A COMPARISON OF COGNITIVE FUNCTIONS OF YOGA-BASED EDUCATION (GURUKULA) SYSTEM AND MODERN EDUCATION SYSTEM

Thesis Submitted

by

RANGAN R

Towards the partial fulfillment of

DOCTOR OF PHILOSOPHY (YOGA)

SWAMI VIVEKANANDA YOGA ANUSANDHANA SAMSTHANA (SVYASA)
(A University established under Section 3 of the UGC Act, 1956)
BENGALURU– 560019
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C E R T I F I C A T E

The Doctoral Committee confirms that this is an authentic approved copy of the thesis titled "A Comparison of Cognitive functions of Yoga-based (Gurukula) Education System and Modern Education System" submitted by Rangan R

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D E C L A R A T I O N

I, hereby declare that this study was conducted by me at Swami Vivekananda Yoga Anusandhana Samsthana (SVYASA), Bangalore, under the guidance of Dr. H.R. Nagendra, Vice-chancellor and Dr. Ramachandra G Bhat, Dean, Division of Yoga-Spirituality, Swami Vivekananda Yoga Anusandhana Samsthana, University, Bangalore.

I also declare that the subject matter of my thesis entitled "A COMPARISON OF COGNITIVE FUNCTIONS OF YOGA-BASED (GURUKULA) EDUCATION SYSTEM AND MODERN EDUCATION SYSTEM" has not previously formed the basis of the award of any degree, diploma, associateship, fellowship or similar titles.

Date: **RANGAN R**

Place: Bangalore (Candidate)

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

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Date: **Rangan R**

Place: Bangalore
(Candidate)

STANDARD INTERNATIONAL TRANSLITERATION CODE TO TO TRANSLITERATE SAṀSKṚTA WORDS

अ	आ	इ	ई	उ	ऊ	ऋ	ॠ
a	ā	i	ī	u	ū	ṛ	ṝ

ऌ	ए	ऐ	ओ	औ	अं	अः
lṛ	e	ai	o	au	ṁ	ḥ

क	ख	ग	घ	ङ
ka	kha	ga	gha	ṅa
च	छ	ज	झ	ञ
ca	cha	ja	jha	ña
ट	ठ	ड	ढ	ण
ṭa	ṭha	ḍa	ḍha	ṇa
त	थ	द	ध	न
ta	tha	da	dha	na
प	फ	ब	भ	म
pa	pha	ba	bha	ma

य	र	ल	व
ya	ra	la	va
श	ष	स	ह
śa	ṣa	sa	ha
ळ	क्ष	ज्ञ	ॐ
ḷa	kṣa	jña	AUM

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A B S T R A C T

Background

The Gurukula Education System (GES) is the oldest system of education in Indian heritage and culture. The wisdom and practices of Yoga included in GES are time tested and have been preserved for millennia in an unbroken tradition. In the tradition it is believed that GES bestows great merits on society, and improves many aspects of student life, including improvement in their cognitive functions. Its advantages stand at the heart of the tradition. Examining this idea that the GES curriculum can enhance cognitive abilities, forms the basis of the research carried out in this study by comparing any enhancements with those observed in the Modern Education System (MES).

The MES is more aimed at 'bread earning', and left brain development than total personality development, which was the key aim of GES. Values were built into this total personality development to create citizens from different categories of students, with the skills and professionalism needed by society to build ideal social values. Attempts to rebuild such GES to suit the needs of modern society today have started showing very encouraging results. They incorporate the holistic approach of personality development with values on one hand, and skill training for bread earning on the other hand.

The question then arises as to whether the GES approach of total personality development also improves the cognitive functions to levels comparable to those in MES. This question is vital to the adoption of GES in modern society. This study

attempts to answer the question using standard modern scientific research tools to measure memory, IQ, sustained attention and planning ability developed in students undergoing the two systems – GES and MES.

Literature review

Total personality development in GES includes physical, mental, emotional and intellectual development of students. While the mental personality includes development of memory and attention span as a vital function, the intellectual personality includes intelligence and its applications such as planning ability. Specific references about these aspects are presented from ancient Indian texts. They show that these texts aim at total personality development, and also contain techniques for cognitive function development. All available information on Gurukula Education System (GES) from the Vedas to Epics were compiled.

In contrast, the MES was gradually evolving, slowly moving towards 'bread earning skill development'. This is presented together with an account of how it is mainly based on left brain development. A literature review is also given of published modern scientific literature on the benefits of Yoga on cognitive variables like memory and attention. This provides a historical backdrop for the present experimental work.

Intelligence is a significant brain function. Memory and attention are vital temporal and frontal lobe functions. Planning skills play a key role in the higher developmental processes related to the frontal lobe. Previous studies have shown that Yoga practice improves these cognitive functions. Kory and Hufnagel (1997) found growth of intelligence and better academic performance among school students practicing Transcendental Meditation. Naveen (1997) found that voluntary regulation of

breathing (Prāṇāyāma) improves the memory. Telles (1993) studied special physical postures (Āsanas), voluntary regulation of breathing (Prāṇāyāma), maintenance of silence, and visual focusing exercises (Trāṭaka), improve the attention span in school children. Manjunath showed that planning ability is improved by practice of Yoga. Thus cognitive functions like memory improve through practice of Yoga. But, how does GES, the Yoga-based education compare to modern education, in improving psychological variables memory, attention, planning and intelligence? That is the theme of this study.

Aim and Objectives

Aim

To examine the GES ability to develop cognitive abilities of students to levels comparable with those in MES.

Objectives

1. To compare changes in levels of Intelligence due to student participation in the two systems.
2. To study the influence of GES and MES on spatial and verbal memories of students.
3. To investigate the effect of GES compared to MES on students' attention span.
4. To examine the effect of GES and MES on planning ability scores.

Methods

Subjects

Two residential schools (one MES and the other GES) providing similar ambiance and daily routines were selected for the study. Forty-nine boys with an age range of 11 to 13 years who were matched for age and socio-economic status were selected out of a total strength of 500 in MES and 110 in GES.

Learning strategies

The GES School used an educational program with integrated yoga practices, while the MES provided a conventional modern education program. The GES program included lectures, yogic postures (Āsanas), voluntary regulated breathing (Prāṇāyāma), meditation (Dhyāna), recitation of mantras (japa), yogic prayers, worship (Pūjā), and Yogic games (a set of games which not only gives stimulation, but also relaxation, and generally calms the mind). The equivalent set of practices for the control group in the MES program, included physical exercises, mathematical puzzles, music, prayer and normal sports.

Assessments

C.M. Bhatia's performance tests of intelligence were administered to assess IQ; spatial and verbal memory tests were conducted to assess the memory; the "Six Letter Cancellation" test was used to assess sustained attention, and the "Tower of London" test to assess planning ability before and after one academic year (10 months).

Data Collection and Analysis

Data were obtained for each test, initially and after one academic year (10 months) intervention period. Data were scored and entered into raw data tables. To check standardization of tests, the pre-data were compared with published normative standard data from similar subjects.

The Kolmogorov-Smirnov Test of Normality showed that the pre-data were not normally distributed. Hence non-parametric tests were used in the analysis. Within groups, the pre-post data were analyzed using the Wilcoxon Signed Ranks Test, while between groups pre-data and post-data were analyzed using the Mann-Whitney U Test. This showed the pre data for the two groups were well matched. Statistical analysis was carried out using SPSS 10.0.

Results

An Independent Sample's 't' Test showed no significant difference in pre-data of all parameters, between the GES and MES groups. The Wilcoxon Signed Ranks Test comparing the pre-post values within the groups showed that improvements in both groups were significant at $p < 0.005$. Between groups Mann Whitney U test indicates that the GES boys showed significantly greater improvements than MES boys: on all IQ test scales; both Spatial and Verbal memory tests; and the Six Letter Cancellation Test. ($p < 0.005$, Mann-Whitney U test).

On the Tower of London Test, differences between the two groups were significant on three of the four subscales, planning, execution and mean time, but only on one of the number of moves subscales (Mann-Whitney U Test). In all cases, smaller numbers of moves were significant. Between groups, the GES group showed greater improvement than the MES group on trial four of the planning time, trials two, three and four of

execution time, and in the trial two for mean number of moves ($p < 0.005$, Mann-Whitney U test).

Conclusions

1. Scriptural review revealed that the GES 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.
2. The most prominent result in the experimental studies is that both systems of education improved IQ, memory, sustained attention, and planning ability. However, the GES students improved significantly more on all the tests.
3. The present study with its clear indication of enhanced cognitive abilities opens the way for further, larger, long-term studies.

CHAPTER - 4

AIM and OBJECTIVES

CHAPTER - 2

L I T E R A R Y R E S E A R C H O N

G U R U K U L A E D U C A T I O N S Y S T E M

A N D Y O G A

CHAPTER 1

INTRODUCTION

1.1 NEED OF THE RESEARCH

The present age is considered a vibrant age in which abundant professional skills are required for survival. Required skills include administration, management, planning, execution, oratory, technical abilities, rapport building, strong memory, flexibility, adjustability, swiftness, bubbling enthusiasm to work hard, vibrant optimism, working according to foresight, artistic skills, creativity, research oriented skills, reason, logic, common sense, arithmetic skills, effective communication, organizing capacity, team spirit and scientific approach.

These skills are more cognitive than physical. In fields of sciences, arts and business, whether working in the division of human resource development in a company, or in the field of information technology, growth in cognitive abilities is required to survive and thrive. Cognitive abilities are required in fields like industrial relations, public relations, human resource development, finance building, security-sector, manpower investment and scientific research.

Efficiency and work ability have also become very significant in the present age. Working ability includes constantly working hard without losing zeal and without getting tired and bored. Traditionally this ability is said to be developed by staying relaxed in the inner bliss of the silent conscious Self (Vivekananda). Yogic practices take one to inner bliss and help to remain fresh and relaxed. As the silent conscious Self is all potent and vibrant, one can manifest various cognitive abilities from pure consciousness for universal well-being (Chinmayananda).

Therefore, Yoga helps in two ways: a. Making one relaxed and fresh, by helping to stay in the fundamental Bliss of the inner Self. b. The fundamental substance is not

only Conscious Being, but also Conscious force; not only peace, bliss and harmony, but also omnipotent, creative power. Thus, Yoga, by enabling one to stay in that fundamental Self, makes one potent, creative and powerful, endowed with the cognitive abilities needed for universal well-being.

As the present age demands cognitive abilities as professional skills, education which is totally exam oriented is neither effective nor complete in today's world. Education which is merely bookish and informative fails the needs of the present age. It is professional skills which are in demand, not just good marks in examinations.

1.2 SIGNIFICANCE OF YOGA IN THE PRESENT AGE

Because of the need to develop students' cognitive abilities, Yoga could be important to education. Yoga is hitting headlines and more and more people are thinking of incorporating Yoga into education. For several reasons Yoga may actually be essential. Yamas and Niyamas (individual and social values) of Yoga are more than mere ethics, because they carry one to the core of Dharma (natural law) and Ṛtam (cosmic order), thus, enabling one to understand the fundamental value of all ethics. Āsana (physical Postures) and Prāṇāyāma (gaining mastery over Prāṇa, the vital energy) of Yoga helps one to stay more in inner Bliss, if they are perfectly performed, than non-yogic physical and breathing exercises.

Dhāraṇā and Dhyāna (meditation), the 5th and the 6th limb of 8-limbed Yoga of Patañjali, can develop cognitive abilities more than other mental exercises such as puzzles and arithmetic problems, because Dhāraṇā and Dhyāna enable one to stay in the fundamental Conscious Being. And the last of the eighth limb, Samādhi (Absorption or super-consciousness) makes one completely relaxed, much more so

than drugs, liquor or sleep. Drugs may appear to offer immediate relief; but create more stress and lead to addiction. Samādhi on the other hand is extremely health-giving and harmonious.

1.3 GURUKULA EDUCATION SYSTEM

A detailed study of satisfaction patterns in students in MES schools, correlating 15 different questions and drawing a five-grade score, concluded that only 42% of all students could be said to be satisfied with the quality of school education (out of which 8% were "very satisfied"). Another 28% were average, 23% were dissatisfied and 8% were very dissatisfied (Danino, 2008). In the modern world at large, it has been taken for granted that education must be bookish, exam-oriented, merely informative, and has to be strictly enforced. But slowly in the post-modern-era people are beginning to realize that education should be something more than bookish syntax; simply because growth in cognitive abilities is now recognized to be the need of the hour in both education and the professions.

Investigating the Gurukula education system from a scientific perspective suggests that its yogic practices can be adopted in MES schools to enhance the cognitive variables. The ancient Gurukula education system (GES) includes many yogic practices. These mainly enhance four abilities: a. to stay in inner silence, b. thereby to be fresh and relaxed, harmonious and peaceful in all activities, c. to derive and manifest the full potential of conscious being, d. to be *Dhārmic to* uphold values, and be transparent as also ethical in all professional activities.

The present study examines one of the GES school which has contextualized the oldest system of education in Indian heritage and culture. The GES is mentioned in Vedic literature (Govindashastry, Taittarīyopaniṣat, 1.1. 1987). Therefore, its

minimum date can be fixed to 3000BCE which is the minimum date fixed for the Vedas in recent years (Frawley).

In India, GES methods and practices are time-tested, updated to the changing context with eternal values kept intact in a changing society (Swami Ranganathananda) with newer ways of implementation and have been preserved for millennia unbroken traditions. In the Hindu tradition it is believed that the GES bestows great merits on society including improvement in student's cognitive health (Dutta). The present study is to compare the GES curriculum with a conventional school of modern education system particularly about enhancement of cognitive abilities.

1.4 VEDIC YOGA AND COGNITION

The present study also explores the concepts of Yoga and cognition mentioned in the Vedas. All available information on the Gurukula Education System (GES) from the Vedas to the Epics alike are compiled in the thesis. A review of published scientific literature on the benefits of Yoga on cognitive variables like memory and attention were carried out to provide a backdrop for the experimental work. Similarly the review of the education systems and the evolution towards the modern educational system has been reviewed highlighting the advantages and disadvantages of the system.

CHAPTER 2

LITERARY RESEARCH ON

GURUKULA EDUCATION SYSTEM AND YOGA

2.1 GURUKULA EDUCATION SYSTEM

2.1.1 Gurukula culture

The GES is a traditional education system of India based on Vedas. It is as ancient as Vedas as it is mentioned in the Vedas themselves (Govindashastry, Taittarīyopaniṣat, 1.1). According to the ancient scriptures education is an obligation to every citizen. It was considered a sin and crime if somebody did not send their children for education (Dutta, 2.39). Nobody was meant to be uneducated in the society (Krishnacharya, 1.6.8).

Education had nothing to do with family income. Gurukula institutions did not and even now do not have systems of fees like modern schools. The children who went for education did not depend upon the earning of their parents. It was the responsibility of the whole society to spend for the education of the children. The children used to seek alms everyday from different local houses. They shared their alms with their Gurus. That was how the Gurus managed their livelihood (Dutta, 2.48). This kind of seeking alms was not considered inferior by the society. In fact the society had lot of reverence to children who were seeking alms for their education (Krishnacharya, 1.29).

There were no separate schools for rich and poor. They all wore the same clothes. The uniform dress code was a white dhoti with a 'Samit' (wooden stick) in the hand and also with a Mauñcī (belt) around their waist, and also a tuft on their head (Dutta, 2.49 -55). With all these things equality was maintained among the children in Gurukula education. Therefore, there was less possibility for the children to develop either

inferiority or superiority complexes. Only after graduating from Gurukula the students used to offer donations to their Gurukula out of their earnings known as gurudakṣiṇā. Meaning of the word dakṣiṇā is not fees but donation. No day-scholars were permitted in Gurukula education. Students stayed with their Guru, not only learning theories and texts from him, but also values and virtues from his example (Govindashastry, Taittarīyopaniṣat, 1.23).

Education was mainly through hearing and not through the writing. That is why the Vedas are called Śrutis. Meaning of Śruti is that which came through hearing. The education was mainly through ears and lips and not through writing and reading. This is not because writing and reading were not available, but because they were considered inferior. This system of education through lips and ears had the power to develop cognition, intelligence and strong memory. Education was more practical than theoretical. Even the examinations were mostly practical. Theory was only to support the practice. Even now such Gurukulas exist in India, with zero fee structure, and where the students still seek alms to help run the Gurukula, and where the society or local citizens donate to maintain the Gurukula. This shows that a school system can still be run on these principles even today.

The Guru-Disciple relationship in ancient Gurukulas was not just formal, professional, business-like and official, it was intimate and personal. Yet the relationship was based on mutual respect, even reverence. Here is a famous Vedic prayer of Guru and disciple which show the intimacy that they had.

सह नाववतु। सह नौ भुनक्तु। सह वीर्यं करवावहै। तेजस्वि नावधीतमस्तु मा विद्विषावहै॥

***Saha nāvavatu* ।*saha nou bhunaktu* । *saha vīryaṁ karavāvahai*।**

***Tejasvi nāvadhītamastu mā vidviṣāvahai* ।।**

"O Divine! Let you guard us together. Let us share with each other. Let us perform the skills together. Let the learnt one be luminous. Let us not hate each other. (Govindashastry)." According to the Vedas, the Guru is filled with love and wisdom. The Guru is also a man of character, a master of his senses, and not influenced by egoistic desires (Sontakke and Kashikar, 1.53.2 & 10.136.6)." Thus, the Guru is the role model in the life of a disciple.

The Rāmāyaṇa also describes this, but in more detail. Viśvāmitra not only taught Rāma the science of missiles but also took great care of him. The Rāmāyaṇa describes how Viśvāmitra made Rāma practice daily routines and rituals. The Rāmāyaṇa also shows how Viśvāmitra made Rāma go to sleep early and wake up early. It also depicts Viśvāmitra as narrating various stories to Rāma, and teaching him about various rivers, states and mountains. It was he who took Rāma to various states, rivers and mountains. He took suitable measures to find a most auspicious bride for Rāma. It was Viśvāmitra who gave Rāma heroic qualities. This was the kind of care a Guru gave to his disciples in Gurukula (Krishnacharya, 1.19-50).

As personal interaction among the Guru and students was prevalent in Gurukulas, the courses were tailor-made. The students could complete the program according to their grasping abilities. It is told in the epic that Kṛṣṇa completed the whole of his education just in sixty-four days. Though this appears to be an exaggeration, it reveals a vital fact, that the program can be completed according to the capacity of students. Even now in many of the Gurukulas, it can be seen that the program gets completed according to the capacity of students.

2.1.2 Education was common to all

There is a misconception that only Brahmins were educated in ancient India, and that 'education for all' only came through the British. This misconception can be disproved even from the old British records of ancient India's education. This demonstrates four things: 1. All castes got education in ancient India. 2. There were more educational institutions in ancient India than British India. 3. Secular education had a vital place in ancient Indian education. 4. Students in ancient India were of both sexes (Dharampal).

The Vedas pray for the wisdom of all in many places.

रुचं नो धेहि ब्राह्मणेषु रुचं राजसु नस्कृधि। रुचं विश्येषु शूद्रेषु मयि धेहि रुचा रुचम्॥

Rucaṁ no dhehi brāhmaṇeṣu rucaṁ rājasu naskṛdhi
Rucaṁ viśyeṣu śūdreṣu mayi dhehi rucā rucaṁ

"O Divine! Offer the wisdom to Brahmins (priests). Offer the wisdom to our kings and royals. Offer the wisdom to our vaiśyas (businessmen) and śūdras (labourers). Maintain wisdom in me (Rakesh Rani, 18.48)."

It is true that Vedic education was not permitted for śūdras in medieval times. But even at that time śūdras received Vedic wisdom through the Purāṇas (Tapasyananda, 1.4). śūdras were taught the Purāṇas through which the message of the Vedas was conveyed. But in the ancient Vedic age, even the śūdras were taught the Vedas (Rakesh Rani, 26.2). Therefore, no one in Vedic society was deprived of education.

2.1.3 Education of women

Another misconception is that women were not educated in early India. Women of the Vedic age were highly educated. Vedas are the only ancient scriptures in India which consider women as prophetesses. Various women were Vedic seers, Vāgāmbhṛṇī, Viśvavārā, Apālā, Lopāmudrā and Śacī to name but a few. Many of the wisdom-symbols are feminine in the Vedas. Sarasvatī, Saramā, Ilā, Aditi and Bhāratī to name a few. Vedas talk about the Gurukulas in which women get educated. **यत्र नार्यपच्यवमुपच्यवं च शिक्षते** ***Yatra nāryapacyavamupacyavaṁ ca śikṣate*** **"The place where the women learn the injunctions and prohibitions (Sontakke and Kashikar, 1.28.3)."** The Vedas talk about women's marriage only after their education. **ब्रह्मचर्येण कन्या युवानं विन्दते पतिम्।** ***Brahmacaryeṇa kanyā yuvānaṁ vindate patim*** **"A virgin girl gets married with her groom only after getting the educational qualification of Brahmacarya (Rakesh Rani, 11.8.16)".**

Brahmacarya in the Vedic context is not mere celibacy. Brahmacarya in the Vedas comprises celibacy, education, residing in the Gurukula to get educated and to observe the disciplines prescribed by the Guru. The Upaniṣads also talk about Brahmavādinis like Gārgī and Maitreyī, women who were not only highly educated, but also realized (Govindashastry, Bṛhadāraṇyakopaniṣat, 3.8). In addition, the great epics like Rāmāyaṇa and Mahābhārata talk about educated women. The Rāmāyaṇa in particular talks about women reciting the Vedas and performing Vedic rituals.

2.1.4 Secular education

It is wrong to think that the Gurukula system had only religious education. This misunderstanding arose from its mistreatment in British India. The Gurukula system had and still has various secular teachings depending on different occupations. Here is a list of various secular sciences which were practiced in ancient Gurukula system: Āyurveda (Medical science), Dhanurveda (Science of missiles), Gāndharva – (Aesthetic arts like music), Nāṭyaśāstra (Art of dance), Kṛṣiśāstra (Agriculture), Tarka (Logic), Nyāya (Laws of Nature), Vaiśeṣika (Atomic sciences), Śilpaśastra (Engineering), Arthaśāstra (Economics and commerce), Dharmaśāstra (Ethics, law and order), Śikṣā (Phonetics), Vyākaraṇa (Science of grammar), Nirukta (Science of etymology), Jyotiṣa (Astrology and Astronomy) and Sāhitya (Literature).

These are all secular studies. Under each and every one there are thousands of texts with additional commentaries, purports and explanations. All such studies were optional. They were concerned with intended occupation. If a person was going to be a warrior, he learned Dhanurveda and if a person was going to be a dancer he learned Nāṭyaśāstra. There were few Gurukulas which taught all sixty-four skills to the interested students. It is told in Bhāgavatam that Kṛṣṇa learnt all sixty-four skills in his Gurukula. In the same context the Shridhara, the commentator of Bhāgavatam gives the list of all sixty-four skills that Kṛṣṇa learnt. He also mentions the list of sports played in Gurukula (Sri Krishnadas). This is given in Appendix 5.

2.1.5 Sacred education

Though secular education depends upon intended occupation in the Gurukula system, its sacred education is common to all. Sacred education is obligatory and not optional. Sacred education means learning the Vedas themselves.

यथेमां वाचं कल्याणीं आवदानि जनेभ्यः। ब्रह्मराजन्याभ्यां शूद्राय चार्याय च स्वाय चारणाय च॥

Yathemāṁ vācaṁ kalyāṇīṁ āvadāni janebhyaḥ।

Brahmarājanyābhyāṁ śūdrāya cāryāya svāya cāraṇāya ca ।।

"Let me speak these auspicious Mantras of the Vedas to all – Brāhmaṇa (priest), Kṣatriya (ruler), Vaiśya (businessman) and Śūdra (labourer) (Rakesh Rani, 26.2)."

This Mantra from Śuklayajurveda saṁhitā advocates learning of the Vedas for all. There are various other references where the Vedas are considered to be common to all. Even in the medieval age when the śūdras were not allowed to read Vedas, they received the concepts of Vedas through the Purāṇas. Thus, even śūdras were not restricted from sacred education. Why Vedic education was considered an obligation to all communities? For two main reasons: 1. Vedas are impersonal. 2. Vedic practices can improve the cognitive powers.

2.1.6 Impersonality of Vedas

Vedas are impersonal. The tradition believes that each and every word and letter of Vedas exists in the space of supreme consciousness. This is a matter of belief. But to consider the concepts found in Vedas impersonal is not a belief. The concepts found in the Vedas are not for a particular community, caste, creed, language, state or country or race. The concepts are basically universal.

The Vedas are rare scriptures, because they never proclaim any caste or race or even religion as superior to any other. The Vedas are the world's only ancient scriptures which never have any abusive word against women. Vedas are the only ancient scriptures which have women seers. The Vedas are rare scriptures in this world in that they are not confined to any particular sect or religion. Concepts like Karma, Dharma, Yoga, Mokṣa and Jñāna cannot be confined to any particular creed, caste, religion or sect.

Vedic concepts do not depend upon any particular time or place. The Vedas are not even confined to a particular pilgrimage or river or society. The Vedas never see any occupation as inferior or superior to any other occupation. The Vedas are firm in saying that this life itself can be divinized. The Vedas always pray for universal well-being. Thus, the Vedas are impersonal as they express disinterested love for all beings. As concepts like Yoga and Dharma discussed in the Vedas are completely relevant to people in all occupations, they were taught to all.

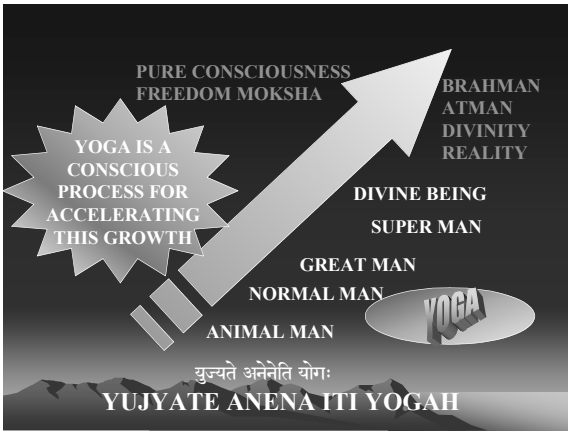
2.2 YOGA

2.2.1 Definition of Yoga

युज्यते अनेन इति योगः *Yujyate anena iti yogaḥ*

Yoga is to unite the individual self with the Divine or Supreme self. Through Yoga one gets transformed from animal man to normal man, further to great man, superman and finally Divine Being. One gets unified with Brahman or Reality or Divine. One enjoys absolute freedom through Yoga. Yoga is a conscious process for accelerating this growth.

Fig 2.1 Yoga is to elevate



(Nagarathna & Nagendra)

Different yogic scriptures define Yoga in different ways.

i. `Yoga' according to Patañjali is to get mastery over the modes of psyche, (Taimini, 1.2). ii. Yoga according to Yoga Vāsiṣṭha- is any method to calm down the mind (Nagendra, 2005). iii. Yoga according to the Gītā is to maintain equilibrium (Chinmayananda, 2.48). The Gītā also defines yoga as dexterity in action (Chinmayananda, 2.50). iv. Therefore Yoga is to get mastery over the modes of psyche, calm down the mind, and perfect action, by maintaining equilibrium.

