.789	4.577	3.310
	P	0.001***	0.001***	0.001***	0.188 (NS)	0.038*	0.076 (NS)

N= 42, *** P < 0.001, ** P< 0.01, * P < 0.05, ^ Reference: linked earlobes, Fz = frontal site, Cz = vertex, Pz = parietal site

Table 5.3.B: Peak latency (ms) of P300 recorded (auditory oddball paradigm) in 'Pre', and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions. Values are group Mean $\pm$ SD

Electrode site^	Cyclic Meditation (CM)		Supine rest (SR)	
	Pre	Post	Pre	Post
Fz	363.92 $\pm$ 23.63	328.07*** $\pm$ 19.95	359.85 $\pm$ 25.52	347.28*** $\pm$ 19.41
Cz	362.92 $\pm$ 24.46	326.21*** $\pm$ 21.79	364.64 $\pm$ 27.44	346.85*** $\pm$ 19.59
Pz	368.42 $\pm$ 27.34	328.28*** $\pm$ 22.06	369.57 $\pm$ 29.81	352.54*** $\pm$ 23.32

N= 42, *** $P < 0.001$, ** $P< 0.01$, * $P < 0.05$. Paired (2 tailed) t – test, 'Post' compared with respective 'Pre' values. ^ Reference: linked earlobes, Fz = frontal site, Cz = vertex, Pz = parietal site

Table 5.3.C: Peak amplitude (µV) of P300 recorded (auditory oddball paradigm) in 'Pre' and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions. Values are group Mean $\pm$ SD

Electrode Site^	Cyclic Meditation (CM)		Supine rest (SR)	
	Before	After	Before	After
Fz	5.92 $\pm$ 3.60	7.96*** $\pm$ 3.51	7.06 $\pm$ 4.01	7.36 $\pm$ 3.97
Cz	7.24 $\pm$ 3.62	9.14*** $\pm$ 3.43	8.65 $\pm$ 3.72	8.64 $\pm$ 3.66
Pz	8.71 $\pm$ 3.62	9.88** $\pm$ 3.84	9.79 $\pm$ 3.67	9.90 $\pm$ 3.86

N= 42, *** $P < 0.001$, ** $P< 0.01$, * $P < 0.05$ Paired (2 tailed) t – test, 'Post' compared with respective 'Pre' values. ^ Reference: linked earlobes, Fz = frontal site, Cz = vertex, Pz = parietal site

Table 5.3.D: Summary of changes in peak latency and peak amplitude of P300 recorded (auditory oddball paradigm) in 'Pre', and 'Post' states of cyclic meditation and supine rest sessions.

Electrode Site^	**Cyclic Meditation (CM)**		**Supine rest (SR)**	
	Latency (ms)	**Amplitude (µV)**	**Latency (ms)**	**Amplitude (µV)**
Fz	↓ 9.85 % *** (35.85 ms)	↑ 34.42 % ***	↓ 3.49 % *** (12.57 ms)	**NS**
Cz	↓ 10.11 % *** (36.71 ms)	↑ 26.18 % ***	↓ 4.87 % *** (17.79 ms)	**NS**
Pz	↓ 10.89 % *** (39.62ms)	↑ 13.51 % **	↓ 4.60 % *** (17.03 ms)	**NS**

Values are percent change or actual units as specified.
N= 42, *** P < 0.001, ** P< 0.01, * P < 0.05, Paired (2 tailed) t – test, 'Post' compared with respective 'Pre' values. ^ Reference: linked earlobes, Fz = frontal site, Cz = vertex, Pz = parietal site

5.3.1 Peak latency of P300 recorded at Fz:

The repeated measures ANOVA which consisted of the two within-subjects factors, i.e., (i) Sessions (cyclic meditation, supine rest) and (ii) States (Pre and Post) for the P300 peak latency (ms) recorded at Fz, showed significant difference between the Sessions (F = 9.526, p =0.004, Greenhouse-Geisser epsilon = 1.000), between the States (F = 82.990, p<0.001, Greenhouse-Geisser epsilon = 1.000), and the interactions between the Sessions and States (F = 21.535, p<0.001, Greenhouse-Geisser epsilon = 1.000).

The group average of P300 peak latency at Fz after (Post) cyclic meditation session was a significantly lower than the baseline value [p <0.001 (2-tailed) paired t –test]. In the supine rest session also the group average of P300 peak latency after (Post) supine rest was significantly lower than baseline (Pre) values (Fig. 5.3.1). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.3.1.A and Table 5.3.1.B respectively (see Appendix – 5).

