

YOGA FOR WORKING MEMORY IN ADOLESCENTS

Thesis submitted by
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DOCTOR OF PHILOSOPHY (YOGA)
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Under the Guidance of
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CERTIFICATE

This is to certify that Natesh Babu who has been given Ph.D. registration with effect from September 1st, 2009 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 physiology, neurology and psychology related to Yoga and has completed the required 'course of research' for not less than two years to submit this thesis entitled **“YOGA FOR WORKING MEMORY IN ADOLESCENTS”** as per the regulations of the University.

We also declare that the subject matter of this thesis entitled **“YOGA FOR WORKING MEMORY IN ADOLESCENTS”** has not previously formed the basis of the award of any degree, diploma, associate-ship, fellowship or similar titles.

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DECLARATION

I, hereby declare that this study was conducted by me at Swami Vivekananda Yoga Anusandhana Samsthana (S-VYASA), Bengaluru, under the guidance of **Dr. H. R. Nagendra**, Chancellor, S-VYASA Yoga University, Bengaluru and

I also declare that the subject matter of my thesis entitled “**YOGA FOR WORKING MEMORY IN ADOLESCENTS**” has not previously formed the basis of the award of any degree, diploma, associate-ship, fellowship or similar titles.

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Date: 29 November, 2014

Place: Bengaluru

Natesh Babu

**STANDARD INTERNATIONAL TRANSLITERATION
CODE USED TO TRANSLITERATE SANSKRIT WORDS**

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

ABSTRACT

INTRODUCTION

The current education system's focus has been on logical and scientific thinking right from the primary level. During this process, the vital part of education: detachment has been ignored. Concentration and detachment are the key processes of education for the comprehensive development of personality in the teenagers as per Swami Vivekananda. Yoga, an ancient science, in its original form consists of diverse practices, such as physical postures (*āsanas*), regulated breathing (*prāṇāyāma*), meditation, understanding the spiritual basis of life and ethical practices. Recent studies have shown Yoga based add-on programs in Modern education, enhance psychological well-being.

LITERARY RESEARCH

In this chapter of literary research, attempts were made to understand *prajñā* (awareness), from ancient Indian scriptures. This chapter elucidates the role of *prajñā* in development of mind and its different aspects (*antaḥkaraṇa*), and removal of impurities (*smṛtimāla*) leading to a state of mastery over the mind (*sthithaprajñā sthithi*). Relevant *slokas* are presented text-wise, and a coherent discussion has provided for the same. Finally, with the theoretical model which depicts the whole concept to understand the process of the cognitive refinement was summarized.

REVIEW OF SCIENTIFIC LITERATURE

Review of scientific literature enumerates working memory, yoga, mindfulness and its relevance to adolescents. Evidence shows that working memory skills are closely

linked to performance on scholastic tests. Further working memory is highly predictive measures of literacy, mathematics, and language comprehension. Yoga has been found to be beneficial for even mentally challenged and healthy adolescents on cognitive function. Cyclic Meditation (CM) is a unique practice which incorporates mind and body movements, along with awareness is a potential for prevention of clinical levels of psychopathology and improving overall psychological well-being in healthy individuals. Further mindfulness-based intervention has shown significant enhancement of mental health and well-being. More research is needed to understand the influence of yoga practices on the working memory in adolescents. Further to our knowledge outshoot of a yoga-based intervention, the mindfulness has not explored over working memory.

AIM

The primary aim was to explore the efficacy of yoga on working memory among adolescents.

OBJECTIVES

1. To establish normative data for working memory task in Indian adolescents.
2. To explore the relationship between yoga related psychological states and working memory in healthy adolescents.
3. To evaluate the effect of intense yoga based personality development program on psychological domains and working memory in healthy adolescents.
4. To examine the immediate outcome of cyclic meditation on working memory and state anxiety in healthy adolescents.

METHODS

SUBJECTS

The source of subjects was from Yoga based Personality Development Camps (YPDC) held at S-VYASA Yoga University and age range from 12 to 16.

DESIGNS

The research designs consisted of incorporating different research designs. To establish the normative data for working memory test and understand relationship between working memory, a cross-section design has been testified. A pre-post design used to evaluate the effect of yoga on the first and tenth day of the YPDC on working memory. Self as control design was executed to understand the immediate effect of CM on working memory and state anxiety.

INTERVENTIONS

Yoga based Personality development camp (YPDC) consisted of training in different yoga-based techniques for approximately eight hours a day, for ten days. It included specialized yoga module for overall personality development such as *Yogāsanas*, breathing practices, eye-cleansing techniques, meditation, emotional culturing sessions, Vedic chanting, and yogic games. Further, the training also included guided relaxation and Cyclic Meditation (CM).

CM is a unique practice which incorporates mind and body movements, along with awareness. CM is an effective training especially for novices has been scientifically evaluated to a greater extent. Cyclic meditation is a technique which combines "stimulating" and "calming" practices, based on a statement in ancient yoga texts

suggesting that such a combination may be especially helpful to reach a state of mental equilibrium.

ASSESSMENT TOOLS

Working memory consists of different domains such as Verbal, Non-Verbal and Spatial. Hence, multidimensional assessments of working memory were administered to understand all areas of working memory. Mindfulness has described as a state or trait in which an individual becomes increasingly aware and attentive at the moment, which can be enhanced through yoga practices. Further majority of cognitive functions were influenced due to anxiety level. Hence, State Anxiety Inventory, State Anxiety Inventory-Short Form, Child and Adolescent Mindfulness Measure, and State Mindful Attention Awareness Scale were used to understand the underlying process of effect of yoga practices on working memory.

DATA EXTRACTION AND ANALYSIS

The data were collected using self-reported questionnaire and computers based assessment. All statistical analyses were performed using Statistical Package for Social Sciences, SPSS (version 16.0). Correlation, Independent sample *t*-tests and Paired sample *t*-tests procedure, were used for statistical analyses.

RESULTS

- 1) The correlation between mindfulness and spatial memory was positive and significant. Further state anxiety has shown a significant negative relationship between spatial memory. State mindfulness had a positive and significant correlation with the Corsi forward (Forward Corrected $r=.35$, $p<0.01$ and forward block span $r=.31$, $p<0.01$).and Corsi backward (backward corrected $r=0.26$, $p<0.01$ and backward block span $r=0.26$, $p<0.01$). Further state mindfulness has

an inverse and significant correlation with the State anxiety ($r=-.49$, $p<0.01$). Furthermore, state anxiety scores were inverse and significant relationship with the Corsi forward (forward corrected $r=0.20$, $p<0.01$ and forward block span $r=0.20$, $p<0.01$) and Corsi backward (Backward Corrected $r=0.21$, $p<0.01$ and Backward Block Span $r=0.19$, $p<0.05$).

- 2) CM session showed a significant increase in non-verbal memory score by 20.06% whereas the Supine Rest (SR) session showed a significant change in non-verbal memory scores by 17.77%. Further subgroup analysis showed a significant increase in the non-verbal memory score by 25.65% following CM session and 17.84% in SR session in boys. Furthermore, result had shown a significant increase in the non-verbal memory score by 11.21% following CM session and 17.85% in SR session in girls. Verbal memory has shown non-significant change following both sessions and in the subgroup analysis.
- 3) CM session showed a significant reduction in the state anxiety score by 4.27% in the total group, whereas in girls sub-group 7.85%. SR session showed decrease in the State anxiety score by 3.24% in the total group, whereas in girls sub-group 7.54%. State anxiety has shown non-significant change following both sessions in boys.
- 4) A significant enhancement of spatial memory and mindfulness after intense ten days yoga program. Further state anxiety has reduced significantly following yoga-based intervention. There is a significant improvement in the scores of Corsi Forward Correct 8.67%, Corsi Forward Block Span 8.33%, Corsi Forward Total Score 18.54%, Corsi Backward Correct 6.33%, Corsi Backward Block Span 6.36%, Corsi Backward Total Score 9.82%. Further result has shown significant

enhancement of State Mindfulness 6.96%, and dispositional mindfulness 3.98%. Furthermore, there was a significant reduction in State Anxiety 11.46% following 10 days of yoga based personality development camp.

CONCLUSIONS

This study offered initial information on the possible interaction between mindfulness and state anxiety in working memory. Further, results confirmed the effect of yoga on enhancing working memory and mindfulness. Furthermore, results have shown promising immediate effects of yoga based relaxation technique on state anxiety and non-verbal memory. Although the current study provides initial insight into the role of yoga in working memory, further research is necessary to explore the applications.

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1. INTRODUCTION

The current education system's focus has been on logical and scientific thinking at the primary level. During this process, the vital part of education "detachment" is ignored (Nagendra & Mohan, 1998). Concentration and detachment are the fundamental processes of education for the comprehensive development of personality in the teenagers as per Swami Vivekananda. Yoga is an ancient Indian science which involves a conscious process to gain mastery over the involuntary system (Nagendra, 2002). Yoga in its original form consists of diverse practices, such as physical postures (*āsanas*), regulated breathing (*prāṇayāma*), meditation, understanding the spiritual basis of life and ethical practices (Nagendra & Nagarathna, 2003). In recent years, it has drawn attention of the people worldwide, because of its usefulness in enhancing mental health and well-being. Research has shown significant enhancement of physical fitness (Telles, Singh, Bhardwaj, Kumar, & Balkrishna, 2013), cognitive function (Sharma et al., 2014) and psychological well-being (Berger, Silver, & Stein, 2009) in a diverse population following the yoga-based intervention. Further, Yoga has shown as a preventive intervention (Tyagi & Cohen, 2014) as well as a means of improving teenagers' bio-psycho-spiritual well-being (Berger et al., 2009; Noggle, Steiner, Minami, & Khalsa, 2012; Satin, Linden, & Millman, 2014 & Bussing, Hedtstuck, Khalsa, Ostermann, & Heusser, 2012) and cognitive function (Cavallera, Gatto, & Boari, 2014).

Most of the above studies have used a combination of different yoga techniques and also specific components of yoga such as *āsana* (Tran, Holly, Lashbrook, & Amsterdam, 2001), *prāṇayāma* (Sharma et al., 2014), meditation (Elder, Nidich, Moriarty, & Nidich, 2014) or sun salutation (Bhavanani, Udupa, Madanmohan, &

Ravindra, 2011). Yoga based *Gurukula* Education System, has shown more effectiveness in increasing performance on visual and verbal memory in students when compared with the Modern Education System (Rangan, Nagendra, & Bhat, 2009). A recent study has shown add on Yoga in modern education helps students to improve resilience, mood, self-regulation skill pertaining to emotions and stress (Hagen & Nayar, 2014).

Meditation is the primary component of the yogic practice to fathom the realm of spiritual expansion (Nagendra, 2002). Meditation is a specific state of mind featured by deep relaxation, expansion, defocusing, alertness and effortlessness (Nagendra, 2002). The ancient yogic scriptures have prescribed different technique of meditation. Children are in the stages of development, and find it not easy to practice meditation that involve them to sit still or inhibits their natural inclination (Jeanne Ball, 2008). Attempts to settle a child through directing their attention to breathing, engaging in focusing, awareness of internal sensations, directing the attention to a mantra, keeping the eyes open to the gaze fixed on the object of meditation or inner silence strategies can instead cause strain and frustration for the exuberant, growing child. Further novice practitioners find it difficult to practice meditation due to two possible risks based on the quality of the mental state (Nagendra, 2010). Practitioners may find that they feel drowsy and fall asleep due to the *tāmasic* nature of mind, while few practitioners may undergo restless due to *rājasic* state of mind. Solution for the this mental state has dealt with in the ancient Indian text, *Māṇḍūkya-kārika* (Chinmayananda, 1984). Based on classical solution, S-VYASA University has developed a meditation technique (Nagendra & Nagarathna, 1997) called cyclic meditation (CM). CM is a 'moving meditation', which combines the practice of yoga postures interspersed with relaxation

techniques. The objective of CM is to calm down the mind through a cyclic process of stimulation and relaxation along with awareness. The core principle of CM is when the mind loses its awareness (*Laya*) and enters into a sleepy state, stimulate (*Sambodhayet*) and awaken it. Do it again and again till mind reaches a state of poise and calmness with present moment awareness (Nagendra & Nagarathna, 1997). Scientific investigations documented that CM showed improvement in physiological (Sarang & Telles, 2006), psychological (Subramanya & Telles, 2009a), and neurophysiological variables (Subramanya & Telles, 2009b). Further school children underwent seven days CM training and found improvement in psychomotor performance (Pradhan & Nagendra, 2010, 2009).

Working memory (WM) is an essential component of any cognitive tasks. WM is a dynamic variable and can be influenced easily by various external conditions and keeps on getting refined. CM as a particular process has been studied to find its effect on working memory. CM directly addresses the multiple distracters of a good working memory, by striking a calm and steady state of mind. This study presents the influence of CM on working memory, especially verbal, non-verbal, and spatial memory.

NEED FOR THE STUDY

More research is desired to understand the influence of yoga practices on the core characteristics of the psycho-cognitive domains for development of successful management strategy of children mental health. Although, much of mindfulness research is in its early stages and focus was more on psychological well-being. Mindfulness has been shown to be an efficient means of reducing stress and improving emotional balance in research with adults. The greater part of this research has been

carried out with adults; research is only beginning to examine the influence of mindfulness among adolescents (Frank, Jennings, & Greenberg, 2013).

It is seen that -

1. Basic understanding of mindfulness as per yoga texts is not available in the literature.
2. One of the key domains of cognitive functions is memory, which plays a significant role in student's academic excellence. The relationship between state mindfulness and working memory in adolescents.
3. Mindfulness and meditation as presented in *pātañjala yoga sutras* are well connected. But there was a dearth of scientific studies on the effect of meditation on psycho-cognitive functions.
4. While Cyclic Meditation as one of the most effective meditation techniques derived from *Māṇḍūkya Upaniṣat Kārikā* and its immediate effect of cyclic meditation has found a positive influence on cognitive functions and psychological states in adults (Subramanya & Telles, 2009c). But the immediate effect of CM on working memory scores and state anxiety on adolescent's are not available.

2. LITERARY RESEARCH

Western science has tried to fathom the working of mind from various dimensions; nonetheless culmination towards holistic understanding would happen with classical Indian thought, which emphasizes on consciousness-based paradigm than matter-based paradigm. Both the eastern and the western thoughts complement each other and therefore help in bringing out holistic understanding of nature and functioning of the mind and its cognitive processes (Nagendra, 2003). An amalgamation of eastern concepts would give deeper insights to understand the deep rooted human cognitive process. Modern science understands awareness as the contents of focused attention from sensory response, whereas ancient Indian thoughts has understood the spectrum of processes of basic pointed awareness to an expanded awareness or stabilized awareness. Overall, this literary review understands the spectrum of perceptual processes leading to sensory awareness (*prajñā*) to expanded awareness (*stitha prajñā*).

2.1 EARLIER INVESTIGATIONS

Author (Year)	Summary
Bhat, Telles and Nagendra (2013)	<i>Dhāraṇā</i> is associated with better attention, incidental learning, and better accuracy. Subjective assessment about the ability to follow guided instructions showed that <i>dhāraṇā</i> is the most difficult state compared to the <i>cañcalatā</i> , <i>ekāgratā</i> and <i>dhyāna</i> states.
Pradhan and Nagendra (2011)	The uninterrupted single thought when broken by other thought then it is called <i>dhāraṇā</i> further its leads to <i>Samādhi</i> .
Kumar, Telles and Nagendra (2010)	i) Attempted to summarize the work already done on mediation from text of ancient Indian lore. ii) Compiled authentic information on <i>cañcalatā</i> , <i>ekāgratā</i> , <i>dhāraṇā</i> and <i>dhyāna</i> from ancient literature.

	ii) Explored the concept of OM meditation from different classical & <i>yogic</i> texts and the usefulness of above aspects in OM meditation
Rangan, Bhatt and Nagendra (2009)	<i>Gurukula</i> Education System based curriculum includes various practices, which calm the mind and develop cognitive skills. It also indicated how the consciousness-based approach to education develops the overall personality more effectively than the matter-based approach.
Pailoor, Telles and Nagendra (2009)	The cyclic meditation contains the intermittent cycles of <i>dhāraṇā</i> (pointed awareness) and <i>dhyāna</i> (pervasive awareness) finally stabilizing in the effortless expansive meditative state
Patil, Telles and Nagendra (2007)	i) Compiled authentic information on meditation from classical yogic and spiritual literature. ii) Studied the basic principles and theory of meditation based on traditional literature. iii) Described in brief the different methods of meditation and commonalities between them. iv) Defined and presented concept of a specific technique i.e., cyclic meditation.
Manjunath, Telles and Nagendra (2005)	Authors suggest that the spiritual growth should be the final goal of an individual. During these process different faculties such as perception, memory etc. has to be used optimally to hasten this process.

2.2 AIM OF LITERARY RESEARCH

To understand the concept of mindfulness and its relation to awareness: sensory awareness (*prajñā*), higher states of awareness, expanded awareness (*stithaprajñā*) from the perspective of the ancient texts of yoga and spiritual lore.

2.3 OBJECTIVES

Some of the most important objectives which were achieved are as follows: Using ancient texts of Yoga and Spiritual lore

- i. To explain the levels of awareness from the outlook of classical texts.
- ii. To enlist the quality of a person established in expanded awareness from the insight of ancient wisdom.
- iii. To unearth the techniques for establishing in expanded awareness from the light of the ancient lore.

2.4 METHODOLOGY

In the initial stages, searches were carried out for the keyword related to awareness, expanded awareness and its process such as *Cañcalatā*, *Ekāgratā*, *Dhāraṇā*, *Dhyāna*, *Smṛti*, *Samādhi*, *Prajña*, *Stitha Prajña* from various scriptural texts. Multimedia e-book for ancient scriptures *śāstrāṇi*, published by the Ramakrishna Mission Ashram was used for search (*śāstrāṇi*, 2004). *Śāstrāṇi* contains almost all the major ancient scriptures in original Sanskrit text, with a powerful search facility with Sanskrit typing and Sanskrit keyboard layout. We limited our search to classical yoga texts such as *Patañjali yoga sūtrās*, *Bhagavad Gīta*, *Haṭha Yoga Pradīpikā*, and *Mahabharata*. Further, search was expanded to seven major *upaniṣads* viz, *Kena Upaniṣat*, *Kaṭha Upaniṣat*, *Muṇḍaka Upaniṣat*, *Māṇḍūkya Upaniṣat*, *Aitareya Upaniṣat*, *Taittirīya Upaniṣat*, *Praśna Upaniṣat* and *Chāndogya Upaniṣat*.