2.2.2 The term Yoga in the Vedas

The term Yoga is derived from the root *yuj*, which has three meanings- 1. To kindle 2. To calm down and 3. To unite. In the Vedas the term is used mainly for uniting and to kindle. A few verses are given below in which the term Yoga and the root *yuj* is used. **"**The Seers yoke their minds and thoughts to him who is illumination and vastness and clearly-perceiving (Seetharaman, 1.2.13.1)." "I unite you with the yoking of the Yajña (Seetharaman, 79.1.8.15. 2)." "You are the shining steed (life-force), yoke of

horses and controller of the horses (Seetharaman, 43.1.4. 28.1)." "Let him yoke you to whom you are yoked (Seetharaman, 53.1.5.10.10)."

The Vedas at the gross level, speak of the yoga (unity) of people in the society. "Assemble, speak together: let your minds be all of one accord, as ancient Light forces unanimously share each other. The place is common, common the assembly, common the mind, so be their thought united. A common purpose do I lay before you and worship with your general oblation. One and the same be your resolve and be your minds of one accord. United be the thoughts of all, that all may happily agree (Kashyap, 10.191)."

The Vedas speak of the Yoga (unity) of all beings in the universe, and see the whole universe as one personality (Kashyap, 10.90). The Vedas also speak of the yoga (unity-harmonizing faculty) of different occupations, which include various skills, arts and sciences (Kashyap, 4.4.57). By describing Viṣṇu as the sole upholder of all Dharmas, the Vedas speak of the yoga of Dharmas (Kashyap, 1.22.18). At a subtler level, the Vedas speak of the yoga of will-powers (Kashyap, 1.89.1). The Vedas also speak of the yoga of intellectual faculties (Kashyap, 1.18.7). In Camaka Praśna of Yajur Veda the yoga of all positive forces is perfectly described.

Vedas describe those positive forces as luminous wealth (Seethraman, 4.7.1-11). At their deepest level, the Vedas speak of the yoga (unity) of all beings with Self. To see the Self in all beings and all beings in the Self is the most important insight in the Vedas (Rakesh Rani, 40.6). The Vedas always speak of unity and universal harmony; they pray for the welfare of all beings. The terms like Viśva (all), Viṣṇu (all pervasive), Vaiśvānara (universal) are often repeated in the Vedic literature. Thus, the Vedas represent the yoga (unity) of all beings with the Self.

2.2.3 The streams of Yoga in the Vedas

Yoga as a subject matter is attaining mastery over the modes of psyche, calming down the mind and perfecting action by maintaining equilibrium. This subject matter is very much dealt with in the Vedas. The Vedas are the very first scriptures which deal with the subject matter of Yoga. In all pages and in all parts of the Vedas, one can see the same yogic insight which takes different forms as deities, rites , arts, sciences and even occupations including agriculture, therapy, engineering etc. To the seers everything they saw represented manifestations of the same spirit. This can be actualized by Yogic insight. Their mundane life is not separate from spirituality. They saw the same conscious Being in all beings, and led a happy life. In general in the later scriptures Yoga is mainly categorized into four: Karmayoga, Rājayoga, Bhaktiyoga and Jñānayoga. Though these terms never occur in the Vedas, the elements of all four yogas can be seen in the Vedas.

A. Karma Yoga in the Vedas

I. To offer the fruits of action which we perform to the Divine is there in the Vedas.

यदंग दाशुषे त्वमग्ने भद्रं करिष्यसि । तवैतत्सत्यमंगिरः ॥

Yadaṅga dāśuṣe tvamagne bhadraṁ kariṣyasi। tavaitatsatyamaṅgiraḥ।।

"O Lord! Whatever welfare you offer to the donor is also to you." (Kashyap, 1.1.6).

II. Reconciliation of being and becoming, silence and action and Divinity and humanity are very important elements in the Vedas. The Vedas shun neither Divinity to achieve humanity nor humanity to achieve Divinity, unlike most other philosophies (Rakesh Rani, 40.9). III. The concept of dedicating life and action to the Divine Will occurs throughout the Vedic literature (Rakesh Rani, 40.12). The Vedas also speak

about accepting results of the actions as blessings of the Divine (Seetharaman 4. 7.1-11). These are the various elements in the Vedas which in general are referred to as Karmayoga in the later scriptures.

B. Rāja Yoga in the Vedas

I. The Yamas and Niyamas occur in several places in the Vedas. They are the dos and dont's of a yoga practitioner (Seetharaman, 1.6.6.13). II. Yamas and Niyamas are framed according to Ṛtam (the cosmic order). Ṛtam is described in most if not all chapters of ṚgVeda (Kashyap, 1.2.8). III. Yamas and Niyamas occur as vratas in ṚgVeda in many places. Vratas means laws or vows (Seetharaman, 59.1.6.6.13). IV. Yamas and Niyamas are based on Dharma, which is also very much explained in the Vedic literature (Kashyap, 1.22.18). V. Prāṇāyāma is to master the life energy; this is described in various places in the Vedas (Kashyap, 3.62.10). VI. Dhāraṇā and Dhyāna are quite often described in the Vedas. The Vedas prescribe various types of Dhyāna (Kashyap). VII. To search, to seek and to find out in the inner heart is beautifully explained in the various places of Vedas (Seetharaman, 2.8.8). VII. The Vedas also speak of various yogic experiences and various levels of samādhi. The Vedas speak of the highest level of samādhi.

ऋचो अक्षरे परमे व्योमन् यस्मिन्देवा अधि विश्वे निषेदुः।

यस्तन्न वेद किमृचा करिष्यति य इत्तद्विदुस्त इमे समासते॥

Ṛco akṣare parame vyoman yasmindevā adhi viśve niṣeduḥ।

Yastanna veda kimṛcā kariṣyati ya ittadvidusta ime samāsate

"What will a person who does not know the supreme space of consciousness in which all Mantras exist, do with mere Mantra (Kashyap, 1.164.39)". These are the various elements which are later termed as Rāja yoga by several yogic scriptures.

C. Bhakti Yoga in the Vedas

i. In several places the Vedas speak of Iśvara, His Omnipotence, Omniscience, Omnipresence, His boundless nature and His all pervasiveness and so on (Kashyap, 2.11.14). ii. The Vedas proclaim that the Īśvara is one (Kashyap, 1.164.46). iii. The Vedas describe boundless love towards Īśvara like the love between husband and wife and love between calf and cow.

गाव इव ग्रामं युयुधिरिवाश्वान् वाश्रेव वत्सं सुमना दुहाना।

पतिरिव जायामभि नो न्येतु धर्ता दिवः सविता विश्ववारः॥

Gāva iva grāmaṁ yuyudhirivāśvān vāśreva vatsaṁ sumanā duhānā।

Patiriva jāyāmabhi no nyetu dhartā divaḥ savitā viśvavāraḥ।।

May lord come to us as cows come to shed, steeds to stable, cow to cow with a loving heart and the lover to the love (Kashyap, 10.149.4). iv. To sing the glories of Īśvara can be seen throughout the Vedas. In many places the Vedas themselves insist on singing the glories of the Lord (Kashyap, 1.5.1). v. The Vedas also glorify the name of the Lord throughout (Kashyap, 8.69.8). vi. To surrender unto the Lord occurs in many places of the Vedas. The concept of Śaraṇāgati is also abundantly present in the Vedas (Kashyap, 1.158.3). vii. The Vedas insist in many verses on leading a Dhārmic life which will propitiate the Lord. They proclaim "let us be in the will of Lord." The Vedas proclaim in many places that the Lord is lovable,

affectionate and adorable. Thus, the principles like boundless love towards Lord, His/Her worship by singing, praying, chanting His names, to surrender our self to the Lord and to lead a peaceful life by accepting His/Her will and offering oblations, can be seen throughout the Vedic literature. These principles are called Bhakti yoga in later yogic scriptures.

D. Jñāna Yoga in the Vedas

i. Analysis of the source of the cosmos with a deep quest can be seen in many places in the tenth maṇḍala of the ṚgVeda. ii. To see the self in all occurs in the Vedas several times (Rakesh Rani, 40.5). iii. The Vedas speak at different places about the concept of Svadhā (self-bearing) which is very important in Jñānayoga (Kashyap, 10.129.6). iv. The Vedas proclaim that finding out the cosmic womb is the way to shed bondage (Kashyap, 4.27.1). v. The Vedas also speak of the Being which is without attributes, qualities, forms and names. E.g.:

आनीदवातं स्वधया तदेकं यस्माद्धान्यन्न परः किंचनास ॥

Ānīdavātaṁ svadhayā tadekaṁ yasmāddhānyanna paraḥ kiñcanāsa ||

"It alone breathed without air, by self-bearing, except which nothing existed (Kashyap, 10.129)." vi. The Vedas speak of the concept of Māyā (Kashyap, 10.25). E.g. "By Māyā the Lord takes varied forms". These are elements in the Vedas which are called Jñāna yoga in the later scriptures.

2.2.4 Vedic Yoga or Integral Yoga

The Vedic literature is a primordial yogic text which has become the source of all other yoga śāstras. The uniqueness of the Vedic literature in its teaching of Yoga is in its integrated approach. The Vedas magnanimously invite all the noble thoughts from all the corners of world.

आ नो भद्राः क्रतवो यन्तु विश्वतः Ā no bhadrāḥ kratavo yantu viśvataḥ

"May all noble thoughts come to us from all the corners (Kashyap, 1.89.1)."

While most of the later scriptures view these Yogas as different paths, the ancient Vedas see different Yogas as the limbs of a single Yoga. Actually the Vedas make us realize life and Self by synthesizing all Yogas. The Vedas declare the Yoga (unity) of all Yogas. The integrated teaching of the Vedas helps a Sādhaka or an aspirant not only to understand the Self or Truth, but also to derive all cognitive abilities out of it, by living in it for the sake of universal well-being, not only to be peaceful but also to be fresh and dynamic.

2.2.5 Dharma in the Vedas

Dharma in its core is nothing but Yoga- an effort to calm down the mind. Dharma has three definitions. 1. Nature 2. Actions done according to Vedic injunctions. 3. Universal well-being. These three are interconnected. That which is in tune with nature can alone be the well-being of the cosmos. That which is the universal well being alone is spoken of in the Vedas. This universal well-being not only includes the gladdening of the beings in the world but also the destruction of evil forces. The Vedas themselves talk about the two dimensions of Dharma in many places. 1. Cherishing the good and 2. Punishing evil.

इन्द्र आशाभ्यस्परि सर्वाभ्य अभयं करत्। जेता शत्रून्विचर्षणिः॥

Indra āśābhyaspari sarvābhya abhayaṁ karat । Jetā śatrūnvicarṣaṇiḥ।।

"Let the Divine offer the boon of fearlessness to all beings in all Quarters. Let him defeat the foes (evil forces)."

मित्रस्याहं चक्षुषा सर्वाणि भूतानि समीक्षे। मित्रस्य चक्षुषा समीक्षामहे॥ मित्रस्य मा चक्षुषा सर्वाणि भूतानि समीक्षन्ताम्॥

Mitrasyāhaṁ cakṣuṣā sarvāṇi bhūtāni samīkṣe।mitrasya cakṣuśā samīkṣāmahe। mitrasya mā cakṣuṣā sarvāṇi bhūtāni samīkṣantām ।।

"Let me see all beings with the eye of love. Let us see with the eye of love. Let all beings see me with the eye of love (Rakesh Rani, 36.18)."

2.3 CONCEPTS OF COGNITION IN VEDAS

2.3.1 Cognition in the Vedas

The word cognition includes both the psychic and conscious forces which have the capacity to grasp, to be alert, to learn, to be attentive and to understand. To be aware of the Self, cognitive abilities are essential. It is cognition which is significant in both internal and external pursuits. Only through cognition can both internal and external knowledge be obtained and understood properly. Therefore, it is essential to understand and develop cognitive abilities through which one can grow spiritually. Even Devas glorified in the Vedas are various powers of cognition only.

The principle subject matter of the Vedas is the description of Devas. Every hymn of the Vedas is dedicated to a Deva. It is very important to know about Devas from the Vedic point of view. Devas are not merely persons in the Vedas. Devas are natural elements around us without which we cannot live. This is the preliminary

understanding about Devas. E.g.: Vāyu is the blowing wind; Agni is the fire; Varuṇa is the power in water; Sarasvatī, Gangā and Sindhu are rivers; Indra is thunder and rain; Sūrya is the sun and Soma is the moon. In this way earth, space, stars, planets and ocean- which are around us are considered as Devas without which humans cannot live. Humans are therefore, obliged to respect them all.

Further in the Vedas, these Devas are not only perceived as natural elements but also as natural forces dwelling in us, without which we cannot live. E.g.: Vāyu is the vital energy; Agni is the heat and sound energy; Varuṇa represents the energy in all fluids; the waters like Sarasvatī and Sindhu represent sperm energy; Indra represents power and strength; Sūrya represents light energy and Soma represents mind and heart. Therefore, Devas like Soma, Sūrya, Varuṇa, Agni, Vāyu and Indra are the natural forces dwelling in us without which we could never live.

In a deeper sense these same Devas are perceived and understood as the various powers of cognition. This is because each and every natural element in the external world has become a symbolic representation or archetypal expression of the higher and the cognitive world. This concrete world is nothing but the manifestation of the conceptual and cognitive world.

E.g.: Vāyu which is blowing wind in the concrete world represents the core Prāṇa of Psyche and beyond, in cognitive world. Agni which is fire in the gross world represents the burning will of the Divine, dwelling in the cognitive realm to guide aspirants.

अग्निर्होताकविक्रतुः सत्यश्चित्रश्रवस्तमः *Agnirhotā kavikratuḥ satyaścitraśravastamaḥ*

"Agni is the truthful will of the seers and excellent in spiritual audition (Kashyap, 1.1.5)."

Varuṇa which is the power of water in the gross world represents the basic law of the universe, or the cosmic order in the cognitive realm. The Sarasvatī and Sindhu, which are rivers in the gross world, represent the flow of inspiration in the cognitive realm. **चोदयित्री सुनृतानां चेतन्ती सुमतीनाम्** *Codayitrī sunṛtānāṁ cetantī sumatīnām*

"Sarasvatī is the impeller of sweet and truthful word and awakener in good thougts (Kashyap, 1.3.11)." Indra which is rain, lightning and thunder in the gross world, represents cognitive strength and the power to destroy all evil forces of the psyche. Sūrya – the sun in the gross world is nothing but the Self-light or Self-wisdom itself in the inner world. Soma – the moon in the gross world is nothing but the aesthetic flow of Bliss and peace.

यत्रानन्दाश्च मोदाश्च मुदः प्रमुद आसते । कामस्य यत्राप्ताः कामाः तत्र माममृतम् कृधि ॥

Yatrānandāśca modāśca mudaḥ pramuda āsate।

Kāmasya yatrāptāḥ kāmāstatra māmamṛtaṁ kṛdhi।।

"O Soma! Make me immortal in those realms where the ecstasies, delights and higher delights exist and where all wishes get fulfilled (Kashyap, 9.113.11)."

In this manner all natural elements and forces remain archetypal expressions and symbolic manifestations of the cognitive forces.

In this way enjoying the rising sun as the Self –wisdom and, waxing moon as the Self bliss, synchronizing the fresh air with the vital force, visualizing Fire as Divine Will, symbolizing the water-force as Divine Law, seeing the flow of water as inspiration,

experiencing thunder and lightning as cosmic strength, and actualizing the whole cosmos as the Self, the seers expressed the impersonal wisdom through the verses, the whole collection of which constitutes the Vedas.

The Devas in the Vedas are also associated with different skills and occupations. e.g.: Indra and Sūrya are associated with farming and agriculture. Varuṇa and the Aśvins are closely associated with navigation. Vāyu and Soma are closely associated with medical sciences. Tvaṣṭā and Viśvakarma are closely related to engineering skills. Agni is closely associated with home and family. Indra and Varuṇa are closely associated with administration and governance. Sarasvatī and Sindhu are closely associated with the skills of creating poetry and art.

Understanding the Self as the fundamental Truth of the whole existence, and to live a life with that as the fundamental principle, is the objective of the Vedas. The very nature of this Self is absolute silence, peace, bliss and harmony. The Self is pure conscious Being and is eternal.

From the ocean-like silent conscious being wave-like cognitive powers, tide-like natural forces and bubble-like gross manifestations of natural elements occur. As tides, waves and bubbles are not different from ocean, Nature – both internal and external – is not different from the conscious being.

Conscious being without changing its Nature takes the shapes of natural forces and elements including cognitive variables, just as the ocean takes on the shape of waves without changing its nature. As the entire nature is the manifestation of the same Self – the all pervasive conscious being, the Vedas see the Self in each and every cognitive force, natural force and natural element; the Vedas see the reality of Nature.

To see the Self in all beings and all beings in the Self is the core subject of the Vedas. To understand and to realize this Self and to live in it is the objective of the Vedas. To understand the whole existence as the manifestation of Self and to live in tune with It is the objective of the Vedas. To establish a social order which is attuned to the core conscious being and to develop the powers of cognition in society is also a Vedic objective.

2.3.2 Growth of cognition through Vedic practices

Self in the Vedas is not only described as peace, silence and bliss, but also as all potent, all pervasive, all comprehensive, and as the seed of all knowledge. Therefore, the scriptures proclaim that the more one stays in Self, the more one derives from it the skills, powers, abilities and energy for the well being of the universe. According to the experiences of the noble beings "one who stays more in the Self or pure consciousness, can grow more in the cognitive abilities".

Vedic practices like Sandhyopāsana, Brahmayajña and Agnikārya can make one to stay in the silent Self, which is not only bliss and peace, but also potent and all comprehensive, not only a conscious being, but also a conscious force, by staying in which one becomes not only peaceful and calm but also fresh and dynamic. Therefore, Vedic practices like Sandhyopāsana lead not only to peace and bliss but also to energy and power. Each and every Mantra in the Vedic practices has to be chanted with total concentration on its resonance

2.3.3 Intelligence

The term Medhā denotes intelligence in the Vedic literature. There are various places in which the Medhā is glorified.

यां मेधां देवगणाः पितरश्चोपासते। तया मामद्य मेधयाग्ने मेधाविनं कुरु स्वाहा ॥

Yāṁ medhāṁ devagaṇāḥ pitaraścopāsate **|**

Tayā māmadya medhayāgne medhāvinaṁ kuru svāhā **||**

"Make me intelligent through the intelligence which the Devas and Pitṛs adore (Rakesh Rani, 36.18)."

The very word Veda has various meanings that are related to intelligence.

विद् - ज्ञाने ***Vid- jñāne*** **- to know, विद् - विचारे** ***Vid –vicāre –*** **to investigate, विद् - . सत्तायाम्** ***Vid – sattāyām –*** **to exist, विदॢ - लाभे** ***Vidṛlṛ - lābhe-*** **Benefit**

At the time of initiation the disciple who starts his life in Gurukula receives the Gāyatrī Mantra from the Guru. This Mantra itself is related to intelligence.

तत्सवितुर्वरेण्यं भर्गो देवस्य धीमहि। धियो यो नः प्रचोदयात्॥

Tatsaviturvareṇyaṁ bhargo devasya dhīmahi **।**

Dhiyo yo naḥ pracodayāt **||**

"Let us meditate upon the adorable effulgence of the generative Divine which kindles our intelligence (Sontakke and Kashikar, 3.62.10)." Gurukula teaching methods strongly increase the power of intelligence. The Vedas talk about transforming the fool into an intelligent person in many places. The Vedas talk about the Guru encouraging questions from their disciples to develop their intelligence.

आ शिक्षायै प्रश्निनं उपशिक्षाया अभिप्रश्निनम् ॥

Ā śikṣāyai praśninaṁ upaśikṣāyā abhipraśninam ||

"The teacher educates the one who has questions (Rakesh Rani, 30.10))."

This does not mean that the Gurukula system only teaches intellectual students. It also uses methods to educate fools and make them wise.

केतुं कृण्वन्नकेतवे *Ketuṁ kṛṇvannaketave*

"He makes the fool intelligent (Sontakke and Kashikar, 1.6.3)."

Vedas also talk about the knower educating the ignorant in many places.

अक्षेत्रवित् क्षेत्रविदं अप्राट् स प्रैति क्षेत्रविदानुशिष्टः ॥

Akṣetravit kṣetravidaṁ aprāṭ sa praiti kṣetravidānuśiṣṭaḥ||

"He who is ignorant of the field approaches the knower, and moves on the right path guided by the knower of the field (Sontakke and Kashikar, 10.32.7)."

The Vedas talk about the growth of intelligence through chanting Mantra.

ब्रह्म जिन्वतमुत जिन्वतं धियः *Brahma jinvatamuta jinvataṁ dhiyaḥ*

"Strengthen the Mantra and strengthen the intelligence through that (Sontakke, and Kashikar, 8.35.16)."

Many of the Vedic Devatās are related to intelligence. e.g. Saramā represents quest and finding. Sāvitrī represents dawn of wisdom. Sarasvatī represents creativity and inspiration, also knowledge and education. Medhā represents intelligence. Śraddhā represents sincerity. Bṛhaspati represents cosmic intelligence. Vāgdevī represents logos. Gurukula learning is a system in which these divine forces are invoked through various meditation practices called upāsanās.

2.3.4 Memory

Smṛti is the Vedic word for memory.

अनुभूतविषयासंप्रमोषः स्मृतिः। ***Anubhūtaviṣayāsaṁpramoṣaḥ smṛtiḥ।***

"Smṛti is not forgetting the experienced things" says Yoga Sūtra (Taimini, 1.11). Yoga and memory are highly interlinked. Through Yoga memory grows and through memory Yoga also grows. Yoga Sūtra says:

श्रद्धावीर्यस्मृतिमाधिप्रज्ञापूर्वक इतरेषाम् ।

Śraddhāvīryasmṛtisamādhiprajñapūrvaka itareṣām।

Yoga grows through sincerity, strength, memory, transcendental experience and awareness (Taimini, 1.20). This passage states that Yoga grows through memory.

स्मृतिपरिशुद्धौ स्वरूपशून्येवार्थमात्रनिर्भासा निर्वितर्का ।

Smṛti pariśuddhau svarūpaśūnyevārthamātranirbhāsā nirvitarkā।

"When memory gets clarity through Yoga practices, meaning of the substance alone remains in awareness as if devoid of one's own identity (Taimini, 1.43, 1961)." This passage describes how through Yoga practices one achieves clarity of memory and how through clarity of memory one grows further in Yoga.

GES has various Yoga practices which facilitates growth of memory. The very fact that Vedic education is mainly through hearing and not through the writing and reading itself makes one aware and alert so that memory starts to grow. Reading and writing develop a lethargy regarding memory since every thing is recorded in books. Memory is perfectly maintained through redundancy. There are various techniques of redundancy in the Gurukula system such as Jaṭa, Krama and Ghana. The fact that the

Vedas remained unchanged for several millennia, itself is proof of the tremendous sincerity shown to memory in the Gurukula system.

There are two memory techniques in the Gurukula system- Sande and Tiruve. Sande is to just repeat several times what the Guru says. After several repetitions one starts to recite by oneself ten times every day for ten days. After the completion of ten days one continues to chant once a day for several months. These techniques increase students' memory power.

According to Yogic lore, memory is formed through prior experiences, and is a process of storing perception and experience. All four forms of mind, evidence, wrong knowledge, random state and deep sleep bring their own memories. They form imprints in various layers of mind, some superficial and some deep rooted. According to the ancient scriptures there is always the possibility of transformation in the process of memories. According to the Upaniṣads the personality has five adjuncts- physical, vital, psyche, intelligence and bliss. Each and every cell on the physical level possesses memory. Through the influence of the higher adjuncts, the cells of the physical structure can be transformed. In the vital level baser instincts can undergo change. On the psychic level transformation of thoughts and feelings is possible. In the intellectual adjunct one experiences the recollection, remembrance, reconsidering, reverting and forgetting of various values. e.g., a value in life to amass wealth will be transformed into doing good to others. In the adjunct of bliss one experiences the complete freedom of memory.

Modern methods to develop memory include the logical method (observing meanings and connections such as similarities and contrasts), rational memory (to be attentive to the meaning of the lesson), over learning (learning the lesson beyond the point which the learner can reproduce without committing an error), spaced (studying with breaks

in between) and unspaced learning (studying without break) and mnemonics (various artifices to make memorizing simpler). Yogic methods to develop memory are deepening perception, increasing attention span, activating dormant brain areas, and shifting useful memories from useless ones for our over all development (Nagendra & Telles).

2.3.5 Sustained attention

In Gurukula students sustained attention grows through daily Vedic practice of Sandhyopāsana that they are supposed to do thrice a day. Sandhyopāsana consists mainly of two things- 1. Prāṇāyāma and 2. Dhyāna. Prāṇāyāma has to be performed with stoppage of breath, inhalation and exhalation. Dhyāna includes chanting Gāyatrī Mantra with two other Mantras, Omkāra and Vyāhṛti. Dharmaśastra prescribes all these things for Gurukula students thrice a day (morning, afternoon and evening).

प्राणायामैस्त्रिभिः पूतस्तत ओंकारमर्हति ॥ २।७५॥

Prāṇāyāmaistribhiḥ pūtastata oṁkāramarhati ||

"Through three Prāṇāyāmas (with the stoppage of breath) one gets cleansed and then one gets qualified to chant Oṁkāra (Dutta, 2.75)."

Gāyatrī Mantra is advised to be chanted internally.

विधियज्ञाज्जपयज्ञो विशिष्टो दशभिर्गुणैः। उपांशुः स्याच्छतगुणः साहस्रो मानसः स्मृतः॥ २। ८५॥

Vidhiyajñājjapayajño viśiṣṭo daśabhirguṇaiḥ |
Upāṁśuḥ syācchataguñaḥ sāhasro mānasaḥ smṛtaḥ ||

"Chanting the Mantra aloud has ten times greater power than any ritual. Chanting through the lips (without producing sound) has a hundred times greater power than chanting aloud. Mental chanting has a thousand times greater power than the chanting through the lips (Dutta, 2.85)." Meditation in Sandhyopāsana is to concentrate on repeating the Mantra which thereby develops sustained attention.

2.3.6 Planning ability

Planning includes the faculties like thinking, deciding and sequential holding. The divinity Agni in the Vedas represents the ability to make righteous decisions. Agni represents perfection in making right decisions. In the Vedas decision making is called Kratu. Kavi means seer in the Vedic literature. Agni is called Kavi-kratu because Agni is the deciding faculty residing within the seers. Agni is also called Sukratu, meaning the good deciding faculty. Agni is a very important divinity in the Vedas through which all other divine principles can be achieved. Agni generally represents the right decision towards the higher enlightenment, the decision to enhance spiritual forces and destroy dark forces. Therefore, Agni is described as a proper guide, Guru and philosopher in the Vedas (Kashyap).

The divinities, Medhā and Bṛhaspati, represent the thinking faculty in the Vedas. Bṛhaspati is the thinking faculty which proceeds to decide through intuition, (Kashyap, 10. 71). Pratibhā is intuition in the Vedas. The divinity Dhiṣaṇā in the Vedas represents clarity of thought and understanding (Seetharaman, 1.6.12.10). The word 'Sam' is a very important term in the Vedas. It occurs as a prefix in the later

Saṁskṛta literature. But in the Vedas 'Sam' is a term representing systematic synthesis which occurs in almost all chapters of the Vedas. 'Svadhā' is a very vital principle in the Vedas which mean 'self-referral' or 'self-reliance'. These constitute the various faculties involved in planning.

