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 dentic zone (Telles, 2006) and decision making of the frontal cortex (Telles, 2006). The present study suggests growth in function of the dentic 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 Saṃskṛta as the principal medium of instruction

The physiological and psychological effects of reading Saṃskṛta are similar to some of those experienced during Transcendental Meditation (Travis et al.). Students of GES learn the language of Saṃskṛta 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 Meditation, 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.