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 prefrontal 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 meditation. 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 by 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 Čavāsana (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 Čavāsana, 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 Kuṇḍalini 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 subserving 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-H2O 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-H2O 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 (Wilcoxon 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

<table>
<thead>
<tr>
<th>Definition and facets</th>
<th>Intelligence Quotient</th>
<th>Memory</th>
<th>Sustained Attention</th>
<th>Planning ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to acquire knowledge and skills. Ability to apply knowledge and skills</td>
<td>Process of storing and preserving newly acquired information for later recall.</td>
<td>Capacity to attend to a task for a required period of time.</td>
<td>identification and organization of the steps and elements needed to carry out an intention or achieve a goal</td>
<td></td>
</tr>
<tr>
<td>Brain associations</td>
<td>Dentritic zone and parietal cortex</td>
<td>Temporal lobe Spatial: Right hemisphere Verbal: Left</td>
<td>Right fronto-parietal network</td>
<td>Pre-frontal cortex</td>
</tr>
<tr>
<td>Papers published</td>
<td>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 &amp; mental age capacities increased by 68% (vs. 41%)</td>
<td>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%.</td>
<td>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 &lt; 0.001), CM producing more change (26%) than SR (14%).</td>
<td>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.</td>
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<tr>
<td>Dixon et al. (2004). TM. 45-week study: 25 experimental &amp; 25 controls: increases in principal components of self-concept, analytical ability, and general intellectual performance in experimental</td>
<td>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.</td>
<td>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.</td>
<td>Banquet, Bourzeix and Lesevre (1979): TM improves attention. Characteristics of Visual Evoked Potentials (N120,</td>
<td></td>
</tr>
<tr>
<td>Jedrzcak et al. (1986): 3 tests Perceptual-motor speed &amp; nonverbal intelligence to individuals practicing the TM-Sidhi programme. Significantly higher performance on 2</td>
<td>(Dillbeck, 2005). College students instructed in the Transcendental Meditation technique displayed significant improvements in</td>
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</tbody>
</table>

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**Note:** The table continues with additional papers and their findings, but the provided text snippet above includes the key components of the table.
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.