The most important thing that should be understood is that planning becomes perfect when it rises from the undisturbed, steady and peaceful heart. The Rāmāyaṇa describes in detail Hanumān′s planning to fulfill Rāma′s mission. Vālmiki says that Hanumān made his heart relaxed, undisturbed and peaceful and generated plans from the depth of his peaceful heart, even under perturbing circumstances like Sītā′s attempt to commit suicide and Rāma's fall in the battlefield (Krishnacharya, 5.30 & 6.74).

Here is a verse from Rāmāyaṇa which describes how Hanumān plans well, relaxing himself.

मनः समाधाय महानुभावो जगाम लंकां मनसा मनस्वी ॥

Manaḥ samādhāya mahānubhāvo jagāma laṅkāṁ manasā mānsvī ||

Hanumān, the master of mind and the experienced soul, planned mentally to go to Laṅkā, after completely calming down and relaxing his mind (Krishnachary, 4.67.49).

A disturbed mind cannot undertake correct planning. It is peace, tranquility and stillness of mind which bless right resolution and clarity with right decision. Planning ability includes original and creative thought which can occur more in the students of GES as they are less exposed to the external influence of media and all.

Table 2.1 Features of GES

Equanimity in GES is maintained through	Zero fees structure	
	Students managed their livelihood through seeking alms	
	Uniform dress code: a white dhoti with a 'Samit' (wooden stick) in the hand and also with a Mauñcī (belt) around their waist, and also a tuft on their head	
Teacher student-relationship	No day-scholar permitted	
	Teacher: role-model to students	
	Interaction	
	More Practical teaching	
	More hearing and repeating than reading	
	Intimate & personal	
Syllabus	Secular	Āyurveda (Medical science), Dhanurveda (Science of missiles), Gāndharva (Aesthetic arts like music), Nāṭya (Art of dance), kṛṣiśāstra (Agriculture), Tarka (Logic), Nyāya (Laws of Nature), Vaiśeṣika (Atomic sciences), Śilpa (Engineering), Arthaśāstra (Economics and commerce), Dharmaśāstra (Ethics, law and order), Śikṣā (Phonetics), Vyākaraṇa (Science of grammar), Nirukta (Science of etymology), Jyotiṣa (Astrology and Astronomy) & Sāhitya – (Literature).
	Sacred	Vedas- Yoga (Spiritual) & Dharma (Social)
Techniques for Cognitive growth in GES	Intelligence Quotient	Group discussions, Interactions with Gurus, Questioning, self-learning etc.
	Memory	2 memory techniques in GES- Sandhe and Tiruve. Sande is to just repeat several times what the Guru says. After several repetitions one starts to recite by oneself ten times every day for ten days. After the completion of ten days one continues to chant once a day for several months. These techniques increase students' retentive power.
	Sustained attention	Sandhyopāsana: Prāṇāyāma &. Dhyāna. Prāṇāyāma with stoppage of breath, inhalation and exhalation. Dhyāna: chanting Gāyatrī Mantra, Omkāra and Vyāhṛti. Thrice a day (morning, afternoon & evening).
	Planning ability	A disturbed mind cannot undertake correct planning. It is peace, tranquility and stillness of mind which bless right resolution and clarity with right decision. Planning ability includes original and creative thought which can occur easily in the students of GES as they are less exposed to the external influence of media.

2.4 EDUCATION IN POST BUDDHISTIC ERA

After the early and later Vedic eras, Buddhism made great contributions to the field of education. The great ancient universities of India like Nālanda and Takṣaśilā had strong Buddhist influence.

Takṣaśilā was in Punjab. It was situated eighteen kilometers of Rawalpindi. The great scholars like Cāṇakya and the physicians like Kaumāra Jīva were the gurus in this institute. Eighteen branches of education were taught in the University of Takṣaśilā**.** Among them, Āyurveda (medical science), Arthaśāstra (economics and commerce), and Rājanīti (political science) were important. The date of Takṣaśilā was from fifth century BCE to sixth century BCE. The archaeologists discovered Takṣaśilā with great effort after thousand five hundred years of its disappearance. Many objects found here are the materials used by Buddhist monks and the artistic relics of Gāndhāra state. A few inscriptions were also found. The inscriptions were in Brāhmī and Karoṣṭrī scripts. Pillar of the King Kaniṣka is found near Takṣaśilā. The inscriptions found here have the subject matter of medical science, economics and commerce written by Brahmins and Buddhist monks. This is ample evidence to show how the education was at its peak in ancient India.

Nālanda University was glorious after the University of Takṣaśilā. Nālanda University brought glory not only to India but also to the whole Asia. Architecture, medical science, economics and music were the various subjects taught in Nālanda University. People generally considered the scholars of Nālanda University as those who had complete education. Nālanda University was founded in the middle of

second century BCE. This was near Bastiapur, Bihar. This university proves the level of education and intelligence of Buddhists. As Buddhists spread their religion even in foreign countries, the students of this university were also from China, Japan, central Asia, Tibet, Burma and Malaysia. The glory of this university can be known from the notes written by Hiuen-tsang who was also a student of this university for sometimes. Śīlabhadra, a glorious scholar was the chief teacher in this university. Vikramaśilā was in Shaltanganch in Bagalpur district. It was run by Buddhists. Eight major teachers of this university were Ratnavajra, Līlāvajra, Kriṣṇasamaravajra, Tathākararakṣita, Dīpaṅkara, Bodhibhadra and Kamalarakṣita. There were one hundred and eight teachers under these major teachers. Sanātana Dharma and Buddhism were taught here along with logic (Tarka), atomic science (Nyāya and Vaiśeṣika), Tantra and art. Date of this university is subsequent to Nālanda's. Therefore, it gave importance to Tantra and Mantra of later age. The great monks like Tombia, Maitri and Smrityakara revealed the truth of Mantra and Tantra in these institutes.

Benaras University developed by the King of Kāśī was glorious from 15th century CE. Various famous scholars of Saṁskṛta were the students of this university. The King of Kāśī invited various scholars from the south and appointed them as teachers in this university. Due to this reason, the relationship of south and north became very strong. Lakṣmaṇabhaṭṭa, the father of a great saint, Vallabhācārya, a functionary in Benaras University was a southern scholar.

Navadvīpa of Bengal was regarded as a great centre of education. Vāsudeva Sārvabhauma who learnt Nyāya from the State of Kashmir started a educational

institute here. Śrīvāsa, a great scholar in literature, Gaṅgādāsa, a great scholar of grammar, Candraśekhara ācāryaratna, a great scholar in Agama and Advaitacārya, a great scholar of Vedānta were the teachers in Navadvīpa. Young scholars like Mukunda, Gadādhara and Gaurāṅga were from Navadvīpa. Various texts of logic authored by Gadādharabhat, Jagadīśabhat and Kṛṣṇabhat of Navadvīpa are available even now. Later Vāsudeva Sārvabhauma settled in Purī and became a guru of the king Pratāparudra. Madhusūdanasarasvatī, a great non dualist scholar and saint, was born and educated in Navadvīpa. Yajñasvāmī went to Navadvīpa by foot from Tamilnadu and learnt logic and atomic science. He came back to the south and taught it to many. Through him, logic and atomic science became prevalent in the south. Educational institute of Avantī was developed by Vikramāditya who had great poets and scholars like Kālidāsa in his assembly.

Educational institute run by Harihara Bukkarāya and Kṛṣṇadevarāya (later) was famous in Hampi. Therefore, this city was also called Vidyānagara (the city of education and knowledge). The greatness of Guru Śrī Vidyāraṇya who was the chief in this centre is known to everybody. The scholarly giants like Śrī Appayya Dīkṣita, Śrī Vedāntadeśika, Śrī Vādirāja, Śrī Vyāsarāja, Nīlakaṇṭha Dīkṣita and Govinda Dīkṣita were honored at Humpi. Tanjore was a great educational centre at the age of Raghunātha Nāyaka. Later education in Tanjore was fostered by Śarabhoji. Sarasvatī Mahāl is a library established by Govinda Dikṣit, the minister of

Raghunātha Nāyaka. This library is several centuries old. Various texts written on palm leaves are preserved here. These are the very great Hindu and Buddhist educational institutions which came after Buddha (Swamigal).

These are various Hindu and Buddhist educational institutes which were the repository of knowledge. Buddhism's rich contribution was in the fields of philosophy, logic and even Yoga. But due to the influence of Buddhism in the field of education, and its emphasis on the principle of Ahiṁsā, Dhanurveda comprising martial arts and missile sciences got dropped from Indian education (Majumdar). Gradually, due to the influence of Buddhism, people started to lose interest in secular science. The emphasis of Buddhism was more on renunciation, monastic life and monkhood (Raju).

2.5 PERSPECTIVES OF THE MODERN EDUCATION SYSTEM

Macaulay introduced the modern education system (MES) into India. This kind of education system had developed in England as a result of the conflict between science and religion and the emergence of new technologies in the industrial revolution. The defeat of European religious thought by the sciences which emerged from the Renaissance had lead European intellectuals to dismiss religion and spirituality. The mechanical technologies based on the new Newtonian ideas in England had shown the advantages of the new ideas to creating wealth.

As individual thinking had started to grow, and new discoveries and inventions to flourish, blind belief had started to disappear. Logic, reason and skepticism grew in the European society. Newtonian physics had influenced each and every aspect of European thought. People started to see the whole of life and existence in terms of

Newton's three laws. People started to think in terms of cause and effect, and logic (Kemp).

Due to this, principles which are beyond Newtonian laws were ignored. Many elements of spirituality, philosophy and psychology do not come under Newtonian laws. Those elements were largely ignored by European civilization. People gradually lost appreciation for religion, philosophy and spirituality including psychology. Even the psychology and philosophy came under strong influence from Newtonian laws and thought. European society, though, it had good development in science and technology, lacked awareness of the subtle forms of nature which are the main features of spirituality, intuition and higher philosophy.

This kind of completely materialist education, which lacked higher spiritual dimensions was introduced to India by Macaulay. When he did so, he also had another intention, which he wrote in a letter containing the following words. "We must at present do our best to form a class who may be interpreters between us and the millions whom we govern, --a class of persons, Indian in blood and color, but English in tastes, in opinions, in morals and in intellect" (Sharp). Macaulay stopped the teaching of Saṁskṛta and introduced the English language into education. His education system included English, a regional language (as a second language), mathematics, history and some science.

The European government strongly imposed this kind of education upon Indian society through various means- 1. It systematically destroyed many of the ancient industries and business concerns of India. India's ancient Gurukula schools were only allowed to prepare students to work in ancient kinds of cottage industries. In general only those educated in the modern British schools were qualified to get the higher jobs in the newly built British industries. As a result the ancient system of education

became irrelevant. 2. The British government encouraged Brahmins (people of high caste) to enter their new education system by offering them privileges. The Brahmins were the ones who set the example to the whole of Indian society. When they left their traditional way of life, and chose British education, all others started to follow them. 3. The British government promised many privileges to those who had English education; they discouraged the ancient system of education by various means like imposing severe taxes etc. This resulted in the decline of India's traditional education system (Dharampal).

The modern education system focuses only on material growth. It hardly recognizes spiritual growth. As a result the modern education system is unable to provide strong, adequate reasons for ethics and morality. Modern education imposes morality and virtue only as rules and instructions without explaining the real science behind them. Students educated under the MES, thus, lack higher dimensions of personality; rather they are very strongly influenced by materialism. They learn to consider all spirituality as superstition. Their highest goal is to get a good job and earn lots of money. The objective of education had become only to earn bread and money, ignoring all other higher aspects of life. Swami Vivekananda calls it bread-making education. Logical thought and skepticism made them start to think of their ancient culture as superstition and to consider their forefathers fools. They started to see westerners for their wisdom and ignore the whole culture of India.

The little history they did learn about the Vedas and Indian culture in the new schools was also distorted. They learnt about the Vedas as compositions of some nomads who worshiped the natural elements like thunder and lightning out of fear. They learnt about their own forefathers as idiots who knew nothing but superstitions. Most of them were completely ignorant of the vast contributions to secular knowledge like

Nyāya, Vaiśeṣika and Āyurveda by their forefathers. They thought that secularism and sciences were introduced to them only by the British. They learned to think of their British rulers as heroes and saviors. Also because they were unable to understand the science behind the religious practices of India, they considered them all blind beliefs. Thus, they too were deprived of the higher spiritual dimensions of personality. In fact, many thought, and still think, that the British had introduced education itself into India.

However, the ancient system of schools too remained in a few places in India, extremely ignored, distorted and poor. Many of their students remaining in British India were weak, poor, and dropouts from the English education system. Hardly any great, intelligent men were the products of the ancient education system under British India (exceptions include Ganapati Muni, T.V. Kapali Shastry, Swami Dayananda, Devarata). As the whole of secular education gradually came under British control, the GES lost the dimension of secular education. Only religious education remained in the GES with very few secular sciences just in theory. Thus, the GES was made very weak and poor in British India, and students who were educated in it were looked down on.

Slowly, due to the hard work of great spiritual masters like Sri Ramakrishna, Swami Vivekananda, Sri Aurobindo and Swami Dayananda of Arya Samaj, people gradually started to recognize the true significance of Indian culture and spirituality. Due to the hard work of great national leaders like B.G.S. Tilak, Madam Kamma and Sister Nivedita, India gradually got an urge to gain independence. Under the leadership of great souls like Mahatma Gandhi, Jawaharlal Nehru and Sardar Vallabhai Patel people worked hard and India got freedom as a result.

Today people are again recognizing gradually the greatness of the Indian sciences like Yoga, Āyurveda, Siddha, Vedic Mathematics and Nyāya. They are slowly acknowledging the significance of Indian philosophies like Sāṅkhya and Vedānta. Many Indians and even foreigners wish to learn Indian arts and sciences systematically, and live the holistic Indian way of life. They are now supporting the fallen GES which is slowly coming back to recognition with the support of those really interested in learning the Vedic way of life and using the Vedic sciences.

Today two kinds of Gurukula are being regenerated. 1. Purely conventional teaching only the Vedas and other Śāstras, and 2. Conventional with a few additional modern elements. (Though their main focus is ancient Śāstras like Vedānta, Yoga, Nyāya, Vaiśeṣika and so on along with the Vedas, they also have a little of modern science like computers and physics. These include Veda Vijnana Gurukulam of Bangalore, Prabodhini Gurukulam of Shringeri to name only two.

A few universities in India like SVYASA in Bangalore, and Devasamskriti in Haridwar represent a blend of the ancient spirituality of the east and modern science of the west. These universities are centered on spirituality at the core and include research topics like protocol design, calculations, measurements and analysis as crust. The educational institutes developed by the movements of Sri Aurobindo and Mother, Maharishi Mahesh Yogi, Swami Vivekananda, Satya Sai baba, Swami Chinmayananda and Swami Dayananda are also blending ancient spirituality of east and modern science of west.

It is noteworthy to mention a survey here which was conducted by Danino, sponsored by NCERT among 11000 students of normal Modern Education System's schools

from all over India to mainly investigate- 1. Are students satisfied with the existing curriculum? 2. Whether sufficient focus is given to Indian culture and values in curriculum? 3. Whether students like to learn Indian culture and value more? 4. Whether sufficient importance is given to values in general? Questionnaires were provided to students. Findings are given below.

An elaborate study of a "satisfaction" pattern, correlating 15 different questions and drawing a five-grade score, concluded that only 42% of all students could be said to be satisfied with the quality of school education (out of which 8% were "very satisfied"). Another 28% were average, 23% were dissatisfied and 8% were very dissatisfied. 62% find the load of textbooks they are made to carry to school unnecessary and excessive. Half of the students find the educational system deficient in some respect. Among their chief criticisms, a lack of Indian culture comes first (17% of those who expressed a criticism), followed by a lack of practical applicability (14%), and of values (11%).

In a study correlating 11 different questions and defining a five-grade scale, 83% of students showed a substantial degree of interest in Indian culture or in learning about it at school, denoting an eagerness for cultural education — undoubtedly one major finding of this Survey. 91% of the students felt that they would definitely get benefited by learning more of Indian culture. 80% wished Indian culture to be part of extra-curricular activities, while 60% wanted it taught as part of the curriculum. Moreover, 45% wanted it through both methods (only 1.3% did not want to learn about it at all).

Only 38% of the students felt that they were acquiring some values at school, an alarmingly low proportion; 7% specifically stated they were acquiring no values at all, 11% gave intermediate replies, and 44% did not reply at all. It is worth dilating on the

study of values, the chief results of which are summarized above, by quoting verbatim a few of the students' thoughts on the values they are assimilating through the educational system:

"A kind of hollow and materialistic thinking." "Everything except human values." "To become more and more selfish." "Values? Hardly any." "The students get to learn only about other countries and nothing of India." "To achieve success, you have to cut others' throats." "The students are not assimilating any value, they are just learning everything like parrots." "Selfishness, money-mindedness." "I really feel that child is not assimilating a single value except from parents." "Nothing other than a materialistic approach for life." "Nothing, blindly reading and vomiting in the paper." "Not much, the present system is backward." "Not many good values. In the present system, students do not develop their hearts." "To be true, nothing." "Students do not assimilate values, they gather qualities like selfishness, self-centeredness, which they call values." "How to get good marks, how to throw off competitors, etc. Having been trained as given above in various schools, I can hardly think." "Lies and dishonesty." "Value of hard work, importance of money, that exams are the only thing in life." "Hard work, punctuality, perseverance." "Through the present system we learn never to get tired and always to carry on your work boldly." "No gain without pain."

A few thoughts on the values students feel they have imbibed from Indian classical texts and stories are given in this paper: "The sense of responsibility, truth and respect." "Honesty is the best policy, expect from others what you have given them, behind every dark cloud there is silver lining, try and try at last you will win, never take unfair means to do your work, God helps those who help themselves." "To concentrate, learn from mistakes, hard work is the only way to success." "Enmity makes you destroy yourself, whereas, friendship makes you safe. You have to live without jealousy." "Being true to oneself." "Be bold enough to face the challenge, always speak the truth, have faith in God." "We are one and no one is superior or inferior." "We have to be the people of high thinking."

When a separate question asked the students which values they felt they had acquired from stimulating stories from the Rāmāyaṇa Mahābhārata Pañcatantra etc., the categories and proportions were very similar, which eloquently reflects on the inspirational potential of such texts and stories when used as educational tools.

CHAPTER 3

SCIENTIFIC RESEARCH REVIEW

3.1 INTELLIGENCE

3.1.1 Nature of intelligence

Intelligence mainly has two components.

i. Ability to acquire knowledge and skills.

ii. Ability to apply knowledge and skills (Catherine).

i. The ability to acquire knowledge and skills is associated with dentric zone, which controls receptivity, and the thalamus, through which all sensory information passes.

ii. Putting cognized information together is the mainly associated with the parietal cortex (Telles, 2006).

3.1.2 Effects of Yoga and related practices on intelligence

Uma et al. (1989) selected 90 children (aged 6-16) with a variety of developmental disabilities from 4 special schools providing for upper, middle, & lower socio-economic strata. They were randomly assigned to the control group (45) and experimental group (45), which received Yoga learning strategies, 1 hour daily, 5 days a week, for 10 months. Both groups were tested for intelligence and social adaptation. The Yoga group showed significant improvements with no deterioration.

- IQ score increased by 89% (vs. 57% for the control group)
- The combination of IQ & mental age capacities increased by 68% (vs. 41%)
- Social quotient and social age increased by 60% (vs. 56%)

Moderate disabilities showed highest means of improvement vs. mild and severe. Two longitudinal experiments by Dixon et al. (2004) investigated the impact on cognitive and self-development of two techniques for holistic personal growth—the

Transcendental Meditation technique, and its Word of Wisdom technique for young children. A six-month study with 37 experimentals and 29 controls reported increases in principal components of psychological differentiation and general intelligence in experimentals, covering for pretest and control variables. Secondly, a 45-week study with 25 experimental and 25 controls found increases in principal components of self-concept, analytical ability, and general intellectual performance among experimental participants (analysis of covariance). These techniques appear to accelerate the natural developmental consolidation of awareness at a deeper level—the thinking level versus the perceptual level—and may be important adjuncts to use alongside current educational interventions.

In a two-year longitudinal study Cranson et al. (1991) investigated the effect of twice-daily practice of the Transcendental Meditation (TM) and TM-Sidhi program as part of a special university curriculum. Measures included Cattell's Culture Fair Intelligence Test (CFIT) and Hick's reaction time, both known to be correlated with general intelligence. 100 male and female students were subjects—45 from Maharishi International University (MIU) and 55 from the University of Northern Iowa (UNI).

Orme-Johnson and Granieri (1977) showed increased field independence (growth of a more stable internal frame of reference, increased perceptual acuity), increased creativity, increased figural fluency and originality, increased intelligence, increased behavioral flexibility, increased psychomotor speed and motor-cognitive flexibility.

Jedrczak et al. (1986) administered 3 brief tests assessing perceptual-motor speed and 2 assessing nonverbal intelligence to individuals practicing the Transcendental Meditation and TM-Sidhi programme. Multiple regression analyses showed that when motivation (measured on a 5-point self-rating scale), age, sex, education, and duration

of practice of the Transcendental Meditation technique were held constant, number of months of practice of the TM-Sidhi programme significantly predicted higher performance on 2 of the perceptual-motor speed tests and both tests of intelligence. Tjoa (1975) found that the Transcendental Meditation technique increases fluid intelligence, and decreases somatic neurotic instability.

3.2 MEMORY

3.2.1 Facets of memory

Memory is defined as the process of storing and preserving newly acquired information for later recall. Otherwise it is referred to as the process of recalling a specific experience, or the total collection of remembered experiences stored in an individual's brain. (Crooks & Stein, 1991)

The memory process has two divisions.

i. Short-term memory

ii. Long-term memory

iii. Short-term memory

Short-term memory comprises immediate recollection of stimuli soon after one perceives it. This system allows temporary storage of information (Brown, 1958).

ii. Long-term memory

Long-term memory is a system of theoretically unlimited capacity enduring over the lifetime of an individual (Baddeley, 1990**).** The three major kinds of memory are explicit memory, episodic memory and semantic memory.

i. Explicit memory

Explicit memory is that which can be brought to conscious awareness. Memory of events, figures, words, scenes and facts are in the domain of explicit memory. Memory for verbal and visual material is an important domain of explicit memory (Rao et al. 2004). The two major divisions of explicit memory are Spatial memory and Verbal memory.

Anterior areas of the temporal cortex are involved in the representation of verbal conceptual knowledge organized categorically (Thompson-Schill, 2003). Lesions in the left temporal lobe disrupt verbal memory and lesions in the right temporal lobe disrupt visuo-spatial memory (Smith & Milner, 1981). Excisions of left hippocampal structures impair verbal memory to a great extent. The impairment of visuo-spatial memory is less clearly lateralized (Jones-Gotman et al, 1997).

ii. Episodic memory

Encoding and retrieval of personally experienced events is episodic memory. The right prefrontal lobe is involved to a great extent in retrieval from episodic memory, which has been termed Hemisphere Encoding Retrieval Asymmetry (HERA) (Tulving, 1999).

iii. Semantic memory

Knowledge of facts and concepts is semantic memory (Tulving, 1999). A gradual acquisition process from episodic to semantic memory is likely, as semantic memory must at some stage have been encoded in episodic memories (Fletcher et al., 1995) The left prefrontal lobe is involved to a great extent in retrieval from semantic memory.

3.2.2 Effect of the practice of Yoga on memory

Various papers discuss and analyze the nature and dimensions of memory and its improvement. Jason et al. (2006) tested the impact of associative strength and retrieval heuristics on false source memory. This study demonstrates that source details of concepts most highly related to critical items are retrieved with false memories. Kessler, (2001) analyzed voice response time (RT) measurements from 4 large-scale studies of oral reading of English monosyllables for evidence that voice key measurements are biased by the leading phonemes of the response. Words with different initial phonemes did have significantly different RTs. This effect persisted after contributions of 9 co-variables, such as frequency, length, and spelling consistency, were factored out, as well as when variance associated with error rate was factored out. A breakdown by phoneme showed that voiceless, posterior, and consonants were detected later than others. The second phonemes of the words also had an effect on RT: words with high or front vowels were detected later. Phoneme-based biases due to voice keys were large (range about 100 ms) and pervasive enough to cause concern in interpreting voice RT measurements. Techniques were discussed for minimizing the impact of these biases.

In four experiments, David, N., Rapp and Richard, J., Gerrig, (2006) demonstrated that reader preferences can influence expectations for future narrative events. In their first two experiments, readers made explicit judgments about the likelihood of narrative outcomes. They tended to agree with outcomes consistent with prior story contexts but also consistent with preferences. In their second pair of experiments, converging evidence for these effects by analyzing reading times for outcomes was provided. Participants were slower to read outcomes inconsistent with prior story contexts and preferences. The results suggest that theories of narrative comprehension

must include some notion of reader wishes and desires to adequately describe the types of outcome expectations readers' use during narrative experiences.

According to temporal distinctiveness models, items that are temporally isolated from their neighbors during list presentation are more distinct and thus should be recalled better. Event-based theories, by contrast, deny that time plays a role at encoding and predict no beneficial effect of temporal isolation; although they acknowledge that a pause after item presentation may afford extra opportunity for a consolidation process such as rehearsal or grouping. Two experiments aimed at differentiating between the two classes of theories were reported. The results show that neither serial recall nor probed recall benefit from temporal isolation, unless participants use pauses to group a list. Simulations of the SIMPLE model provide convergent evidence that short-term memory for serial order need not involve temporal representations (Stephen Lewandowsky, 2006). Statistical analysis of English sound-to-spelling correspondences (Treiman, 2002) show that vowel spellings become more predictable, in some cases, when the preceding and following consonants are taken into account. Evidence for sensitivity to associations involving both preceding and following consonants when examining adults' spellings of vowels in non words (Experiments 1 and 2) and their substitution errors on vowels in real words (Experiment 3) was found. The results show that phoneme-to-grapheme mapping is sensitive to a broader array of context than just rime context. Additional findings suggest that the context must be within the same syllable to be influential (Experiment 4). To the extent that rimes play a special role in spelling, this role may derive from the fact that associations between vowels and codes are more common in English than

associations between vowels and onsets, not from spellers' greater sensitivity to within-rime associations.

A few papers analyze the effects of Yoga practices including physical postures and meditation on memory. Seashore Tonal Memory Test conducted by Pagano and Frumkin (1977), among a non mediator group, inexperienced TM meditator group and an experienced TM meditator group showed that in general the meditators were significantly better in both pre-test and post-test performance than the non-meditators, and experienced meditators are significantly better than inexperienced ones. These results suggest that the TM technique facilitates memory of right hemispheric functioning. College students instructed in the Transcendental Meditation technique displayed significant improvements in performance over a two-week period on a perceptual and short-term memory test involving the identification of letter sequences presented rapidly. They were compared with subjects randomly assigned to a routine of twice-daily relaxation with their eyes closed and to subjects who made no change in their daily schedule (Dillbeck, 2005). Kember (1985) proved through the psychological tests that the college students who practiced TM were able to enhance their ability of spontaneous organization of memory. TM practice improved verbal memory in high school students (Kory and Hufnagel, 1997).