5.3.2 Peak amplitude of P300 recorded at Fz:

The repeated measures ANOVA which consisted of the two within-subjects factors, i.e., (i) Sessions (cyclic meditation, supine rest) and (ii) States (Pre and Post) for the P300 peak amplitude (μV) recorded at Fz, showed no significant difference between the Sessions (F = 0.426, p =0.518, Greenhouse-Geisser epsilon = 1.000), however showed significant difference between the States (F = 9.723, p<0.003, Greenhouse-Geisser epsilon = 1.000), and the interactions between the Sessions and States (F = 4.944, p=0.032, Greenhouse-Geisser epsilon = 1.000). Also the comparison of baseline values of both the sessions (CM and SR) showed no significant difference (P >0.05 Paired t – test).

Fig. 5.3.1: Peak latency (ms) of P300 recorded at Fz (auditory oddball paradigm) in 'Pre', and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions.

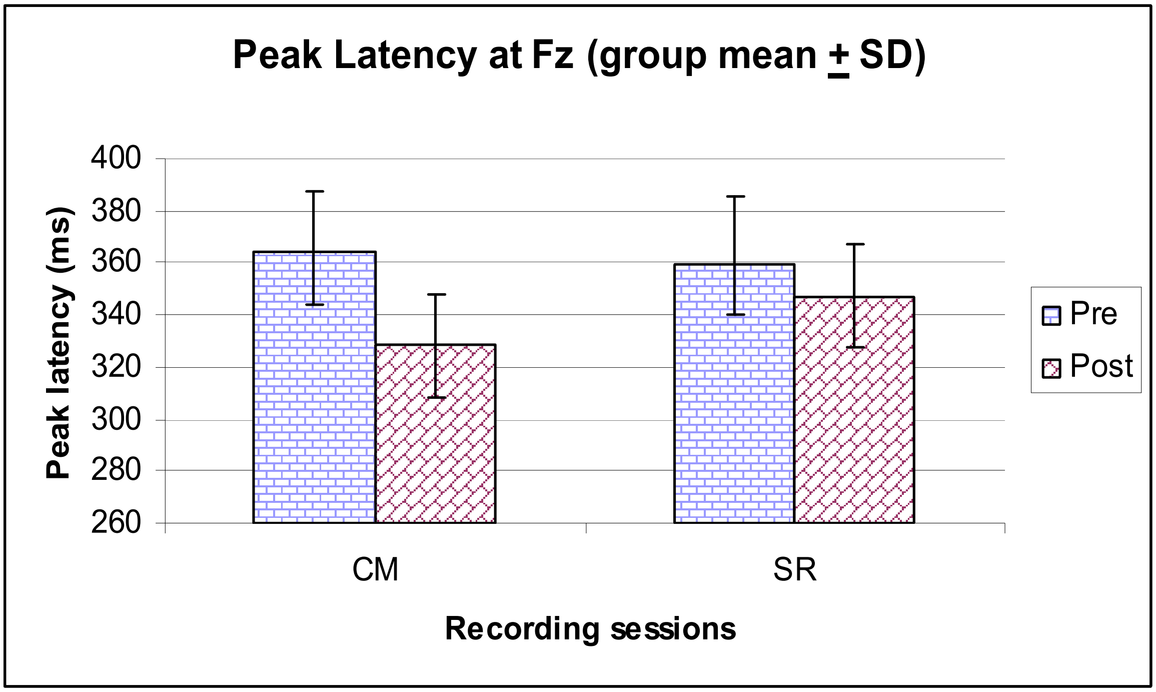
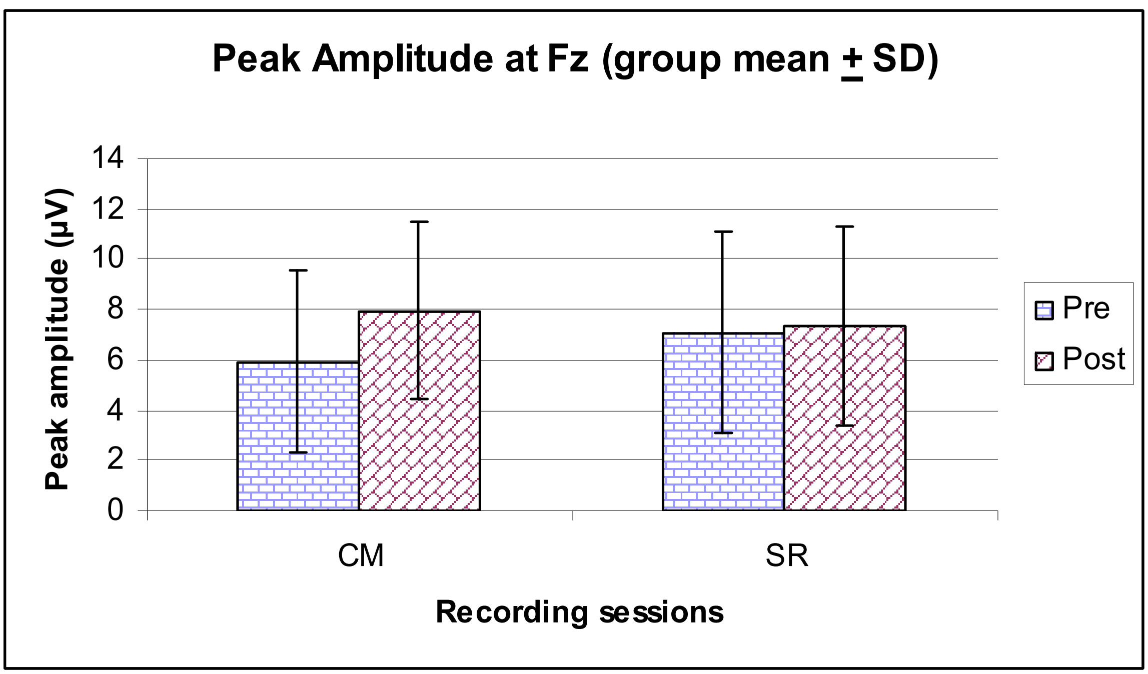