2.5 DEVELOPMENT OF THEORETICAL MODEL: REFINEMENT OF ANTAḤKARAṆA CATUSHTAYA AND UNFOLDMENT OF PRAJÑA LEADING TO STITHAPRAJÑA STHITHI.

The model description of the process of *antaḥkaraṇa catuṣṭaya* and unfoldment of *prajñā* leading to *stithaprajñā sthithi* has been depicted in the Figure.2.5. This model describes development of *prajñā* and refinement of *smṛti mala*, along with corresponding influences in *pancha kośa*. *Antaḥkaraṇa* is the internal faculty which facilitates inner cognition. It is functionally classified as *manas*, *chitta*, *buddhi*, and *ahaṅkāra*.

In order to bring out right knowledge, functioning of these facets of *antaḥkaraṇa* is very essential. The refinement of *antaḥkaraṇa* is also a function of systematic unfoldment of *prajñā*. As the quality and depth of *prajñā* enhance, unadulterated cognition also develops, which facilitates in establishing stability in higher states of consciousness.

सर्वार्ण्येवैतानि प्रज्ञानस्य नामधेयानि-वन्ति ।

Sarvāṅnyevaitāniprajñānasyanāmadheyāni-vanti

(*Aitereyopaniṣat 3.2*)

All these mind, that is consciousness, perception, discrimination, intelligence, wisdom, insight, steadfastness thought, thoughtfulness, impulse, memory, conception, purpose, life, desire, control, all these, indeed, are names of intelligence.

Here we find a classification of various mental functions and different kinds of perception, conception, intuition, as well as feeling and will.

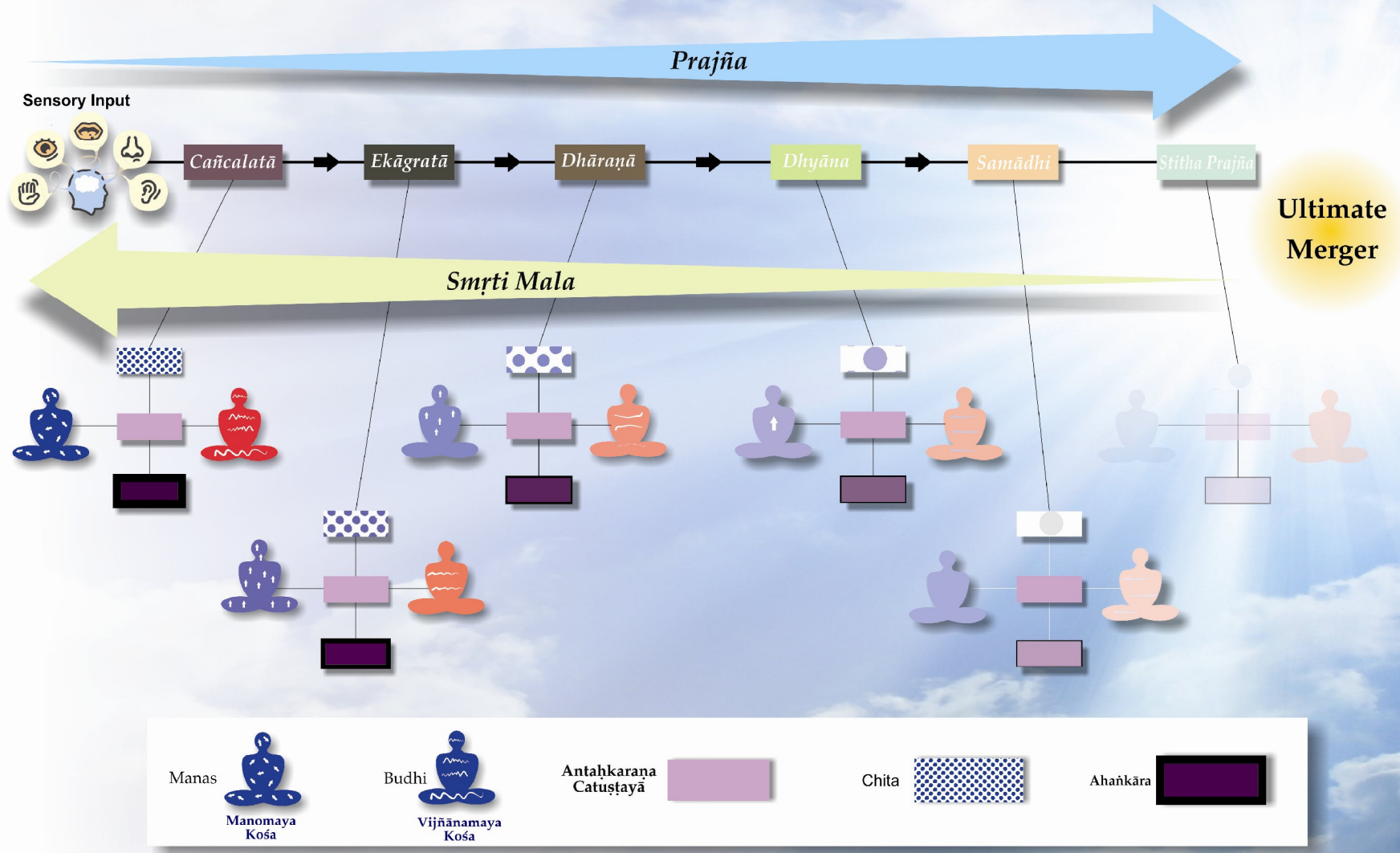


Figure-2.5: Model - Refinement of *Antahkarana Catusṭayā* and Unfoldment of *Prajña* leading to *Stithaprajñā Sthithi*.

प्रज्ञानेत्रो लोकः प्रज्ञा प्रतिष्ठा प्रज्ञानं ब्रह्म ।

Prajñānetrolokaḥprajñāpratiṣṭhāprajñānam brahma

(Aitereyopaniṣat 3.3)

Five great elements namely, earth, air, ether, water, light, etc., are all are guided by intelligence. The support is intelligence; intelligence is said to be the basis of all existence and the final reality.

We get information from all the sensory inputs, which bring information from the external environment. For further, processing, these sensory inputs undergo internal processing. The way they are processed in the presence of *prajñā*, leads to various experiences and thereby the structure and content of *antaḥkaraṇa* also undergoes a constant flux of change.

श्रद्धावीर्यस्मृतिसमाधिप्रज्ञापूर्वक इतरेषाम् ।

Śraddhāvīryasmृतिसमाधिप्रज्ञापूरुवका इतरेषाम् ।

(Pātañjalayogasūtrāṇi 1.20)

The concentration of the true spiritual aspirant is attained through faith, energy, recollectedness, absorption and illumination.

Hierarchically, primitive functional aspect of mind is the state of *cañcalatā*, then sequentially, *ekāgratā*, *dhāraṇā*, *dhyāna*, *samādhi*, and ultimately leading to the establishment of equipoise state, called *sthita prajñā sthithi*.

तस्यसप्तधाप्रान्तभूमिः प्रज्ञा ।

Tasyasaptadhāprāntabhūmiḥprajñā ।

(Pātañjalayogasūtrāṇi 2.27)

The experiencer gains this knowledge in seven stages, advancing toward the highest.

In the state of *cañcalatā*, the *antaḥkaraṇa* is in the grossest form. *Manas* will be fluctuating dynamically. *Buddhi* will not be able to make sharp discrimination. *Ahaṅkāra* will also be highly grossified. This state is characterized by maximum *Smṛti Mala* or least *Chitta Śuddhi*. As a consequence of this stability of memory is quite poor. *Buddhi* and *manas* represent *vijñānamaya kośa* and *manomaya kośa* respectively. In *cañcalatā* state, there would be the dominance of *manomaya kośa* activity than *vijñānamaya kośa*.

In *ekāgratā* state, and in subsequent states of *dhāraṇā* and *dhyāna* instability of *manas*, and *buddhi*, relatively reduces. As the random fluctuation reduces, stability of *smṛti* increases. Also the *manomaya kośa* gets purified more and more as level of *prajña* increases. This also facilitates cleansing of *vijñānamaya kośa*. As a consequence discriminative power increases, and it fosters further development of right actions and that creates a strong impression of good deeds, which is considered as good *smṛti*, devoid of *smṛti mala*.

तज्ज्यात्प्रज्ञालोकः ।

Tajjyātprajñālokaḥ ।

(Pātañjalayogasūtrāṇi 3.5)

Through mastery of Samyama comes the light of knowledge.

In *Samadhi* state, there is a sudden explosive expansion of *prajña*, leading to a quantum jump in state of consciousness. Here also there are various levels of *samādhi*. As one progresses in higher stages of *samādhi* experience, proliferating scale cleansing happens in all the facets of the mind; *manas* become still and silent; *budhi* becomes

unperturbed; *chitta* becomes devoid of mala, and *ahaṅkāra* loses its grossness and gradually dissolves and ultimately vanishes. Both *manomaya kośa* and *vijñānamaya kośa* becomes more expansive and lesser grosser.

This leads to the state of *sthitha prajñā sthithi*. In this the *smṛti mala* is least and there is always the remembrance of that state of ultimate *sat-chit-ānanda*. And at the stage of ultimate merging, there dissolves all the *kośa*, and *antaḥkaraṇa*, like the salt doll, with all its identity intact, which goes to fathom the depth of the ocean, loses its individualized identity and becomes one with the ocean.

The above model attempts to depict the evolution of *antaḥkaraṇa* as a function of increasing level of *prajñā*. The main highlighting concept is a gradual decrease in *smṛti mala* and corresponding increase in level of *prajñā* leading to the experience of higher states of consciousness and ultimately the highest merger state of *sat-chit-ānanda*. In this ultimate state, there is no bondage of *Kośas*, no bondage of *antaḥkaraṇa*. This is defined as the state of the highest realization giving infinite power infinite knowledge and infinite bliss. The model description of the process of *antaḥkaraṇa catushtaya* and unfoldment of *prajñā* leading to *stitha prajñā sthithi* has been depicted in the Fig.2.5.

2.6 CONCLUSION

Level of awareness increases as *smṛti mala* reduces. As the internal impurities of *antaḥkaraṇa* are removed, ability to have the awareness without discontinuity becomes easy. Various aspects of a person who is established in that *stitha prajñā sthithi*, has been discussed and elaborated. As the level of awareness (*prajñā*) increases, person tends to be more established in the state of expanded awareness and he is called as

jñānī. Techniques to achieve the state of expanded awareness have been discussed. The key factor is to undo the impurities at all the levels of *pañca kośa*. Here the focus is given to the reduction in impurity of the mind, and most importantly related to the memory.

2.7 TEXTWISE PRESENTATION OF MODEL FROM ANCIENT SCRIPTURES

2.6.1 *Jñānendriyās*

` AaPyayNtu mma¼ain vaKàa[i]u>ïaeÇmwae blimiNÔyai[c svaRi[,svj
äüaEpin;d<ma=h< äü inrak...ya| ma ma äü
inrakaraedinrakra[mSTvinrakra[< me=Stu,tdaTmin inrte y%pin;Tsu
xmaRSte miy sNtu te miy sNtu, ` zaiNt> zaiNt> zaiNt>.

*Om āpyāyantu mamāṅgāni vākprāṇaścakṣuḥ śrotramatho balmindriyāṇi ca sarvāṇi|
Sarvaṁ brahmaupniṣadam mā'haṁ brahma nirākuryāṁ mā mā brahma
Nirākārodnirākaraṇamastōnirākaraṇam me'stu| tadātmni nirate ya upaniṣatsu
Dharmāste myi santu te myi santu| om śāntiḥ śāntiḥ śāntiḥ||*

(Kenopaniṣat, Prathamodhyāyaḥ)

Harih Om! May my limbs, speech, eye, ear, strength and all my senses grow vigorous. All (everything) is Brahman of the Upanishads. May I never deny Brahman. May Brahman never spurn me? May there be no denial of Brahman. May there be no spurning by Brahman. Let all the virtues recited by the Upanishads repose in me delighting in the Ātman. May they in me repose!

yae va @tamev< vedaphTy paPmanmnNte SvgeR
laeke Jyeye àititóit àititóit. 9.

*Yo vā etāmevaṁ vedāpahatya pāpmānāmanante svarge
Loke jyeye prtitiṣṭhti prtitiṣṭhti||*

(Kenopaniṣat, Caturthodhyāyaḥ, Verse: 9)

He, who knows this thus, after having shaken off all sins, abides firmly seated in the

endless, blissful and highest Brahman. He is established in Him.

#iNÔye_y> pra ýwaR AweR_yí pr< mn>,
mnsStu pra buiľbuRĪeraTma mhaNpr>. 10.

*Indriyebhyaḥ parā hyarthā arthebhyaśca param manaḥ|
Manasastu parā buddhirbuddherātmā mahānparaḥ|| 10||*

(Kaṭhopeniṣat, Prathamah Khandah, Tr̥tīyo'dhyāyah, Verse: 10)

Beyond the senses are the rudiments of objects, beyond these rudiments is the mind,
beyond the mind is the intellect, and beyond the intellect is the great Self.

ta< yaegimit mNyNte iSwraimiNÔyxar[am!,
AàmÄStda -vit yaegae ih à-vaPyyaE. 11.

*Tān yogmiti manyante sthirāmindriyadhāraṇām|
Apramattastadā -viti yogo hi pra-vāpyayau|| 11||*

(Kaṭhopeniṣat, Dvitiyo Khandah, Tr̥tīyo'dhyāyah, Verse: 11)

The firm control of the senses, they regard as Yoga. At that time one gets careful, for
Yoga is acquired and lost.

tejae h va %danStSmaĒpzaNtteja>,
pun-RvimiNÔyEmRnis sMpXymanE>. 9.

*Tejo ha vā udānastasmādupaśāntatejāḥ|
Punar-vmindriyairmansi sampadhyamānaiḥ|| 9||*

(Praśnopeniṣat, Tr̥tīyah Praśnah, Verse:9)

The external fire indeed is Udana. Therefore, he whose fire has gone out, enters another
body with his senses absorbed in the mind.

2.7.2 Cañcalatā

yae=y< yaegSTvya àae> saMyen mxusUdn,
@tSyah< n pZyaim cÂITvaiTSwit< iSwram!. 33.

Yo'yam yogastvayā pro-ḥ sām̐yena madhusūdana |

Etasyāham na paśyāmi cañcalatvātsthitim sthirām || 33 ||

(Śrīmadbhagavadgītā, Ṣaṣṭho'dhyāyaḥ, Verse: 33)

This Yoga of equanimity taught by Thee, O Krishna, I do not see its steady continuance, because of restlessness (of the mind)!

cÂI< ih mn> k«:[àmaiw blvdœ †Fm!,
tSyah< inçh< mNye vayaeirv suÊ:krm!. 34.

Cañcalaṁ hi manaḥ kṛṣṇa pramāthi balavad dṛḍham |

Tasyāham nigrahaṁ manye vāyoriva suduṣkaram || 34 ||

(Śrīmadbhagavadgītā, Ṣaṣṭho'dhyāyaḥ, Verse: 34)

The mind verily is restless, turbulent, strong and unyielding, O Krishna! I deem it as difficult to control as to control the wind.

rsSy mnsíEv cÂITv< Sv-avt>,
rsae bīae mnae bī< ik< n isī(it -Utle. 26.

Rasasya manasaścaiva cañcalatvam sva-āvataḥ |

Raso baddho mano baddhaṁ kiṁ na siddhyti -ūtale || 26 ||

(Haṭha Yoga Pradīpikā, Caturthopadeśaḥ, Verse:26)

Mercury and mind are unstable by nature. By stabilizing (seizing or fixing) mercury and mind what cannot be perfected?

2.7.3 Ekāgratā

svaRwRtEkaçtyae>]yaedyae icÄSy smaixpir[am>. 11.

Sarvārthataikāgratayoḥ kṣayodayau cittasya samādhipriṇāmaḥ|| 11||

(Pātañjalayogasūtrāṇi, Tṛtīyo'dhyāyaḥ, Verse:11)

The decrease of varying objectives in the mento-emotional energy and the increase of the one aspect within it, is the change noticed in the practice of continuous effortless linking of the attention to higher concentration forces, objects or persons.

tt> pun> zaNtaeidtaE tuLyàTyyaEicÄSyEkaçtapir[am>. 12.

Tataḥ punaḥ śāntoditau tulyapratyayau cittasyaikāgratāpriṇāmaḥ|| 12||

(Pātañjalayogasūtrāṇi, Tṛtīyo'dhyāyaḥ, Verse:12)

Then again, when the mind's content is the same as it was when it is subsiding and when it is emerging, that is the transformation called "having one aspect in front of, or before the attention".

dezbNxiiÄSy xar[a. 1.

Deśabandhścittasya dhāraṇā|| 1||

(Pātañjalayogasūtrāṇi, Tṛtīyo'dhyāyaḥ, Vibhūti Padaḥ, Verse 1)

Linking of the attention to a concentration force or person, involves a restricted location in the mento-emotional energy.

@ksmye cae-yanvxar[m!. 20.

Ekasamaye co-yānavadhāraṇam|| 20||

(Haṭha Yoga Pradīpikā, Caturtho'dhyāya, Verse:20)

It cannot execute the focus of both at the same time.

2.7.4 Dhāraṇā

ta< yaegimit mNyNte iSwraimiNÔyxar[am!,
AàmÄStda -vit yaegae ih à-vaPyyaE. 11.

*Tām yogmiti manyante sthirāmindriyadhāraṇām |
Apramattastadā -viti yogo hi pra-vāpyayau || 11 ||*

(Kaṭhōpaniṣat, Dvītīyaḥ Khaṇḍaḥ, Tṛtīyo'dhyāyaḥ, Verse:11)

The firm control of the senses, they regard as Yoga. At that time one gets careful, for Yoga is acquired and lost.

*yZDNdsam&;-ae ivñêp>, DNdae_yae=Xym&taTs<b-Uv, s meNÔae
mexya Sp&[aetu, Am&tSy dev xar[ae -Uyasm!, zrlr< me ivc;R[m!, ijpa me
mxumÄma, k[aR_ya< -Uir iviuvm!, äü[> kaezae=is mexya ipiht>, üt< me
gaepay, AavhNtl ivtNvana. 1.*

*Yaśchandasāmṛṣabho viśvarūpaḥ | Chandobhyo'dhyamṛtātsamba-ūva | Sa mendro
medhayā spr̥ṇotu | Amṛtasya deva dhāraṇo -ūyāsam | Śarīraṁ me vicarṣaṇam | Jihvā
me madhumattamā | Karṇābhyāṁ -ūri viśruvam | Brahmaṇaḥ kośo'si medhayā pihitaḥ |
Śrutam me gopāya | Avahantī vitanvānā || 11 ||*

(Taittirīyopaniṣat, Śikṣāvānī, Caturtho'nuvākaḥ, Verse:1)

May He, who is the supreme among all Devas, who is of cosmic form, who has been born of the immortal Vedas, who is the Lord of all, strengthen me with wisdom? May I become the possessor of wisdom that leads to immortality? May my body be fit (for meditation). May my tongue become extremely sweet? May I hear much with my ears? Thou art the sheath of Brahman, enveloped by intelligence (worldly knowledge). May Thou protect what I have heard?