Studies have been conducted at SVYASA on students attending nonresidential personality development camp for ten days, where the integrated approach of Yoga was taught to the students. Students were monitored to collect audio, visual, audio-visual, short and long-term memory scores before and after the 10 day Yoga practice. The result showed highly significant improvements in all these memory scores. The visual-verbal test, visual-spatial test, audio-visual test and audio memory test were conducted before and after on two groups of 38 children each, with one group

attending the 10 day Yoga training camp. The Yoga group showed a significant improvement.

In another 10 day Yoga camp, subjects were assessed before and after using the standard Wechsler memory scale. The Yoga group showed significant increases in diverse aspects of memory, ranging from visual reproduction to digit span. Nagendra and Telles (1999) showed that special physical postures (Āsana), voluntary regulation of breathing (Prāṇāyāma), maintenance of silence and visual focusing exercises (Trātaka) improve memory in school children.

Uninostril breathing facilitates performance on spatial and verbal cognitive tasks, said to be right and left brain functions, respectively. Since hemispheric memory functions are also known to be lateralized, Naveen et al. assessed the effects of uninostril breathing on performance in verbal and spatial memory tests. School children (N = 108 whose ages ranged from 10 to 17 years) were randomly assigned to four groups. Each group practiced a specific yoga breathing technique: (i) right nostril breathing, (ii) left nostril breathing, (iii) alternate nostril breathing, or (iv) breath awareness without manipulation of nostrils. These techniques were practiced for 10 days. Verbal and spatial memory was assessed initially and after 10 days. An age-matched control group of 27 were similarly assessed. All 4 trained groups showed a significant increase in spatial test scores at retest, but the control group showed no change. Average increase in spatial memory scores for the trained groups was 84%. It appears yoga breathing increases spatial rather than verbal scores, without a lateralized effect (Naveen et al.1997). Dynamic asana practices were given to the school children for nine days. Visual memory measured in this practice showed an improvement (Shatrughan, 2005).

3.3 SUSTAINED ATTENTION

3.3.1 Attention and its facets

Attention is mainly associated with the frontal lobe, and is an essential element of cognition. It is characterized either as a resource or capacity or as a skill of resource deployment. Three types of attention are

i. Focused attention

ii. Sustained attention and

iii. Divided attention. (Posner, 1978)

i. Focused attention:

Focused attention is the capacity to perform a task in the presence of distracting stimuli. To be able to study in a noisy hostel is an example of focused attention. The orbitofrontal area of the prefrontal cortex is hypothesized to be more associated with focused attention, as it mediates the capacity to inhibit responding to stimuli irrelevant to the task in hand. Lesion studies have shown that damage to this area results in distractibility (Rao et al. 2004).

ii. Sustained attention:

Sustained attention is the capacity to attend to a task for a required period of time. Sustained attention is closely associated with the task difficulty or task complexity. While it is easier for simple tasks, it is more difficult for complex tasks. To be attentive to a lecture for hours together is an example of sustained attention. The right fronto parietal network is associated with sustained attention. Damage to the right prefrontal cortex leads to poor sustained attention (Rueckert & Graffman,1996). Imaging studies have shown that vigilance tasks requiring sustained attention activate a network of structures in the right frontal and parietal cortices (Pardo, Fox &Raichle, 1991)

iii. Divided attention:

Divided attention is the capacity to attend to two or more tasks simultaneously. The concept of divided attention explains dual tasking, wherein two tasks require effort and attention. Divided attention is closely related to the central executive function of working memory. Discrimination of shape, color and speed of a visual stimulus under conditions of divided attention activate the anterior cingulate and the dorsolateral prefrontal cortex [Corbetta et al. 1991(a) Corbetta et al. 1991 (b)]. Bilateral dorsolateral prefrontal cortices are associated with the central executive, as tested by dual task paradigms (D'Esposito, et al. 1995). Several papers given below prove that the practice of Yoga improves attention.

3.3.2 Effect of Yoga practices on attention

A study of EEG coherence, heart rate variability and trait anxiety in Zen meditation showed that lower trait anxiety more readily induces meditation with a predominance of internalized attention, while higher trait anxiety more readily induces meditation with a predominance of relaxation. In another study on Zen meditation both sympathetic and parasympathetic indices were increased during the appearance of frontal midline theta rhythm (Fm theta) compared with control periods (Kubota et al. 2001). The Fm theta rhythm is recognized as a distinct theta activity which reflects mental concentration as well as a meditative state or relief from anxiety. Hence meditation appears to bring about a relaxed state with heightened internalized attention and concentration. The effect of meditation on attention to external objects was seen when the effects of transcendent experiences, described to occur during the practice of Transcendental Meditation, were studied on the contingent negative variation amplitude, rebound, and distraction effects (Travis et al. 2002). Contingent

negative variation is an event-related potential occurring between a warning stimulus and an imperative stimulus requiring a response (Walter, et al. 1964). Late contingent negative variation amplitudes were largest in meditators who had transcendental experiences daily. Since late contingent negative variation reflects proactive preparatory processes including mobilization of motor, perceptual, cognitive, and attentional resources, the data were taken to suggest that transcendental experiences could enhance cortical responses and executive functioning.

Banquet, Bourzeix and Lesevre (1979) proved that Transcendental Meditation improves selective attention. Characteristics of Visual Evoked Potentials (N120, P200, P300) were investigated during choice reaction time situations in a group of 10 subjects practicing meditation (E.S.) versus a matched control group (C.S.) During a series of visual stimuli occurring at fixed intervals, with 10% random omissions, the subjects were asked: 1) to respond by a finger displacement to each visual stimulus; 2) to hold on the response to the stimulus and to respond to omission. Both tasks were recorded before and after the practice of meditation or rest for the controls. The intergroup comparison showed that the experimental subjects had faster RT's with less mistakes, and N120 and P200 of larger amplitude and shorter latency. These differences were significant before and after meditation. The transient effects of meditation or rest, were opposite for the two groups : whereas after meditation the RT's became longer with less mistakes, and the amplitude of P300 larger, after rest there was a decrease of the P300 amplitude and no change in the RT's of the controls. These results are interpreted in terms of selective attention capacity and information processing strategies.

Donna (1984) reported that chanting OM for even 5 minutes calms down unruly kids, deepens their sense of self-control, and adds up to 20% to their ability to be attentive.

Kids with the same level of ability who chant half an hour prior to an exam will score up to 18% higher, according to research published in NeuroImage Journal.

In a previous study at SVYASA, Sarang et al. (2007) assessed performance on the Six Letter Cancellation Task (a task requiring visual selectivity and repetitive motor response) in forty male subjects immediately before and after two Yoga-based relaxation techniques of equal duration i.e., cyclic meditation (CM) and supine rest (SR). CM consists of alternating cycles of yoga postures and supine rest. Both practices significantly improved net scores ($P < 0.001$), CM producing more change (26%) than SR (14%). These results suggest that CM brings about a greater improvement in task performance. The study indicates that Yoga improves sustained attention.

3.4 PLANNING ABILITY

3.4.1 Planning ability

Planning has been defined as identification and organization of the steps and elements needed to carry out an intention or achieve a goal (Lezak, 1995). Planning is a complex function with many components such as speed of processing, mental flexibility, working memory, regulation of thoughts and error correction ability (Rao et al, 2004). Planning ability is mainly associated with the functioning of the pre-frontal cortex (Stuss & Benson, 1984). Planning is a central multi component process which is associated with the pre frontal cortex, and is involved in the execution of non-routine actions. Lesion studies have shown that left frontal lesions are associated with deficits of planning (Shallice, 1982). Other studies have found that inappropriate organization associated with poor planning is greater with bilateral prefrontal lesions

(Owen, 1990). The dorso-lateral pre frontal cortex is associated with the components of generating, selecting and / or remembering mental moves (Rowe, 2001).

3.4.2 Effect of Yoga practices on planning ability

A study conducted by Manjunath and Telles (2001) assessed planning ability before and after a Yoga intervention of 1 hour 15 minutes per day for one month in school students. The students who practiced yoga showed significantly higher values than the students who performed physical exercises.

Kadambini (2005) assessed the short-term effect of intensive yoga practices and a yoga way of life for 9 days in a RCT design. The Tower of London test among 30 school students in each of the Yoga and control groups, showed significantly higher improvement on planning ability in the Yoga group in contrast to controls. These studies suggest that Yoga is effective in improving planning ability.

3.5 REDUCTION OF STRESS AND ANXIETY

3.5.1 Nature of emotions

Emotions are associated mainly with the cingulate cortex in the frontal lobe (Papez, 1937). Emotions are fast when the ego gets more identified with them. When egoistic attachment gets thinned the emotions become a slow aesthetic flow. Thinned emotions are maintained by peace, relaxation and tranquility. Various published papers indicate that Yoga improves positive emotions like peace, relaxation, tranquility and harmony. Yoga has also been found to reduce negative emotions associated with over anxiety. This can help growth of cognitive variables like intelligence, planning ability, memory and sustained attention (Saltz, 1970). Papers reporting Yoga to improve positive emotions like love featured with peace, harmony

and tranquility, and that Yoga removes negative emotions associated with over anxiety and egoistic attachment are given below.

3.5.2 Improvement of peace and positive emotions through Yoga practices

EEG coherence was measured by Orme-Johnson et al. (1982), between pairs of three different subjects during a one-hour period practice of the Transcendental Meditation (TM) program. Coherence between subjects was evaluated for two sequential fifteen minute periods. On six experimental days, these periods preceded and then coincided with a fifteen minute period during which 2500 students participated in the TM-Siddhi program at a course over 1000 miles away. After the course had ended coherence was evaluated on six control days. It was found that intersubject coherence was generally low, between 0.35 and 0.4, with coherence in the alpha (8-12 Hz) and beta (16-20 Hz) frequencies significantly higher than at other frequencies. On the experimental days, inter subject EEG coherence increased during the experimental period relative to the 15 minute baseline period immediately proceeding the experimental period. Coherence increased significantly from baseline to experimental periods on experimental days compared with control days ($p = 0.02$). This effect was particularly evident in the alpha and beta frequencies. The results reinforce previous sociological studies showing decreased social disorder in the vicinity of TM and TM-Sidhi participants and are discussed in terms of a field theoretic view of consciousness.

Wachsmuth and Dolce (1980) obtained Polygraphic records (EEG, EOG, and heart rate) were obtained on 5 subjects during and after Transcendental Meditation (TM) as well as during night sleep. The records were analyzed twice. During TM the amplitude of the alpha-waves was higher than before TM and appeared continuously.

Bilateral theta-bursts were also observed. The same EEG changes were seen during relaxation with closed eyes. The discriminance-analysis of 5 frequency-bands of the EEG recorded from C3 showed no differences in dominant frequency, power and variancy. No differences were observed between the flat EEGs recorded during TM or sleep. The heart rate was significantly slower during meditation or light sleep - when a flat EEG (stage 1) was recorded - as when the recording showed an alpha-rhythm. The vigilosomnograms of all subjects were normal. The subjects reported that they experienced increased relaxation, alertness and floating consciousness. They were able to maintain themselves for an unusually long time in a state of increased alertness

Middle latency auditory evoked potentials were recorded by Telles et al. (1994) in 18 male volunteers aged between 25 and 45 years, 9 of whom had more than 10 years experience in "Om" meditation (senior subjects), whereas the other 9 had no meditation experience (naive subjects). Both groups were studied in two types of session. (1) Before, during, and after 20 minutes of mentally repeating "one" (control session), and (2) a similar session, though with 20 minutes of mentally chanting "Om" (meditation session). The senior subjects showed a statistically significant (paired t-test) increase in the peak amplitude of Na wave (the maximum negative peak between 14 and 18 ms) during meditation, while the same subjects showed a statistically significant reduction in the Na wave peak amplitude during control sessions. In contrast, the naive subjects had a significant decrease in the Na wave peak amplitude during meditation sessions and a non significant trend of reduction during control sessions, as well. This difference between senior and naive subjects was significant (two-way ANOVA). There were no significant changes in short latency wave V or Pa wave (the positive peak between the Na wave and 35 ms). The changes in the Na

wave suggest that both meditation on a meaningful symbol and mental repetition of a neutral word cause neural changes at the same level (possibly diencephalic). However, the change could be in opposite directions and this difference could be correlated with differences in the duration of experience in meditation between senior and naive subjects.

Middle latency auditory evoked potentials were examined by Telles and Desiraju (1993) in 7 proficient subjects during the practice of meditation on the syllable 'OM', to determine whether these evoked potentials would differ significantly from those recorded during the baseline state without practicing mediation. Similar records were also obtained from 7 'naive' subjects, matched for age, before and during a control period which involved sitting with eyes closed and with no special instructions for focusing their thoughts. There was considerable inter-subject variability in the different components. However, during meditation there was a small but significant reduction in the peak latency of the Nb wave (the maximum negativity occurring between 35 and 65 msec). This reduction was observed consistently during the 3 repeat sessions of each subject, while the 'naive' subjects did not show this change. These results suggest that the inter-subject variability of middle latency auditory evoked potentials precludes using them as the method of choice for assessing the effects of meditation. The small but consistent decrease in the Nb wave peak latency indicates that the middle latency auditory evoked potentials do change with meditation. However, the variability of the potentials may mask subtle changes.

To examine the extent to which advanced meditative practices might alter body metabolism and the electroencephalogram (EEG), three Tibetan Buddhist monks living in the Rumtek monastery in Sikkim, India were investigated by Benson et al.

(1990). In a study carried out in February 1988, it was found that during the practice of several different meditative practices, resting metabolism (VO_2) could be both raised (up to 61%) and lowered (down to 64%). On the EEG, marked asymmetry in alpha and beta activity between the hemispheres and increased beta activity were present. From these three case reports, we conclude that advanced meditative practices may yield different alterations in metabolism (there are also forms of meditation that increase metabolism) and that the decreases in metabolism can be striking.

In a study designed Badawi et al. (1984) to identify the electrophysiological characteristics of the Transcendental Meditation Program, 52 periods of spontaneous respiratory suspension (RS) were observed in 18 subjects during the practice of this program. These periods were correlated with some but not all the subjective experiences of pure consciousness. Nineteen RS periods (belonging to 11 subjects) free from any artifact were selected for EEG analysis. The mean total EEG coherence over all frequencies and over nine derivations for TM subjects showed a significant increase during the RS periods as compared to pre- and post-RS control periods. There was no significant change in mean total EEG coherence in a control group of 30 subjects voluntarily holding their breath. The heart rate showed a significant decrease during the RS periods in both the experimental and control groups, whereas there was no significant change in EEG alpha power in either group. These findings extend those of previous studies and help characterize the physiologic correlates of the state of pure consciousness during the TM program.

A study designed by Jella and Shannahoff-Khalsa (1993) described the effects of 30 minutes of unilateral forced nostril breathing on cognitive performance in 51 right-handed undergraduate psychology students (25 males and 26 females). A verbal

analogies task modeled after the Miller Analogies and SAT Tests was used as a test of left-hemispheric performance and mental rotation tasks. Vandenburg and Kuse's adaptation of Shepard and Metzler's tests were used as spatial tasks for testing right-hemispheric performance. Spatial task performance was significantly enhanced during left nostril breathing in males and females, $p = .028$. Verbal task performance was greater during right nostril breathing, but not significantly $p = .14$. The study concluded that these yogic breathing techniques may have useful application to treating psycho physiological disorders with hemispheric imbalances, or autonomic abnormalities.

Frontal midline theta rhythm (Fm theta) was recognized by Kubota et al. (2001) as distinct theta activity on EEG in the frontal midline area, reflecting mental concentration, a meditative state, or relief from anxiety. The attentional network in the anterior frontal lobes, including the anterior cingulate cortex, is suspected to be the generator of this activity, connected to the regulative function of the frontal neural network over autonomic nervous system (ANS) during cognitive processes.

Their study used a standard procedure of Zen meditation requiring sustained attention and breath control to provoke Fm theta. Simultaneous EEG and ECG recordings were performed. For the subjects in which Fm theta activities were provoked (six men, six women, 48% of the total subjects), peripheral autonomic activities were evaluated during the appearance of Fm theta, as well as during control periods. Successive inter-beat intervals were measured from the ECG, and a method of analysis based on heart rate variability used to separately assess cardiac sympathetic and parasympathetic functions. Both sympathetic and parasympathetic indices increased during the appearance of Fm theta, compared with control periods. Theta band

activities in the frontal area were negatively correlated with sympathetic activation. The results suggested a close relationship between cardiac autonomic function and activity of medial frontal neural circuitry. In Yogic terms this suggests that the techniques activated first the Ājñā and then the Hṛdaya.

A series of four experiments designed by Cuthbert et al. (1981) assessed the effects of instructions to lower heart rate on heart rate change and general arousal reduction. Various conditions of biofeedback, cognitive load, incentive, knowledge of results and the experimenter-subject relationship were tested. Experiment 1 compared physiological responses to the delivery of direct organ feedback (i.e., heart rate) with responses to electromyographic biofeedback from the frontals muscle area and with responses to a nonfeedback tracking task. The results suggested that neither heart rate nor muscle tension feedback is an especially powerful method for achieving sustained reductions in heart rate. Furthermore, although some specificity of physiologic pattern was apparent, biofeedback was no more effective in lowering general activation level than simple instructions to relax accompanied by a general knowledge of results. The second experiment was designed to assess the role of cognitive load in arousal reduction. Heart rate biofeedback was compared with a procedure involving minimal external information processing the secular meditation exercise of Wallace and Benson. The results indicated a clear superiority for the meditation strategy in effecting reductions in cardiac rate and activation. However, in a third experiment, meditation subjects lowered heart rate much less than observed in the previous study and this time the reduction did not exceed that achieved by feedback subjects. Subsequent analysis suggested that the quality of the subject-experimenter relationship (active-supportive vs. formal-distant) was a significant variable in accounting for outcome differences. The above hypothesis was supported by a fourth

experiment. Under conditions of high subject-experimenter involvement, the superior meditation performance of Experiment 2 was reproduced; under low-involvement conditions the Experiment 3 result of no difference between training groups was obtained. The findings suggest that the effectiveness of any method for achieving relaxation (or physiological control) rests on a complex interaction between informational and motivational imperatives of the stimulus context, and definable aspects of the interpersonal exchange between subject and experimenter.

The research raised serious questions about the effectiveness of the usual biofeedback paradigm as an aid to arousal reduction, and the cost efficiency of its applications in the clinical situation. Furthermore, these results demonstrate the great power in relaxation experiments on psychosocial and other moderator variables, and indicate the practical difficulty of controlling them, when these variables appear to be as potent in changing physiology as the primary training methods.

A study by Schwartz (1976) developed the basic premise that learning to self-regulate a pattern of responses can have different consequences from those observed when controlling individual functions alone. Self-regulation of patterns of responses seemed to be a particularly sensitive and effective procedure for (a) uncovering biological linkages and constraints between responses in the intact human, (b) investigating how multi-physiological systems combine to produce unique subjective experiences and effects on performance, and (c) enhancing the clinical effectiveness of biofeedback procedures by training patients to integrate and coordinate voluntarily specific patterns of cognitive, autonomic and motor responses. These hypotheses are illustrated by basic research involving biofeedback training for patterns of blood

pressure, heart rate and EEG activity. They relate to experiments on cognitive self-regulation of patterns of physiological responses, using affective imagery and meditation procedures, and case studies of patients treated with biofeedback.

Recovery from induced physiological stress in Śavāsana (a yogic relaxation posture) and two other postures (resting in chair and resting supine posture) was compared by Bera, Gore and Oak (1998). Twenty-one males and 6 females (age 21-30 yrs) were allowed to take rest in one of the above postures immediately after completing a schedule of treadmill running. Recovery was assessed in terms of Heart Rate (HR) and Blood pressure (BP). HR and BP were measured before and every two minutes after the treadmill running, until they returned to the initial level. Results revealed that the effects of stress were reversed in significantly ($P < 0.01$) shorter time in Śavāsana, compared to the resting-in-chair, and supine postures.

The effect of Sahaja yoga meditation on 32 patients with primary idiopathic epilepsy on regular and maintained antiepileptic medication was studied by Panjwani et al. (2000). Patients were randomly divided into 3 groups: group I practiced Sahaja Yoga meditation twice daily for 6 months under proper guidance; group II practiced postural exercises mimicking the meditation for the same duration; and group III was the control group. Visual Contrast Sensitivity (VCS), Auditory Evoked Potentials (AEP), Brainstem Auditory Evoked Potentials (BAEP), and Mid Latency Responses (MLR) were recorded initially (0 month) and at 3 and 6 months for each group. There was a significant improvement in VCS following meditation practice in group I participants. Na, the first prominent negative peak of MLR and Pa, the positive peak following Na did not register changes in latency. The Na-Pa amplitude of MLR also

showed a significant increase. There were no significant changes in the absolute and interpeak latencies of BAEP. The reduced level of stress following meditation practice may make patients more responsive to specific stimuli.

Khasky and Smith (1999) made a study of the effect of Yoga on creativity and relaxation. One hundred and fourteen participants in four groups practiced 25 minutes of progressive muscle relaxation, yoga stretching, imagery, or a control task. Before and after training, participants took state versions of the Smith Quick Stress Test (which measures Somatic Stress, Negative Affect, and Worry) and the Smith R-State Inventory (which measures relaxation-related states Disengagement, Physical Relaxation, Mental Relaxation, Strength and Awareness, Joy, Love and Thankfulness, and Prayerfulness). After training, all took both the Verbal and Figural forms of the Torrance Tests of Creative Thinking. At posttest, groups' scores did not differ on Creativity; however, when compared with yoga stretching, imagery trainees had lower posttest scores on Negative Affect. Both yoga stretching and imagery trainees displayed higher scores on self-reported Physical Relaxation than did controls. Progressive muscle relaxation trainees had lower scores on Somatic Stress than controls. Paradoxically, for all relaxation trainees, Disengagement (feeling "distant, far away, indifferent") correlated positively with both Negative Affect and Physical Relaxation, suggesting that disengagement in relaxation may not lead to relaxation-induced anxiety but may help one cope with such anxiety.

Peng et al. (2000) reported extremely prominent heart rate oscillations associated with slow breathing during specific traditional forms of Chinese Chi and Kuṇḍalinī Yoga meditation techniques in healthy young adults. They applied spectral analysis, and a novel analytic technique based on the Hilbert transform to quantify these heart rate

dynamics. The amplitude of these oscillations during meditation was significantly greater than in the pre-meditation control state and also in three non-meditation control groups: i) elite athletes during sleep, ii) healthy young adults during metronomic breathing, and iii) healthy young adults during spontaneous nocturnal breathing. This finding, along with the marked variability of the beat-to-beat heart rate dynamics during such profound meditative states, challenges the notion of meditation as only an autonomically quiescent state.

Lou et al. (1999) designed a study examining whether the neural structures sub-serving meditation can be reproducibly measured, and, if so, whether they are different from those supporting the resting state of normal consciousness. Cerebral blood flow distribution was investigated with the 15O-H20 PET technique in nine young adults, who were highly experienced yoga teachers, during the relaxation meditation (yoganidrā), and during the resting state of normal consciousness. In addition, global CBF was measured in two of the subjects. Spectral EEG analysis was performed throughout the investigations. In meditation, differential activity was seen, with the noticeable exception of V1, in the posterior sensory and associative cortices known to participate in imagery tasks. In the resting state of normal consciousness (compared with meditation as a baseline), differential activity was found in dorso-lateral and orbital frontal cortex, anterior cingulate gyri, left temporal gyri, left inferior parietal lobule, striatal and thalamic regions, pons and cerebellar vermis and hemispheres. These structures are thought to support an executive attentional network. The mean global flow remained unchanged for both subjects throughout the investigation (39+/-5 and 38+/-4 ml/100 g/min, uncorrected for partial volume effects). It is concluded that the 15O-H20 PET method may measure CBF distribution in the meditative state as well as during the resting state of normal consciousness, and

that characteristic patterns of neural activity support each state. These findings enhance our understanding of the neural basis of different aspects of consciousness.

The article presented by Roth and Creaser (1997) describes a bilingual mindfulness meditation-based stress reduction program in an inner-city setting. Mindfulness meditation is defined, and the practice of breathing meditation, eating meditation, walking meditation, and mindful yoga are described. Data analysis examined compliance, medical and psychological symptom reduction, and changes in self-esteem, of English- and Spanish-speaking patients who completed the 8-week Stress Reduction and relaxation Program at the Community Health Center in Meriden, Conn. Statistically significant decreases in medical and psychological symptoms and improvement in self-esteem were found. Many program completers reported dramatic changes in attitudes, beliefs, habits, and behaviors. Despite the limitations of the research design, these findings suggest that a mindfulness meditation course can be an effective health care intervention when utilized by English- and Spanish-speaking patients in an inner-city community health center

Miller, Fletcher and Kabat-Zinn (1995) conducted a study proving that Yoga can help anxiety disorders. A previous study of 22 medical patients with DSM-III-R-defined anxiety disorders had showed clinically and statistically significant improvements in subjective and objective symptoms of anxiety and panic; intervention consisted of 8 weeks of outpatient, physician-referred, group stress reduction based on mindfulness meditation. Twenty subjects showed significant reductions in Hamilton and Beck Anxiety and Depression scores both post-intervention, and at the 3-month follow-up.

In this study, 3-year follow-up data were also obtained and analyzed for 18 of the original 22 subjects to probe long-term effects. Repeated measures analysis showed maintenance of the gains obtained in the original study on the Hamilton [$F(2,32) = 13.22$; $p < 0.001$] and Beck [$F(2,32) = 9.83$; $p < 0.001$] anxiety scales as well as on their respective depression scales, on the Hamilton panic score, the number and severity of panic attacks, and on the Mobility Index-Accompanied and the Fear Survey.

A 3-year follow-up comparison of this cohort with a larger group of subjects who had met criteria for screening for the original study was conducted. Ongoing compliance with the meditation practice was also demonstrated in the majority of subjects at 3 years. The study concluded that an intensive but time-limited group stress reduction intervention, based on mindfulness meditation, can have long-term beneficial effects in the treatment of anxiety disorders.

Deshpande S et al (2008) studied the efficacy of Yoga on *Guṇa* (yogic personality measure) and general health in normal adults. Of the 1228 persons who attended introductory lectures, 226 subjects aged 18–71 years, of both sexes, who satisfied the inclusion and exclusion criteria and who consented to participate in the study were randomly allocated to two groups. The Yoga(Y) group practiced an integrated yoga module that included asana, Prāṇāyāma, meditation, notional correction and devotional sessions. The control group practiced mild to moderate physical exercises (PE).

Both groups had supervised practice sessions (by trained experts) for one hour daily, six days a week for eight weeks. *Guṇa* (yogic personality) was assessed before and after eight weeks using the self-administered Vedic Personality Inventory (VPI)

which assesses *Sattva* (gentle and controlled), *Rajas* (violent and uncontrolled) and *Tamas* (dull and uncontrolled). The general health status (total health), which includes four domains namely somatic symptoms (SS), anxiety and insomnia (AI), social dysfunction (SF) and severe depression (SP), was assessed using a General Health Questionnaire (GHQ). Baseline scores for all the domains for both the groups did not differ significantly ($P > 0.05$, independent samples t test).