Fig. 5.3.2: Peak amplitude (μV) of P300 recorded at Fz (auditory oddball paradigm) in 'Pre', and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions.



N= 42, *** P < 0.001, ** P< 0.01, * P < 0.05. Paired (2 tailed) t – test, 'Post' compared with respective 'Pre' values. Fz = frontal site, Reference: linked earlobes.

The group average of P300 peak amplitude at Fz after (Post) cyclic meditation session was significantly higher than the baseline (Pre) value [$p < 0.001$]. In the supine rest session the group average of P300 peak amplitude at Fz after (Post) supine rest showed no significant change (Fig. 5.3.2). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.3.2.A and Table 5.3.2.B respectively (see Appendix – 5).

5.3.3 Peak latency of P300 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 and Post) for the P300 peak latency (ms) recorded at Cz, showed significant difference between the Sessions ($F = 22.167$, $p < 0.001$, Greenhouse-Geisser epsilon = 1.000), between the States ($F = 92.290$, $p < 0.001$, Greenhouse-Geisser epsilon = 1.000), and the interactions between the Sessions and States ($F = 16.451$, $p < 0.001$, Greenhouse-Geisser epsilon = 1.000).

The group average of P300 peak latency at Cz after (Post) cyclic meditation session was a significantly lower than the baseline value [$p < 0.001$]. In the supine rest session the group average of P300 peak latency after (Post) supine rest was also significantly lower than baseline (Pre) values (Fig. 5.3.3). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.3.3.A and Table 5.3.3.B respectively (see Appendix – 5).

5.3.4 Peak amplitude of P300 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 and Post) for the P300 peak amplitude (μV) recorded at Cz, showed no significant difference between the Sessions (F = 01.178, p = 0.284, Greenhouse-Geisser epsilon = 1.000), however showed significant difference between the States (F = 8.932, p<0.005, Greenhouse-Geisser epsilon = 1.000), and the interactions between the Sessions and States (F = 6.793, p=0.013, Greenhouse-Geisser epsilon = 1.000). Also the comparison of baseline values of both the sessions (CM and SR) showed no significant difference (P >0.05 Paired t – test).

The group average of P300 peak amplitude at Cz after (Post) cyclic meditation session was a significantly higher than the baseline (Pre) value [p <0.001]. In the supine rest session the group average of P300 peak amplitude at Cz after (Post) supine rest showed no significant change (Fig. 5.3.4). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.3.4.A and Table 5.3.4.B respectively (see Appendix – 5).

5.3.5 Peak latency of P300 recorded at Pz:

The repeated measures ANOVA which consisted of the two within-subjects factors, i.e., (i) Sessions (cyclic meditation, supine rest) and (ii) States (Pre and Post) for the P300 peak latency (ms) recorded at Pz, showed significant difference between the Sessions (F = 16.622, p <0.001, Greenhouse-Geisser epsilon = 1.000), between the States (F = 130.831, p<0.001, Greenhouse-Geisser epsilon = 1.000), and the interactions between the Sessions and States (F = 18.163, p<0.001, Greenhouse-Geisser epsilon = 1.000).

Fig. 5.3.3: Peak latency (ms) of P300 recorded at Cz (auditory oddball paradigm) in 'Pre', and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions.