*svRÖarai[s<yMy mnae ùid inéXy c,
mUXNyarxayaTmn> àa[maiSwtae yaegxar[am!. 12.*

*Sarvadvārāṇi samyamya mano hṛdi nirudhya ca |
Mūrdhnyādhāyātmanaḥ prāṇamāsthito yogadhāraṇām || 12 ||*

(Śrīmadbhagavadgītā, Aṣṭamo'dhyāyaḥ, Verse:12)

Having closed all the gates, confined the mind in the heart and fixed the life-breath in the head, engaged in the practice of concentration,

mUXNyRxayaTmn> àa[maiSwtae yaegxar[am!.8-12.
Mūdhnyārdhāyātmanah prāṇamāsthito yogadhāraṇām || 8-12||

(Śrīmadbhagavadgītā, Aṣṭamo'dhyāyaḥ, Verse:13)

Having closed all the gates, having confined the mind in the heart, having fixed the life-breath in the head engaged in the practice of concentration.

àCDdRnivxar[a_ya< va àa[Sy. 34.

Pracchardanvidhāraṇābhyām vā prāṇasya|| 34||

(Pātañjalayogasūtrāṇi, Prathamo'dhyāyaḥ, Verse: 34)

or by regulating the exhalation and inhalation of the vital energy;

k«tawj àit nòm! APynò< tdNysaxar[Tvat!. 22.

Kṛtārtham prti naṣṭam apyanaṣṭam tadanyasādhāraṇatvāt|| 22||

(Pātañjalayogasūtrāṇi, Dvitiyo'dhyāyaḥ, Verse-22)

It is not effective for one to whom its purpose is fulfilled but it has a common effect on the others.

yminymasnaà[ayamāTyaharxar[aXyansmaxyae=òav A¼ain. 29.

Yamniyamāsanaprāṇāyāmapratyāhāradhāraṇādhyānasamādhayo'sṭāva aṅgāni|| 29||

(Pātañjalayogasūtrāṇi, Dvitiyo'dhyāyaḥ, Verse-29)

Moral restrains, recommended behaviors, body posture, breath enrichment, sensual energy withdrawal, linking of the attention to higher concentration forces or persons, effortless linkage of the attention to higher concentration forces or persons, continuous effortless linkage of the attention to higher concentration forces or persons, are the eight parts of the yoga system.

xar[asu c yaeGyta mns>. 53.

Dhāraṇāsu ca yogyatā manasaḥ|| 53||

(Pātañjalayogasūtrāṇi, Dvitiyo'dhyāyaḥ, Verse-53)

and from that, is attained the state of the mind for linking the attention to a higher concentration force or person.

dezbNxiĀSy xar[a. 1.

Deśabandhścittasya dhāraṇā|| 1||

(Pātañjalayogasūtrāṇi, Tṛtīyo'dhyāyaḥ, Vibhuti Padaḥ, Verse 1)

Linking of the attention to a concentration force or person, involves a restricted location in the mento-emotional energy.

2.7.5 Dhyāna

īeyae ih }anm_yasaJ}anaĀ(an< iviz:yte,
XyanaTkmR)ITyagSTyagaCDaiNtrnNtrm!. 12.

Śreyo hi jñānamabhyāsājñānāddhyānam viśiṣyate|

Dhyānātkarmaphalatyāgastyāgācchāntiranantaram|| 12||

(Śrīmadbhagavadgītā, Dvādaśo'dhyāyaḥ, Verse:12)

Better indeed is knowledge than practice; than knowledge meditation is better; than meditation the renunciation of the fruits of actions; peace immediately follows renunciation.

विविक्तसेवी लघ्वाशी यतवाक्कायमानसः ।

Xyanyaegprae inTy< vEraGy< smupaiit>. 52.

Viviktasevī laghvāśī yatavākkāyamānasah|

Dhyānayogaparo nityam vairāgyam samupāśritaḥ|| 52||

(Śrīmadbhagavadgītā, Aṣṭādaśo'dhyāyaḥ, Verse: 52)

Dwelling in solitude, eating but little, with speech, body and mind subdued, always engaged in concentration and meditation, taking refuge in dispassion,

tÇ àTyyEktanta Xyanm!. 2.

Tatra pratyayaikatānatā dhyānam || 2 ||

(Pātañjalayogasūtrāṇi, Tṛtīyo' dhyāyaḥ, Verse: 2)

Uninterrupted (effortless) flow (of the mind) towards the object (chosen) is meditation.

tÇ Xyanjm! Anazym!. 6.

Tatra dhyānajam anāśayam || 6 ||

(Haṭha Yoga Pradīpikā, Caturtho' dhyāya, Verse: 6)

Of these the mind born of meditation is free from impressions

2.7.6 Smṛti

ydetī̄dy< mníEtt!,
s<}anma}an< iv}an< à}an< mexa †iòx&RitmitmRnl;a
jUit> Sm&it> s<kLp> ³tursu> kamae vz #it,
svaR{yevEtain à}anSy namxeyain -v<it. 2.

Yadetaddhṛdayam manaścaitat |

Samjñānamājñānam vijñānam prajñānam medhā dṛṣṭirdhṛtimtirmanīṣā

Jūtiḥ smṛtiḥ saṅkalpaḥ kraturasuḥ kāmo vaśa iti |

Sarvāṅyevaitāni prajñānasya nāmadheyāni -varīti || 2 ||

(Aitareyopaniṣat, Pañcamaḥ Khaṇḍaḥ, Verse:2)

This which is known as the heart, this mind, consciousness, mastery, knowledge of arts, comprehension, power of retaining import of books, perception, fortitude, reflection, independent power of thinking, distress of mind caused by diseases, etc., memory volition, application, any pursuit for maintenance of life, desire, desire for the company of women, all these are indeed the names of consciousness.

tde; ðaekae n pZyae m&Tyu< pZyit n raeg< naet Ê>ota svRh pZy> pZyit
svRmaβaeit svRz #it s @kxa -vit iÇxa -vit pÂxa sÝxa nvxa cEv
puníEkadz> Sm&t> zt< c dz cEkí shöai[c ivsÁvzuíaE Øuva Sm&it>
Sm&itIM-e svRçNwlina< ivàmae]StSmE m&idtk;ayay tmsSpar< dzRyit -
gvaNsnTk...marStSkNd #Tyac]te tSkNd #Tyac]te. 2.

Tadeṣa śloko na paśyo mṛtyuṃ paśyati na rogaṃ nota duḥkhatā sarvaḥ paśyaḥ paśyati sarvamāpnoti sarvaśa iti sa ekadhā -viti tridhā -viti pañcadhā saptadhā navadhā caiva punaścaikādaśaḥ smṛtaḥ śataṃ ca daśa caikaśca sahasrāṇi ca visattośuddhau dhruvā smṛtiḥ smṛtilam-e sarvagrānthīnāṃ vipramokṣastasmai mṛditakaśāyāya tamasaspārāṇ darśayati -gavānsanat Kumāraṣṭakāṇḍa ityācakṣate taskanda ityācakṣate|| 2||

(Chāndogyaopniṣada, Saptamo'dhyāyaḥ, Ṣaḍviṃśaḥ Khaṇḍaḥ, Verse:2)

**m&Tyu> svRhríahmuÑví -iv:ytam!,
klitR> ïlvaR< narl[a< Sm&itmeRxa x&it>]ma. 34.**

Mṛtyuḥ sarvāharaścāhamudbhavaśca -viśyatām|

Kīrtiḥ śrīrōākca nārīnāṃ smṛtirmedhā dhṛtiḥ kṣamā|| 34||

(Śrīmadbhagavadgītā, Daśamo'dhyāyaḥ, Verse:34)

I am all devouring death also of the six manifestations of all living entities I am the first as birth; of feminine attributes I am fame, beauty, perfect speech, memory intellect, patience and compassion.

**svRSy cah< ùid siÚivòaeMÄ> Sm&it}aRnmpaehnÄ,
vedEí svERrhmev ve*ae vedaNtk«Öedivdev cahm!. 15.**

Sarvasya cāham hṛdi snniviśto mattaḥ smṛtirjñānamapohanañca|

Vedaśca savarirahameva vedyo vedāntakṛdvedvideva cāham|| 15||

(Śrīmadbhagavadgītā, Pañcadaśo'dhyāyaḥ, Verse:15)

And, I am seated in the hearts of all; from Me are memory, knowledge, as well as their absence. I am verily that which has to be known by all the Vedas; I am indeed the author of the Vedānta, and the knower of the Vedas am I.

**nòae maeh> Sm&itlRBxa TvTàsadaNmyaCyut,
iSwtae=iSm gtsNdeh> kir:ye vcn< tv. 73.**

Naṣto mohaḥ smṛtirlabdḥa tvatprasādānmayācyuta|

Sthito'smi gatasandehaḥ kriṣye vacanaṃ tava|| 73||

(Śrīmadbhagavadgītā, Aṣṭādaśo'dhyāyaḥ, Verse:73)

Destroyed is my delusion as I have gained my memory (knowledge) through Thy Grace, O Krishna! I am firm; my doubts are gone. I will act according to Thy word.

Anu-Utiv;yas<àmae;>Sm&it>. 11.

Anubhūtvīṣayāsāmpramoṣaḥ smṛtiḥ || 11 ||

(Pātañjalayogasūtrāṇi, Prathamo'dhyāyaḥ, Verse:11)

Memory is the retained impression of experienced objects

īlavlyRSm&itsmaixà}apUvRk #tre;am!. 20.

Śraddhāvīryasmṛtisamādhiprajñāpūroaka itareṣām || 20 ||

(Pātañjalayogasūtrāṇi, Prathamo'dhyāyaḥ, Verse:20)

For others, confidence, stamina, introspective memory, the continuous effortless linkage of the attention to a higher concentration force, and profound insight, all being previously mastered, serve as the cause.

jaitdezkaIvyihtanam! APyanNty;
Sm&its<Skaryae> @kêpTvat!. 9.

Jātidēśakālavyaḥhitānām apyānantaryam

Smṛtisamīskārayoḥ ekarūpatvāt || 9 ||

(Pātañjalayogasūtrāṇi, Caturtho'dhyāya, Verse:9)

There is the relation of cause and effect even though separated by class, locality and time because memory and impressions are the same in form

icÄaNtr†Zye buiġbuġeritās¼> Sm&its<krī. 21.

Cittāntaradṛṣye buddhibuddhertiprasaṅgaḥ smṛtisamīkaraśca || 21 ||

(Pātañjalayogasūtrāṇi, Caturtho'dhyāya, Verse:21)

If cognition of one mind by another (be postulated), we would have to assume cognition of cognitions and confusion of memories also

2.7.7 Samādhi

iSwtà}Sy ka -a;a smaixSwSy kezv,
iSwtxl> ik< à-a;et ikmaslt ljet ikm!. 54.

*Sthitaprajñasya kā -āṣā samādhisthasya keśava |
Sthitadhīḥ kiṁ pra-āṣeta kimāsīta vrajeta kim || 54 ||*

(Śrīmadbhagavadgītā, Dvītīyo'dhyāyaḥ, Verse:54)

What, O Kṛṣṇa, is the description of him who has steady wisdom and is merged in the Super conscious State? How does one of steady wisdom speak? How does he sit? How does he walk?

īlavlyRSm&itsmaixà}apUvRk #tre;am!. 20.

Śraddhāvīryasmṛtisamādhiprajñāpūrvaka itareṣām || 20 ||

(Pātañjalayogasūtrāṇi, Prathamo'dhyāyaḥ, Samādhipādaḥ, Verse:20)

(In the case) of others (Upaya-Pratyaya Yogis) it is preceded by faith, energy, memory and high intelligence necessary for Samādhi.

ta @v sbll> smaix>. 46.

Tā eva sabījaḥ samādhiḥ || 46 ||

(Pātañjalayogasūtrāṇi, Prathamo'dhyāyaḥ, Samādhipādaḥ, Verse:46)

They (stages corresponding to subtle objects) constitute only Samādhi with seed'.

tSyaip inraexe svRinraexan! inbIRj> smaix>. 51.

Tasyāpi nirodhe sarvanirodhān nirbījaḥ samādhiḥ || 51 ||

(Pātañjalayogasūtrāṇi, prathamo'dhyāyaḥ, samādhipādaḥ, verse:51)

On suppression of even that o wing to suppression of all (modifications of the mind) 'Seedless' Samādhi (is attained).

smaix-avnawR> ueztnUkr[awRí. 2.

Samādhi-āvanārthaḥ kleśatanūkaraṇārthaśca || 2 ||

(Pātañjalayogasūtrāṇi, Dvītīyo'dhyāyaḥ, Verse:2)

It is for the purpose of producing continuous effortless linkage of the attention to a higher concentration force and for causing the reduction of the mental and emotional afflictions.

smaixisiĩrlĩñràì[xanat!. 45.

Samādhisiddhirīśvaraprñidhānāt|| 45||

(Pātañjalayogasūtrāṇi, Dvītīyo'dhyāyaḥ, Verse:45)

From the profound religious meditation upon the Supreme Lord comes the perfection of continuous effortless linkage of the attention to that Divinity.

tdœ @vawRmaÇin-aRs< SvêpzUNym! #v smaix>. 3.

Tad evārthamātrni-rāsam svarūpaśūnyam iva samādhīḥ|| 3||

(Pātañjalayogasūtrāṇi, Tṛtīyo'dhyāyaḥ, Verse:3)

From the profound religious meditation upon the Supreme Lord comes the perfection of continuous effortless linkage of the attention to that Divinity.

svaRwRtEkaçtyae>]yaedyaE icÄSy smaixpir[am>. 11.

Sarvārthataikāgratayoḥ kṣayodayau cittasya samādhipriṇāmāḥ|| 11||

(Pātañjalayogasūtrāṇi, Tṛtīyo'dhyāyaḥ, Verse:11)

The decrease of varying objectives in the mento-emotional energy and the increase of the one aspect within it is the change noticed in the practice of continuous effortless linking of the attention to higher concentration forces, objects or persons.

**A_yase tu ivinÔa[a< mnae x&Tva smaixna,
éÔa[l va pra muÔa -Ôa< isiĩ< àyCDit. 125.**

Abhyāse tu vinidrāṇām mano dhṛtvā samādhinā|

Rudrāṇi vā parā mudrā -drām siddhiṁ prayacchti|| 125||

(Haṭha Yoga Pradīpikā, Tṛtīyopadeśaḥ, Verse: 125)

For those who are alert and the mind one-pointed (disciplined) in samādhi, rudrani or

shambhavi mudra is the greatest mudra for bestowing perfection.

AwedanI- àvúyaim smaix³mmuÄmm!,
m&Tyu¹< c suaepay< äüanNd kr< prm!. 2.

Athedānī- pravakṣyāmi samādhikramamuttamam!

Mṛtyughnaṁ ca sukhopāyaṁ brahmānanda karaṁ param|| 2||

(Haṭha Yoga Pradīpikā, Caturthopadeśaḥ, Verse:2)

Thus, I shall now expound the best process of samādhi which eliminates death and takes one to the greatest bliss of Brahma.

raj yaeg> smaixí %Nmnl c mnaeNmnl,
AmrTv< lyStÅv< zUNyazUNy< pr< pdm!. 3.

Rāja yogaḥ samādhiśca unmanī ca manonmanī!

Amaratvaṁ layastattovaṁ śūnyāśūnyaṁ paraṁ padam|| 3||

(Haṭha Yoga Pradīpikā, Caturthopadeśaḥ, Verse:3)

Raja yoga, samādhi, unmani, manonmani, amaratwa, laya, sahaja tattwa, shoonyashoonya, parampadam.

sille sENxv< yÖTsaMy< -jit yaegt>,
twaTm mnsaerEKy< smaixri-xlyte. 5.

Slile saindhavaṁ yadvatsāmyaṁ -jti yogataḥ!

Tathātma manasoraikyaṁ samādhir-idhīyate|| 5||

(Haṭha Yoga Pradīpikā, Caturthopadeśaḥ, Verse:5)

As salt merges in the sea, likewise the mind and atma are considered united in samādhi.

yda s<]lyte àa[ae mans< c àllyte,
tda smrsTv< c smaixri-xlyte. 6.

Yadā sarikṣīyate prāṇo mānasaṁ ca pralīyate!

Tadā samarasatvaṁ ca samādhir-idhīyate|| 6||

(Haṭha Yoga Pradīpikā, Caturthopadeśaḥ, Verse:6)

When the movement of prāṇa is completely annihilated, then mind is reabsorbed and then samādhi is considered attained.

tt! sm< c ÖyaerEKy< jlvaTm prmaTmnae>,
àò svR s»Lp> smaix> sae=i-xlyte. 7.
Tat samam ca dvayoraikyam jīvātma paramātmanoḥ |
Prāṇaṣṭa sarva saṅkalpaḥ samādhiḥ so'-idhīyate || 7 ||

(Haṭha Yoga Pradīpikā, Caturthopadeśaḥ, Verse:7)

When the twofold nature of the individual soul and cosmic soul becomes one, all desires/ ideations are destroyed and that is considered samādhi.

@v< nana ivxaepaya> sMyKSvanu-vaiNvta>,
smaix magaR> kiwta> pUvaRcayERmRhaTmi->. 63.
Evam nānā vidhopāyāḥ samyaksvānu-vānvitāḥ |
Samādhi mārgāḥ kthitāḥ pūrvācāyairimahātm-iḥ || 63 ||

(Haṭha Yoga Pradīpikā, Caturthopadeśaḥ, Verse:63)

Thus, there are many various methods, depending on individual experience, of the path of Samadhi, told by the great one (mahatmas).

nadanusNxañ smaix -aja<yaeglñra[a< ùid vxRmanm!>
AanNdmek< vcsamgMy<janait t< ìl guénaw @k>. 81.

Nādānusandhāna samādhi -ājāṁ
Yogīśvarāṇām hṛdi vardhamānam |
Ānandamekaṁ vacasāmagamyam
Jānāti taṁ śrī gurunātha ekaḥ || 81 ||

(Haṭha Yoga Pradīpikā, Caturthopadeśaḥ, Verse: 81)

There is plenitude of bliss in the hearts of the great yogis who remain in Samadhi through nada anusandhana or exploration of nada, which is unequalled and beyond any description, known by the one and only Gurunath.

yavÚEv àivzit crNmaétae mXy mageR
yaviÖÊnR -vit †F> àa[vat àbNxat!,
yavÍ(ane shj s†z< jayte nEv tÁv<
tavJ}an< vdit tidd< dM- imWya àlap>. 114.