Sattva showed a significant difference within the groups and the effect size was more in the Y than in the PE group. *Rajas* showed a significant decrease within and between the groups with a higher effect size in the PE group. *Tamas* showed significant reduction within the PE group only. The GHQ revealed that there was significant decrease in SS, AI, SF and SP in both Y and PE groups (Wilcoxcon Singed Rank t test). SS showed a significant difference between the groups (Mann Whitney U Test).

Though all these papers suggest the cognitive growth of Yoga practices, none of them studied the Yoga based education, which is the main subject matter of this study.

Table 3.1 Cognitive growth through Yoga

	Intelligence Quotient	Memory	Sustained Attention	Planning ability
Definition and facets	Ability to acquire knowledge and skills. Ability to apply knowledge and skills	Process of storing and preserving newly acquired information for later recall.	Capacity to attend to a task for a required period of time.	identification and organization of the steps and elements needed to carry out an intention or achieve a goal
Brain associations	Dentric zone and parietal cortex	Temporal lobe Spatial: Right hemisphere Verbal: Left	Right fronto-parietal network	Pre-frontal cortex
Papers published	Uma et al. (1989) 90 children (aged 6-16) with a variety of developmental disabilities from 4 special schools 45: randomly assigned to each group. Yoga practice, 1 hour daily, 5 days a week, for 10 months. Intelligence and social adaptation. IQ score increased by 89% (vs. 57% for the control group) The combination of IQ & mental age capacities increased by 68% (vs. 41%)	Naveen et al. (1997): School children (N = 108 whose ages ranged from 10 to 17 years) were randomly assigned to four groups. Each group practiced a specific yoga breathing technique: (i) right nostril breathing, (ii) left nostril breathing, (iii) alternate nostril breathing, or (iv) breath awareness without manipulation of nostrils. 10 days. Verbal and spatial memory was assessed. An age-matched control group of 27 were similarly assessed. All 4 trained groups showed a significant increase in spatial test scores at retest 84%.	Sarang et al. (2007): assessed performance on the Six Letter Cancellation Task (a task requiring visual selectivity and repetitive motor response) in forty male subjects immediately before and after two Yoga-based relaxation techniques of equal duration i.e., cyclic meditation (CM) and supine rest (SR). CM consists of alternating cycles of yoga postures and supine rest. Both practices significantly improved net scores ($P < 0.001$), CM producing more change (26%) than SR (14%).	A study conducted by Manjunath and Telles (2001) assessed planning ability before and after a Yoga intervention of 1 hour 15 minutes per day for one month in school students. The students who practiced yoga showed significantly higher values than the students who performed physical exercises.
	Dixon et al. (2004). TM. 45-week study: 25 experimental & 25 controls: increases in principal components of self-concept, analytical ability, and general intellectual performance in experimental	Kember (1985) proved through the psychological tests that the college students who practiced TM were able to enhance their ability of spontaneous organization of memory.	Donna (1984) reported that chanting OM for even 5 minutes calms down unruly kids, deepens their sense of self-control, and adds up to 20% to their ability to be attentive.	Kadambini (2005) assessed the short-term effect of intensive yoga practices and a yoga way of life for 9 days in a RCT design. The Tower of London test among 30 school students in each of the Yoga and control groups, showed significantly higher improvement on planning ability in the Yoga group in contrast to controls.
	Jedrczak et al. (1986): 3 tests Perceptual-motor speed & nonverbal intelligence to individuals practicing the TM-Sidhi programme. Significantly higher performance on 2	(Dillbeck, 2005). College students instructed in the Transcendental Meditation technique displayed significant improvements in	Banquet, Bourzeix and Lesevre (1979): TM improves attention. Characteristics of Visual Evoked Potentials (N120,	

	of the perceptual-motor speed tests and both tests of intelligence.	performance over a two-week period on a perceptual and short-term memory test involving the identification of letter sequences presented rapidly. They were compared with subjects randomly assigned to a routine of twice-daily relaxation with their eyes closed and to subjects who made no change in their daily schedule	P200, P300): investigated during choice reaction time situations in a group of 10 subjects practicing meditation versus a matched control group. The intergroup comparison showed that the experimental subjects had faster RT's with less mistakes, and N120 and P200 of larger amplitude and shorter latency. These differences were significant before and after meditation.	

CHAPTER 4

AIM and OBJECTIVES

4.1 AIM

To compare the ability of GES and MES systems to develop cognitive abilities of students.

4.2 OBJECTIVES

A comparative study of GES and MES based on literary and historical sources,

and a comparative experimental evaluation of the effects of a year's study in the MES and GES systems on:

a. Levels of Intelligence

b. Spatial and verbal memories

c. Attention span

d. Planning ability

4.3 NULL HYPOTHESES

There is no difference between MES and GES on cognitive skills with respect to IQ, memory, attention span and planning ability development of students.

CHAPTER 5

METHODS

5.1 SUBJECTS

Out of the 110 students in the Yoga-based Gurukula (GES), a group of 49 healthy boys were selected, each of whom was one-to-one matched for age, family atmosphere, and socio-economic background, with a student from among the 500 at the MES school. All selected boys were aged between 11 to 13 years.

5.1.1 Inclusion criteria

1. GES students are all boys, so all selected MES students had to be male.

2. All selected subjects had to be (a) matchable, and (b) healthy.

5.1.2 Exclusion criteria

The boys' health status was assessed by a doctor based on their personal history and a general clinical examination; any having congenital defects or on medication known to affect cognitive abilities were excluded from the study.

5.1.3 Informed consent

The subjects were told that the tests were for their self-assessment to understand the benefit they derived from the course. Informed consent was signed by all subjects. Those who gave their consent to participate in the study were recruited. None of them was aware of the hypothesis of the study. Approval was obtained from the Institutional Ethical Committee, as all tests are essentially noninvasive in nature.

5.1.4 Sample size

A sample of 98 subjects was studied. Required sample size was 60, based on the effect-size obtained in a previous study of changes in cyclic meditation (Sarang, 2007). It was calculated using G-power software, University of Düsseldorf, Germany; http://www.psycho.uni-duesseldorf.de /aap/projects/gpower where the α power was set at 0.05. Details are given in appendix 6.

5.2 VENUE

Two residential schools (one MES and the other GES) providing similar ambiance and daily routines were chosen. Both the schools had similar natural surroundings with an atmosphere congenial for learning.

5.2.1 GES school

The GES school was Prabodhini Gurukula, situated in Ajeya Vishvastha Mandali, Hariharapura, Koppa taluk, Chikmangalore district, Karnataka. The school's building structure is simple. Class rooms and hostel rooms are roofed with tiles. Within the school there is a small temple with a Śiva-Liṅga to which daily worship is conducted by Gurukula students themselves. Apart from the class rooms there is a small play ground in which students play in the evening. The school is situated in the bank of the river Tuṅga. Every full moon day students themselves go to the houses of the village to seek alms and collect some rice and vegetables to make their daily food. This convention, adopted by early Gurukula schools, is still followed by this Gurukula school.

Fig 5.1 Gurukula building structure

5.2.2 MES school

The MES school was the Indian Matriculation Higher Secondary School situated in Gopinathanpatti, X-road, Palayapatti, Pudur post, Pappirettipatti taluk, Dharmapuri district, Tamilnadu. Roofs of the Class rooms and hostel rooms are made of concrete. The MES school building structure is a little more sophisticated than that of GES school; also, it has a big playground with facilities to play volleyball, basketball, football and cricket.

Table 5.1 Details of subjects

Group	No.	Age range	Age (mean±sd)
GES	49	11 to 13	12.16 ± .66
MES	49	11 to 13	12.31 ± .68

The two groups matched for age.

Table 5.2 Trial profile

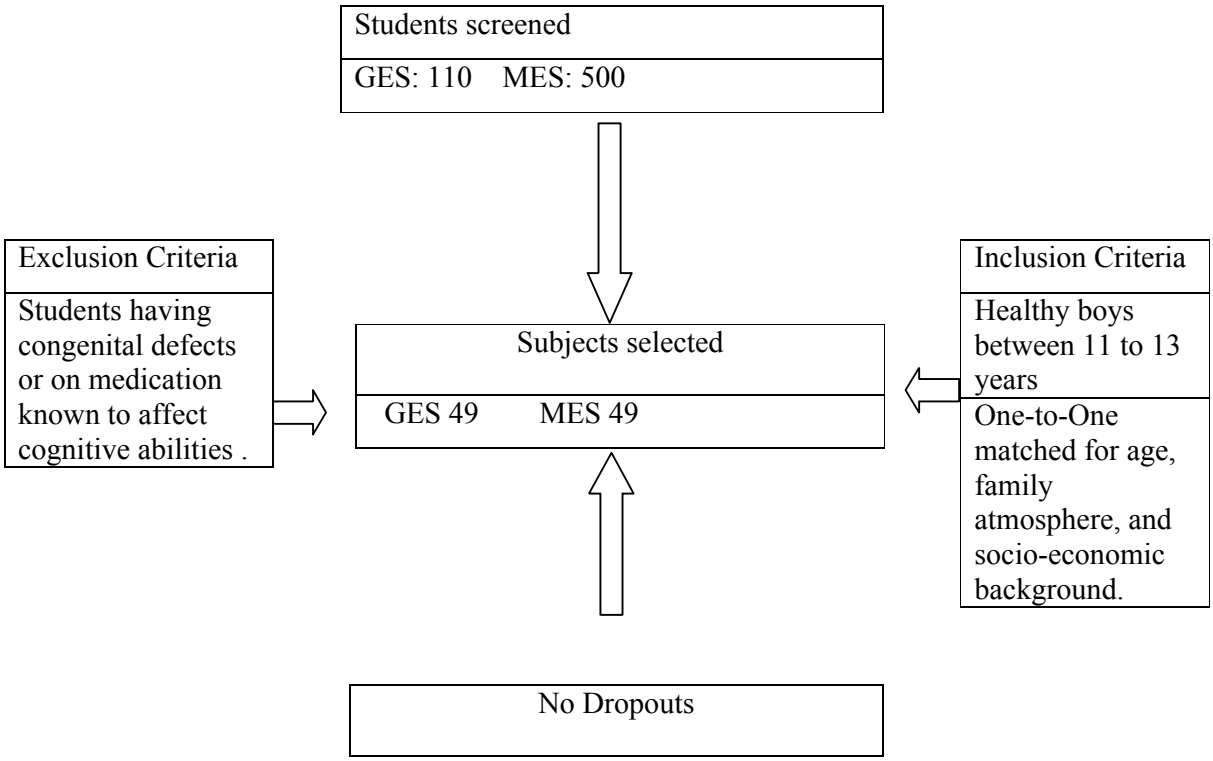


Fig 5.2 Schematic diagram of the academic year

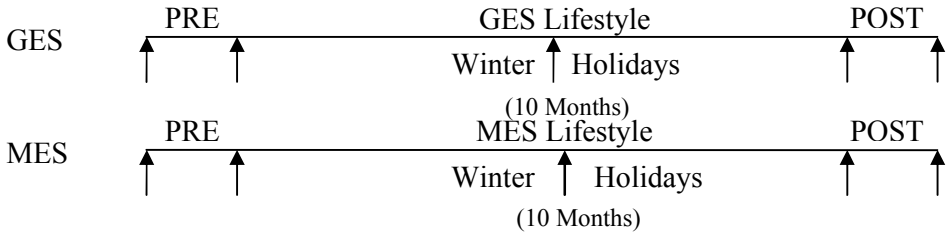


Table 5.3

Demographic data

	N	S	A	B	C	D	E
Groups	Number of subjects	Rs per year (mean±sd)	(mean±sd)	(mean±sd)	(mean±sd)	(mean±sd)	(mean±sd)
GES	49	6448.98 ± 1969.15	1.31 ± 1.37	1.18 ± .39	2.18 ± 1.52	4.02 ± .14	1.35 ± .48
		6704.08 ±			2.35 ±		1.33 ±

GES Gurukula Education system & MES Modern education System

S- Salary, A- Education of father, B- Education of mother, (Education up to SSLC – 1, Gaduation- 2, Post graduation- 3, Professionials – 4) C-Occupation of father, D-Occupation of mother (Agriculture-1, Business-2, Academician-3, Others – 4) E- social set up (Rural -1 Urban-2)

The results show no significant differences between GES and MES in all the demographic parameters (Independent samples t test $p>0.05$). Differences between the GES and MES groups for levels of education of father, education of mother, occupation of father, occupation of mother and social set up were assessed using X^2 test and were found to be not significant ($p>0.05$).

5.3 DESIGN OF THE STUDY

5.3.1 Matching

The students in the GES school were all freshers and had received a similar modern education up till that time, when, being interested in GES they had chosen the Gurukula school. An independent samples t test on the baseline data showed no significant differences ($p>0.05$) between the two groups for any of the demographic parameters.

5.3.2 Masking

Demographic data were collected by trained persons not involved in the design of the study. Assessments were carried out under the guidance of a psychologist by trained persons, who had not been involved in the selection process, and who did not know the design of the study. No teacher at either school was involved in making the assessments. There were no interactions between the GES and MES schools as they were in different locations more than 100 kilometres apart. Furthermore, no one at either school knew the identity of the other school. The person scoring the test sheets was different from the person administering each test and was blinded concerning subjects identities.

5.4 LEARNING STRATEGIES

5.4.1 Overview of GES and MES

The GES School used an educational program with integrated yoga practices, while the MES provided a conventional modern education program. The practice at the GES consisted of practice of Āsana, Prāṇāyāma, Dhyāna, Japa, Pūjā and Yogic games, as normally included in their daily routine.

5.4.2 Āsanas and physical exercises

Āsanas are Yoga physical postures. Gurukula students practiced more Āsanas and less common physical exercises while the MES students practiced more physical exercises and less Āsanas. Both of them practiced their particular combination of Āsanas and common physical exercises for half an hour each day.

Fig 5.3 Āsana traning in GES

5.4.3 Prāṇāyāma

Prāṇāyāmas are breathing exercises practiced to gain mastery over the body's vital energy (Prāṇa). Gurukula students perform Nāḍiśuddhi (regulation of inhalation and exhalation and with inner chanting of Vyāhṛti and Gāyatrī Mantras) for 5 minutes every morning and evening.

5.4.4 Dhyāna and mathematical puzzles

Dhyāna is meditation. Gurukula students meditated using the Gāyatrī Mantra for 10 minutes every morning, afternoon and evening. The MES students practiced mathematical puzzles for half an hour everyday.

5.4.5 Japa of Mantras and reciting rhythmic poems

Japa means chanting. In this context it means chanting Vedic Mantras. Gurukula students chanted Mantras from the Vedas for 1 hour every day. In the MES school rhythmic poems and rhymes were taught every day.

Fig 5.4 GES students in class

Fig 5.5 GES students doing Sandhyopāsana

Fig 5.6 GES students performing Agni kārya

5.4.6 Pūjā and prayer

Pūjā is formal worship of the Divine, said to develop cognitive strength. Gurukula students performed Pūjā every day for 20 minutes. The MES students attended a session of Prayer every morning and evening for 15 minutes each.

Fig 5.7 GES students performing Pūjā

5.4.7 Yogic games and general sports

Yogic games are special kinds of games based on Vedic principles to calm down the mind and to increase attention. Gurukula students played these games, while the MES students played mostly conventional modern sports.

Fig 5.8 Yogic games

5.4.8 Classical arts and modern arts

Gurukula students learnt Karnatic music with Bhajans and musical instruments, soothing their thoughts and making them relaxed. Yakṣa gāna dance was also taught. In the MES school light music was taught.

Fig 5.9 Classical dance and music by GES students

5.5 ASSESSMENTS

The following cognitive variables were studied:

1. Intelligence Quotient **(5.5.1)**

2. Spatial and Verbal Memory **(5.5.2)**

3. Sustained Attention **(5.5.3)**

4. Planning Ability **(5.5.4)**

5.5.1 C.M. Bhatia's performance tests of intelligence

C.M. Bhatia's Battery of performance tests of intelligence has five subtests (Bhatia, 1953): Koh's block design test; pass along test; pattern drawing test; test for immediate memory for sounds; and picture **c**onstruction test.

A. Koh's Block Design Test (Test No.1):

Four cubes are placed before the subject; all are alike and colored in different ways. The subject handles and examines the cubes to become familiar with each of them. Card no.1 is then showed to him. The design on the card has to be constructed by the subject using the four cubes. If the subject succeeds within the 2 minute time limit, he is asked to construct design no.2. The test proceeds in this manner with successive designs. At the start of design no.6, five more blocks are given to the subject, bringing the total up to 9; at design no.8, the remaining 7 are given, making the total 16. The test stops when the subject fails twice in succession. The time limit for designs nos. 1 to 5 is 2 minutes each and for designs nos. 6 to 10 is 3 minutes each.

B. The Pass Along Test (Test No. 2):

(i) The subject takes the first, smallest box together with card no.1. It is pointed out to him that the red block has been placed near the blue end of the box, and the blue block near the red end. The subject is told that the red block must be moved to the red end and the blue block to the blue end, as shown on the card. It is emphasized that

blocks must not be lifted, but may only be moved horizontally. The solution of the first box is demonstrated to the subject.

(ii) Card No. 1 and the first box are again placed before the subject who is asked to do the same as before. Success or failure within the time limit is recorded.

(iii) The experimenter then proceeds to designs No. 2, 3 etc. with the appropriate boxes, after placing the blocks in their required initial positions. The initial positions are obtained simply by reversing the colored ends of the box. The box is placed before the subject with cubes arranged as on the design card, which is presented to the subject with its number facing up.

(iv) The test stops when the subject fails twice in succession.

(v) The time limit of designs 1 to 4 is 2 minutes each, and for designs 5 to 8 is 3 minutes each.

C. Pattern Drawing Test (Test No.3):

1. This consists of eight figures of increasing difficulty from the 1st to the 8th.

2. A card is placed before the subject, displayed so that the number of the card appears on top before the subject. The subject has to draw the figure as shown on the card; without repeating any lines and without lifting the pencil off the paper once he has started. The card remains in full view of the subject throughout.

3. The subject attempts to draw the designs on successive cards, and is allowed as many attempts as needed within the time limit.

4. The test stops when the subject fails twice in succession.

5. A maximum of 2 minutes is allowed for each of designs 1 to 4, and 3 minutes for patterns nos. 5 to 8.

D. Immediate memory for sounds (Test No.4):

(i) Direct

Immediate memory is closely related to mental development or general intelligence.

1. The subject has to repeat a sequence of letters as told. The sequence should be read out distinctly and with even intonation.

2. To give the subject practice, the test starts with two letters. The experimenter then proceeds increasing the number of letters one at a time until failure is recorded. At each level three alternative sets of letters are given. If the subject fails on the first set, the second and then the third alternatives can be given, if the subject fails all three the test stops.

(ii) Reversed

Here the subject has to pronounce the letters in reverse order. The experimenter continues the sequence until failure is recorded, meaning failure in all three alternatives of a particular set, as previously.

E. Picture Construction Test (Test No.5)

The pieces of a picture puzzle are placed in front of the subject. All the pieces have to be put together to make a picture. The test consists of five different pictures, for the subject to construct. The test stops when the subject fails twice in succession. The time limit is two minutes each for pictures one to three and three minutes each for pictures four and five.

5.5.2 Spatial and Verbal Memory Tests

Standard tests developed based on the published material of Baddeley (1993) were used to assess spatial and verbal memories. Subjects were told that the memory tests were for their self-assessment, to understand the benefit they had derived from the

course. Subsequently, they were given a report, to make them enthusiastic and interested. No further details were given about the study.

For both verbal and spatial tests, a correct response is scored as 1 and an incorrect one as 0. On a practice trial, many subjects scored maximum (leaving no scope for further improvement) when a free recall test was used, so for the actual assessment a delayed recall test was used, as this is known to be more difficult (Baddeley, 1990). However there was no special interest in assessing the effect of interference on recall.

Subjects were assessed 20 at a time, seated approximately a meter apart to avoid distraction and interference. The test material, in the form of slides, was projected on a screen, allowing 10 sec. for each slide. After 10 slides had been shown, a mathematical problem (e.g., 7-4+9-3+6-5-8+2) was shown on the screen, and subjects were asked to solve it. Immediately after this, subjects were asked to recall and write down (or in the case of spatial memory, to draw) within 60 sec. the 10 test-items which had been showed to them. To test verbal memory, standard nonsense syllables of three letters, like XOL and CEM were selected from a prepared list. The test for spatial memory consisted of ten simple line drawings. The drawings were very simple and easy to reproduce.

5.5.3 Six Letter Cancellation Test

The Six Letter Cancellation Test consists of a worksheet, specifying six target letters to be cancelled. It has a 'working section' consisting of letters of the alphabet randomly arranged in 22 rows of 14 columns. Subjects are asked to cancel as many of the six target letters as possible in the specified time, i.e., 1 min; 30 sec. They are told that there are two possible strategies, (i) doing all six letters at a time, or (ii) selecting one target letter out of the six, and are asked to choose whichever strategy suits them. They are also told that they can follow a horizontal, vertical or random path according

to their choice. Scoring was done by a person, who was unaware of the purpose of the assessment. The total number of cancellations and wrong cancellations were scored; net scores were calculated by deducting wrong cancellations from the total cancellations attempted (Agarwal et al.). Total score is indicative of the motor skill directed by cognitive function. Net score is indicative of degree of attention. Wrong cancellations are indicative of amount of mental distractions.

5.5.4 Tower of London Test

Shallice's Tower of London test was used to assess planning abilities and execution skills (Shallice). The Tower of London test requires the subject to move an array of colored discs mounted on three vertical rods, to match a particular goal arrangement given in a picture. Each subject has to complete four tasks at increasing levels of complexity; the first level requires two moves to reach the goal, the second three moves, the next four, and the fourth level, five moves. Subjects are assessed on planning time, execution time, mean total time and number of moves.

The measure of planning time assesses planning skill. The essence of planning is to see how to attain a goal through a series of intermediate steps. The subject plans in advance the complete sequence of moves required to solve the problem. In order to do so he considers the consequences of various courses of action (Baker). Goal setting involves not only identifying the final goal but also any necessary intermediate goals. Thus assessment of planning time evaluates both these faculties, setting the goal and intermediate steps.

Measuring execution time not only assesses motor skill, but also planning ability. This is because new decisions can occur during execution. Planning ability not only sets goals, but also monitors performance to reach a goal and make corrections to the chosen course, in order to ensure that the goal is attained (Baker). In carrying out a

planned strategy, frontal association areas of the brain cortex are used to execute complex functions such as delayed response motor tasks and changing strategies if and when necessary (Fuster, 1989). Thus, assessing execution time can evaluate the motor skills and planning ability related to frontal association areas. Assessing the number of moves evaluates perfection of planning. If planning has not been perfect, the number of moves increases. This is also a measure of brain function. Imaging studies have found that more efficient planning involving fewer moves is associated with increased activation of the left prefrontal cortex.

All assessments were made before lunch. Time of day of assessments for matched pairs was the same. Test instructions were given in English in both schools.

CHAPTER 6

DATA COLLECTION AND ANALYSIS

Data were obtained for each test, initially and after one academic year (10 months). Data were scored and entered into raw data tables. To check standardization of tests, the pre-data were compared with published normative standard data of similar subjects (Table 6.1).

Table 6.1. Comparative study of the pre-data with published normative standard data of similar subjects

	Scores		ES	PT	NNBM
Memory	Spatial Memory		3.1	6.49	-
-	Verbal Memory		3.8	4.63	7
Sustained attention	Net Scores		41.75	40.49	
	Total Scores		42.23	41.82	30.78
	Wrong Cancellations		0.48	1.39	
Planning ability	Planning Time	2	6.70	3.73	_
		3		6.08	_
		4	9.02	9.22	_
		5	11.39	12.39	_
	Execution Time	2	7.69	4.22	_
		3		6.69	_
		4	19.38	10.24	_
		5	24.39	14.98	_
	Mean Time	2	14.39	7.95	7.05
		3		12.78	13.49
		4	28.4	19.47	20.79
		5	35.78	27.37	28.82
	Mean Moves	2	2.73	2.11	2.31
		3		3.09	3.83
		4	6.49	4.16	6.07
		5	8.42	5.07	8.23

ES (Memory) – Earlier study by Naveen (1997)

ES (Sustained attention) – Earlier study by Sarang Patil

ES (Planning ability) – Earlier study by Kadambini

PT - Present thesis

NNBM- NIMHANS Neuro-psychology battery-2004 Manual.

The difference between the ES and PT results on memory is because in PT, ovals and circles were not included, making it easier to obtain high scores on the test. Similar differences are present in auditory verbal learning tests: in the NNBM test, 15 syllables had to be recalled, but in our PT test only ten syllables were used. NNBM assessed sustained attention using the Digit Vigilance test, consisting of randomly ordered sets of the numbers 1 to 9 set out in 50 closely packed rows of 30 digits on the test sheet. A sustained level of mental effort and attention are required over the time of the test. The subject has to focus on the target digits ie. 6 & 9 amongst other distracter digits. Inability to sustain focused attention increases both errors and time to complete the test.

On all tests, Kolmogorov-Smirnov Test of Normality found the pre-data not to be normally distributed. Hence the statistical analysis used non-parametric tests throughout. Within groups, the pre-post data were analyzed using the Wilcoxon Signed Ranks Test, while between groups pre-data and post-data were analyzed using the Mann-Whitney U Test. Statistical analysis was carried out using SPSS 10.0.

CHAPTER 7

RESULTS

7.1 INTELLIGENCE

Test results are summarized in Table 7.1. An Independent Sample's 't' Test found no significant difference between the pre-test data for the two groups at the start of the academic year, the two groups were equivalent. This means that it was legitimate to directly compare their performances subsequently.

The Wilcoxon Signed Ranks Test comparing the pre-post values within the groups showed that improvements in both groups were significant at $p < 0.05$. Whereas the initial data found the two groups to be fairly equal, the post-tests found the GES group to perform better on all 5 tests, for which the sign test yields a significance of $p < 0.03$.

The Mann-Whitney U Test used to compare results between the two groups showed a significance of $p < 0.05$ for 4 out of the 5 tests. The exception was the Pattern Drawing test, for which the two improvements were approximately equal. In all the other tests the ratio of improvements was 1.6 or more in favor of the GES group. This means that overall improvements in the GES group performance were significantly better than those of the MES group.

Table 7.1

Effect of GES on C.M. Bhatia's Battery of performance tests of intelligence as compared to that of MES

n= 29	GES			MES			Between groups significance p†
No of tests	Pre (mean ± SD)	Post(mean ± SD)	% Change	Pre (mean ± SD)	Post(mean± SD)	% Change	
1.	11.38±2.41	14.55±2.29*	27.85	11.14±2.47	13.10±2.11*	15.65	0.015
2.	11.21±1.26	14.38±1.27*	28.27	11.24±1.48	13.00±1.34*	15.65	0.001
3.	5.62±1.12	6.21±1.1.05*	10.49	5.28±0.88	5.90±1.05*	11.74	0.284
4.	10.69±1.58	15.79±2.16*	47.70	10.34±1.59	12.69±1.58*	22.78	0.001
5.	7.66±0.86	10.03±1.24	30.94	7.69±0.97	8.97±0.98	16.64	0.001
6.	46.56±7.23	60.96±8.01	30.92	45.69±7.39	53.66±7.06	17.44	0.001

1- Koh's block design test, 2- Pass along test, 3- Pattern Drawing test, 4- Memory test, 5- Picture **c**onstruction test, 6- Total of 5 sub-tests. *Wilcocxon test p<.001. † Mann-Whitney U test.