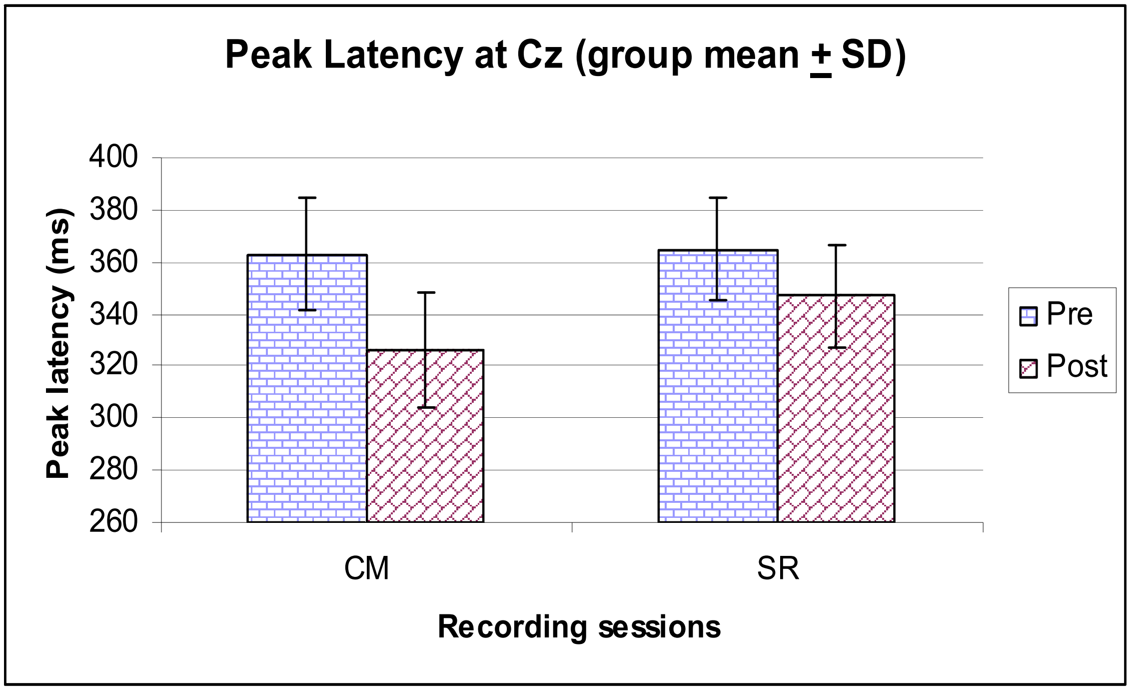
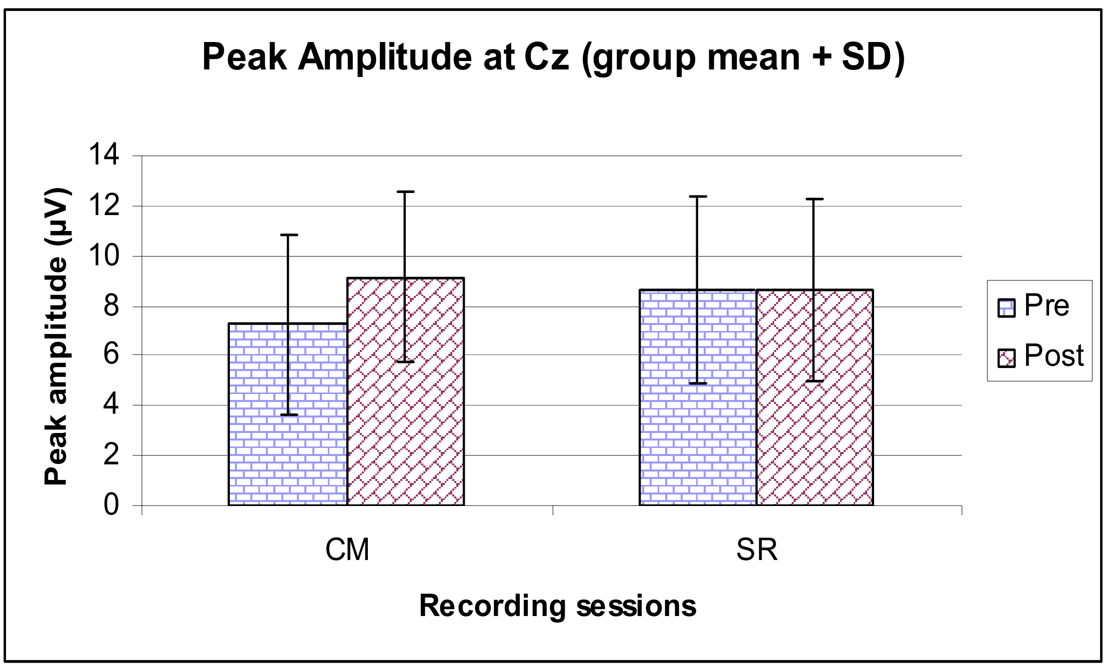


Fig. 5.3.4: Peak amplitude (μV) of P300 recorded at Cz (auditory oddball paradigm) in 'Pre', and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions.