*Yāvannaiṅva praviṣṭi caranmāruto madhya mārga
Yāvovidurna -voti dṛḍhaḥ prāṇa vāta prabandhāt|
Yāvaddhyāne sahaja sadṛśaṁ jāyate naiva tattvaṁ
Tāvajjñānaṁ vadi tidiḁaṁ dam- mithyā pralāpaḥ|| 114||*

(Haṭha Yoga Pradīpikā, Caturthopadeśaḥ, Verse: 114)

While the prāṇa does not flow in the middle passage (of sushumna), while the bindu is not steadied by restraining the prāṇa, while mind does not reflect spontaneous meditation, then those who speak of spiritual knowledge are only indulging in boastful and false tales.

2.7.8 Prajñā

naivrtae ÊiirtaÚazaNtae nasmaiht>,
nazaNtmansae va=ip à}anenEnmaṢuyat!. 24.

*Nāvirato duṣcritānnāsānto nāsamāhitaḥ|
Nāsāntamānaso vā'pi prajñānenainamāpnuyāt|| 24||*

(Kaṭhōpaniṣat, Prathamāḥ Khandāḥ, Dvitiya'dhyāyaḥ, Verse:24)

But he who has not turned away from bad conduct, whose senses are not subdued, whose. Mind is not concentrated, whose mind is not pacified, can never obtain this Atman by knowledge.

àa[Syed< vze svj iÇidve yt! àitiótm!,
matev puÇan! r]Sv ilí à}a< c ivxeih n #it. 13.
#it àîaepin;id iÖTly> àî>.

*Prāṇasyedaṁ vaśe sarvaṁ tridive yat prtiṣṭhitam|
Māteva putrān rakṣasva śriśca prajñāṁ ca vidhehi na iti|| 13||
Iti praśnopniṣdi dvitīyaḥ praśnaḥ||*

(Praśnopaniṣat, Dvitiyaḥ Praśnaḥ, Verse:13)

All this is within the control of Prāṇa, as also all that is in the third heaven. Protect us like a mother. Give us prosperity and wisdom.

jagirtSwanae bih:à}> sÝa¼ @kaeniv<zitmuo>
SwUI-uGvEñanr> àwm> pad>. 3.

*Jāgritasthāno bhiṣprajñāḥ saptāṅga ekonvīmśtimukhaḥ
Sthūla bhugvaiśvānaraḥ prathamāḥ pādaḥ|| 3||*

(Māṇḍukyopaniṣat, Verse:3)

The first quarter is Vaisvanara, whose sphere is the state of waking, who is conscious of the external objects, who has seven limbs and nineteen mouths and who enjoys the gross objects.

SvßSwanae=Nt> à}a> sÝa¼ @kaeniv<zitmuo>
àiviv-uEjsae iÖtly> pad>. 4.

*Svapnasthāno'ntaḥ prajñāḥ saptāṅga ekonvīmśtimukhaḥ
Privi--u-aijaso dvitīyaḥ pādaḥ|| 4||*

(Māṇḍukyopaniṣat, Verse:4)

The second quarter is the Taijasa, whose sphere or field or place is dream, who is conscious of internal objects, who has seven limbs and nineteen mouths and enjoys the subtle objects

yÇ suÝae n kÂn kam< kamyte n kÂn Svß< pZyit tt!
su;uÝm!, su;uÝSwan @kl-Ut> à}an"n @vanNdmyae
ýanNd-ukœ cetae muo> àa}St&tly> pad>. 5.

*Yatra supto na kañcana kāmam kāmāyate na kañcana svapnam paśyati tat
Suṣuptam| suṣuptasthāna ekī-ūtaḥ prajñānaghana evānandamayo
Hyānanda-uk ceto mukhaḥ prājñastṛtīyaḥ pādaḥ|| 5||*

(Māṇḍukyopaniṣat, Verse:5)

That is the state of deep sleep, wherein the sleeper does not desire any objects nor does he see any dream. The third quarter or condition is the *prajñā*, whose sphere is deep sleep, in whom all experiences have become one, who is verily amass of consciousness,

who is full of bliss, who enjoys bliss, and who is the way leading to the knowledge (of the two other states).

naNt>à}< n bih:à}< nae-yt>à}< n à}an"n<
n à}< naà}m!, A†òmVyvhayRmçayml][<
AicNTymVypdeZymekaTmàTyysar< àpÂæpzm<
zaNt< izvmÖEt< ctuwj̄ mNyNte s AaTma s iv}ey>. 7.

*Nāntaḥprajñānāṁ na bhiṣprajñānāṁ no-yataḥprajñānāṁ na prajñānaghanānāṁ
Na prajñānāṁ nāprajñānāṁ| adṛṣṭamavyavahāryamagrāhyamalakṣaṇānāṁ
Acintyamavyapadeśyamekātmapratyayasārāṁ prapañcopaśamaṁ
Śāntaṁ śivamadvaitaṁ caturthaṁ manyante sa ātmā sa vijñeyaḥ|| 7||*

(Māṇḍukyopaniṣat, Verse:7)

The wise think that the fourth, Turiya, is not that which is conscious of the internal (subjective) world, nor that which is conscious of the external (objective) world, nor that which is conscious of both, nor that which is a compact mass of knowledge, nor that which is simple consciousness, nor that which is insentient. It is unseen, unrelated, in comprehensible, undefinable, unthinkable, indescribable, the sole essence of the consciousness of the Self, with no trace of the conditioned world, the peaceful, all-bliss, non-dual. This is the Atman, the Self, and it is to be realised.

ydetī̄dy< mníEtt!,
s<}anma}an< iv}an< à}an< mexa †iò&RitmitmRnl;a
jUit> Sm&it> s<kLp> ³tursu> kamae vz #it,
svaR{yevEtain à}anSy namxeyain -v<it. 2.

Yadetaddhṛdayaṁ manaścaitat

Saṁjñānamājñānānāṁ vijñānānāṁ prajñānānāṁ medhā dṛṣṭirdhṛtimtirmanīṣā

*Jūtiḥ smṛtiḥ saṁkalpaḥ kraturasuḥ kāmo vaśa iti|
Sarvāṅyevaitāni prajñānasya nāmadheyāni -vaṁti|| 2||*

(Aitareyopaniṣat, Pañcamaḥ Khaṇḍaḥ, Verse:2)

This which is known as the heart, this mind, consciousness, mastery, knowledge of arts, comprehension, power of retaining import of books, perception, fortitude, reflection,

independent power of thinking, distress of mind caused by diseases, etc., memory volition, application, any pursuit for maintenance of life, desire, desire for the company of women, all these are indeed the names of consciousness.

@; äüE; #NÔ @; àjapitrete sveR deva #main c pÂmha-Utain
 p&iwvl vayurakaz Aapae Jyaetl-;lTyetanlmain c]uÔimïa[lv,
 bljanltraï[cetrai[ca{fjain c jaéjain
 c Svedjain caeiÑ¼ain caña gav> pué;a hiStnae
 yiTkÂed< àai[j¼m< c ptiÇ c y½ Swavr< svj tTà}aneÇ< à}ane àitiót<
 à}aneÇae laek> à}a àitóa à}an< äü. 3.

Eṣa brahmaiṣa indra eṣa prajāptirete sarve devā imāni ca pañcamahā-ūtāni

Pr̥thivī vāyurākāśa āpo jyotī-ṣītyetanīmāni ca kṣudrmiśrāṇīva|

Bījānītarāṇi cetarāṇi cāṇḍajāni ca jārujāni

Ca svedajāni codbhijjāni cāśvā gāvah puruṣā hstino

*Ytkiñcedam prāṇi jaṅgamam ca pattri ca yacca sthāvaram sarvaṃ tatprajñānetraṃ
 prajñāne prtiṣṭhitam*

Prajñānetro lokah prajñā prtiṣṭhā prajñānam brahma|| 3||

(Aitareyopaniṣat, Pañcamah Khaṇḍah, Verse:3)

This Brahman, this Indra, this Creator, all these gods, these five great elements, earth, air, ether, water, fire, all these small creatures, these others, the seeds of creation, these egg-born (oviparous), the womb-born (viviparous), sweat-born, sprout-born, horses, cows, men, elephants, whatever else which breathes and moves and flies and is immovable-all these are guided by wisdom and are supported by wisdom. The universe has wisdom for its guide. Wisdom is the basis or stay of all. Verily wisdom (prajñānam) is Brahman.

2.7.9 Sthitaprajña

àjhait yda kamaNsvaRNpawR mnaegtan!,
 AaTmNyevaTmna tuò> iSwtà}StdaeCyte. 55.

Prajahāti yadā kāmānsarvānpārtha manogatān|

Ātmanyevātmanā tuṣṭaḥ sthitaprajñastadocyate|| 55||

(Śrīmadbhagavadgītā, dvitīyo'dhyāyah, verse:55)

When aman completely casts off, O Arjuna, all the desires of the mind and is satisfied in the Self by the Self, then is he said to be one of steady wisdom!

y> svRÇani-ðehStÄTaaPy zu-azu-m!,
nai-nNdit n Öeiò tSy à}a àitióta. 57.
Yaḥ sarvatrān-isnehastattatprāpya śu-āśu-m|
Nā-inandti na dveṣṭi tasya prajñā prtīṣṭhitā|| 57||

(Śrīmadbhagavadgītā, dvitīyo'dhyāyah, verse:57)

He who is everywhere without attachment, on meeting with anything good or bad, who neither rejoices nor hates, his wisdom is fixed.

yda s<hrte cay< k^amaeR=¼anlv svRz>,
#iNÔya[liNÔyaweR_yStSy à}a àitióta. 58.
Yadā sanharate cāyañ kūrmo'ñgānīva sarvaśaḥ|
Indriyāñindriyārthebhyastasya prajñā prtīṣṭhitā|| 58||

(śrīmadbhagavadgītā, dvitīyo'dhyāyah, verse:58)

When completely withdraws the senses similarly as the tortoise withdraws its limbs, from the objects of the senses he is established in perfect knowledge.

tain svaRi[s<yMy yu Aaslt mTpr>,
vze ih ySyeiNÔyai[tSy à}a àitióta. 61.
Tāni sarvāñi sañyamya yu- āsīta matparaḥ|
Vaśe hi yasyendriyāñi tasya prajñā prtīṣṭhitā|| 61||

(śrīmadbhagavadgītā, dvitīyo'dhyāyah, verse:61)

Having restrained them all he should sit steadfast, intent on Me; his wisdom is steady whose senses are under control.

#iNÔya[a< ih crta< yNmnae=nuivxlyte,
tdSy hrit à}a< vayunaRvimvaM-is. 67.
Indriyāñāñ hi caratāñ yanmano'nuvidhīyate|
Tadasya harti prajñāñ vāyurnāvomivāñ-si|| 67||

(śrīmadbhagavadgītā, dvitīyo'dhyāyaḥ, verse:67)

For the mind which follows in the wake of the wandering senses, carries away his discrimination as the wind (carries away) a boat on the waters.

tSma*Sy mhabahae ing&hltain svRz>,
#iNÔya[liNÔyaweR_yStSy à}a àitióta. 68.

*tasmādyasya mahābāho nigṛhītāni sarvaśaḥ|
indriyāṇīndriyārthebhyastasya prajñā prtiṣṭhitā|| 68||*

(Śrīmadbhagavadgītā, dvitīyo'dhyāyaḥ, verse:68)

Therefore, o mighty-armed arjuna, his knowledge is steady whose senses are completely restrained from sense-objects!

t³/4yat! à}a==laek>. 5.

tajjayāt prajñā'lokaḥ|| 5||

(Pātañjalayogasūtrāṇi, dvitīyo'dhyāyaḥ, verse:5)

By mastering it (samyama), comes the light of the higher consciousness.

स्थितप्रज्ञस्य का भाष समधिस्थस्य केशव

स्थितधीः किं प्रभाषेत किमासीत ब्रजेत किम

Sthitaprajñasya kā bhāṣa samadhisthasya keśava

Sthitadhīḥ kiṁ prabhāṣeta kimāsīta vrajeta kim

(śrīmadbhagavadgītā, dvitīyo'dhyāyaḥ, verse:54)

What, O Kesava, is the description of a man of steady wisdom, merged in Samadhi?

How (on the other hand) does the man of steady wisdom speak, how sit, how walk?

3. SCIENTIFIC REVIEW

Effective learner, it is vital that attention is maintained on the task in hand and other distracting information is filtered out. The consequences of inattentive and distractive behaviour cause the children ability to learn and remember information's. The concept of working memory has been extensively researched over several decades. Working memory is one of the extensively explored areas in cognitive psychology. It is recognized that working memory is a vital component in children ability to acquire information (Gathercole et al., 2008). Working Memory (WM) is the ability to store and manipulate information over short periods of time. Although a number of theories of working memory have been explored, one of the most prominent was put forward by Baddeley and Hitch in 1974. This ability to focus on important stimuli is essential, as all aspects of working memory have limited capacity (Baddeley, 2006).

We need to keep certain bits of information accessible in mind, but also we need to perform cognitive operations on them, mulling them over, manipulating or transforming them. These short-term mental storage and manipulation operations are collectively called working memory. WM comprised a single unitary store, proposing instead the three-component system

shown in this Figure 3.1 (Baddeley & Hitch 1974). Baddeley-Hitch model there is an integral relationship between a control system a central executive, that governs the deposition and removal of information from short-term storage and the storage

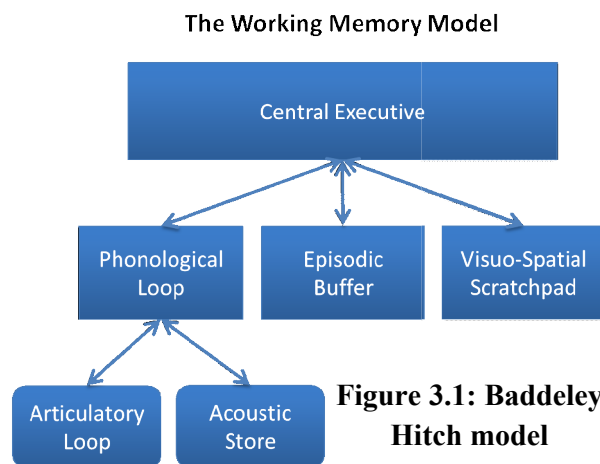


Figure 3.1: Baddeley Hitch model

buffers themselves. This tight level of interaction is what enables the short-term stores

to serve as effective work-places for mental processes. Third, the model proposes at least two distinct short-term memory buffers, one for verbal information (the phonological loop) and the other for visuo-spatial information (the visuo-spatial scratchpad). Because these short-term stores are independent, there is greater flexibility in memory storage. Thus, even if one buffer is engaged in storing information, the other can still be utilized to full effectiveness. The supervision of these storage systems by a central executive suggests that information can be rapidly shuttled between the two stores and coordinated across them. The three components of the Baddeley-Hitch model interact to provide a comprehensive workspace for cognitive activity

3.1 WORKING MEMORY AND ITS RELEVANCE TO ADOLESCENTS

The central executive is supported by two sub-systems. First, the phonological loop enables the storage and manipulation of verbal information and second, the visuo-spatial sketchpad provides the same facility for visual information (Gathercole & Alloway, 2009). Visual information is often converted into verbal information by verbalising or naming items (Baddeley, 2006), which could lead to the assumption that adequate verbal memory skills are of particular importance. Assessments aimed at measuring verbal short-term memory capacity measure the ability to temporarily store information, such as a list of numbers. There has been found to be a close and specific link between verbal short-term memory capacity and the ability to learn sound patterns in new words (Gathercole & Alloway, 2006). Hence poor verbal short-term memory skills will impact on children ability to learn new spoken vocabulary and on their reading and spelling skills. This evidence is reflected in the recent independent report on dyslexia commissioned by the Secretary of State for children, Schools and Families (Rose, 2009) which clearly states that poor verbal memory is one of three markers of dyslexia. In order to assess verbal working memory rather than short-term verbal

memory, pupils would be expected to complete tasks that involve both storing and manipulating information (Gathercole & Alloway, 2009), for example by presenting children with a list of digits and asking them to repeat the digits in the reverse order. Many classroom activities require pupils to store and manipulate information, an obvious example being mental arithmetic tasks.

Working memory assessments mean that it is possible to formally identify pupils with poor working memory skills. Evidence shows that working memory skills are closely linked to performance on scholastic tests and are highly predictive of measures of literacy, mathematics and language comprehension (Gathercole & Alloway, 2006).

Working memory studies from life span developmental perspective to specific role in various conditions, including major deficit areas were elaborately done. Working memory development across early childhood to early adolescent years were investigated in children 4-15 years of age. The results indicated that the basic modular structure of working memory is present from 6 years of age and possibly earlier, with each component undergoing sizable expansion in functional capacity throughout the early and middle school years to adolescence (Gathercole, Pickering, Ambridge & Wearing, 2004). Working memory seemed to put constraint on the acquisition of skill and knowledge in reading and mathematics. In a study it was found that there may be an association between working memory (measured by complex memory tasks) and both reading and mathematics abilities, as well as the possible mediating factors of fluid intelligence, verbal abilities, short-term memory (STM), and phonological awareness (Gathercole et al., 2006). Complementing this evidence, relationship between working memory and academic attainment were also investigated and it was found that working memory is a powerful predictor of subsequent academic success than intelligence quotient (Alloway, 2009).

3.2 YOGA AND ITS RELEVANCE TO ADOLESCENTS

Yoga is known to be beneficial for various people across the age, across the type, both healthy and unhealthy. This focus of the current study being yoga for adolescent children, the literature has been organized into categories like, yoga for children, mindfulness and its influences, and a special attention on yoga for memory in children. There has been an increasing interest to introduce yoga to children both at schools and at homes, as it offers a good technique to calm the mind and increase health and wellbeing. White (2009) has attempted to describe the philosophical basis of yoga, the basic components of a yoga practice, safety concerns, and how to locate and evaluate a yoga program for children. It has been shown that if yoga is introduced at quite a young age, before 12 years, report says that in later years that can help in managing anxiety and other worry symptoms during musical performances (Khalsa, 2013; Noggle et al., 2012). Such yoga programs are evaluated for feasibility and qualitative evaluation has been attempted by Conboy (2013). A blend of qualitative interview study and a randomized, controlled trial study design, this study has shown various aspects of benefits of yoga for children.