[GES=Gurukula system of education, MES= Modern education system, GES group (28 to 48%) was significantly better than that of the MES group (17 to 23%).]

Fig: 7.1

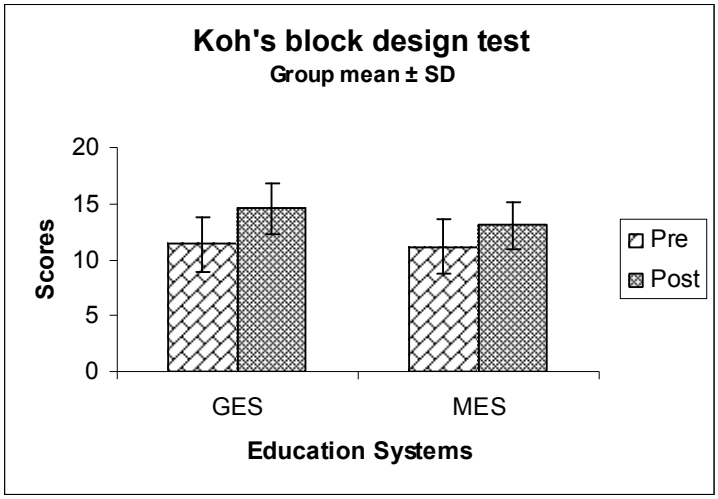

Koh's block design test
Group mean ± SD
Scores
20
15
10
5
0
GES
MES
Education Systems
Pre
Post

Fig: 7.2

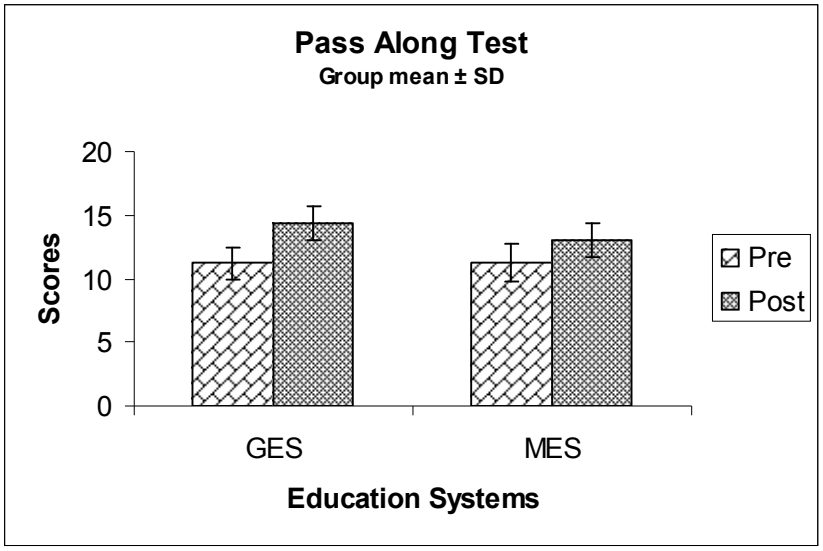

Pass Along Test
Group mean ± SD
Scores
20
15
10
5
0
GES
MES
Education Systems
Pre
Post

Fig: 7.3

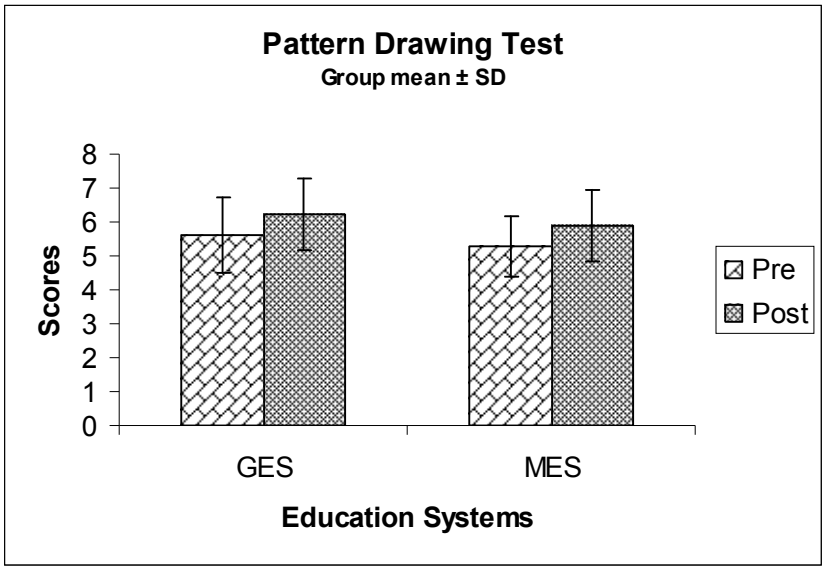

Pattern Drawing Test
Group mean ± SD
Scores
8
7
6
5
4
3
2
1
0
GES
MES
Education Systems
Pre
Post

Fig: 7.4

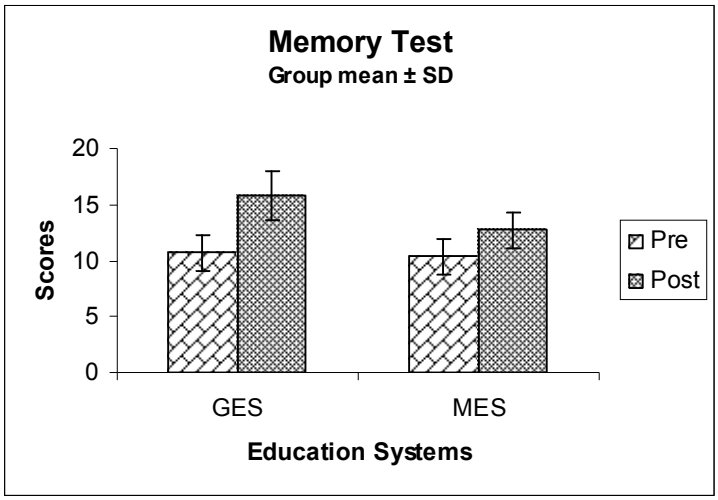

Memory Test
Group mean ± SD
Scores
20
15
10
5
0
GES
MES
Education Systems
Pre
Post

Fig: 7.5

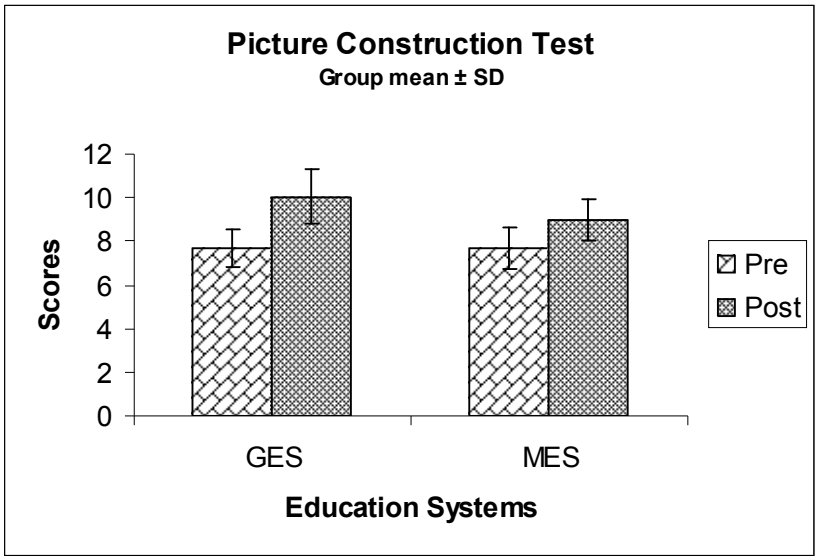
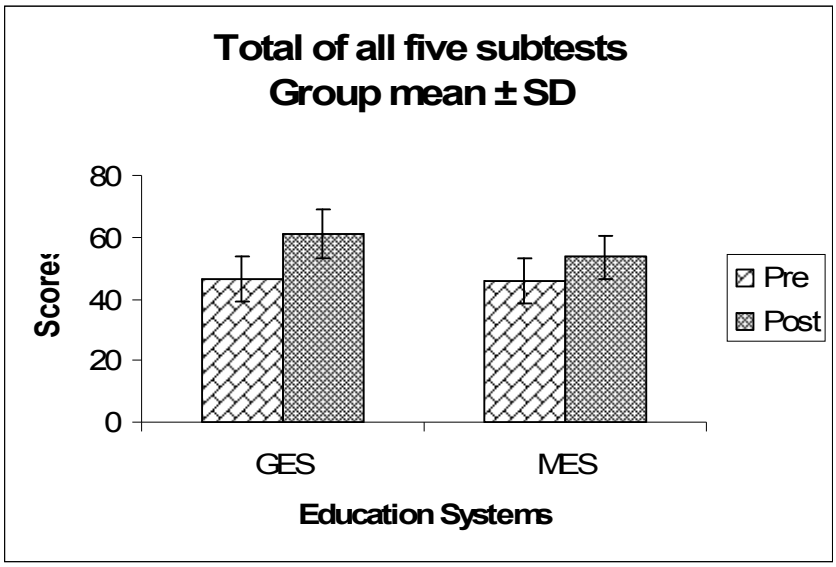

Picture Construction Test
Group mean ± SD
Scores
12
10
8
6
4
2
0
GES
MES
Education Systems
Pre
Post

Fig: 7.6


Total of all five subtests
Group mean ± SD
Scores
80
60
40
20
0
GES
MES
Education Systems
Pre
Post

7.2 MEMORY

Both groups of students performed similarly on the pre-test at the start of the academic year (pre-data). An Independent Sample's 't' Test found no significant difference between the GES and MES groups. The Wilcoxon Signed Ranks Test comparing the pre-post values within the groups showed that improvements in both groups were significant at $p < 0.05$. The GES boys showed significantly greater improvements than MES boys in both Spatial and Verbal memory scores ($p < 0.001$, Mann-Whitney U test) as can be seen in Table 7.2.

Table 7.2

Effect of GES on Spatial and Verbal memory test as compared to that of MES

Total N=49	GES			MES			Between Groups Significance p†
	Pre (mean ± SD)	Post (mean ±SD)	% Change	Pre (mean ± SD)	Post (mean ±SD)	% Change	
Spatial memory	6.29 ± 1.04	8.24 ± 0.63*	31.002	5.96 ± 1.0	7.16 ± 0.92*	20.134	0.001
Verbal memory	4.63 ± 0.83	7.27 ± 0.73*	57.019	4.67 ± 0.90	6.02±0.95*	28.907	0.001

*p<0.05, Wilcoxon signed ranks test, comparing Pre and Post values within groups, † Mann Whitney U test, between groups comparison

[GES=Gurukula system of education, MES= Modern education system, GES group (32 to 57%) was significantly better than that of the MES group (20 to 29%).]

Fig. 7.7

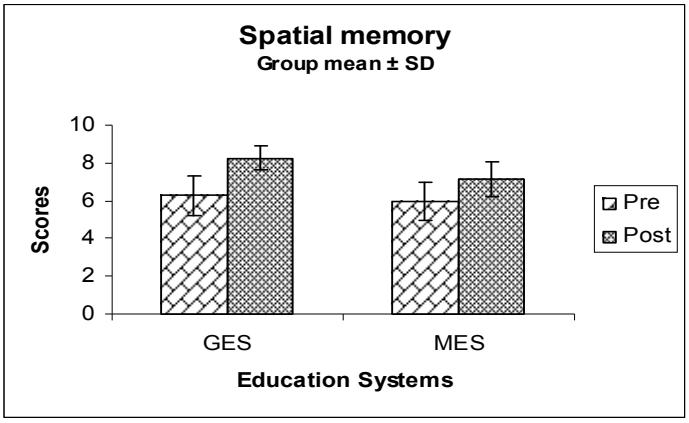
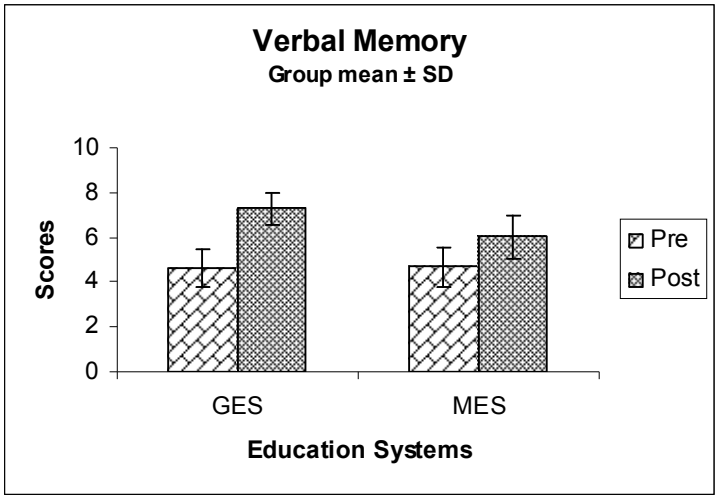

Spatial memory
Group mean ± SD
Scores
10
8
6
4
2
0
GES
MES
Education Systems
Pre
Post

Fig. 7.8


Verbal Memory
Group mean ± SD
Scores
10
8
6
4
2
0
GES
MES
Education Systems
Pre
Post

7.3 SUSTAINED ATTENTION

Both groups of students performed similarly on the pre-test at the start of the academic year (pre-data). An Independent Sample's 't' Test found no significant difference between the GES and MES groups. The Wilcoxon Signed Ranks Test comparing the pre-post values within the groups showed that improvements in both groups were significant at $p < 0.05$. The Mann-Whitney U Test used to compare results between the two groups showed a significant difference. The group average values ± SD for Total Scores, Net Scores and scores for wrong cancellations of both GES and MES groups are given in Table 7.3. This result may be due to the meditation practices in the GES curriculum such as the internal chanting of Gayatri Mantra.

Table 7.3

Effect of GES on Six letter Cancellation test as compared to that of MES

N = 49	GES			MES			Between Groups Significance p†
	Pre (mean ± SD)	Post (mean ± SD)	% Changes	Pre (mean ± SD)	Post(mean ± SD)	% Changes	
Total Scores	41.82±3.18	46.33±3.68*	10.78	40.67±2.45	43.08±2.38*	5.93	0.001
Net scores	40.49±3.09	45.39±3.76*	12.10	39.37±2.59	41.73±2.49*	5.99	0.001
Scores wrongly cancelled	1.39±0.64	0.84±0.72*	39.56	1.41±0.73	1.35±0.75	4.26	0.001
*p<0.05, Wilcoxon signed ranks test, comparing Pre and Post values within groups, † Mann Whitney U test, comparing between groups							

[GES=Gurukula system of education, MES= Modern education system, GES group (11 to 40%) was significantly better than that of the MES group (4 to 6%).]

Fig 7.9

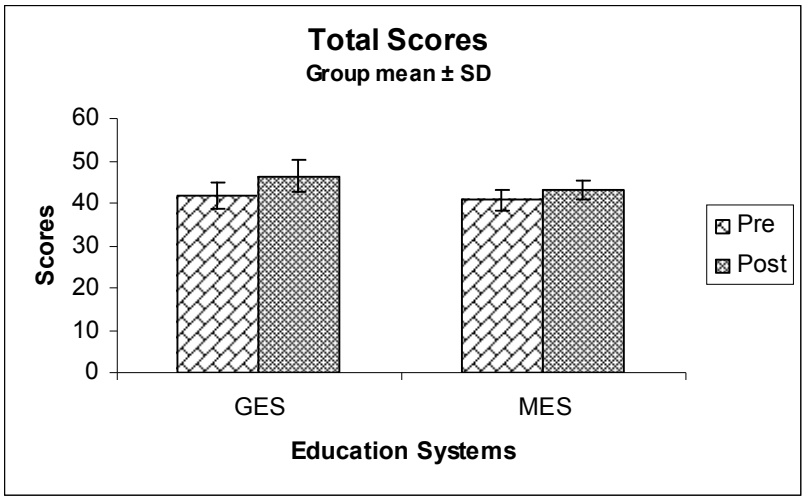


Fig 7.10

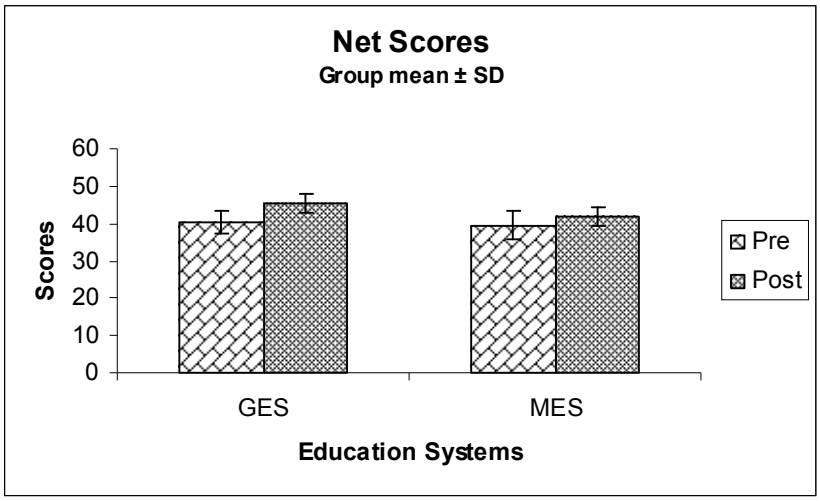
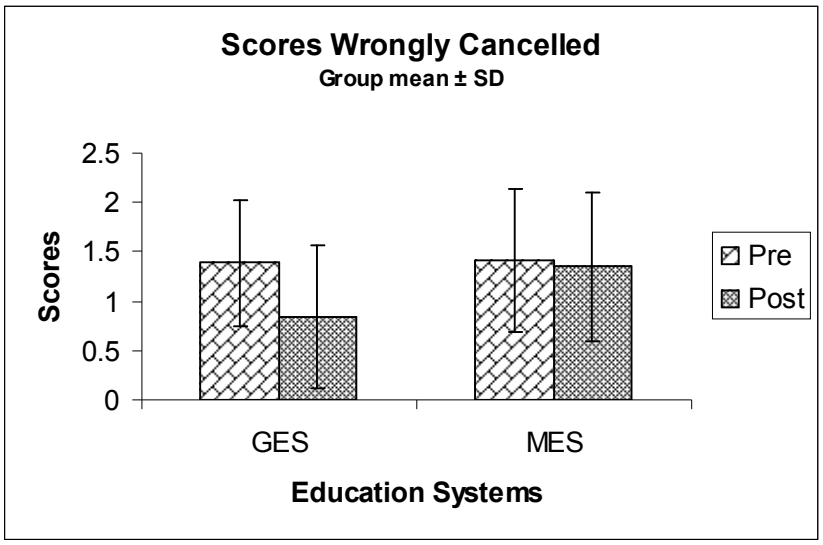


Fig 7.11


Scores Wrongly Cancelled
Group mean ± SD
Scores
2.5
2
1.5
1
0.5
0
GES
MES
Education Systems
Pre
Post

7.4 PLANNING ABILITY

Test results are summarized in Table 7.4. Both groups of students performed similarly on the pre-test at the start of the academic year (pre-data). An Independent Sample's 't' Test found no significant difference between the two groups. This means that it was legitimate to compare their performances subsequently. The Wilcoxon Signed Ranks test comparing the pre-post values within the groups showed that improvements in both groups were significant at $p < 0.05$.

The Mann-Whitney U Test used to compare results between the two groups showed that the difference was significant on three of the four subscales: planning, execution and mean time, but only on one of the number of moves subscales. In all cases only smaller numbers of moves reached significance. Between groups results showed that the greater improvement in GES compared to the MES group was significant in trial four of the planning time, trials two, three and four of execution time, and in trial two in the number of moves ($p < 0.005$, Mann-Whitney U test).

Table 7.4

Result of Tower of London test contrasting GES with MES schools

N = 49		GES			MES			Between Groups Significance p†
	Trials	Pre (Mean ± SD)	Post (Mean ± SD)	% Changes	Pre (Mean ± SD)	Post (Mean ± SD)	% Changes	
Planning time	2	4.35±0.63	3.73±0.57*	14.253	4.31±0.55	3.94±0.52*	8.584	0.061
	3	6.45±0.84	6.08±0.40*	5.736	6.57±0.50	6.18±0.53*	5.936	0.250
	4	9.59±0.57	9.22±0.55*	3.858	9.80±0.58	9.47±0.62*	3.367	0.034
	5	12.73±0.070	12.39±0.64*	2.670	12.78±0.77	12.53±0.71*	1.956	0.196
Execution Time	2	4.90±0.47	4.22±0.42*	13.877	4.92±0.45	4.43±0.58*	9.959	0.030
	3	7.43±0.61	6.69±0.58*	9.959	7.22±0.59	6.90±0.42*	4.432	0.036
	4	11.08±0.86	10.24±0.69*	7.581	11.04±0.82	10.51±0.65*	4.800	0.025
	5	15.51±1.49	14.98±0.80*	3.417	15.63±0.88	15.10±1.14*	3.390	0.125
Mean Total time	2	9.24±0.85	7.95±0.76	13.961	9.22±0.71	8.37± 0.83*	9.219	0.011
	3	13.88±0.78	12.78±0.79*	7.925	13.80±0.69	13.08±0.73*	5.217	0.040
	4	20.67±1.16	19.47±0.96*	5.806	20.84±1.12	19.98±0.90*	4.126	0.004
	5	28.24±1.35	27.37±1.24*	3.080	28.41±1.29	27.63±1.47*	2.745	0.103
Mean moves	2	2.39 ± 0.36	2.11 ± 0.26*	11.715	2.28±0.31	2.22 ± 0.31	2.631	0.050
	3	3.35 ± 0.40	3.09 ± 0.35*	7.761	3.31±0.37	3.12±0.21*	5.740	0.084
	4	4.26 ± 0.41	4.16 ± 0.30	2.347	4.37±0.46	4.20±0.37*	3.890	0.661
	5	5.32 ± 03.7	5.07±0.14 *	4.699	5.25±0.32	5.06±0.30*	3.619	0.880

*p<0.05, Wilcoxon signed ranks test, comparing Pre and Post values within groups, † Mann Whitney U test, comparing the two groups

[GES=Gurukula system of education, MES= Modern education system, GES group (2.7 to 14%) was significantly better than that of the MES group (2.6 to 10%).]

Planning efficiency level

.	GES	MES
Planning time p<0.05 for 4 moves	3 to 14	2 to 9
Execution time p<0.05 for 2, 3 and 4 moves	3 to 14	3 to 9
Mean moves p< 0.05 for 2 moves	5 to 12	4 to 6

Fig 7.12

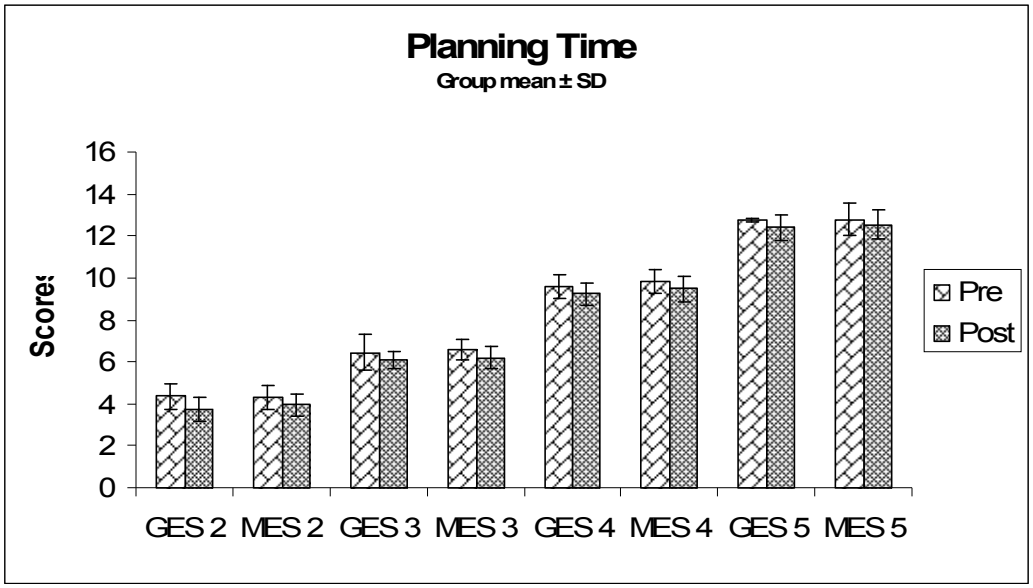


Fig 7.13

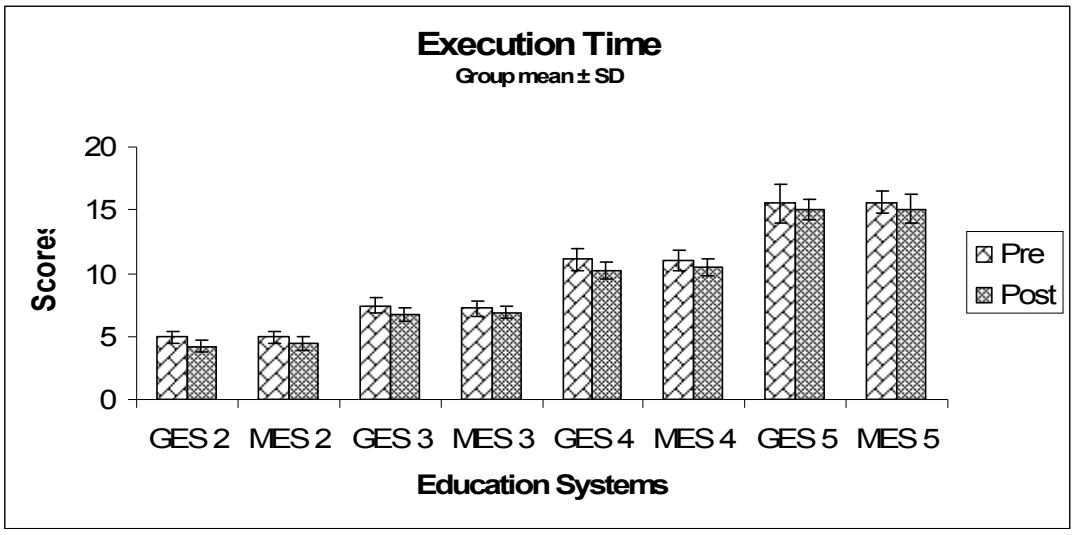


Fig 7.14

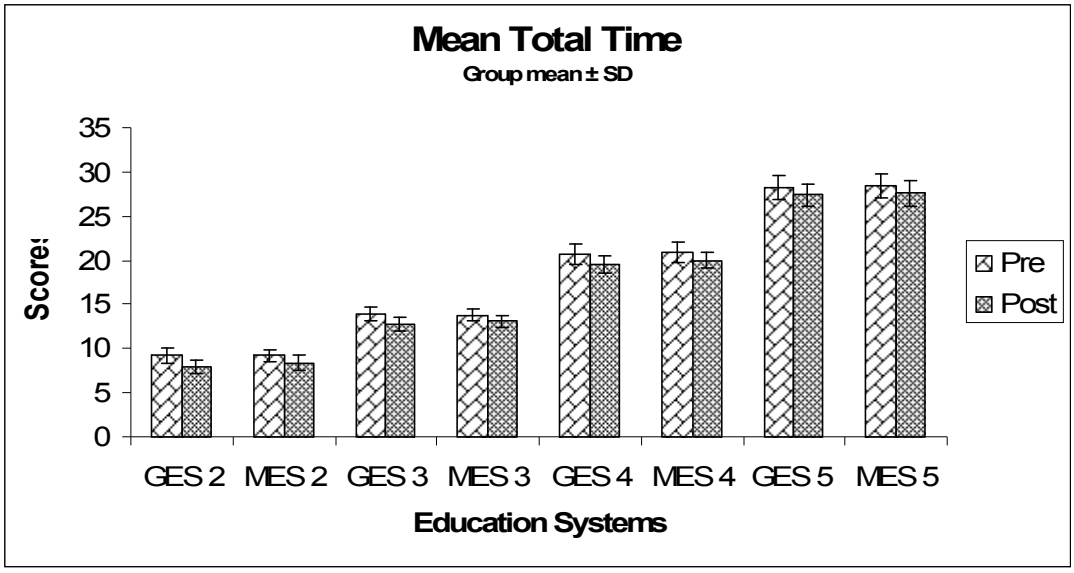
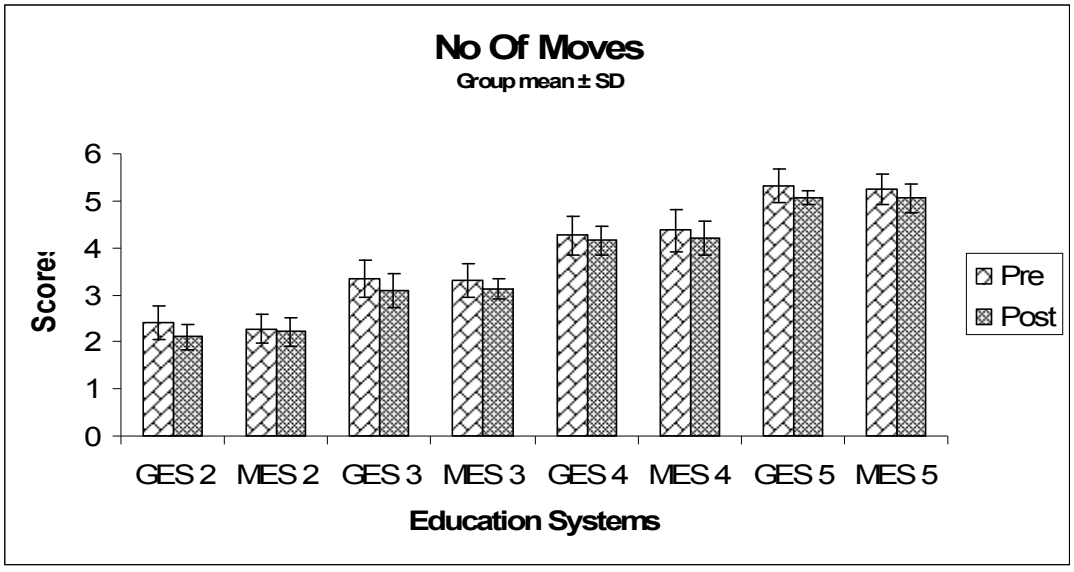


Fig 7.15



CHAPTER 8

DISCUSSIONS

8.1 AN OVERVIEW

The present study showed that after an academic year of Yogic way of life and learning in the GES, the GES group showed a significant improvement in cognitive function like memory, sustained attention and planning ability than the MES group.

