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 $\alpha$ 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-Līṅga to which daily worship is conducted by Gurukula students themselves. Apart from the class rooms there is a small playground 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.
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

<table>
<thead>
<tr>
<th>Group</th>
<th>No.</th>
<th>Age range</th>
<th>Age (mean±sd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GES</td>
<td>49</td>
<td>11 to 13</td>
<td>12.16 ± .66</td>
</tr>
<tr>
<td>MES</td>
<td>49</td>
<td>11 to 13</td>
<td>12.31 ± .68</td>
</tr>
</tbody>
</table>

The two groups matched for age.

Table 5.2 Trial profile

Students screened
GES: 110  MES: 500

Exclusion Criteria
Students having congenital defects or on medication known to affect cognitive abilities.

Inclusion Criteria
Healthy boys between 11 to 13 years
One-to-One matched for age, family atmosphere, and socio-economic background.

No Dropouts
Table 5.3
Demographic data

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>S</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>/GES</td>
<td>49</td>
<td>6448.98</td>
<td>1.31</td>
<td></td>
<td>2.18</td>
<td></td>
<td>1.35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1969.15</td>
<td>±1.37</td>
<td>1.18±.39</td>
<td>1.52</td>
<td>4.02±.14</td>
<td>.48</td>
</tr>
<tr>
<td>MES</td>
<td></td>
<td>6704.08</td>
<td>±</td>
<td>2.35</td>
<td>±</td>
<td></td>
<td>1.33</td>
</tr>
</tbody>
</table>

GES Gurukula Education system & MES Modern education System

S- Salary, A- Education of father, B- Education of mother, (Education up to SSLC – 1, Graduation- 2, Post graduation- 3, Professionals – 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 training in GES

5.4.3 Prāṇāyāma

Prāṇāyāmas are breathing exercises practiced to gain mastery over the body’s vital energy (Prāṇa). Gurukula students perform Nāḍīśuddhi (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 construction 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.