Patil et al. (2013) have shown that in sub-junior athletes, integrated yoga module decreases sympathetic activity and causes a shift in the autonomic balance towards parasympathetic dominance indicating a reduction in stress. Further, indicating highly beneficial aspects of yoga for mental and physical fitness. A similar study done earlier (Dash & Telles, 1999) on 152 children shows increase in motor speed for repetitive finger movements following yoga training, however, not in strength or endurance, as the increase was not sustained over 30 sec.

Yoga has been found to be beneficial for even mentally challenged adolescents. Once in a week yoga training for more than 3 years has shown improvement in neuromuscular abilities in mentally challenged adolescents (Bhavanani, 2012). Not only in this domain, in many other clinical domains also, has yoga been found very

effective in both management and prevention of various conditions. In a study to evaluate Yoga for anxiety Williams-Orlando (2012) has shown clinical efficacy of yoga therapy in the treatment of anxiety and panic disorder (PD) in an adolescent girls. Treatment consisted of 4 wks of individual sessions (60-min session/wk) and 6 wks of group sessions (90-min session/wk) with daily home practice. Also hospitalized condition of oncology, the quality of life has been shown to significantly influence by yoga (Geyer et al., 2011). Further, in 12 to 21 years old group has shown positive response towards yoga intervention in handling traumatized conditions (Spinazzola et al., 2011). Another study to evaluate the effect of yoga exercises on pain frequency and intensity and on quality of life in children with functional abdominal pain (Brands, 2011), has shown significant reduction of pain intensity and frequency after a 10 yoga lessons in 20 children, aged 8-18 years, with irritable bowel syndrome (IBS) or functional abdominal pain (FAP). Yoga has been found to be beneficial in exercise-induced bronchoconstriction (EIB) in children. This shows better control of asthma in children (Tahan, Eke, Bicici, 2014). Yoga has also been found useful in eating disorders like anorexia nervosa and bulimia nervosa. Individualized yoga treatment decreased eating disorder examination scores at 12 weeks, and significantly reduced food preoccupation immediately after yoga sessions (Carei, Fyfe-Johnson, Breuner & Brown, 2010).

Yoga practice, including physical postures, yoga breathing, meditation and guided relaxation have been shown to improve delayed recall of spatial information (Manjunath & Telles, 2004). A study evaluating the impact of a meditation program on resting and ambulatory blood pressure and heart rate in youth has shown potential beneficial impact of meditation on blood pressure and heart rate in the natural environment in healthy normotensive youth (Barnes, 2004). The effect of *Bhastrika*, *Anulom Vilom Prāṇāyāma* and *yogāsana* on heart rate variability, general wellbeing, anxiety levels and cognition of the medical students were studied. The results showed

highly significant increase in high frequency (HF) components of heart rate variability and decrease in low frequency (LF) components and LF/HF in the group practicing *prāṇāyāma*. There was also highly significant improvement of cognition, general well being and anxiety as shown by the PGI memory scale, Hamilton- anxiety scale and psychological general well being schedule scores in this group. In the yogasana group no significant changes were observed in the heart rate variability, cognition and anxiety although psychological general well being schedule scores significantly improved after six weeks practice of *yogāsana*. The study shows that practice of slow breathing type of *prāṇāyāma* for six weeks improves cognition, anxiety and general well being and increases the parasympathetic activity. There was no effect of *yogāsana* on the above parameters except improvements in the general well being (Chandla et al., 2013). Healthy life style like getting up in the early morning also has shown to be influence in cognitive tasks. A study was undertaken to assess the influence of early rising (during Brahma-muhurtha) on tasks requiring attention and the ability to recall. Fifty four normal healthy male volunteers, with ages ranging from 16-22 years from a residential school were selected. They were randomly allocated to two groups (Brahma-muhurtha and control). They were assessed on day 1, day 10 and day 20 of the intervention, using a digit letter substitution task and verbal and spatial memory task. The Brahma-muhurtha group was asked to rise before 4:30 am in the morning based on the traditional Indian astrological calculations, while the control group was allowed to wake up just before 7 am which was their regular timing for waking. Brahma-muhurtha group after 20 days showed a significant improvement in the net scores for digit letter substitution task as well as scores for verbal and spatial memory tasks. The control group also showed an improvement in the memory task but not in the task requiring attentional processes. This study suggests that rising early in the morning as described

in ancient Indian tradition influences the process of attention and can improve the ability to recall (Kumaran, Raghavendra & Manjunath, 2012).

3.3 CYCLIC MEDITATION (CM) AND COGNITIVE FUNCTIONS:

Cyclic (CM) meditation is a unique practice which incorporates mind and body movements, along with awareness. An effective practice especially for novices, has been scientifically evaluated to a greater extent. Cyclic meditation is a technique which combines "stimulating" and "calming" practices, based on a statement in ancient yoga texts suggesting that such a combination may be especially helpful to reach a state of mental equilibrium (Sarang & Telles, 2006). CM has shown to improve mindfulness in experienced practitioners of CM using a Mindfulness Attention Awareness Scale (MAAS). CM can lead to development of higher levels of mindfulness and may have the ability to positively impact mental states and attention, thereby offering the potential for prevention of clinical levels of psychopathology and improving overall psychological well-being in healthy individuals (Vinchurkar, Singh & Visweswaraiiah, 2014).

The effect of two yoga-based relaxation techniques, namely, cyclic meditation (CM) and supine rest (SR), using the six letter cancellation task was done. The subjects were assessed on SLCT before and immediately after both yoga-based relaxation techniques. Both CM and SR led to improvement in performance, as assessed by SLCT, but the change caused by CM was larger than SR (Pradhan & Nagendra, 2010). Previously cyclic meditation and supine rest have been shown to improve performance in a letter cancellation task requiring attention, visual scanning, and motor speed. The DLST assessed attention and speed of information processing, while the other 2 tests assessed motor speed. Each participant was assessed before and after three types of sessions: Cyclic Meditation, Supine Rest, and Control (no intervention). DLST scores and scores

for letter-copying and circle-dotting tasks improved significantly after cyclic meditation; the same scores also improved after supine rest (Subramanya & Telles, 2009). CM improved memory scores immediately after the practice and decreased state anxiety more than rest in a classical yoga relaxation posture (*Śavāsana*) (Subramanya, & Telles, 2009).

The performance in a six-letter cancellation task was assessed with 69 boys volunteers, ages 18 to 48 years, immediately before and after two yoga-based relaxation techniques and a control session of equal duration. The results suggest that Cyclic Meditation brings about a greater improvement in performance in this task, which requires selective attention, concentration, visual scanning abilities, and a repetitive motor response (Sarang & Telles, 2007). Day time activities are known to influence the sleep on the following night. Cyclic meditation (CM) has recurring cycles. Hence yoga practice during the day appears to shift sympatho-vagal balance in favor of parasympathetic dominance during sleep on the following night (Patra & Telles, 2010). Practicing cyclic meditation twice a day appeared to improve the objective and subjective quality of sleep on the following night (Patra & Telles, 2009). Cyclic meditation enhances cognitive processes underlying the generation of the P300 (Sarang & Telles, 2006). The effect of practicing meditation while focusing on a sound or a symbol has shown influence on midlatency auditory evoked potentials (MLAEPs). Following CM the latencies of neural generators corresponding to cortical areas is prolonged, whereas following SR a similar change occurs at mesencephalic-diencephalic levels (Subramanya & Telles, 2009).

3.4 MINDFULNESS AND ITS RELEVANCE TO ADOLESCENTS

The effects of a school-based mindfulness-based stress reduction (MBSR) program for young urban males were evaluated for psychological functioning and MBSR

participants showed less anxiety, improved coping, and a possible attenuation of cortisol response to academic stress (Sibinga et al., 2013). Acceptability and efficacy study was also conducted in a schools-based universal mindfulness intervention to enhance mental health and well-being (Kuyken et al., 2013). Mindfulness-based meditation intervention on quality of life, sleep, and mood in adolescents with cancer showed improvement compared to a control group (Malboeuf-Hurtubise, Achille, Sultan, & Vadnais, 2013). Mindful attention was successful in helping children focus attention on experimental pain without increasing pain intensity or decreasing tolerance compared with a well-established intervention for acute pain reduction (Petter, Chambers, & Mac Laren, 2013). Mindfulness-based intervention program was found to be beneficial for adolescents with psychiatric disorders (Tan & Martin, 2013). In a study to explore test anxiety in adolescent students, a comparative study revealed that adolescents with high test anxiety scored significantly higher in negative forms of self-criticism, social anxiety and lower in self-reassurance, acceptance and mindfulness, compared to those with low test anxiety (Cunha & Paiva, 2012). Inducing distress and measuring state rumination showed that a brief period of mindfulness was found to be helpful in getting youth out of their ruminative state (Hilt & Pollak, 2012). In a study to assess potential effect of a mindfulness-based stress reduction (MBSR) program for human immune deficiency virus (HIV)-infected and at-risk urban youth, MBSR was shown to have a positive effect on hostility, interpersonal relationships, school achievement, and physical health (Sibinga et al., 2011). Socially and economically less privileged youth are at risk for a range of negative outcomes related to stress, including social-emotional difficulties, behaviour problems, and poor academic performance. Mindfulness-based approaches may improve adjustment among chronically stressed and disadvantaged youth by enhancing self-regulatory capacities (Mendelson et al.,

2010). A RCT was designed to assess the effect of the MBSR program for adolescents. MBSR group showed a higher percentage of diagnostic improvement over the 5-month study period and significant increases in global assessment of functioning scores relative to controls, as rated by condition-naïve clinicians (Biegel, Brown, Shapiro & Schubert, 2009).

4. AIM AND OBJECTIVES

4.1 AIM

To evaluate the relationship and effect of Yoga on Working Memory in Adolescents

4.2 OBJECTIVES

1. To establish normative data for working memory task in Indian adolescences.
 - 1.1 To demonstrate normative data for the verbal and non-verbal memory task in Indian adolescents.
2. To explore the relationship between yoga related psychological states and working memory in healthy adolescents.
 - 2.1 To explore the relationship between state mindfulness and spatial memory in healthy adolescents.
 - 2.2 To understand the relationship between state anxiety and spatial memory in healthy adolescents.
3. To evaluate the effect of intense yoga based personality development program on psychological domains and working memory in healthy adolescents.
 - 3.1 To assess the effect of intense yoga based personality development program on dispositional mindfulness in healthy adolescents.
 - 3.2 To evaluate the effect of intense yoga based personality development program on state mindfulness in healthy adolescents.
 - 3.3 To assess the effect of intense yoga based personality development program on state anxiety in healthy adolescents.
 - 3.4 To estimate the effect of yoga based personality development program on spatial memory in healthy adolescents.

4. To examine the immediate effect of cyclic meditation on working memory and psychological states in healthy adolescents.
 - 4.1 To examine the immediate effect of cyclic meditation on verbal and non-verbal memory in healthy adolescents.
 - 4.2 To investigate the immediate effect of cyclic meditation on state anxiety in healthy adolescents.

4.3 RESEARCH QUESTION AND HYPOTHESES

The following research questions and hypotheses were addressed through four different studies:

Research Question 1: What is the relationship between psychological states and working memory in adolescents?

Hypothesis 1: Higher levels of state mindfulness will be positively related to working memory.

Hypothesis 2: Higher levels of state anxiety will be negatively related to working memory.

Research Question 2: What is the effect of intense yoga based personality development program on psychological domains and spatial memory in healthy adolescents?

Hypothesis 3: Intense yoga based personality development program may enhance spatial memory in healthy adolescents.

Hypothesis 4: Intense yoga based personality development program may improve dispositional mindfulness in healthy adolescents.

Hypothesis 5: Intense yoga based personality development program may increase state mindfulness in healthy adolescents.

Hypothesis 6: Intense yoga based personality development program may reduce state anxiety in healthy adolescents.

Research Question 3: *What is the immediate effect of cyclic meditation on state anxiety and working memory in adolescents?*

Hypothesis 7: Immediate effect of *cyclic meditation* may enhance verbal and non-verbal memory in healthy adolescents.

Hypothesis 8: Immediate effect of *cyclic meditation* may reduce state anxiety in healthy adolescents.

4.4 DEFINITIONS OF KEY TERMS

Definitions of terms are provided below to clarify the purpose of this study:

- **Mindfulness** is conceptualized as a state of attentiveness to present events and experiences that are unmediated by discursive or discriminating cognition (Brown & Ryan, 2003; Brown, Ryan & Creswell, 2007). For the purposes of this study, state mindfulness was operationalized through total scores obtained on the *Mindfulness Attention Awareness Scale* developed by Brown & Ryan (2003). Further dispositional mindfulness was operationalized through total scores obtained on the Child and Adolescent Mindfulness Measure (CAMM) developed by Greco, Baer, & Smith (2011).
- **Working Memory (WM)** is conceptualized a limited capacity system serving to keep “active” a limited amount of information for a brief period of time, and then to operate on it (Teixeira, Zachi, Roque, Taub & Ventura, 2011), has also been conceptualized as a component of higher-order cognitive processes (Engle, 2002). For the current study, multidimensional assessments of working memory, all

domains verbal, non-verbal and spatial measures were administered to understand the working memory. Various tools like visual memory task, spatial memory task (Baddeley, 1993) and Corsi Block-Tapping Task (Kessels et al, 2000) were used to operationalize working memory.

- **State Anxiety** (a temporary condition experienced in specific situations) refers to transitory unpleasant feelings of apprehension, tension, nervousness or worry, often accompanied by activation of the autonomic nervous system; it reflects how threatening a person perceives his environment to be. For the purposes of this study, state mindfulness was operationalized through total scores obtained on the State Anxiety Inventory & State Anxiety Inventory short form developed by Spielberger (1977).
- **Yoga** is defined as various component (Nagendra, 2010) such as *āsana* (seat or meditative posture), *prāṇāyāma* (regulation of breath), *pratyāhāra* (withdrawing the mind from the objects of sense experiences), *dhāraṇa* (confinement of the mind to one point or one object or one area) and *dhyāna* (relaxed dwelling of the mind in a single thought with awareness while practicing unbroken concentration). Further practice of yoga involves ethical principles of self restraints (*Yama*) and observances (*Niyama*).
- **Cyclic Meditation** (CM) is a 'moving meditation', which combines the practice of yoga postures interspersed with relaxation techniques. The objective of CM is to calm down the mind through a cyclic of awareness. The core principle of CM is when mind loses its awareness (*laya*) and enters into a sleepy state, stimulate (*Sambodhayet*) and awaken it. Do it again and again till mind reaches a state of

poise and calmness with present moment awareness (Nagendra & Nagarathna, 1997).

- *Adolescence* transitional phase of growth and development between childhood and adulthood. The World Health Organization (WHO) defines an adolescent as any person between ages 10 and 19. The biological determinants of adolescence are fairly universal; however, the duration and defining characteristics of this period may vary across time, cultures, and socioeconomic situations.

5. METHODS

5.1 PARTICIPANTS

5.1.1 Source of subject

Participants were healthy school adolescents who attended Yoga based Personality Development Camp (YPDC) in summer holidays in the serene campus of S-VYASA Yoga University, Bangalore. Participants' age ranged from 12 to 16 years were included.

5.1.2 Sample size

On the conservative side, considering a moderate effects size, according to Cohen (1988), sample sizes were calculated for all the studies. For correlational study (effect size = 0.3), required sample size was calculated as 138, and for the experimental design (effect size = 0.5), the required sample size was calculated as 54. For all the above calculations, G*Power 3.0 was used, and alpha was fixed at 0.05, power at 0.95, and assuming two tailed condition.

5.1.3 Inclusion Criteria

- Normal health status
- Both genders
- Normal or corrected to normal vision
- Proficiency in English
- Age ranging 12 to 16

5.1.4 Exclusion criteria

- Major disability
- History of neurological disorder

- History of psychiatric disturbance
- Undergoing any medication.

5.1.5 Ethical consideration

Signed informed consent was obtained from the parent or guardian of the child at the time of registration, after they had read the proposal that involves non invasive data collection methods and risks free intervention. All procedures were reviewed and accepted by the institutional ethical committee of S-VYASA University. The adolescents were explained in detail about the nature of the study and the voluntary nature of participation and were not provided with any incentives for their participation.

5.2 DESIGN AND PROCEDURE

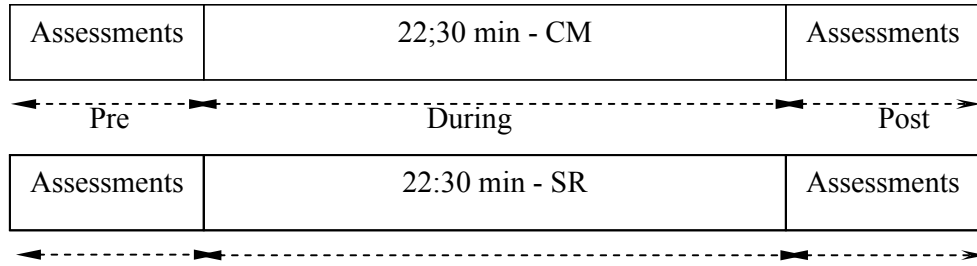
The research design was novel in incorporating different research methods such as Correlational, Pre-Post and Self as Control experimental designs. To establishing the normative data for working memory test as well as cross-section design to understand the relation between mindfulness and working memory, assessment was conducted on the initial day. Moreover, for experimental study data to evaluate the effect of yoga was assessed on the first and tenth day of the YPDC. Further for self as control design to evaluate the immediate effect of CM on working memory and state anxiety was collected on 9th and 10th day of YPDC. Detail descriptions of the designs are depicted in the following diagram. The participants were given training for the practice of both CM and SR for 8 days for self as control. They were assessed before and after equal duration of both CM and SR. The assessments were taken on two consecutive days, on day 9 and 10. The subjects were randomly assigned into two groups equally. Subjects were tested on the state anxiety and working memory immediately before and after a session of CM of 22:30 minute duration on one of the days, and immediately before

and after an equal duration of SR on the other day. The first group performed CM on day 9 and SR on day 10, and the second group with the order reversed.

Figure-5.2a: Design of the Study

PRE	YOGA BASED PERSONALITY DEVELOPMENT CAMP (YPDC)								SR	CM
	Day-1	Day-2	Day-3	Day-4	Day-5	Day-6	Day-7	Day-8	Day-9	Day-10
CYCLIC MEDITATION & SUPINE REST									CM	SR
YOGA BASED PERSONALITY DEVELOPMENT CAMP (YPDC)									POST	

Figure-5.2b: Time allocation within sessions for self as control design.