Four variables assessed were IQ, memory, sustained attention and planning ability by Bhatia's Performance Tests of Intelligence, Spatial and Verbal memory tests, Six Letter Cancellation Test and Tower of London test.

An Independent Sample's 't' Test found no significant difference between the pre-test data for the two groups at the start of the academic year indicating that the two groups were equivalent at the start.

The Wilcoxon Signed Ranks Test comparing the pre-post values within the groups showed significant improvements in both groups at $p < 0.05$. The Mann-Whitney U Test showed that the GES group performance were significantly better than those of the MES group ($p < 0.05$).

8.2 INTELLIGENCE

In Koh's block design test, the pass along test and the pattern drawing test, receptivity and right decisions are essential. The GES group performed all three effectively. Receptivity is the concern of the dentric zone (Telles, 2006) and decision making of the frontal cortex (Telles, 2006). The present study suggests growth in function of the dentric zone and frontal cortex in the GES group. Secondly, the GES group performed effectively on the immediate memory test, which includes memory. This suggests growth in temporal cortex function in the GES group as temporal cortex is more related to memory than other brain regions (Telles, 2006). Thirdly, the GES group performed effectively on the Picture Construction test. The role of the parietal cortex is to put information together, which is vital to picture construction (Telles, 2006), so the data suggests growth of parietal cortex function.

The present study showed that after a year of GES group showed a significant increase in IQ scores, and while the MES group also improved they did so to a smaller extent. In early teenage years, performance on IQ type tests improves steadily. The data indicate that the GES curriculum enhanced IQ growth. Mental function required in the first four subtests is more analytical, while the fifth subtest requires more synthetic thinking. Thus, C.M. Bhatia's Battery of Performance Tests of Intelligence include components requiring both left and right hemisphere functions. Data suggest that growth of both are been enhanced in the GES group.

These results beg the question as to why the practices in the GES school should have produced the differences observed. The GES yoga-based lifestyle includes most key features of Yoga: Āsanas, physical postures, which produce relaxation at a bodily level; Prāṇāyāma, voluntary regulation of breathing, which is designed to calm down the breath; Dhyāna, generally understood in this context as an internal Japa or

repetition of a Mantra, which calms the mind; Yogic prayers and Pūjā, or worship, which culture and balance the emotions; Yogic games, a set of games, which not only stimulates the mind, but also relaxes and expands it to states of greater freedom. The overall purpose of incorporating these Yogic features into life is for the student to learn to perform all actions against a backdrop of stress-free states of mind. The intention is that such stress-free patterns of functioning should carry over into other activities such as academic tests, examinations and professional life in later years. These activities and purposes are characteristically different from the non-yogic MES school. On this basis different results may be expected.

8.3. MEMORY

Matching base-line memory score data (Table 3) shows that the boys in the two groups selected for study were well matched and homogeneous. Differences over the year are first considered, then possible reasons why the observed differences might have occurred.

1. The observed increase in memory scores in both GES and MES groups might be expected. They should occur in any good education system. However, the GES group showed significantly higher memory enhancement than the MES group: the null hypothesis that boys from both groups would score equally is rejected.

2. Both groups showed greater memory enhancement over the year-long study, than that produced by a 10-day yoga intervention in a residential set up (Rao, Subbakrishna & Gopukumar). In that study, nine days practice of left nostril breathing 4 times a day for 15 minutes, Āsana and special quiz & group discussions, yogic games and chanting once in a day for 45 minutes produced 10.02 % improvement in memory. The year-long education intervention produced 31.002 % improvement in the GES group, and 20.134 % in the MES group. This shows that sustaining such a Yoga intervention at the GES maintains growth of memory capacity.

The pre-post changes in both groups after an academic year showed significant increases in memory scores. However, the GES group showed a greater increase in memory scores than the MES group. Several factors could have contributed to the increase in memory scores of the GES. Boys from GES have scored better than MES in verbal memory also.

Studies conducted by Naveen (1997) and Shatrughan (2005) suggest that right hemisphere spatial memory grows through the practice of Āsanas and Prāṇāyāma.

However, Naveen's study (1997) excluded ovals and circles from the picture memory test, to make it more challenging; the present study included them. The Kory study (1977) indicates that internal use of a mantra in TM improves left hemisphere, verbal memory. GES includes internal mental Mantra-chanting in meditation, Prāṇāyāma and Āsanas. Memory growth is stimulated in both the hemispheres in GES students. In present day GES, Mantra recitation is practiced more than Prāṇāyāma and Āsanas, so growth of the verbal memory in GES students may be expected to be greater than growth of spatial memory.

4. Base line data show scores on spatial memory increasing with age. Retest scores showed that improvements also increased with age: GES boys scored significantly better than MES boys on both verbal and spatial memory at all age levels, except for the 11 year olds on spatial memory, where the difference between the two did not reach significance.

5. Greater improvements with age were also found on verbal memory. Differences between the GES and MES groups reached significance in all of them. Verbal memory increased more in the 12 and 13 year olds than in the 11 year olds. In contrast, spatial memory differences were greater for the 11 year olds than the 12 and 13 year olds. However, since there were only 6 in each 11 year group, this may not be robust.

Possible reasons for the observed differences

1. Overall reasons why GES boys could have scored better:

   a. Reduction in anxiety by specific anxiety reducing Yoga practices and counseling

Anxiety mars memory development (Saltz). The GES provides an atmosphere in which students are less anxious. Both schools were chosen to have good atmospheric ambience in natural surroundings. These should produce equal effects on memory. The GES includes Yoga practices with anxiety reducing effects that are already well known (Epply et al.). Moreover, teachers' personal care of students by practices like counseling are included to a greater extent in GES than MES. GES teachers are Vedic scholars qualified to impart various Vedic and Yogic anxiety reducing techniques such as counseling according to students' mental make up. Learning Vedic Mantras has the effect of training consciousness and regulating and balancing the brain physiology (Travis et al.). This may be one reason for the growth of memory among GES students as memory improves with balance of mind.

b. Specific techniques used in GES schools for enhancement of memory

In GES, students are taught several techniques to memorize Mantras. For beginners these consist of Sande and Tiruve. In Sande, teachers train students to memorize Mantras by repeating them two or three times. In Tiruve students chant the Mantras themselves in the way they have been trained: initially, ten repetitions per day for ten days, then one repetition per day for 2 or 3 months, a practice known as Āvṛtti. Finally, they chant each memorized Mantra at least once per month. Āvṛtti compares well with MMOST (Tony Buzan's Mind Map Organic Study Technique) (Bijlani).

Other techniques of a more advanced kind, featuring redundancy, are also used to preserve Vedic Mantras. These include Pada, Krama, Jata and Ghana. It is traditionally thought that when used regularly, these techniques strongly develop students' verbal memory. Vedic pundits have preserved the Vedic Mantras throughout history using these techniques alone, accurately maintaining each word's

pronunciation, and intonation. All these assist in developing students' verbal memory.

c. Holistic personality development as the main aim of GES

Holistic personality development is achieved through repetitive recitation of Vedic Mantras, which GES students do in a group every day. Vedic mantras are highly rhythmic, and fill the body uniformly with their resonance. Any rhythmic resonance of this kind has the power to make the mind relaxed and peaceful (Nagendra, 2005), improving memory and eliminating psychological blockages. Use of Bhajan and Pūjā in its science of emotion culture helps GES students develop peace and relaxation, which may also be expected to improve students' memory (Saltz).

2. Possible reasons why GES boys scored better on short term enhancement of memory

a. Psychological growth is continuously monitored in GES.

b. Yoga techniques are made more attractive by regularly introducing new, subtler techniques to avoid monotony and boredom.

c. An atmosphere supporting continuous improvement is provided by group effects and team efforts.

3. Possible reasons why GES students performed better on verbal memory than spatial memory compared to MES students.

Blakeslee stated that the left hemisphere is more involved with verbal memory, while the right hemisphere is more concerned with recall of non-verbal, spatial information. Elements of Jñānayoga can assist in improving left hemisphere function, and its associated verbal memory. More of these are contained in the GES curriculum than in MES: e.g. three major aspects of Jñānayoga – Śravaṇa (hearing lectures from the teacher and interacting with him), Manana (contemplation and understanding through

question, enquiry and analysis) and Nididhyāsana (various techniques like meditation which promote observation of the student's internal and external nature). Shravana involves learning Vedic Mantras by repeatedly hearing them from the teacher (in GES the students are not generally allowed to learn the Mantras from a book, normally they learn by listening to their teachers). Manana means repeating Mantras to be memorized every day by oneself. Nididhyāsana means meditating on the Mantras. All these practices present in GES tend to increase the power of verbal memory, particularly Śravaṇa.

GES teachers are particular about asking questions, which develop thinking ability, the Manana aspect, in students. In GES, individual instruction of each student by their teachers develops analytical abilities to a greater extent than in MES. This is an associated left hemisphere function. Innovative techniques used in GES increase students' inquisitiveness e.g. observation of the growth of plants right from the day the seed is sown – experimentation or Nididhyāsana.

4. Possible reasons why GES boys improved more than MES on spatial memory scores

a. Yoga Techniques are tailored to different age groups to bring about total personality growth.

To enhance right hemisphere function, various creative arts can be taught. In both GES and MES such arts are taught, like music and dance. Yet the GES group showed a more significant result. This may be because the creative arts taught in GES have the capacity to calm the mind better. For example, in GES in South India, traditional Karnatic music is taught, which has the capacity to make the mind peaceful. In contrast, in MES schools popular music is mainly taught. Becoming calmer and more

peaceful makes a person more artistic and creative. Through creative and artistic practices right hemisphere use becomes nourished. Though MES students are exposed to various arts in the external world, such as TV and other media, they did not perform the spatial memory test as well as the GES students. This may be because TV etc. generally tend to agitate the mind. On the other hand, the GES students, though less exposed to multimedia creative arts, are trained in tranquility, which integrates right hemisphere function.

Naveen (1997) found improved spatial memory following Prāṇāyāma performance. The GES students' more significant result on the spatial memory test may well have been due to their regular Prāṇāyāma practice.

b. Use of Saṁskṛta as the principal medium of instruction

The physiological and psychological effects of reading Saṁskṛta are similar to some of those experienced during Transcendental Meditation (Travis et al.). Students of GES learn the language of Saṁskṛta and use it as their medium of instruction. This might also have helped them achieve increased balance of mind and improved memory, especially as higher standards of language use were involved, including writing and analysis skills.

8.4 SUSTAINED ATTENTION

Cancellation tasks require visual selectivity and a repetitive motor response (Lezak). They not only require sustained attention, but also visual scanning and activation and inhibition of rapid responses. The present study found a significant increase in sustained attention scores after the academic year for the GES group ($p < 0.05$), but the increase for the MES group did not reach significance.

The significant increase in Net Score on the test for the GES group suggests that the GES curriculum improves functioning of the right fronto-parietal network mediating sustained attention (Rueckert & Graffman). As discussed above, this is probably due to the meditation practices in the curriculum such as the internal chanting of Gayatri Mantra. Similarly, the significant increase in Total Score by the GES group suggests improvement in the frontal association areas, where the cognitive function guiding motor skills are located (Fuster). Decrease in wrong cancellations suggests that GES improves functions in the orbitofrontal area of the prefrontal cortex, which is hypothesized to mediate distraction avoidance (Rao, Subbakrishna and Gopukumar). Once again, meditation practices in the curriculum may have produced this result: Transcendental Meditation produces strong increases in field independence (Orme-Johnson and Granieri), which is equivalent to distraction avoidance. Further research should be carried out to test this hypothesis.

Several other components in the GES curriculum could have contributed to the increase in the GES group's sustained attention scores. Any kind of rhythmic resonance has the power to make the mind more relaxed and peaceful (Nagendra, 2005) and so improve attention span. Vedic mantras are highly rhythmic, and uniformly filled with resonance. Their daily chanting by the GES group may have been responsible for the observed increase in the group's sustained attention scores.

Various papers have been published regarding growth of sustained attention through regular practice of meditation (Sarang). The GES group was engaged in daily practice of the Gāyatrī Mantra meditation throughout the year. By analogy with Transcendental Meditaiton, this may also have contributed to the group's observed increase in sustained attention (Kory).

In addition to Gāyatrī meditation and Vedic chanting, the GES group participated in Yogic practices such as Āsanas, Prāṇāyāma, and Pūjā, which have the power to calm the mind, and bring the attention from past or future to the present moment. This should also have contributed to the observed growth of attention span.

Reduced anxiety may also improve performance on tasks requiring sustained attention (Saltz); hence Yoga's known anxiety reducing effects (Wallace, Benson and Wilson) could also have facilitated it.

8.5 PLANNING ABILITY

The most prominent result is that both systems of education improve planning and execution abilities. How much of this improvement is attributable to natural increase in IQ in early teenagers is not clear. In most of the Tower of London test subscales, both level of performance and percentage improvement were greater for the GES group compared to the MES group: 15 out of 16 subscales for level of performance, and 14 out of 16 subscales for percentage improvement. However, the four mean total time subscales are not statistically independent. Applying the non-parametric sign test to the data for the remaining twelve subscales yields a significance of $p < 0.003$ for better performance, and $p < 0.016$ for greater improvement, for GES students compared to MES students. At the end of the year, the GES students had definitely improved more and performed better on the test than their MES counterparts.

In Planning Time, the only significant comparative result was for the 4 move trial. In contrast, for Execution Time, significant results were achieved for the 2, 3, and 4 move trials: while both groups took much the same time to plan, the GES group executed each task more quickly. Overall, the two most significant differences were $p < 0.004$ for trial 4 of mean total time, and $p < 0.011$ for trial 2 of the same subscale. The results of the GES group's yoga practice, translated into increased accuracy of planning, improved speed of action, and to some extent more precise task execution.

Although results reached significance in these cases, no significance was found between the groups for the number of moves assessment, but the $n = 2$ result was borderline significant, and three out of the four showed higher values for GES compared to MES.

Similarly the five moves task showed no significant differences between the two groups, though the GES group consistently improved more than the MES group, in itself a result of borderline significance. There may be various reasons for this. In harder problems, more complex planning is required and creates difficulties (Shallice). All the subjects found the five move-task complicated and only a few completed the task in five moves.

The first observation is that the Tower of London test depends on mental speed in both planning and execution. Which of the above practices in GES might develop mental alertness and speed? Planning is a central multi-component process mediated by the prefrontal cortex, and is involved in the execution of non-routine actions. Several of the practices lead practitioners to peace and tranquility of the mind, which might seem contrary to speed, but in general a settled mind has greater clarity of thinking, and can function more quickly. A few GES practices like Kapālabhāti (a breathing exercise), Bhajans (harmonious songs of expansion and surrender) and Yogic games have the element of speed and stimulation; their objective is also mental calmness and peace. This is because, although they start with speed-related stimulation, they end in a state of relaxation and silence. That may be why the comparative results were initially significant, but, as the number of moves increased, they gradually decreased to insignificance at five moves. It would appear that, although the GES group could execute their plans more quickly, when they had to think about complicated tasks, they were reduced to almost the same speed as the MES group.

This suggests that the GES group were better able to visualize their plan, and hold it in mind. Interestingly, such an improved ability to hold an idea in mind is a well known result of the practice of Transcendental Meditation (TM). TM has been shown

in several studies to strongly improve the property of field independence where a particular property or pattern has to be identified against a confusing background (Orme-Johnson and Granieri).

With regard to Execution Time, increased alertness may also be expected to improve performance. In particular, in trials with 2, 3 and 4 moves, the GES group perceived wrong moves quickly and were able to make the correct move without much delay. In addition, the task cannot be achieved efficiently without growth of the Supervisory Attentional System (S.A.S.), which contains the general programming or planning systems that operate on schemas in every domain. It is already known that Yoga related mental techniques improve S.A.S. functioning (Lazar, Bush, Gollub, Fricchione, Khalsa and Benson). The data suggest that the S.A.S. is developed better by the GES curriculum.

Earlier studies using the Tower of London test by Manjunath et al. and Kadambini et al. compared yoga practices (Āsana and Prāṇāyāma) with physical exercises. Both were randomised control trial studies, and found higher levels of planning ability in the yoga group. The present study is consistent with these findings.

It is pertinent to compare these results with those found for various kinds of meditation. Several studies have shown that the practice of the Transcendental Meditation technique produces a state of restful alertness, which enhances cognitive and functional abilities (Kember). Positron emission tomography (PET) study of regional cerebral metabolic responses showed that ratios of frontal versus occipital responses were significantly higher during yoga relaxation in eight practitioners (Herzog et al.). An fMRI imaging study showed that the dorso-lateral pre-frontal cortex is among the brain regions activated during meditation (Lazar et al.). The different techniques produce different effects. They may well activate different

regions of the brain. What is found in a study on one technique has no guarantee of carrying over to another technique. Some caveat to this effect is needed. Therefore the comments given above are suggestive, but not compelling. Further research is required to establish what is really going on.

Previously, the question of which brain regions are involved in performing the Tower of London test was discussed. These are confirmed by the following studies. The Tower of London test is now used to study planning ability in normal persons (Morris et al.). Shallice originally developed it to investigate planning abilities in patients with frontal lobe damage; this correlated with poor test performance (Shallice). His lesion studies showed that left frontal lesions are associated with planning deficiencies (Shallice). Other studies found that inappropriate organization associated with poor planning is increased by bilateral prefrontal lesions (Owen et al.). The dorso-lateral prefrontal cortex is associated with components of generating, selecting and remembering mental moves (Rowe et al.). All these frontal and pre-frontal areas may be involved in performance of the Tower of London Test.

Single photon emission computerized tomography (SPECT) has shown that, in normal persons, the level of regional cerebral blood flow increases in the left prefrontal cortex during Tower of London test performance (Morris et al.). Improvements in Tower of London task performance seen in the present study, following a year of GES suggest that the Yogic system of GES improves left frontal lobe function more than MES. If this is the case, the questions are, which pre-frontal cortex functions does it improve, and which curriculum areas cause the improvement?

According to Morris et al., planning during the Tower of London test activates a wide network consisting of the dorsal prefrontal cortex, pre-motor and parietal cortex and the cerebellum (Morris et al.). The association of the dorso-lateral prefrontal cortex

with generation, selection and memory of mental moves (Rowe et al.), suggests that it may also be involved in improving GES students performance on the test. Similarly, another study has related growth of planning ability and attention to higher fractional anisotropy and lower apparent diffusion coefficient; both these may also be increased in GES students.

CHAPTER 9

APPRAISAL OF THE THESIS

9.1 SUMMARY

The GES is as old as the Vedas themselves (Govindashastry, Taittarīyopaniṣat, 1.1. 1987). Therefore, its minimum date can be fixed to 3000BCE which is the minimum date fixed for the Vedas in recent years (Frawley).

According to the ancient scriptures education is an obligation for any citizen. It was considered a sin and crime if somebody did not send their children for education (Dutta, 2.39). Nobody was meant to be uneducated in the society (Krishnacharya, 1.6.8). There were no separate schools for rich and poor. The students did not pay the fees when they were being educated. They all sought alms and shared them with their Gurus. It was the responsibility of the whole society to spend for the education of the children. They paid their services to their Gurus. They all had uniformity in clothes. The common dress code was a white dhoti with a 'Samit' (a wooden stick) in the hand and also with a Mouñcī (a belt) around their waist and also with a tuft on their head (Dutta, 2.49-55). With all these things equality was maintained among the children in Gurukula education. But after coming out of Gurukula the students used to offer donations to their Gurukula out of their earnings known as Gurudakṣiṇā (Govindashastry). For the duration of their education, Gurukula students would leave their home and go to Gurukula for several years. No day-scholars were permitted in the Gurukula way of education. Students stayed with their Guru, not only learning theories and texts from him, but also learning values and virtues from his example. The education was mainly through hearing, not through writing and reading. This is not because writing and reading were not available, but because they were considered inferior to hearing. This system of education through hearing had the power to

develop cognition, intelligence and strong memory. It was more practical than theoretical. Even the examinations were mostly practical. Theory was only to support the practice. Both secular and sacred principles were taught. Sacred science was taught through the Vedas, while secular study included Āyurveda (Medical science), Dhanurveda (Science of missiles), Gāndharva (Aesthetic arts like music), Nāṭyaśastra (Art of dance), kṛṣiśāstra (Agriculture), Tarka (Logic), Nyāya (Laws of Nature), Vaiśeṣika (Atomic sciences), Śilpaśastra (Engineering), Arthaśāstra (Economics and commerce), Dharmaśāstra (Ethics, law and order), Śikṣā (Phonetics), Vyākaraṇa (Science of grammar), Nirukta (Science of etymology), Jyotiṣa (Astrology and Astronomy) and Sāhitya (Literature).

After the early and later Vedic eras, Buddhism made great contributions to the field of education. The great ancient universities of India like Nālanda and Takṣaśila had strong Buddhist influence. Buddhism's rich contribution was to the fields of philosophy, logic and even Yoga. But due to the influence of Buddhism in the field of education and its emphasis upon the principle of Ahiṁsā, Dhanurveda comprising martial arts and missile sciences got dropped from Indian education (Majumdar). Gradually, due to the influence of Buddhism, people started to lose interest in secular science, as the emphasis of Buddhism was more on renunciation, monastic life and monkhood (Raju).

Macaulay introduced into India the modern education system (MES) which was completely material and secular and lacked the higher spiritual dimension of natural law. Modern education can impose morality and virtue only as rules and instructions without explaining the real science behind them. Therefore, students educated under

MES lack higher dimensions of personality, rather they come under a very strong influence of materialism. They are taught to consider the whole of spirituality as superstition. Their highest goal is to get a good job to earn money.

But due to the hard work of great spiritual masters like Sri Ramakrishna, Swami Vivekananda, Sri Aurobindo and Swami Dayananda of Arya Samaj, people gradually started to recognize the true significance of Indian culture and spirituality. Gradually people are again recognizing the greatness of the Indian sciences like Yoga, Āyurveda, Siddha, Vedic Mathematics and Nyāya. They are slowly acknowledging the significance of Indian philosophies like Sāṅkhya and Vedānta. Nowadays many Indians and even foreigners wish to learn Indian sciences and arts systematically, and wish to live the holistic Indian way of life. They are now supporting the fallen GES which is slowly coming back with the support of those really interested in learning the Vedic way of life and Vedic sciences.

Today two kinds of Gurukulas are being regenerated. – 1. Purely conventional which teaching only the Vedas and other Śāstras and 2. Conventional with few additional modern elements. (Though their main focus is ancient Śāstras like Vedanta, Yoga, Nyāya, Vaiśeṣika and so on along with the Vedas, they also have a few modern sciences like computers and physics. (These include Veda Vijnana Gurukulam of Bangalore, Prabodhini Gurukulam of Shringeri to name but a few).

A few universities in India like SVYASA in Bangalore, and Devasamskriti in Haridwar represent a blend of the ancient spirituality of the east and modern science of the west. These universities are centered on spirituality at the core and include research topics like protocol design, calculations, measurements and analysis as crust.