N= 42, *** P < 0.001, ** P< 0.01, * P < 0.05. Paired (2 tailed) t – test, 'Post' compared with respective 'Pre' values. Cz = vertex site, Reference: linked earlobes.

The group average of P300 peak latency at Pz after (Post) cyclic meditation session was a significantly lower than the baseline value [p <0.001]. In the supine rest session the group average of P300 peak latency after (Post) supine rest was also significantly lower than baseline (Pre) values [p <0.001] (Fig. 5.3.5). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.3.5.A and Table 5.3.5.B respectively (see Appendix – 5).

5.3.6 Peak amplitude of P300 recorded at Pz:

The repeated measures ANOVA which consisted of the two within-subjects factors, i.e., (i) Sessions (cyclic meditation, supine rest) and (ii) States (Pre and Post) for the P300 peak amplitude (μV) recorded at Pz, showed significant difference between the States (F = 4.577, p =0.038, Greenhouse-Geisser epsilon = 1.000), but showed no significant difference between the Sessions (F = 1.789, p = 0.188, Greenhouse-Geisser epsilon = 1.000), and the interactions between the Sessions and States (F = 3.310, p=0.076, Greenhouse-Geisser epsilon = 1.000).

The group average of P300 peak amplitude at Pz after (Post) cyclic meditation session was a significantly higher than the baseline (Pre) value [p <0.001]. In the supine rest session the group average of P300 peak amplitude at Pz after (Post) supine rest showed no significant change (Fig. R20). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.3.6.A and Table 5.3.6.B respectively (see Appendix – 5).

Fig. 5.3.5: Peak latency (ms) of P300 recorded at Pz (auditory oddball paradigm) in 'Pre', and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions.

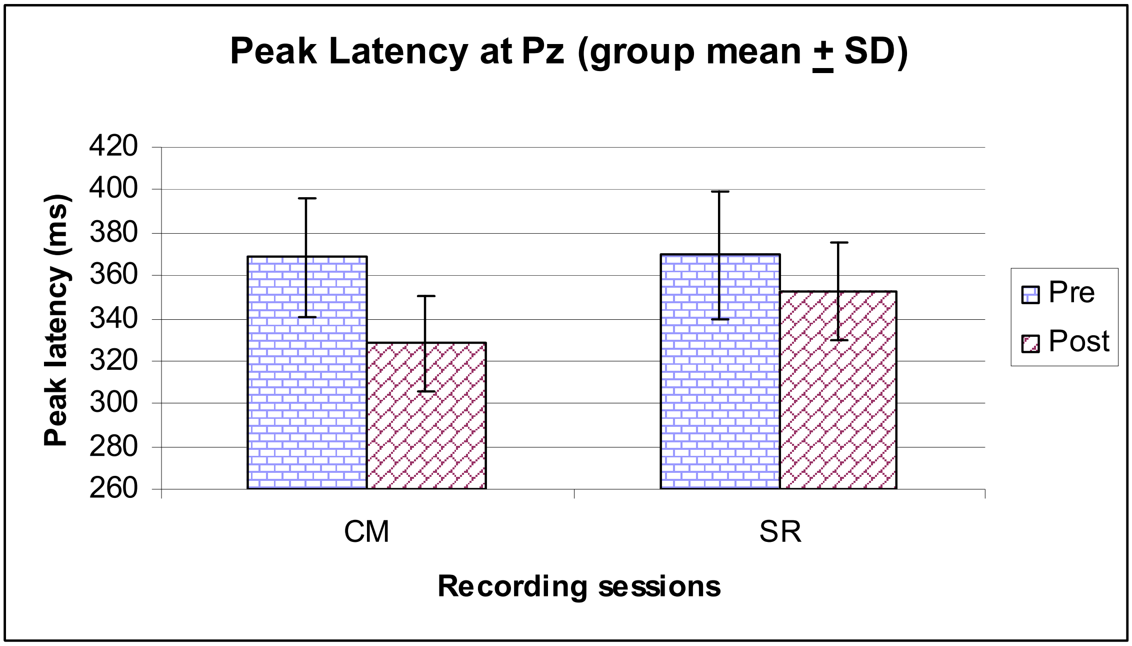
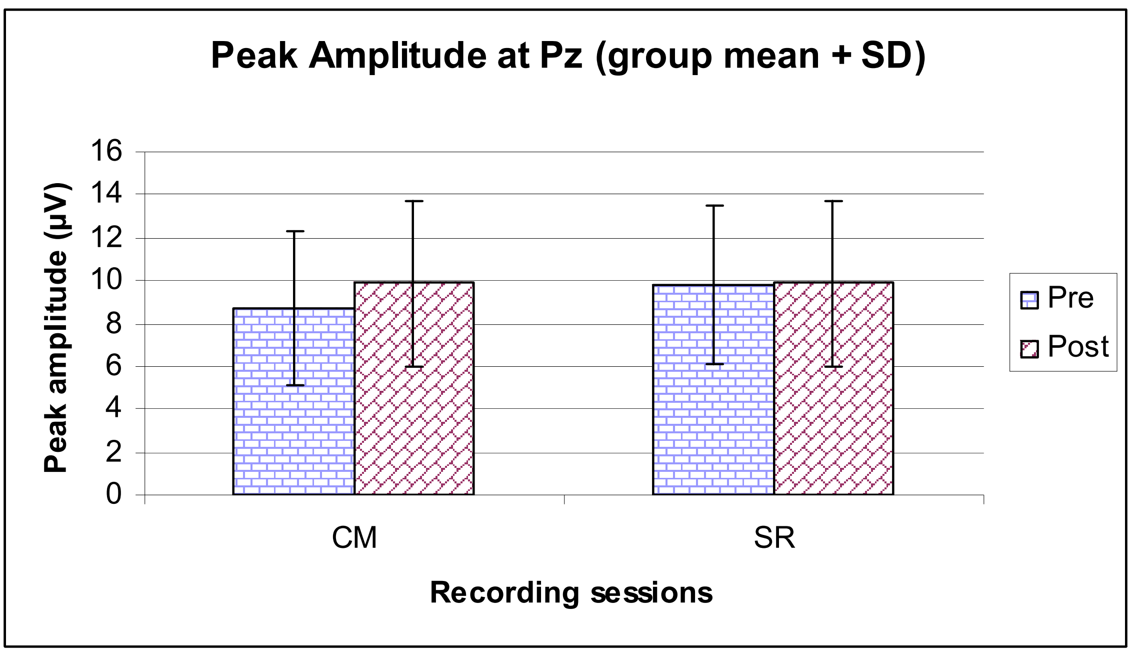