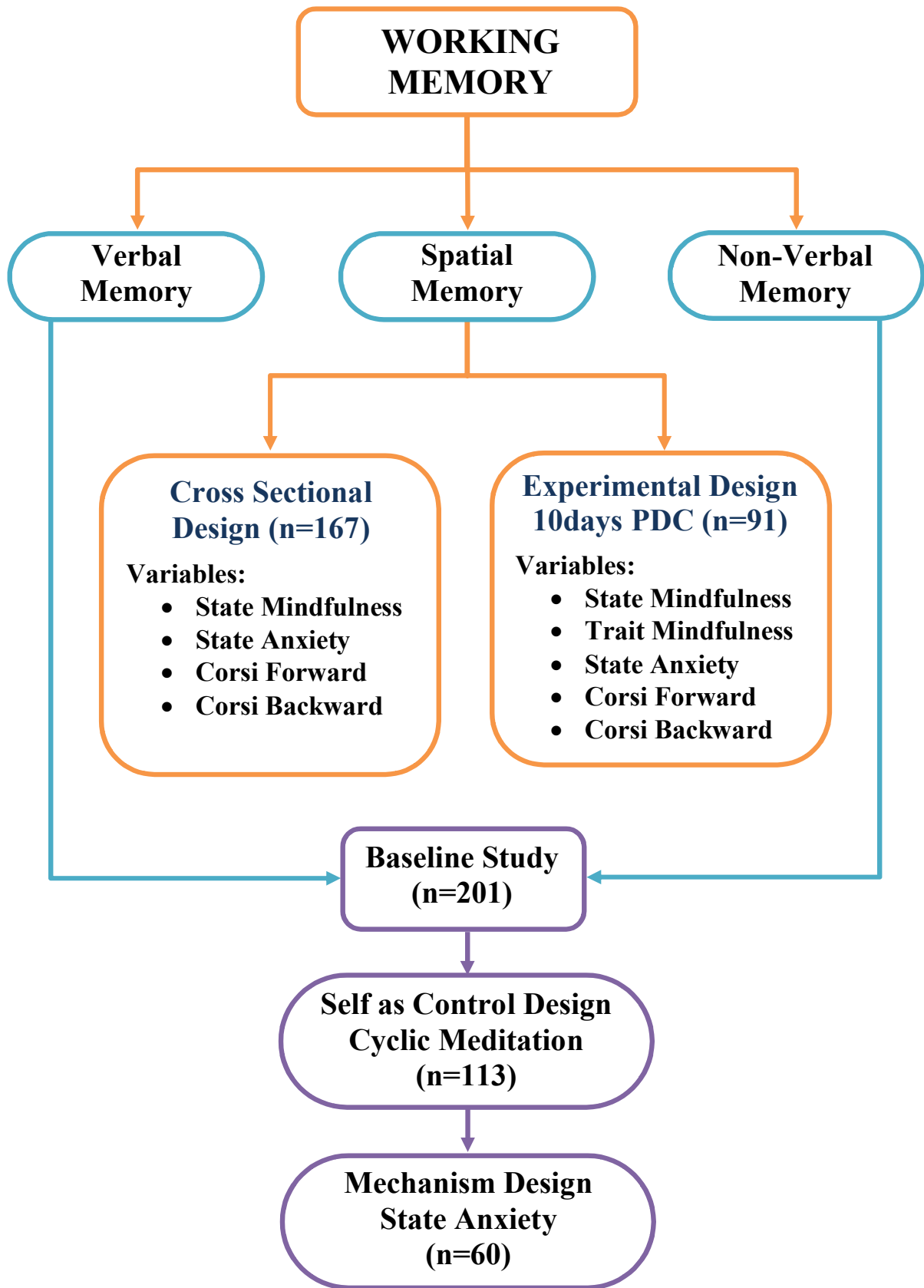


Figure-5.2c: Pictorial representation of the Designs

5.3 INTERVENTION

5.3.1 Yoga based Personality Development Program

Yoga based Personality development camp (YPDC) consisted of training in different yoga based techniques (Telles, Hanumanthaiah, Nagarathna, & Nagendra, 1993) for approximately eight hours a day, for 10 days. It included specialized yoga module for overall personality development such as yogasanas, breathing practices, eye-cleansing techniques, meditation, emotional culturing sessions, Vedic chanting, and yogic games. Further, the training also included guided relaxation and Cyclic Meditation (CM). (Deatiled YPDC program given in Appendix - 2)

5.3.2 Experimental session - Cyclic Meditation (CM)

Subjects were instructed to keep their eyes closed throughout the practice during CM and SR. CM used pre-recorded instructions, which emphasized the need to carry out the practice slowly, with awareness and relaxation. Practice starts with subjects lying on their back in supine (*Śavāsana*) and consists of the following sequence:

Chanting of a verse from the *Muṇḍūkya Upaniṣat* (Chinmayananda, 1984)(0:40 min);
Isometric contraction of the muscles of the body ending with supine rest (1:00 min);
Slowly getting up by shifting the body to the left side and standing at ease (*Tāḍāsana*),
'balancing' the weight on both feet, called centering (2:00 min); The first standing
lateral bending posture, towards the right side (*Ardha kaṭi cakrāsana*) (1:20 min);
Tāḍāsana (1:10 min) with instructions about relaxation and awareness; *Ardhakaṭi*
cakrāsana bending toward the left side (1:20 min); *Tāḍāsana* as previously (1:10 min);
Forward bending (*Pāda hastāsana*,) (1:20 min); *Tāḍāsana* as previously (1:10 min);
Backward bending (*Ardha cakrāsana*,) (1:20 min); Slowly coming down into the supine

posture (*Śavāsana*) with instructions to relax different parts of the body in sequence (10:00 min). All postures are practiced slowly, with instructions to be aware of all felt sensations. Total duration of practice is 22: 30 minutes all postures are practiced slowly, with instructions to be aware of all the felt sensations (Balaram & Nagendra, 2010). Total duration of practice is 22.30 minutes. (Detailed CM practice is given in Appendix - 3)

5.3.3 Control Session - Supine Rest (SR)

During SR session, participants were asked to relax in the corpse posture (*Śavāsana*). In *Śavāsana* participants had been lying flat on the floor with their legs to one side, arms away from the sides of the body, palms facing upwards and with the eyes closed. This control session was also for the equivalent duration, i.e., 22:30 min. (Manjunath & Telles, 2004). During the training, participants had been given instruction to attempt to continue relaxation while being aware of body sensations during *Śavāsana* (Subramanya & Telles, 2010). This is a standard yoga posture, intended for relaxation (Muktibodhananda, 1985).

5.4 ASSESSMENT

5.4.1 Rationale for choosing these tools

One of the objectives of yoga practices is to enhance the mindfulness. The concept mindfulness and the practice employed to develop mindfulness have in recent years come into view as one of the main focus of study within the positive psychology movement. Mindfulness is conceptualized as a state of attentiveness to present events and experiences that is unmediated by discriminating cognition (Brown, Ryan, & Creswell, 2007). The study demonstrated that mindfulness brings about various positive

psychological effects, emotional reactivity, self regulation and antidotes against common forms of psychological distress (Keng, Smoski & Robins, 2011; Hayes & Feldman, 2004). Mindfulness is described as a state or trait in which an individual becomes increasingly aware and attentive in the moment. Initial researches on mindfulness-based programs were for adults, more recent focus has been on the well-being of children's and adolescents; as a result, mindfulness based activities in schools is becoming prevalent and popular. Schools-based mindfulness intervention has reported promising evidence of its acceptability, evidence of its impact on depressive symptoms, efficacy in reducing stress and bolstering well-being (Kuyken et al., 2013).

The human brain appears to have a synchronized system that directs Working memory is a limited capacity system serving to keep "active" a limited amount of information for a brief period of time, and then to operate on it (Teixeira, Zachi, Roque, Taub & Ventura, 2011), has also been conceptualized as a component of higher-order cognitive processes (Engle 2002). The majority of mental health disorder encompasses the influence of anxiety level (Kessler et al., 2009). Anxiety can be due to distraction, disruption, and incapacity, which in turn declines cognitive performance (Vytal, Cornwell, Arkin & Grillon, 2012). Anxiety evokes several distinct emotional, cognitive, and perceptual realms (Dvorak-Bertsch, Curtin, Rubinstein & Newman, 2007). Previous reports have shown, resources for the executive process of working memory engages in anxious thought and limits the resources committed to working memory (Vytal et al., 2012 & Dvorak-Bertsch et al., 2007).

5.4.2 Anxiety Assessment

The state-trait anxiety inventory (STAI) consists of two questionnaires of 20 items each (Spielberger, 1983). The first questionnaire measures state anxiety (how one feels at the

moment); the second, trait anxiety (how one generally feels). Standardized and Short-Form (SF) of state anxiety has been used for this study (Marteau & Bekker, 1992). STAI-SF consists of six items assessing the extent to which patients feel such as calm, tense, upset, relaxed, content and worried on a 4-point scale ranging from not at all to very much. Items consist of equal numbers of the anxiety-present and anxiety-absent. Few items are scored in reverse order to avoid a response bias. The items were summed to produce a total score in which higher scores are related to greater anxiety. Further standard and SF of state anxiety have demonstrated good reliability coefficient to 0.80 and 0.82. (A sample sheet of STAI & STAI-SF given in Appendix - 4&5)

5.4.3 State Mindful Attention Awareness Scale (SMAAS)

The SMAAS is a valid tool for measuring state mindfulness (Brown, & Ryan, 2003). The scale is designed to assess the short-term or current expression of a core characteristic of mindfulness; this is a receptive state of mind and sensitive awareness of observing the present moment. The SMAAS draws items from the trait form of the MAAS (e.g., "I'm finding it difficult to stay focused on what's happening in the present"). SMAAS has shown excellent psychometric properties (Cronbach's alpha = 0.92). (A sample copy of SMAAS given in Appendix - 6)

5.4.4 Child and Adolescent Mindfulness Measure (CAMM)

The CAMM (Greco, Baer, & Smith, 2011) was administered to evaluate the mindfulness. The CAMM is a 10-item measure of mindfulness and assesses the degree to which children and adolescents observe internal experiences, act with awareness, and accept internal experiences without judging them. Respondents were asked to indicate how true each item reflected their experience using a 5-point scale ranging from 0 (Never true) to 4 (Always true). All items in this scale described actions contrary to a

mindfulness perspective therefore all items were reverse scored. A total mindfulness score was generated by summing the total items. Higher scores indicate higher levels of mindfulness. The CAMM demonstrates good internal consistency, with Cronbach's alpha = 0.87. (A sample sheet of CAMM given in Appendix - 7)

5.4.5 Verbal and Non-Verbal Memory

The test stimuli were projected on a screen for 10 seconds each allowing participants to memorize. After the ten different slides had been shown, a mathematical problem (e.g., 7 minus 4 plus 9 minus 3 plus 6 minus 5 minus 8 plus 2) was shown on the screen. Immediately after this, the subjects were asked to recall and write-down (or Non-Verbal Memory, to draw) within 60 sec the 10-test items which had been shown to them. Further, to test verbal memory, standard nonsense syllables of three letters, e.g., LYB, were selected from a prepared list (Baddeley, 1993). Non-verbal Memory test consisted of ten simple stroke drawings. Geometrical or other shapes which could be described verbally, e.g., square or a circle had not been used. The drawings were very simple and easy to reproduce. Correct response for both verbal and non-verbal tests had been scored as '1' while incorrect one as a '0'. During the assessment, subjects were asked to sit erect in the floor, with participants approximately a meter apart to avoid distraction. Four different sets of 10-nonsense syllables have presented on before and after each session (experimental and control). As described for verbal Working Memory, there were four separate, similar sets of 10-line drawings each for before and after each session. Intervention sessions and assessments were done as groups by yoga therapist and trained assistants in the neuropsychological testing laboratory (A sample content of VM and NVM is given in Appendix - 8).

5.4.6 Corsi Block-Tapping Task

The Corsi Block-Tapping task is a measure of visuo-spatial working memory (Kessels et al, 2000). A digital version of the task was used. The Corsi Block task was programmed presented by the INQUISIT Millisecond software package (Inquisit 3, 2012) on a Dell computer, 17-inch colour monitor. For each trial, nine randomly arranged blue squares were shown on the screen. Each trial consisted of a sequence of blocks that light up one block per second. Adolescents were instructed to remember the sequence. Once a sequence had finished, participants reproduce the sequence, by clicking those blocks in the same order for Corsi forward recall, while they have to reproduce the order in reverse for Corsi backward. Two trials of each sequence length were shown, and sequences gradually increased in length from two to nine blocks. If participants correctly reproduced at least one of the trials of the same sequence length, then the sequence length was increased by one. The task continued until both trials of the same sequence-length were incorrect, or participants completed trials with the largest sequence. We recorded the number of the longest sequence remembered as Block Span and number of correct sequence as total correct (Teixeira, Zachi, Roque, Taub, & Ventura, 2011) (A sample image of Corsi Block-Tapping Task is given in Appendix-9).

5.5 DATA EXTRACTION AND ANALYSIS

The data were collected using self-reported questionnaire and computers. All statistical analyses were performed using the Statistical Package for Social Sciences (version 16.0). Correlation, Independent-samples t-tests and Paired sample t-tests, procedures were used for statistical analyses.

5.5.1 State anxiety

Items consist of equal numbers of the anxiety-present and anxiety-absent. Few items are scored in reverse order to avoid a response bias. The items were summed to produce a total score in which higher scores are related to greater anxiety

5.5.2 State Mindfulness

To have high scores reflect higher state mindfulness, reverse score all items then average all 5 values.

5.5.3 CAMM

Items in this scale described actions contrary to a mindfulness perspective therefore all items were reverse scored. A total mindfulness score was generated by summing the total items.

5.5.4 Verbal and Non-Verbal Memory

Correct response for both verbal and non-verbal tests had been scored as '1' while incorrect one as a '0'. The items were summed to produce a total score on verbal and non-verbal tests. Higher scores are related to verbal and non-verbal.

5.5.5 Corsi Block-Tapping Task

The number of the longest sequence remembered as Block Span and number of correct sequence as total correct (Teixeira, Zachi, Roque, Taub, & Ventura, 2011).

6. RESULTS

6.1 NORMATIVE DATA FOR VERBAL AND NON-VERBAL MEMORY SCORES

Study assessed verbal and non-verbal memory normative data on healthy adolescences, has shown girls scored slight higher scores in verbal and non verbal memory, especially in the lower age range. There was also a linear trend in verbal and non-verbal memory; however nonverbal memory seems to be slightly higher. Independent sample t-test showed no significant gender difference.

Table 6.1a: Gender and Age wise descriptive statistics for Verbal and Non-verbal Memory

n	Age	Gender	Verbal Memory	Non-verbal Memory
42	13	F	5.86±1.42	6.86±1.59
21	14	F	6.19±1.36	7.38±1.50
33	15	F	6.27±1.64	7.82±1.31
10	16	F	6.6±1.58	7.1±1.79
30	13	M	5.80±1.03	6.83±1.68
33	14	M	6.09±1.10	6.61±1.46
21	15	M	6.81±0.93	6.67±1.43
11	16	M	6.55±1.21	7.36±1.43

Study-1 assessed verbal and non verbal memory of the participants. Table 6.1a shows gender and age wise descriptive statistics for verbal and non-verbal memory. Girlss have shown little higher scores in verbal and non verbal memory, especially in the lower age range (Table-6.1a). There was also a linear trend in verbal and non-verbal memory; however nonverbal memory seems to be slightly higher.

Table 6.1b: Gender wise descriptive statistics for Verbal and Non-Verbal memory

n	Gender	Verbal Memory	Non verbal Memory
106	F	6.12±1.50	7.28±1.54
95	M	4.95±6.21	5.95±6.78

6.2 RELATIONSHIP BETWEEN SPATIAL MEMORY AND STATE MINDFULNESS

Descriptive statistics for all three variables and demographic details are presented in Table-6.2a. Correlations with State Mindfulness are reported in Table 6.2b.

State mindfulness has shown a large inverse and significant correlation with the State anxiety ($r=-0.49$, $p<0.01$) and a large positive and significant correlation with the Corsi forward (Forward Corrected $r=0.35$, $p<0.01$, forward block span $r=0.31$, $p<0.01$ and forward total score $r=0.33$, $p<0.01$). Further state mindfulness had significant positive correlation with Corsi backward (backward corrected $r=0.26$, $p<0.01$, backward block span $r=0.26$, $p<0.01$ and backward total score $r=0.28$, $p<0.01$). Furthermore, state anxiety scores were inverse and significant correlation with the Corsi forward (forward corrected $r=0.20$, $p<0.01$, forward block span $r=0.20$, $p<0.01$ and forward block span $r=0.19$, $p<0.01$) and Corsi backward (Backward Corrected $r=0.21$, $p<0.01$, Backward Blockspan $r=0.19$, $p<0.05$ and Backward total score $r=0.20$, $p<0.01$).

Table-6.2a: Descriptive statistics for all three variables and Demographic details (N=167)			
Variable	Mean	SD	Range
Age	13.98	1.03	12 - 16
State Mindfulness	4.34	1.16	1.2 - 6
State Anxiety	12.57	3.69	6 - 21

Corsi Forward Correct	7.57	1.63	2 - 13
Corsi Forward Block Span	5.29	0.91	3 - 8
Corsi Backward Correct	7.53	1.84	2 - 11
Corsi Backward Block Span	5.44	1.00	2 - 8

Table-6.2b: Correlation Matrix for State Mindfulness, State Anxiety and Working Memory (N=167)

Variable	State Mindfulness	State Anxiety	Corsi Forward Correct	Corsi Forward Block Span	Corsi Forward Total Score	Corsi Backward Correct	Corsi Backward Block Span
State Anxiety	-.493**						
Corsi Forward Correct	.353**	-.204**					
Corsi Forward Block Span	.305**	-.201**	.854**				
Corsi Forward Total Score	.327**	-.186*	.952**	.950**			
Corsi Backward Correct	.264**	-.207**	.471**	.454**	.452**		
Corsi Backward Block Span	.259**	-.193*	.449**	.402**	.407**	.859**	
Corsi Backward Total Score	.275**	-.204**	.471**	.448**	.451**	.968**	.930**

6.3 THE EFFECT OF YOGA BASED PERSONALITY

DEVELOPMENT CAMP ON SPATIAL MEMORY AND PSYCHOLOGICAL STATES

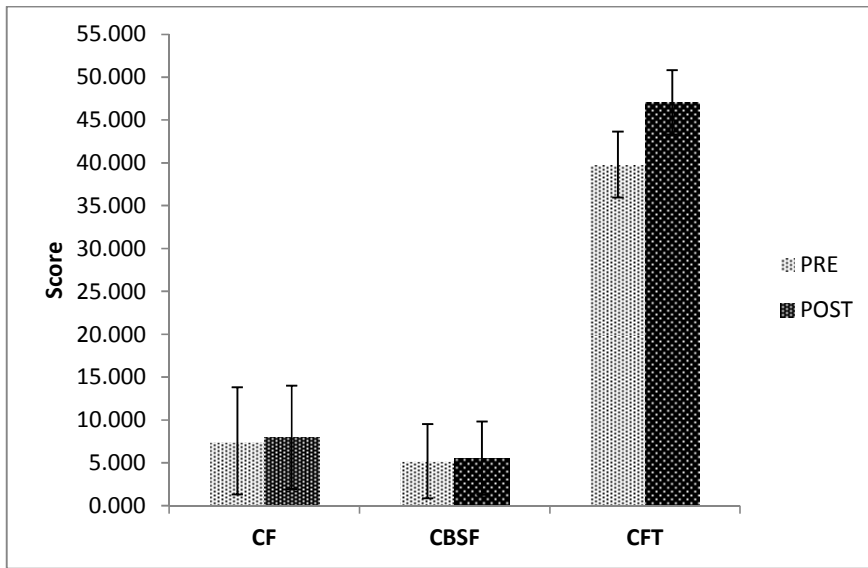
Study had shown a significant improvement in the scores of Corsi Forward Correct (p=0.002), Corsi Forward Block Span (p<0.001), Corsi Forward Total Score (p<0.001), Corsi Backward Correct (p=0.036), Corsi Backward Block Span

(p=0.026), Corsi Backward Total Score (p=0.025). Further significant enhancement of State Mindfulness (p=0.012), and dispositional mindfulness (p=0.013) following intervention. Furthermore, there was a significant reduction in State Anxiety (p=0.001) following 10 days of yoga based personality development camp.