The thesis' study was conducted to assess the effect of the Yoga way of life and learning practiced in Gurukula system of education as compared to modern education system. Two groups of 49 male subjects matched for age, daily routine and socio-economic background were chosen from pre-selected groups with ages ranging from 11 to 13 years. Four psychological tests were used to assess the subjects – Performance Tests of Intelligence, Tests of Spatial and Verbal Memory, Tower of London Test, and Letter Cancellation Test.

i. Performance Tests of Intelligence- This is mainly to assess intellectual functions like

a. Gathering and correctly using several different pieces of information (a function of the parietal lobe).

b. Memory (a function of the temporal lobe).

c. Making the decision (a function of the dorsolateal zone of the frontal lobe).

d. Having emotional involvement (a function of the cinuglate cortex of the frontal lobe).

ii. Tests of Spatial and Verbal Memory – This assesses verbal and spatial memory abilities (the main concern of the temporal cortex). Spatial memory is more contained in the right hemisphere while verbal memory is more related to the left hemisphere.

iii. Letter Cancellation Test – This is to assess sustained attention (a function of the dentric zone and the prefrontal lobe).

iv. Tower of London – This is to assess planning ability, (mainly the function of the Dorsolateral zone of the frontal lobe).

The present study showed that after one academic year of Yogic way of life and learning in the Gurukula system of education the GES group showed a significantly greater increase in cognitive functions than the control group. Within groups data

(before and after) were analyzed using the Wilcoxon test, while between groups data were analyzed using the Mann Whitney U test, which showed that between groups differences reached significance. After the one year learning period, the improvement of the Gurukula group was significantly better than that of the control group ($P < 0.005$, Mann-Whitney U Test).

9.2 CONCLUSIONS

9.2.1 This study on 49 boys in the age range of 11 to 13 comparing the Yoga-based Gurukula System of Education with Modern Education System has showed significant improvements in planning ability of students over one academic year.

9.2.2 The IQ test as assessed by Bhatia's battery of Performance Tests of Intelligence have shown significantly higher improvements (28 to 48%) in GES compared to MES (11 to 23%) also showing statistical significance between groups.

9.2.3 The spatial and verbal memory scores showed between group significance ($p<.001$) showing 31 to 57% increase in GES compared to 20 to 29% in MES.

9.2.4 The attention span of students as measured by Six Letter Cancellation Test has shown higher improvements in GES (11 to 40%) compared to MES (4 to 6%) with between groups significance ($p<.001$ in the total, net and wrong scores).

9.2.5 The Tower of London Test used to assess the planning ability of students has shown between group significance ($p<0.05$) in all parameters. The planning and execution as also mean total time have shown 3 to 14% improvement in GES in comparison to 2 to 9% in MES. Mean moves show 5 to 12% in GES while 4 to 6% improvement in MES.

A critical review of the work done to assess the strengths and limitations of the study is presented below, together with insights for future research.

9.3 STRENGTH OF THE STUDY

9.3.1 This is the first study of its kind taken up to examine with an open mind the usefulness of traditional Indian Yoga based educational system (called Gurukula system) in comparison to MES.

9.3.2 While RCT is the gold standard design which is not applicable in this type of investigation, matched control trial (MCT) for one academic year is the next acceptable standard design used in this study. The one to one matching of each student for socio-economic status adds to the strength of the study apart from other matching parameters.

9.3.3 All assessments used in this study are standard tests, applicable to Indian students.

9.3.4 The highly significant between group results showing a clear edge of GES over MES disproving the null hypothesis is yet a great strength of this study.

9.4 LIMITATIONS OF THE STUDY

9.4.1 The sample of students restricted to males, age range of 11 to 13 as also the study restricted to residential set up is a very narrow window to claim generalization and the useful adoption of GES over MES.

9.4.2 Data was not collected about the practices of Yoga, during the break at the time of holidays. Two more data before and after the holidays would have added greater strength to the study.

9.4.3 Quantitative measures related to cognitive variables as EEG, Brain wave coherence, EP, fMRI on one hence and studies of neurotransmitters, biochemical parameters, physiological variables as GSR, MR etc on the other, would be needed to understand possible mechanisms involved in GES as compared to MES.

9.4.4 This study has only assessed the students twice, at the beginning and end of the academic year. No periodical assessments were conducted. Therefore, the study did not evaluate immediate effects of GES. Also, it is not a long-term study covering the whole time span of GES.

9.4.5 The study did not include the evaluation of how Gurukula students utilize their skills in normal life after completing their education.

9.4.6 A survey conducted among the Indian students (Danino) suggests that girls appear more interested in Indian culture as well as more aware of it. Perhaps, a study conducted among the girl students, might have provided better results.

9.5 SUGGESTIONS FOR FUTURE

9.5.1 The study could lead to more detailed investigations at all levels of school and collegiate education. Multi-centered trials, larger span of age of students, inclusions of girls would be warranted to generalize the favorable results found in this study.

9.5.2 Correlations with Indian- personality Inventory (measures of guṇas – Tamas, Rajas and Sattva), emotional parameters such as Emotional intelligence and competence would add new dimensions to evaluate all round personality development of students in both systems.

9.5.3 Adoption of selected Yoga techniques used in GES to be included in the MES to conduct a 3 arm study (MES with and without Yoga techniques and GES) in residential and non residential set ups with larger number of students which can be of great value to spread the traditional Yoga-based education system in MES.

9.5.4 This study has shown evidence of greater improvements in cognitive abilities in GES compared to MES disproving the null hypothesis that GES can at best bring the

same changes as MES in boys in the age group of 11 to 13 years over one academic year (10 months) paving way for possible adoption of Yoga techniques and the Yoga way of life in education system.

CHAPTER - 8

D I S C U S S I O N

CHAPTER - 7

R E S U L T S

Agarwal, A.K., Kalra, R., Natu, M.V., Dadich, A.P., & Deswal, R.S. (2002). Psychomotor performance of psychiatric inpatients under therapy: Assessment by paper and pencil tests. Human Psychopharmacology, 17: 91-93.

Apte, Vaman Shivram. (1997). The students' Sanskrit-English dictionary. Motilal Banarsidass publishers, New Delhi.

Badawi,K., Wallace, R.K., Orme-Johnson, D., Rouzere, A.M., (1984). Electrophysiologic characteristics of respiratory suspension Periods occurring during the practice of the Transcendental Meditation Program. Psychosom Med**,** 46(3):267-76.

Baddeley, A. D. (1993): Your memory – a user's guide. Avery, New York.

Baddeley, A.D. (1990). Human Memory: Theory and Practice. Allyn & Bacon, Boston.

Bahadur, K.P. (1988). The wisdom of Samkhya. Sterling publishers PVT. LTD.

Baker, S.C., Rogers, R.D., Owen, A.M., Frith, C.D., Dolan, R.J., Frackowiak, R.S., and Robbins, T.W. (1996). Neural systems engaged by planning: A PET study of Tower of London task. Neuropsychologia, 34:515-26.

Banquet, J.P., Bourzeix, J.C., & Lesevre, N. (1979). Evoked potentials and vigilance states induced during the course of choice reaction time tests. Rev Electroencephalogr Neurophysiol Clin, 9(3):221-7.

Benson, H., Malhotra, M.S., Goldman, R.F., Jacobs, G.D., & Hopkins, P.J. (1990). Three case reports of the metabolic and electroencephalographic changes during advanced Buddhist meditation techniques. Behav Med Summer, 16(2):90-5.

Bera, T.K., Gore, M.M., & Oak, J.P. (1998). Recovery from stress in two different postures and in Shavasana--a yogic relaxation posture. Indian J Physiol Pharmacol, 42(4):473-8.

Bernaidi, L., Sleight, P., & Bandinelli, G. (2001). Effect of rosary prayer on Yoga mantras on autonomic cardiovascular rhythms. BMJ, 323(7327), 1446-9.

Bhatia, C.M. (1953). Intelligence testing and National Reconstruction, Bombay Hind Kitab, pp. 71-76.

Bijlani, R.L. (2004). Understanding medical physiology. Jaypee Brothers medical publishers (p) Ltd.

Blakeslee, T.R. (1980). The right brain. London: Macmillan.

Brown, J. (1958). Some tests of the decay theory of immediate memory. Quarterly journal of experiment psychology, 10: pp12-21.

Catherine, Soanes., & Angus, Stevenson. (2004). Concise Oxford English Dicitonary. Oxford University press, p 738.

Chinmayanada, Swami. (2001). The Holy Geeta. Central Chinmaya Mission Trust, Mumbai.

Corbetta, M., Miezin, M.F., Dobmeyer. S., Shulman, G.L. & Peterson, S.E. (1991). Selective and divided attention during visual discrimination of color, shape and speed: Functional anatomy by PET. The Journal of Neuro science, 11, 2383-24002.

Cranson, R.W., Orme-Johnson, D.W., Gackenbach, J., Dillbeck, M.C., Jones, C.H., & Alexander, C.N. (1991). Transcendental Meditation and improved performance on intelligence-related measures: a longitudinal study. Journal of Personality and Individual Differences, 12: 1105-1116.

Crooks, R.L., & Stein, J. (1991). Psychology: Science, Behavior and life. Fort Worth: Holt, Rinehart and Wiston, Inc.

Cuthbert, B., Kristeller, J., Simons, R., Hodes, R., & Lang, P.J., (1981). Strategies of arousal control: biofeedback, meditation, and motivation. JExp Psychol Gen, 110(4):518-46.

Danino, M. (2008), The Voice of Students: Conclusions from a Survey on Cultural Content at School. Journal of Value Education, Vol.4, 1&2: 124-135.

David, N., Rapp, Richard, J., & Gerrig. (2006). Predilections for narrative outcomes: The impact of story contexts and reader preferences. JML, 54-67.

D'Esposito, M., Detre, J.A., David, C.A., Shin, K.A., Atlas, S., & Grossman, M. (1995). The neural basis of the central executive system of working memory. Nature, 378, 279: 281.

Deshpande S, Nagendra HR & Raghuram Nagaratna (2008). A randomized control trial of the effect of yoga on Gunas (personality) and Health in normal healthy volunteers. International Journal of Yoga, 1:1.

Devarupananda, Swami. (2000). Mantrapushpam. Ramakrishna Mutt, Mumbai.

Dharampal. (1995). The Beautiful Tree: Indigenous Indian Education in the Eighteenth Century. Keerthi Publishing House and AVP Printers and Publishers, Coimbatore.

Dharmarajadhvari. (1932). Vedantaparibhasha. p.63. Akhila Bharatiya Samskrita Parishad, Luknow.

Dillbeck, M.C. (2005). Meditation and Flexibility of Visual Perception and Verbal problem solving. Memory and cognition, 10: 207-215.

Dixon, C., Dillbeck, M.C., Travis, F., Msemaje, H.I., Clayborne, B.M., Dillbeck, S.L., & Alexander, C.N. (2004). Accelerating cognitive and self-development: Longitudinal studies with preschool and elementary school children. Applications of Maharishi Vedic Science. [Special issue]. Journal of Social Behavior and Personality, 65–91.

Donna, H.B.W. (1984). "Effect of Chanting Om." Neuro Image Journal, 103, 72-86.

Dutta, M.N. (1987), The Dharam Shasthra: Hindu Religious Codes. Cosmo publications, New Delhi, 11-32.

Eppley, K., Abrams, A., & Shear, J. (1989). Differential Effects of relaxation techniques on trait anxiety: a meta-analysis. J Clin Psychol, 45:957–974.

Fletcher, P.C., Frith, C.D., Grasby, P.M., Shallice, T., Frackowiak, R.S.J., & Dolan, R.J. (1995). Brain systems for encoding and retrieval of auditory- verbal memory; an in vivo study in humans. Brain, 118, 401-416.

Frawley, David. (1999). Gods, sages and kings, Vedic secrets of ancient civilization. p.15. Motillal Banarsidass publishers private ltd, New Delhi.

Fuster JM. (1989). The prefrontal cortex anatomy, physiology and neurophysiology of the frontal lobe, Second edition. Raven Press, New York.

Gordeev, S.A., Baziian, B.K.H., & Liubimov, N.N. (1992). The dynamics of somatosensory and visual evoked potentials as a correlate of reversible states of altered consciousness. Biull Eksp Biol Med, 114(11):451-3.

Govindashastry. (1987). Ten principal Upanishads with Shankarabhashya. Motilal Banarasidass, New Delhi.

Habib, R., MacIltosh, A.R., Wheeler, M.A., & Tulving, E. (2003). Memory encoding & hippocampally based novelty/ familiarity discrimination networks. Neuro psychologia, 41, 271-278.

Hansenne, M. (2000). The p300 cognitive event-related potential: Theoretical and psychobiologic perspectives. Neurophysiol Clin Aug, 30(4):191-210.

Herzog, H., Lele, V.R., Kuwert, T., Langen K-J., Kops, E.R., & Felnendegen, L.E. (1990): Changed pattern of regional glucose metabolism during yoga meditative relaxation. Neuropsychobiology, 23 (4): 182-187.

Ikemi, A., Tomita, S., Kuroda, M., Hayashida, Y., & Ikemi, Y. (1986). Self-regulation method: psychological, physiological and clinical considerations; an overview. Psychother Psychosom, 46(4):184-95.

Jason, L., & Jeffrey, J. (2006). The roles of associative strength and source memorability in the contextualization of false memory. JML, 39-53.

Jedrczak, A., Toomey, M., & Clements, G. (1986). The TM-Sidhi programme, age, and brief tests of perceptual-motor speed and nonverbal intelligence. J Clin Psychol, 42(1):161-4.

Jella, S.A., & Shannahoff-Khalsa, D.S. (1993). The effects of unilateral forced nostril breathing on cognitive performance. Int J Neurosci, 73(1-2):61-8.

Jones-Gotman, M., Zatorre, R.J., Olovier, A., Andermann, F., Cendes, F., Cendes, F., Staunton, H., McMackin, D., Siegel, A.M., & Wieser, H.G. (1997). Learning and retention of words and designs following excision from medial temporal lobe structures. Neuropsychologia, 35, 963-973.

Kadambini, A. (2005). Effect of Yoga on performance in a planning task with the tower of London test. Masters's Dissertation, SVYASA University, Bangalore.

Kashyap, R.L. (1998). Rig-Veda, I edition. Sri Aurobindo Kapali Sastry institure of Vedic culture, Bangalore.

Kemp, Arthur. (1999). March of the titans, a history of the white race. Ostara Publications, New York.

Kember, P. (1985). The Transcendental meditation Technique and academic performance: A short report on control longitudinal pilot study, Br J of Edu Psychol, 55, 164 – 166.

Kessler, B., & Treiman, R. (2001). Relationships between sounds and letters in English monosyllables. Journal of Memory and Language, 44, 592-617.

Kessler, B., Treiman, R., & Mullennix, J. (2002). Phonetic biases in voice key response time measurements. Journal of Memory and Language, 47, 145-171.

Khasky, A.D., Smith, J,C. (1999). Stress, relaxation states, and creativity. Percept Mot Skills, 88(2):409-16.

Kory, R., & Hufnagel, P. (1997).The effect of the science of creative intelligence course on high school students: a preliminary report. In scientific research on transcendental meditation program VOL-I Eds, D W Orme-Johnson and J T Farrow, Germany, pp 400-402. Maharishi ERU press.

Krishnacharya, T.R. (1912).The Valmiki Ramayana, I edition. Sri Sadguru publications, Delhi-110007.

Kubota, Y., Sato, W., Toichi, M., Murai, T., Okada, T., Hayashi, A., & Sengoku, A. (2001). Frontal midline theta rhythm is correlated with cardiac autonomic activities during the performance of an attention demanding meditation procedure. Brain Res Cogn Brain Res, 11(2):281-7.

Lazar, S.W., Bush, G., Gollub, R.L., Fricchione, G.L., Khalsa, G., Benson, H. (2000): Funcitonal brain mapping of the relaxation response and meditation. Neuroreport, 11(7): 1581-1585.

Lezak, M.D. (1995). Neuropsychological assessment (3rd edition). New York, us: Oxford university press, New York, USA.

Litscher, G., Wenzel, G., Niederwieser, G., & Schwarz, G. (2001). Effects of QiGong on brain function. Neurological Res, 23(5):505.

Liu, G.L., Cui, R.Q., Li, G.Z., & Huang, C.M. (1990). Changes in brainstem and cortical auditory potentials during Qi-Gong meditation. Am J Chin Med, 18(3-4):95-103.

Lou, H.C., Kjaer, T.W., Friberg, L., Wildschiodtz, G., Holm, S., & Nowak, M.(1999); A 15O-H2O PET study of meditation and the resting state of normal consciousness. Hum Brain Mapp, 7(2):98-105.

Majumdar R.C. (1984). History and culture of the Indian people. Vol 4. Bharatiya Vidya Bhavan, Mumbai.

Manjunath, K.N., & Telles, S. (2001). Improved performance in the Tower of London test following Yoga. Indian journal of physiology and pharmacology, 45(3): 351-354.

McEvoy, T.M., Frumkin, L.R., & Harkins, S.W. (1980). Effects of meditation on brainstem auditory evoked potentials. Int J Neurosci, 10(2-3):165-70.

Miller, J.J., Fletcher, K., & Kabat-Zinn, J. (1995). Three-year follow-up and clinical implications of a mindfulness meditation-based stress reduction intervention in the treatment of anxiety disorders. Gen Hosp Psychiatry, 17(3):192-200.

Morris, R.G: Ahmed, S., Syed, G.M., & Toone, B.K. (1993). Neural correlates of planning ability: frontal lobe activation during the Tower of London test. Neuropsychologia, 31 (12): 1367-1378.

Nagarathna, R., & Nagendra, H.R. (2008). Integrated approach of Yoga therapy for Positive Health. p:2.

Nagendra, H.R. (2005). HOLSYM: Holistic system of management. Swami Vivekananda Yoga Prakashana, p:37.

Nagendra, H.R. (2005). Mind sound resonance technique (MSRT). Swami Vivekananda Yoga Prakashana, Bangalore.

Nagendra, H.R., & Telles S. (1999). Yoga and memory. Vivekananda Kendra Yoga Prakashana, Bangalore.

Nagendra, H.R. (2005). Yoga, the science of holistic living, p: 103, V edition. Vivekananda Kendra Prakashana Trust.

Naveen, K.V., Nagendra, H.R., Nagaratna, R., & Telles, S. (1997). Breathing through a particular nostril improves spatial memory scores without lateralized effects. Psychol Rep, 81,555-561.

Orme-Johnson, D., Dillbeck, M.C., Wallace, R.K., & Landrith, G.S. (1982). Intersubject EEG coherence: is consciousness a field? Int J Neurosci, 16(3-4):203-9.

Orme-Johnson, D. W., & Granieri, B. (1977). The effects of the Age of Enlightenment Governor Training Courses on field independence, creativity, intelligence, and behavioral flexibility. Centre for the Study of Higher States of Consciousness. Maharishi European Research University, Switzerland.

Owen, A.M., Bownes, J.J., Shakan, B.J., Poltrey, C.A., & Robbins, T.W. (1990). Planning and spatial working memory following frontal lobe lesions in man. Neuro psychologia, 28: 1021-1034.

Pagano, R. R., & Frumkin, L. R. (1977).The effect of Transcendental meditation on right hemisphere functioning. Bio feed back self-Regul, 2(4), 407-15.

Panjwani, U., Selvamurthy, W., Singh, S.H., Gupta, H.L., Mukhopadhyay, S., & Thakur, L. (2000). Effect of Sahaja yoga meditation on auditory evoked potentials (AEP) and visual contrast sensitivity (VCS) in epileptics. Appl Psychophysiol Biofeedback, 25(1):1-12.

Papez, J. (1937). A proposed mechanism of emotion. Arch. Neurol. Psychiatry, 38: 725-743.

Pardo, P.V., Fox, P.T., & Raichle, M.E. (1991). Localization of a human system for sustained attention by positron emission tomography. Nature, 349, 61; 65.

Peng, C.K., Mietus, J.E., Liu, Y., Khalsa, G., Douglas, P.S., Benson, H., Goldberger, A.L., & Margaret, H.A. (2000). Exaggerated heart rate oscillations during two meditation techniques. Int J Cardiol, 31; 70 (2):101-7. Comment in: Int J Cardiol, 28; 73 (2):199.

Persinger, M.A. (1984). Striking EEG profiles from single episodes of glossolalia and Transcendental Meditation. Percept Motor Skills, 58(1):127-33.

Petrenko, E.V., Orlova, T.V., & Liubimov, N.N. (1993). The cerebral control of afferent somatosensory projections. Biull Eksp Biol Med, 116(9):229-31.

Posner, M.I. (1978). Chronometric Explorations of Mind. Lawrence Erlbaum Associates, Hillsdale, N. J.

Raju, P.T. (1993). Introduction to comparative philosophy, Vol. 66, No. 5, pp. 86-87, JSTOR.

Rakesh Rani, Pandit. (1985).Yajur Veda. Dayanand Samsthan, New Delhi .

Ranganathananda, Swami. (1971). Eternal values for changing society, Education for human excellence, Vol.III. Bharatiya Vidhya Bhavana, Bombay.

Rao,L., Shobini., Subbakrishna, D.K., & Gopukumar, K. (2004). Nimhans neuropsychology battery-2004 manual. National institute of mental health and neurosciences, Bangalore.

Roth, B., & Creaser, T. (1997). Mindfulness meditation-based stress reduction: experience with a bilingual inner-city program, Nurse Pract, 22(3):150-2, 154, 157.

Rowe, Owen, Johnsrude & Passingham. (2001). Imaging the mental components of the human task. Neuro psychologia, 39,315-327.

Rueckert, I., & Graffman, J. (1996). Sustained attention deficits in patients with right frontal lesions. Nerupsychologia, 36, 953 and 963.

Russel, P. (1979). The brain book. Routledge & Kegan Paul, London.

Saltz, E. (1970). Manifest anxiety: have we missed the data? Psychological Review,77, 568-573.

Sarang, S.P., and Telles, S. (2007). Immediate effect of two Yoga-based relaxation techniques on performance in a letter-cancellation task. Perceptual and Motor skills, 105 (2): 379-385.

Schwartz, G.E. (1976). Self-regulation of response patterning: implications for psychophysiological research and therapy. Biofeedback Self Regulation, 1(1):7-30.

Seetharaman, G.K. (1998). Krishna Yajur Veda Taittariya Samhita, 1 edition. Your family friend, New Delhi.

Shallice,T. (1982); Specific impairments of planning. Phil Trans R Soc Lon, 298; 199-209.

Sharma, & Dash, B. (1998). Caraka Samhita. Chowkamba Samskrit series office, Varanasi.

Sharp, H. (1965). Selections from Educational Records, Part I (1781-1839). National Archives of India. New Delhi: 107-117.

Shatrughan, S (2005). Eefficacy of 3 modules of yoga practice on visual memory in children. M.Sc dissertation submitted to Swami Vivekananda Yoga Anusandhana Samsthana, Bangalore.

Siegel, A.M., & Wieser, H.G. (1997). Learning and retention of words and designs following excision from medical or lateral temporal lobe structures. Neuropsychologia, 35, 963 & 973.

Smith, M.L. & Milner, B. (1981). The role of the right hippocampus in the recall of spatial location. Neuro psychologia, 19, 781 & 795.

Sontakke, N.S., & Kashikar, C.G. (2005). Rig Veda-Samhita. Vaidika Samshodhana Mandala, Pune.

Sridevi, K., & Rao, Krishna P.V. (1998). Temporal Effects of Meditations and Personality. Psychological Studies, Vol. 43, No.1.

Sri Krishnadas, Kshemaraj. (1867). Srimadbhagavata-Mahapuranam, Sridhariya Vyakhyana sahitam. Steam press, Mumbai.

Stephan, Lewandowsky., Gordon, D.A., Brown, Tarryn Wright., & Lisa, M. Nimmo. (2006). Timeless memory: Evidence against temporal distinctiveness models of short-term memory for serial order, 20-38.

Stuss, D.T., & Benson, D.F. (1984). Neurophysiological studies of frontal lobes. Psychol Bull, 95: 3-28.

Swamigal, Sri Krishnapremi. (2007). Adhyatma Bharatam. Sri Sri press, Srirangam, Tamilnadu.

Taimini, I.K. (1961). The science of yoga. The Theosophical Publishing House,

Madras.

Tapasyananda, Swami. (1982). Srimad Bhagavata Mahapuranam. Sri Ramkrishana Math, Chennai.

Telles, S. (2006). A Glimpse Of The Human Body, The Structure and Functions, p-11&91. Swami Vivekananda Yoga Prakashana, Bangalore.

Telles, S., & Desiraju, T. (1993). Recording of auditory middle latency evoked potentials during the practice of meditation with the syllable 'OM'. Indian J Med Res, 98:237-9.

Telles, S., Hanumanthaiah, B., Nagarathna, R., & Nagendra, H.R. (1993). Improvement in static motor performance following yogic training of school children, Percept Motor Skills, 76(3 Pt 2):1264-1266.

Telles, S., Nagarathna, R., Nagendra, H.R., & Desiraju, T. (1994). Alterations in auditory middle latency evoked potentials during meditation on a meaningful symbol--"Om." Int J Neurosci, 76(1-2):87-93.

Telles, S., Nagarathna, R., & Nagendra, H.R. (1998). Autonomic Changes while mentally repeating two syllables – One meaningful and the other neutral. Ind J of Physiology & pharmacology, 42(1), 57-63.

Thompson-Schill, S.L. (2003). Neuro imaging studies of semantic memory: Inferring how from “where”. Neuro psychologia, 41, 280-292.

Tjoa, A. (1975). Increased intelligence and reduced neuroticism through the Transcendental Meditation program. Behavior: Journal of Psychology, 3: 167–182.

Treiman, R., Kessler, B., & Bick, S. (2002). Context sensitivity in the spelling of English vowels. Journal of Memory and Language, 47, 448-468.

Travis, F., Tecce, J., Arenander, A., & Wallace, R. K. (2002). Patterns of EEG coherence, power, and contingent negative variation characterize the integration of transcendental and waking states. Biological Psychology, 61(3), 293-319.

Travis, G., Olson, T., Egenes, T., Gupta, HK. (2001). Physiological patterns during practice of the Transcendental Meditation technique compared with patterns while reading Sanskrit and a modern language. International journal of neuro science, 109 (1-2): 71-80.

Tulving, E. (1999). On the uniqueness of episodic memory. In L.G. Nilson & H.J.Marcowitsch (eds.) Cognitive Neuro science memory, Seattle Hogrefe & Huber, 11-42.

Uma, K., Nagendra, H.R., Nagarathna, R., Vaidehi, S., & Seethanlakshmi, R. (1989). The Integrated Approach of Yoga: a therapeutic tool for mentally retarded children: a one-year controlled study. Journal of Mental Deficiency Research, 33: 415-421.

Vivekananda Swami. (1995), Raja Yoga, Conquering the Internal Nature. Advaita Ashrama, Calcutta.

Wachsmuth, D., & Dolce, G. (1980). Visual and computerized analysis of EEG during Transcendental Meditation and sleep. EEG EMG Z Elektroenzephalogr Elektromyogr Verwandte Geb, 11(4):188.

Wallace, R.K., Benson, H., & Wilson, A.F. (1971). A wakeful hypo metabolic physiologic state. American Journal of physiology, 221,795-799.

Walter, W. G., Cooper, R., Aldridge, V. J., Mccallum, W. C., & Winter, A. (1964). Contingent negative variation. An electric sign of sensorimotor association and expectancy in the human brain. Nature, 203, 380-384.

Zhang, W., Zheng, R., Zhang, B., Yu, W., Shen, X., (1993). An observation on flash evoked cortical potentials and Qigong meditation. Am J Chin Med, 21(3-4):249.

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