Fig. 5.3.6: Peak amplitude (μV) of P300 recorded at Pz (auditory oddball paradigm) in 'Pre', and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions.



N= 42, *** P < 0.001, ** P< 0.01, * P < 0.05. Paired (2 tailed) t – test, 'Post' compared with respective 'Pre' values. Cz = Pz = parietal site, Reference: linked earlobes.

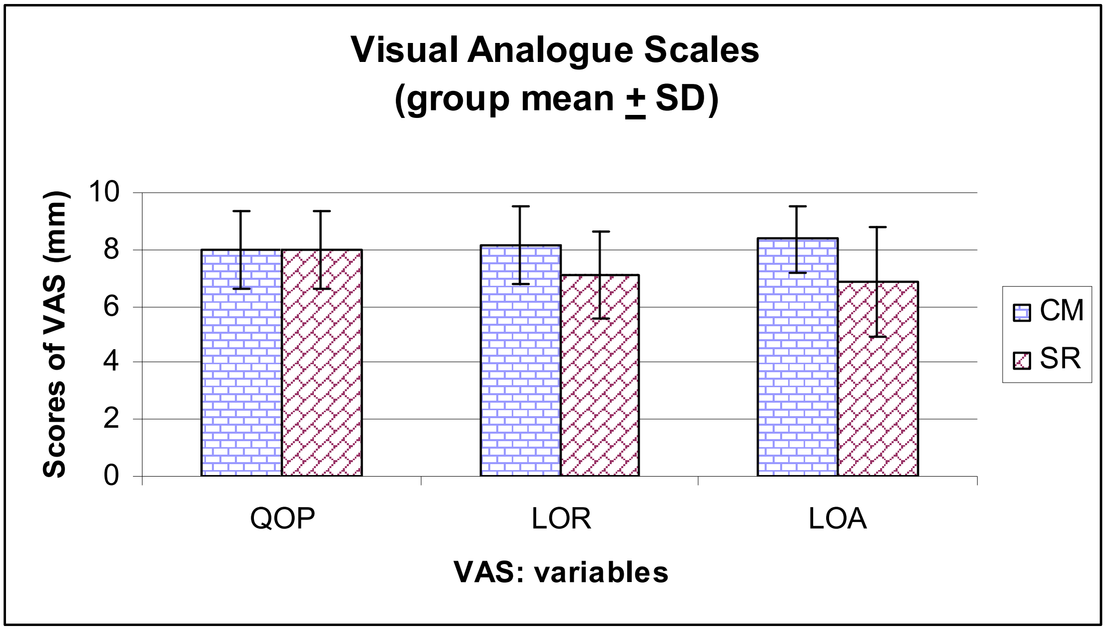
5.3.7 Visual Analogue Scale (VAS) while recording P300:

The subjective impressions of the quality of practice, level of relaxation and level of awareness were measured in 42 subjects after both cyclic meditation and supine rest sessions (Fig.5.3.7). The actual scores of individual subjects after CM and SR sessions are presented with group mean ± SD in Table 5.3.7.A and Table 5.3.7.B respectively (see Appendix – 5).