Table-6.3: Pre-Post of 10 days Yoga Intervention: Corsi Block-Tapping Task, Child and Adolescent Mindfulness Measure, State-Trait Anxiety, State Mindfulness (mean ± standard deviation) (N=91)				
Variables	Pre	Post	P	% Chgange
	Mean±SD	Mean±SD		
Corsi Forward Correct	7.35±1.93	7.99±2.16	0.002	8.67
Corsi Forward Block Span	5.14±1.11	5.57±1.28	0.001	8.33
Corsi Forward Total Score	39.71±16.48	47.08±21.41	<0.001	18.54
Corsi Backward Correct	7.12±2.33	7.57±2.1	0.036	6.33
Corsi Backward Block Span	5.19±1.5	5.52±1.28	0.026	6.36
Corsi Backward Total Score	40.18±16.83	44.12±17.36	0.025	9.82
State Mindfulness	20.94±6.47	22.4±6.02	0.012	6.96
CAMM	25.85±4.38	26.87±4.27	0.013	3.98
STAISF	12.52±3.95	11.09±3.75	<0.001	11.46

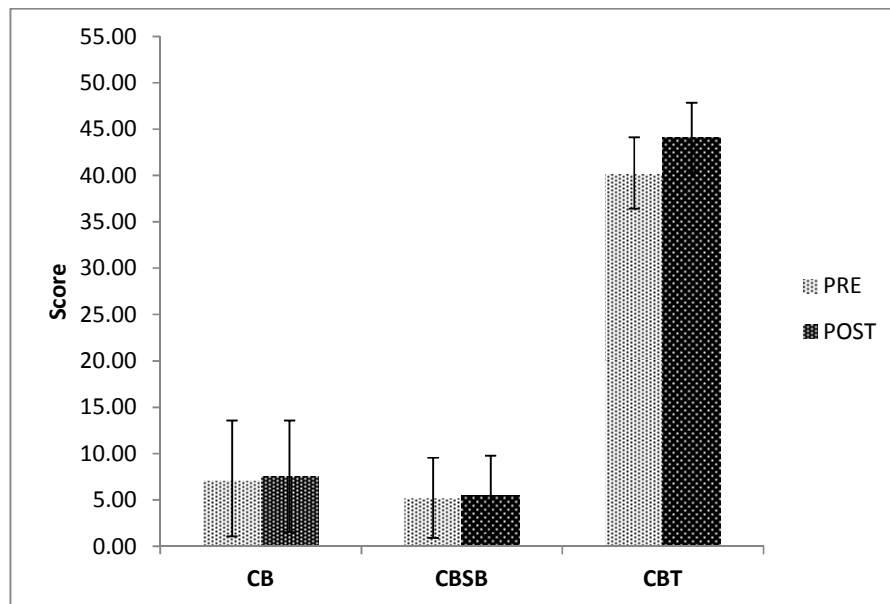
CAMM: Child and Adolescent Mindfulness Measure; STAISF: State-Anxiety Inventory Short Form

Figure-6.3a : Pre-Post data of Corsi Block-Tapping Task (Forward)



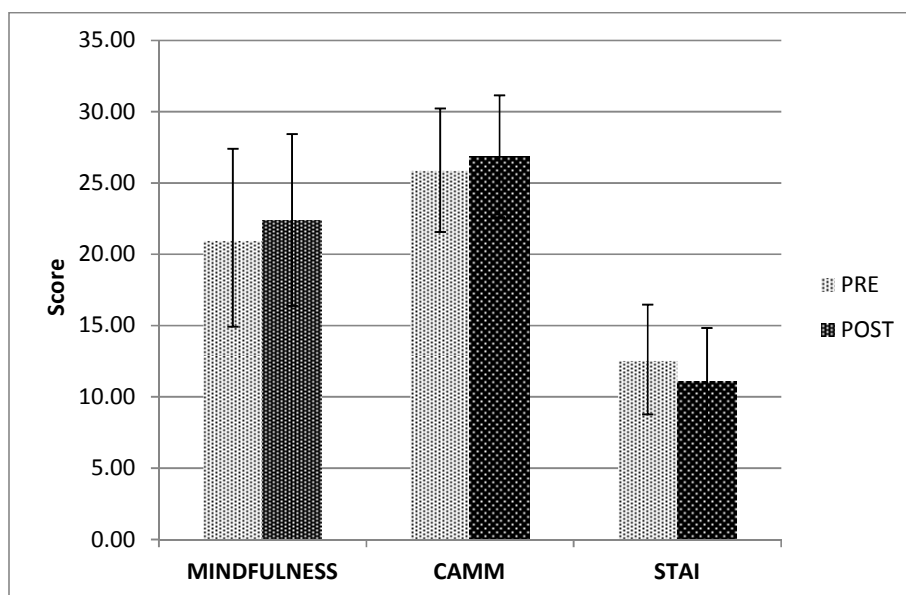
CF - Corsi Forward Correct, CBSF - Corsi Forward Block Span, CFT - Corsi Forward Total Score

Figure-6.3b : : Pre-Post data of Corsi Block-Tapping Task (Backward)



CB - Corsi Backward Correct, CBSF - Corsi Backward Block Span, CBT - Corsi Backward Total Score

Figure-6.3c : Pre-Post data of Mindfulness, CAMM and STAI



CAMM: Child and Adolescent Mindfulness Measure; STAISF: State-Anxiety Inventory Short Form

6.4 IMMEDIATE EFFECT OF CYCLIC MEDITATION (CM) AND SUPINE REST (SR) ON WORKING MEMORY

The two sessions (CM and SR) showed no significant difference in their baseline mean ($p=0.790$ in verbal memory and $p=0.996$ in non-verbal memory, paired sample t -tests). Both sessions showed a non-significant difference in their post mean score ($p=0.722$ in verbal memory and $p=0.489$ in non-verbal Memory, paired sample t -tests). CM session showed significant increase in non-verbal memory score from 6.18 to 7.42 ($p < 0.001$, paired sample t -tests). The SR session showed a non-significant change in non-verbal memory scores from 6.19 to 7.29 ($p < 0.001$, paired sample t -tests).

		Cyclic Meditation				Supine Rest			
	Variable	Pre	Post	% change	p value	Pre	Post	% change	p value
Total (113)	VM	7.27 ± 1.97	7.42 $\pm 1.80 \uparrow$	2.06	.245	7.21 ± 1.94	7.34 $\pm 1.99 \uparrow$	1.80	.430
	NVM	6.18	7.42	20.06	<0.001***	6.19	7.29	17.77	<0.001***

		± 2.33	± 1.76 ↑			± 2.13	± 1.73 ↑		
Boys (74)	VM	7.22 ± 1.90	7.41 ± 1.71 ↑	2.63	.225	7.03 ± 1.97	7.08 ± 1.92 ↑	0.71	.789
	NVM	5.81 ± 2.36	7.30 ± 1.76 ↑	25.65	<0.001***	6.11 ± 2.30	7.20 ± 1.65 ↑	17.84	<0.001***
Girls (39)	VM	7.38 ± 2.12	7.44 ± 1.97 ↑	0.81	.793	7.56 ± 1.85	7.82 ± 2.02 ↑	3.44	.303
	NVM	6.87 ± 2.13	7.64 ± 1.75 ↑	11.21	.023*	6.33 ± 1.78	7.46 ± 1.88 ↑	17.85	.001***

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$ paired sample t -tests, Post scores compared with respective Pre scores; VM= verbal memory; NVM= Non-Verbal Memory

On boys group sub analysis, CM session showed a significant increase in the non-verbal memory score from 5.81 to 7.30 ($p < 0.001$, paired sample t -tests). The SR session also showed a significant increase in the non-verbal Memory score from 6.11 to 7.20 ($p < 0.001$, paired sample t -tests). Further girls group sub analysis, CM session showed a significant increase in the non-verbal memory score from 6.87 to 7.64 ($p = 0.023$, paired sample t -tests). The SR session showed a significant change in non-verbal memory scores from 6.33 to 7.46 ($p < 0.001$, paired sample t -tests).

Figure-6.4a : Verbal Memory scores of Cyclic Meditation(CM) and Supine Rest (SR)

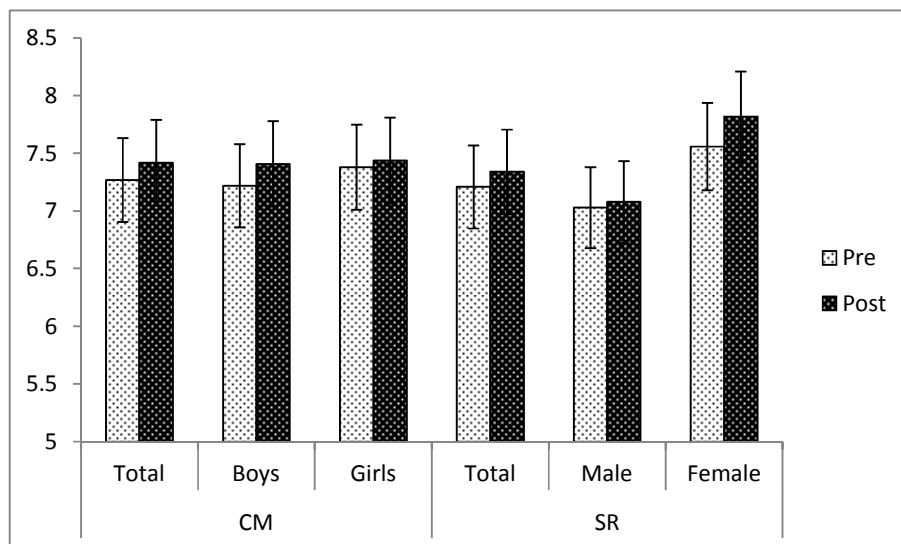
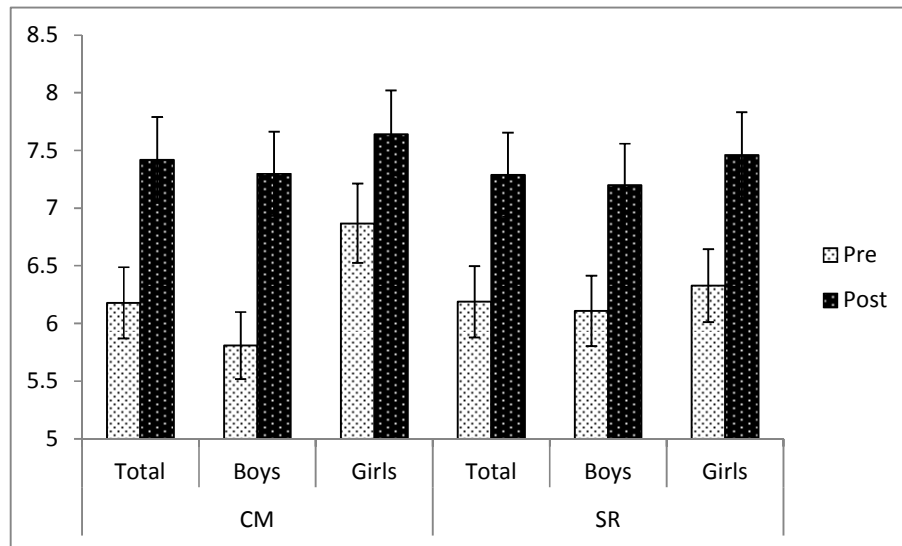


Figure-6.4b : Non-Verbal Memory scores of Cyclic Meditation(CM) and Supine Rest (SR)



6.5 IMMEDIATE EFFECT OF CM SESSION ON STATE ANXIETY

This Mechanism study evaluated the CM session showed a significant reduction in the STAI score from 38.90 to 37.24 ($p= 0.016$, paired sample t -tests). The SR session showed a non-significant reduction in the STAI score from 38.88 to 37.62 ($p=0.073$, paired sample t -tests). The two sessions showed no significant difference in their baseline mean ($p=0.981$, Independent t -tests) and also following CM and SR sessions ($p= 0.705$, Independent t -tests).

Table-6.5a: Age groups mean \pm standard deviation, of boys and girls.

	Mean \pm SD	N
Total	14.37 \pm 1.22	60
Boys	14.47 \pm 1.14	30
Girls	14.27 \pm 1.31	30

Table-6.5b: State Anxiety Inventory of Cyclic Meditation (CM) and Supine Rest (SR) (values are group mean \pm standard deviation)

Gender	n	Cyclic Meditation			Supine Rest		
		Pre	Post	% change	Pre	Post	% change
Total	60	38.9 \pm 8.84	37.24 \pm 9.76***	-4.27	38.88 \pm 9.49	37.62 \pm 10.02	-3.24
Boys	30	40.09 \pm 9.59	39.73 \pm 9.6	-0.90	39.81 \pm 9.38	40.15 \pm 9.36	0.85
Girls	30	37.71 \pm 8.01	34.75 \pm 9.42**†	-7.85	37.94 \pm 9.66	35.08 \pm 10.16***	-7.54

*** $p < 0.05$, ** $p < 0.01$ student's paired t -tests, Post scores compared with respective Pre scores. † $p < 0.05$, Independent t -tests, Post score compared with Post score between gender (boys versus girls).

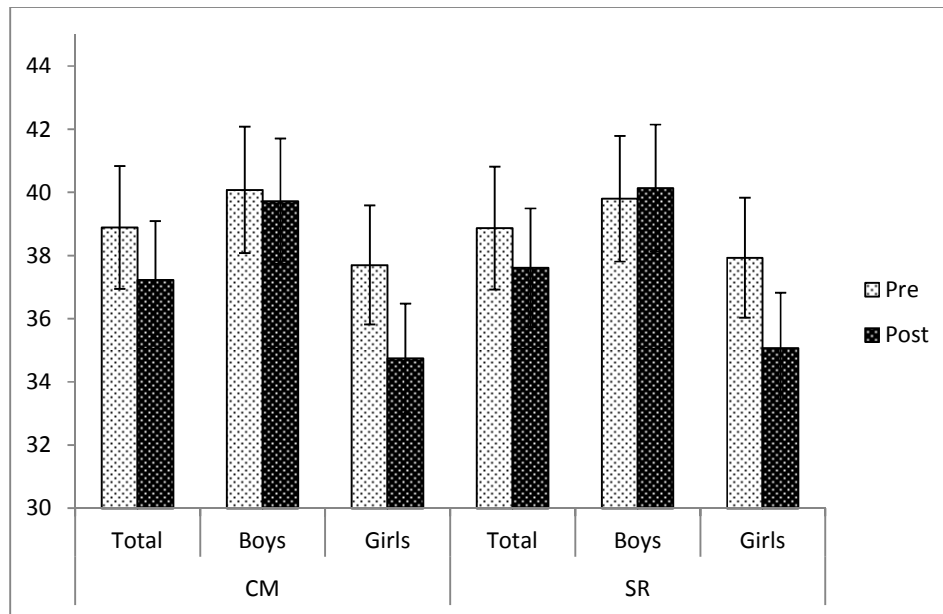
Girls group: CM sessions showed a significant reduction in the STAI score from 37.71 to 34.75 ($p=0.01$, paired-sample t -tests). The SR session showed a significant reduction in the STAI score from 37.94 to 35.08 ($p=0.017$, paired-sample t -tests).

Boys group: CM sessions showed a non-significant reduction in the STAI score from 40.09 to 39.73 ($p=0.633$, paired-sample t -tests). The SR session SR showed a non-significant reduction in the STAI score from 39.81 to 40.15 ($p=0.620$, paired-sample t -tests).

There was no significant gender difference of the mean before sessions of CM ($p=0.301$, Independent t -tests) and SR ($p=0.451$, Independent t -tests). However, there were significant difference in the mean score after session of CM ($p=0.047$, Independent t -tests) and SR ($p=0.049$, Independent t -tests).

The girls group had significantly higher reduction in STAI score as compared to boys group in CM ($p=0.049$, Independent t -tests) and SR ($p=0.019$, Independent t -tests).

Figure-6.5 : State Anxiety Inventory of Cyclic Meditation(CM) and Supine Rest (SR)



7. DISCUSSIONS

7.1 SUMMARY

In this study, we have attempted to bring to the attention of yoga researchers, the relationship and effect of yoga based intervention on working memory. Result supports the need of yoga based intervention for enhancing working memory on adolescents. Current results were in line and supports emerging literature on yoga they are summarized as:

1. The significant positive relationship between state mindfulness and working memory confirmed our primary hypothesis. Further state anxiety has shown significant negative relationship between working memory. This study supports cultivating mindfulness as an effective and efficient technique for performance in a visual working memory (Vugt & Jha, 2011).
2. A single group pre - post design in shown significant enhancement of working memory and mindfulness. Further results shown significant reduction in state anxiety, current study result are in line with previous studies on yoga reported enhanced cognitive functions in adolescents.
3. Immediate after Cyclic Meditation session, participants has shown a significant enhancement in spatial memory test scores. Study assessed the immediate effect of yoga based relaxation Cyclic Meditation and Supine Rest on recollection in a verbal and non-verbal memory test. Immediate after Cyclic Meditation session, participants has shown a significant enhancement in non-verbal memory test scores. Further study has shown a significant reduction in State Anxiety Scores following CM session.