The Pearson correlation coefficient was performed to correlate the scores of VAS with percent changes in P300 latencies at Fz, Cz and Pz electrode sites. No significant correlations were observed. However a significant correlation [$p < 0.001$ (2-tailed) Pearson correlation test] was observed when quality of practice of CM was correlated with both the levels of relaxation and levels of awareness after CM. Also a significant correlation was seen between levels of relaxation and levels of awareness [$p < 0.001$(2)] after the practice of CM. Scores of quality of practice of SR also showed a significant correlation [$p < 0.01$(2)] with levels of relaxation and with levels of awareness [$p < 0.001$(2)] after SR session. A significant correlation was seen between levels of relaxation and levels of awareness [$p < 0.001$(2)] after SR session.

Quality of practice showed no significant difference between recording sessions of cyclic meditation and supine rest ($p > .05$, paired t-test) where as level of relaxation and level of awareness showed a significant difference between cyclic meditation and supine rest sessions ($p < .001$, paired t-test).

Fig. 5.3.7: Scores of visual analogue scales (VAS) measured (mm) after P300 ERPs recording sessions of cyclic meditation (CM) and supine rest (SR).



QOP = Quality of practice, LOR = Level of relaxation, LOA = Level of awareness
N= 42, *** P < 0.001, ** P< 0.01, * P < 0.05. Paired (2 tailed) t – test 'CM' compared with respective 'SR'.

5.4 LETTER CANCELLATION TEST

Recapitulation: A six letter cancellation test was administered in 42 subjects in cyclic meditation and supine rest sessions. As described under Methods (data analysis), separate repeated measures ANOVAs were performed to compare the 'Pre' and 'Post' states of both the sessions. The test values of repeated measures of ANOVAs are summarized in Table 5.4.A. The paired t – tests were performed to compare the data of the 'Post' period with those of the respective 'Pre' period. The summary of changes in CM and SR sessions are given in Table 5.4.B.

5.4.1 Net scores of letter cancellation test:

The net scores were calculated by deducting wrong cancellations from the total cancellations attempted. The repeated measures ANOVA which consisted of the two within-subjects factors, i.e., (i) Sessions (cyclic meditation, supine rest) and (ii) States (Pre and Post) for the net scores, showed no significant difference between the Sessions ($F = 0.323$, $p = 0.573$, Greenhouse-Geisser epsilon = 1.000), however showed significant difference between the States ($F = 149.195$, $p < 0.001$, Greenhouse-Geisser epsilon = 1.000), and the interactions between the Sessions and States ($F = 11.695$, $p = 0.001$, Greenhouse-Geisser epsilon = 1.000). Also the comparison of baseline values of both the sessions (CM and SR) showed no significant difference ($P > 0.05$ Paired t – test).

The group average of net scores after (Post) cyclic meditation session was significantly higher when compared to the baseline (Pre) scores [$p < 0.001$ (2-tailed) paired t –test]. In the supine rest session also the group average of net scores after (Post) supine rest were significantly higher than baseline [$p < 0.001$] (Fig. 5.4.1). The actual data of individual subjects in CM and SR sessions are presented with group mean ± SD in Table 5.4.1.A and Table 5.4.1.B respectively (see Appendix – 5).

Table 5.4.A: Repeated Measures of ANOVA: Six letter cancellation test (SLCT)

Variable	Repeated Measures ANOVA	SESSIONS (CM/SR)	STATES (Pre and Post)	SESSIONS* STATES
Net Score	df, Error	1, 41	1, 41	1, 41
	F	0.323	149.195	11.695
	P	0.573	< 0.001***	< 0.001***