7.2 COMPARISON WITH PREVIOUS STUDY

To our knowledge, this is the first study to understand the relationship between state mindfulness and working memory in children. Mindfulness can be enhanced by training. Numerous studies have shown mindfulness-enhancing interventions reduce pathological mental and physical health symptoms across a wide variety of conditions and diseases. Further immediate after Cyclic Meditation session result was in line with earlier studies showed enhancement in delayed recall of spatial information following yoga-based breathing techniques (Naveen, Nagarathna, Nagendra, & Telles, 1997), Gurukula System of Education (Rangan et al., 2009) and 10 days intervention program (Manjunath & Telles, 2004). In the previous study with similar design has found different effects of cyclic meditation on different attention task with varying degree of changes. For example, the magnitude of change in (1) Six-Letter cancellation score was higher (Pradhan & Nagendra, 2010), (2) Digit letter substitution score was low following cyclic meditation compare to supine rest (Pradhan & Nagendra, 2009). Previous study in adult group with similar design showed higher magnitude of changes. This may be due to participants in the previous study who were highly experienced and well-trained in meditation, relaxation and different yoga techniques. They were residential students doing undergraduate and post-graduate yoga courses (Subramanya & Telles, 2009b).

Table-7.2: Comparison with Previous studies (Baseline values)

	Intervention	VM	% Change VM	NVM	% Change NVM
Present Study	CM	7.27	2.06	6.18	20.06
	SR	7.21	1.80	6.19	17.77
Manjunath, 2004(S1)	Yoga	4.20	19.05	4.00	42.50
	FA	4.30	4.65	4.40	27.27
	Control	3.90	12.82	3.90	10.26
Naveen, 1997(S2)	RN	3.80	21.05	3.10	90.32
	LN	4.00	25.00	3.60	86.11
	BN	2.90	31.03	3.30	78.79
	BA	3.40	29.41	3.10	80.65
	Control	3.50	25.71	3.40	26.47
Ghaligi, 2006(S3)	VCG	8.43		8.34	
	NCG	7.00		6.91	
Kumaran, 2012(S4)	ERG	3.67	35.15	4.44	31.08
	LRG	3.41	17.30	4.11	24.33
Joshi, 2008(S5)	RNB	4.53	13.25	5.67	18.69
	LNB	4.67	-4.28	6.20	15.00
	BA	3.37	32.64	5.20	3.85
Rangan, 2009(S6)	GES	6.60	27.27	4.67	58.46
	MES	5.53	25.32	4.27	32.79
Khemka, 2012(S7)	KB	3.05	33.44	4.56	34.21
	BA	3.67	-36.51	4.81	-16.84

ERG-Early Rising Group ; LRG-Late Rising Group; VCG-Vedic Chanting Group; NCG-Non Chanting Group; GES-Gurukula Education System; MES-Modern Education System; KB- Kapalabhati; BA- Breath Awareness; RNS-Right Nostril Breathing; LNB-Left Nostril Breathing; BN-Both Nostril Breathing; FA-Fine Arts; CM-Cyclic Meditation; SR-Supine Rest; VM - Verbal Memory; NVM – Non-Verbal Memory, S1 to S7 – Study1 to Study 7

Figure-7.2a : Comparison with earlier studies on Verbal Memory

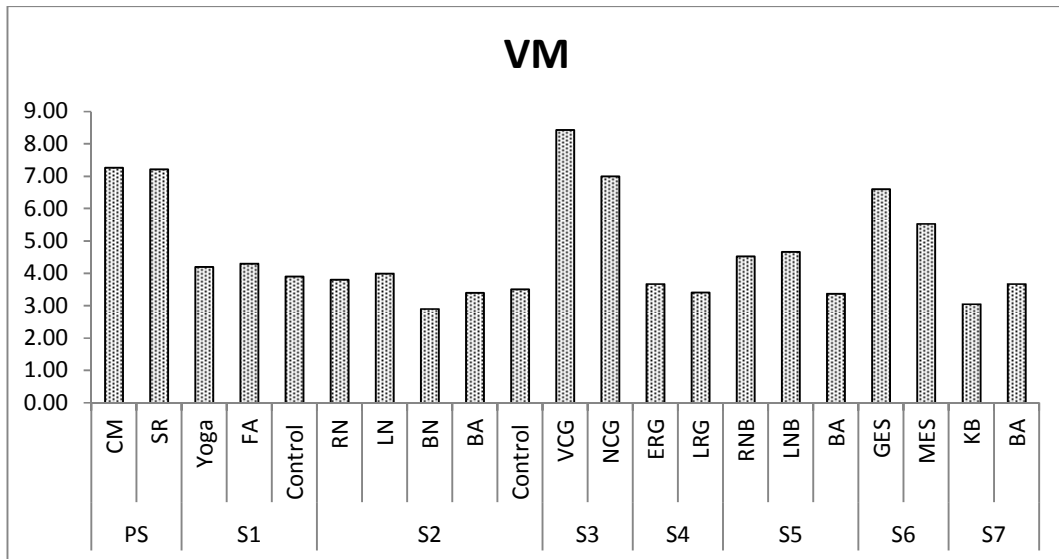


Figure-7.2b : % Change comparison with earlier studies on Verbal Memory

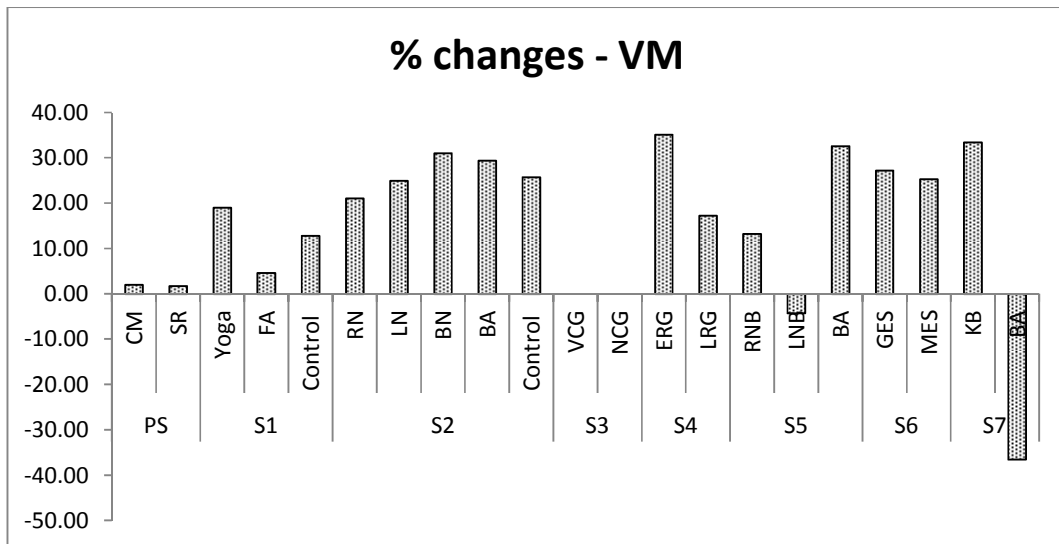


Figure-7.2c : Comparison with earlier studies on Non-Verbal Memory (NVM)

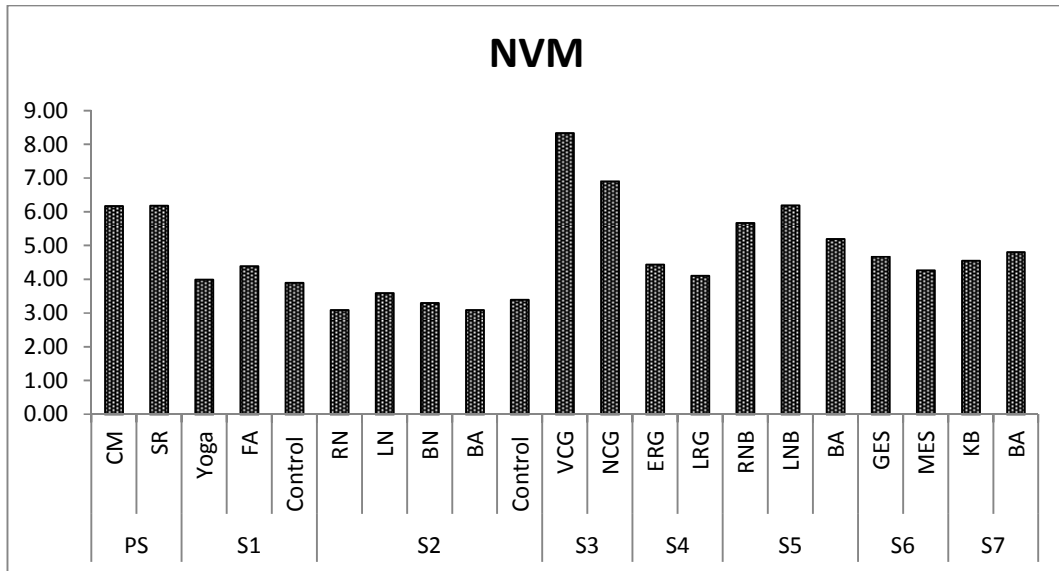
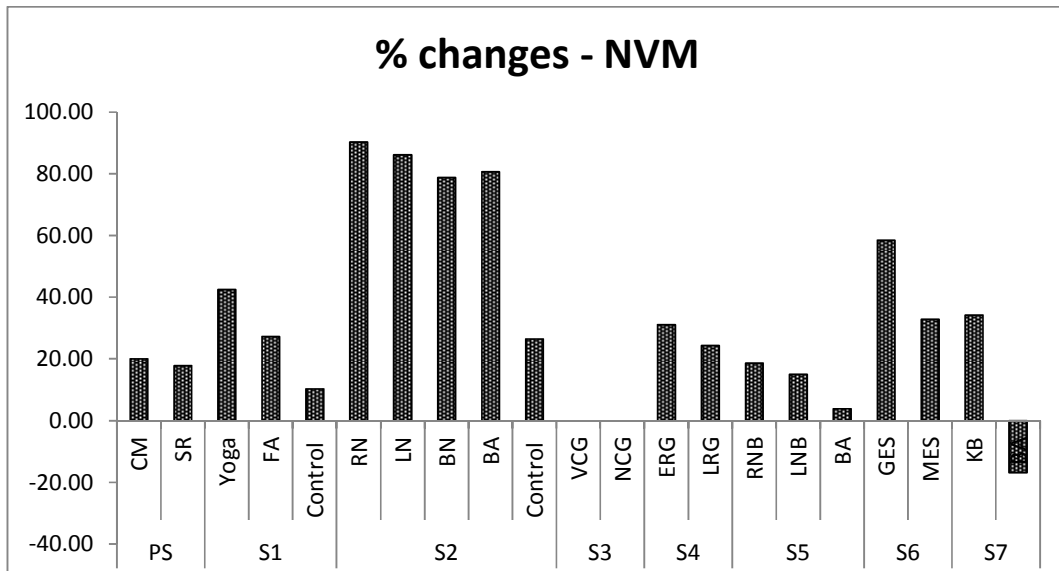


Figure-7.2d : % Change comparison with earlier studies on Non-Verbal Memory (NVM)



7.3 POSSIBLE MECHANISM

Potential mechanisms by which state mindfulness benefit performance in a visual working memory may be positive emotional states through present movement awareness and reduced mind wandering among participants who were prone to distraction at testing (Mrazek et al, 2013). Mindfulness develops as a result of consistent practice or attempt of yoga practices. Possible mechanism of enhancement may be due to receptive attention to and awareness of present events and experience. The earlier investigation of meditation showed parasympathetic dominance (An, Kulkarni, Nagarathna, & Nagendra, 2010). The key components of CM are slow, smooth, effortless body movement with awareness and relaxation. The relaxation component of CM occurs at the end of last seven minutes, which may lead to lowering the sympathetic arousal and anxiety scores. These characteristics of CM may be contributing towards reducing the state of anxiety. Anxiety has key role to modulate the functioning of memory (Saltz, 1970). Reducing anxiety enhances the memory task performance (Pailoor & Telles, 2009). Current result has shown significant reduction in anxiety following CM. Hence enhancement in working memory can be attributed to reduction of anxious behavior.

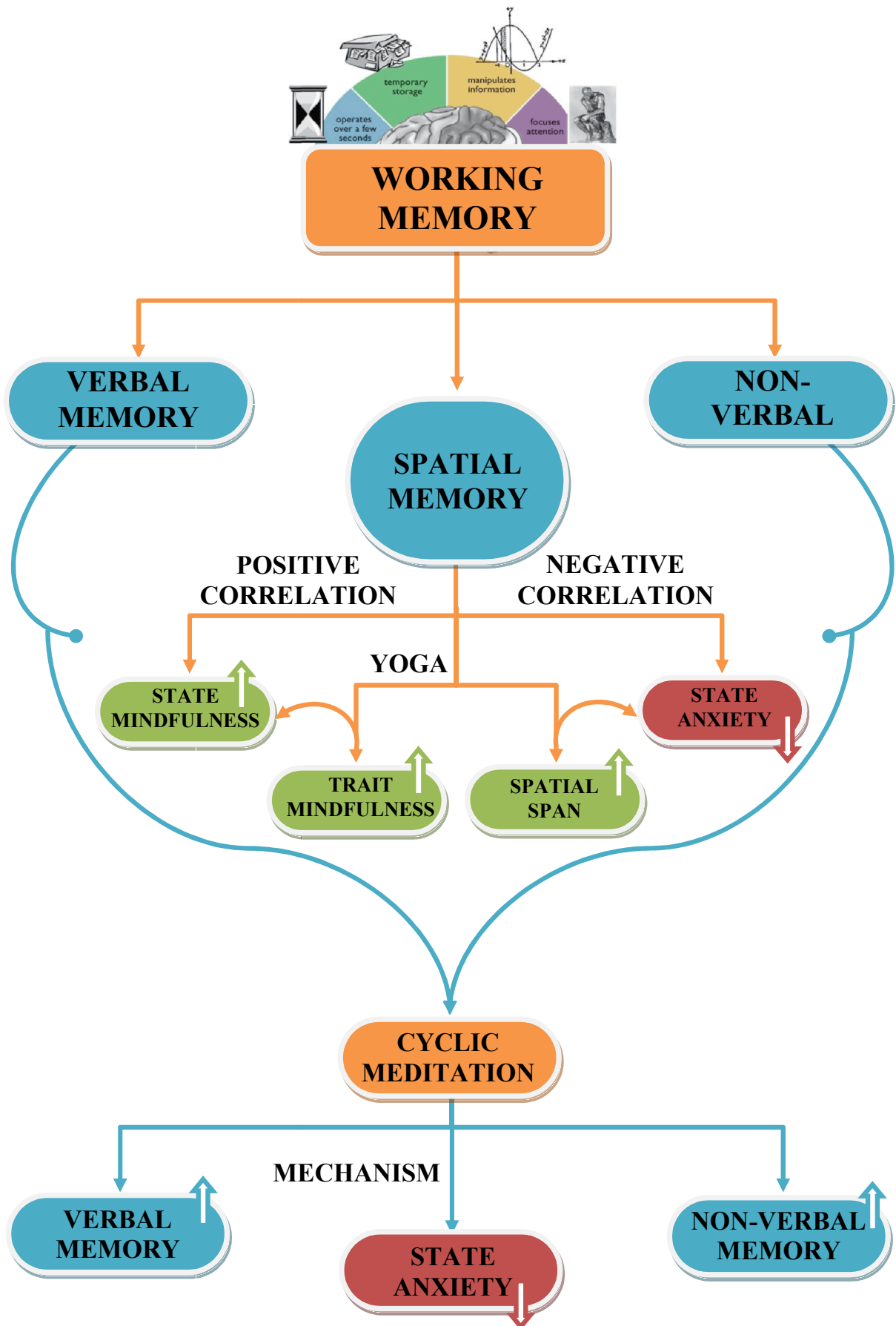


Figure-7.3 : Mechanism of working memory

8. APPRAISAL

8.1 CONCLUSIONS

The current studies contributed to the literature in several ways. To date, mindfulness had not been studied as an element within the adolescents in Indian settings. This study highlighted the importance of examining yoga related constructs mindfulness and its application in mental health of adolescents. Results from this study offered initial information on the possible interaction between mindfulness and state anxiety in working memory. Further, results show promising immediate effects of yoga based relaxation technique on spatial and nonverbal working memory. Furthermore, results confirmed the effect of yoga on enhancing working memory and enhancement of mindfulness. Although the current study provides initial insight into the role of yoga in working memory further research is necessary to explore the applications.

8.2 STRENGTH

To our knowledge, this may be the first study on Indian adolescents to understand the relationship between mindfulness and working memory. As per our knowledge there is no previous reports specific to cyclic meditation on working memory in adolescences. Further current thesis explored various spectrum of working memory its relation and enhancement through yoga. Our study suggests that development of mindfulness and effect of yoga based intervention in younger populations and understanding possible mechanisms linking yoga and working memory may be a fruitful avenue for future research.

This pre-post design shown that yoga based intervention a potential benefits to enhance attention and memory on adolescent adolescents. These results make a contribution to the literature on improving adolescents' attention within educational settings. The

techniques might serve as a cost-effective means to enhancing attention performance and accuracy on healthy adolescents

8.3 LIMITATIONS

Despite of these encouraging findings, there are important limitations that have to be considered. This was the general limitations for all the studies; participants were recruited from yoga camp, which could be a confounding variable, as the outcome variable might be influenced because of the motivation towards yoga practices. The sample included was healthy young adolescents in a yoga camp environment which may be difficult to generalize for all adolescents and adults.

1. The causal direction of this relation is uncertain in these studies due to cross-sectional design. Further self-report measures may be compromised by response biases.
2. Current research sample were having an average working memory.
3. It should be noted that this experiment was pre-post design which has it on limitation on controlling the confounding variables (recreation activity, drama, games etc.,)
4. It is limited to self reported questionnaires
5. It was a self as control study design with convenient sampling, and the lasting effect of the intervention has not been assessed.

8.4 APPLICATION OF THE STUDY

In conclusion, these data signify that 10days personality development camp of integrated yoga module enhance attention and memory which can potentially be implemented within an educational system.

8.5 FUTURE STUDIES

Longitudinal and experimental studies on mindfulness training may provide causal relationships between mindfulness and working memory. Additional higher-order cognitive measures such as attentional control and self-regulation measures could also be considered in this line of research. Further, the generalizability of these results needs to be tested with randomized control trials. Future studies could be investigated on physiological variable viz., EEG, EMG activity, and Cortisol level, and hormonal activity. Prospect research incorporating different age group, different level of attention and with various assessment methods to capture changes including physiological performing the task and intervention may be looked forward to understand the underlying mechanism. Future studies should include adolescents with low working memory skills assess on measures of working memory, IQ and academic attainment before and after yoga based training.

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