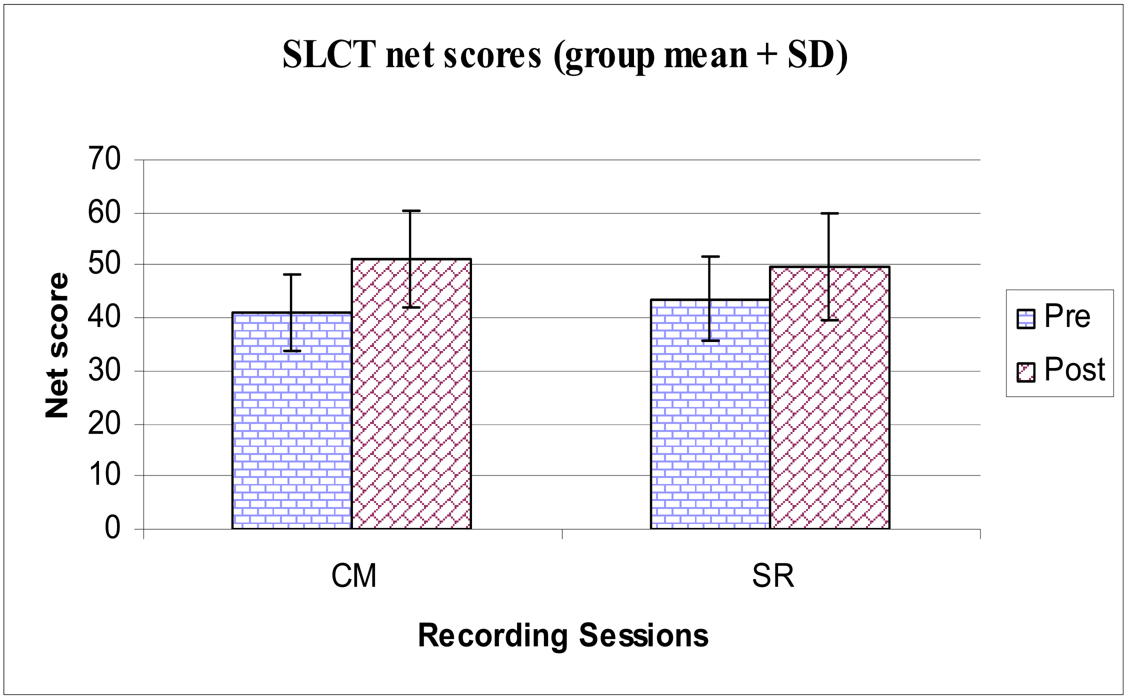
N= 42, *** P < 0.001, ** P< 0.01, * P < 0.05

Table 5.4.B: Summary of changes in the net scores of six letter cancellation test in 'Pre', and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions.
Values are group Mean + SD and percent change

Variable	Cyclic Meditation (CM)			Supine rest (SR)		
	Before	After	% change	Before	After	% change
SLCT Net Score	40.98 ±7.11	51.29*** ±9.08	↑26.22	43.62 ±7.86	49.71*** ±9.97	↑14.29

N= 42, *** P < 0.001, ** P< 0.01, * P < 0.05
Paired (2 tailed) t – test, 'Post' compared with respective 'Pre' values.

Fig. 5.4.1: Net scores of six letter cancellation test (SLCT) measured in 'Pre', and 'Post' states of cyclic meditation (CM) and supine rest (SR) sessions.



N= 42, *** P < 0.001, ** P< 0.01, * P < 0.05
Paired (2 tailed) t – test, 'Post' compared with respective 'Pre' values.

The present study compared two techniques practiced for same duration with two main aspects being considered. The techniques were (i) cyclic meditation, which included yoga postures and periods of supine rest, and (ii) supine rest alone. The two aspects considered were (i) physiological arousal, assessed by metabolic and respiratory variables and heart rate variability spectrum, and (ii) the ability to maintain sustained attention based on recording of the P300 and performance in a letter cancellation task.

With respect to physiological arousal, it was interesting to note that during the phases of cyclic meditation which involved actual practice of yoga postures there was an (anticipated) increase in oxygen consumption and correspondingly in energy expenditure. However the interesting fact is that these values returned to the ‘pre’ values in the fourth (last) phase of cyclic meditation in which subjects lay supine and further decreased after the practice. While there was a decrease following supine rest, the magnitude was greater after cyclic meditation.

Taking the heart rate variability spectrum into account, a similar trend of increased arousal (based on an increase in the low frequency power values, and/or a decrease in the high frequency power values) was seen in the second phase of cyclic meditation where subjects were practicing yoga postures. There was a return to baseline in the fourth phase and a reverse trend after the practice, suggesting a decrease in sympathetic activity (as this may be correlated with the low frequency power values). In contrast the changes in heart rate variability after supine rest showed no significant difference.

Along with these changes suggestive of decreased psychophysiological arousal and also of sympathetic tone following cyclic meditation, it was interesting to note that after this practice there were changes suggestive of a better ability to sustain and focus attention. These were evidenced by electrophysiological changes in a cortical event related potential (the P300) and in the actual performance in a letter cancellation task, which requires the ability to sustain, focus and shift attention. These findings are especially interesting as attentional mechanisms are considered to be always associated with an increase in sympathetic tone.

In summary, from these results a model of cyclic meditation has emerged, as a technique which can reduce psychophysiological arousal but also enhance different aspects of attention, such as the ability to sustain, focus and shift attention.

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