CHAPTER 6
DISCUSSIONS

This matched controlled study with 12 ASD children (yoga group six and non-yoga six) showed significant improvement in all the parameter studied which included:

- Eye to eye gaze
- Sitting tolerance
- Body posture and balance
- Imitation skills
- Self-stimulatory and self-injurious behaviors and
- Receptive skills related to spatial relationships.

This is the first scientific study to explore the efficacy of IAYT on various aspects of behavior in children with ASD. Appropriately designed IAYT modules have shown beneficial results in a variety of medical applications, but here, consistently valuable results in a seemingly intractable behavioral condition were obtained for the first time, both for the ASD condition and as a yoga application.

Construction of a new test of imitation skills, ITB and RSBTB had been stimulated by changes observed in the pilot study involving 6 children over a single ten month period. Its implementation is another novelty of the study design. Use of the test was justified by the magnitude of quantitative changes observed in all the measures. Consistent with these quantitative differences, the study noted almost unique qualitative behavioral changes, effectively removing the ‘autistic’ label from all the experimental group children, and transforming the life of their parents, as confirmed by the parental reports. Possible reasons for this merit consideration.

Previous reports of qualitative changes of behavior of children with autism following a short term yoga intervention include the promising observations of increased sitting tolerance and increased tolerance of adult proximity and subsequent socialization (Goldeberg L 2004\[^{19}\], Molly K  2002\[^{20}\], Betts DE 2006\[^{21}\]). Our observations confirm
these changes, and our quantitative results amplify them.

Qualitative and quantitative analysis reveals substantial gains in all the parameters studied especially with stereotyped repetitive, self-injurious behavior, imitation and sitting tolerance. Changes in the imitation skill noticed contributed to significant increase in learning in yoga group children. When the research project started children in yoga group were admitted to pre-nursery education. Over a period of three years these children were promoted to first grade, clearly indicating a progressive change in their learning skills.

6.1 Mechanism : Neural Plasticity and ASD

For a long time, it was believed that as we aged, the connections in the brain became fixed. Research has shown that in fact the brain never stops changing through learning. Plasticity is the capacity of the brain to change with learning. Changes associated with learning occur mostly at the level of the connections between neurons. New connections can form and the internal structure of the existing synapses can change.

According to Hadjikhani N (2007) [64] the brain is plastic organ and training can modify its structure and its function. This is shown in the animal model; motor skill learning increases cortical thickness in rats, implying that repetitive environmental demand leads to structural changes in the brain. Similar results have been recently shown in humans; increases in gray matter have been shown in volunteers learning to juggle, in musicians and bilinguals individuals. In all these cases brain gray matter increase correspond to skill training and was probably due to an increase in the number of connection of neuronal population. An approach consisting in a training of imitative skills may be a valid way to develop not only imitation per se, but also socio-cognitive aspect of autism. Our observation of increased in imitation skills after prolonged yoga intervention of twenty months intervention supports this theory.
6.2 Immune system and ASD

Several studies have indicated that interactions between the immune system and the nervous system begin early during the embryonic stage of life, and successful neurodevelopment depends on a balanced immune response. Several symptoms consistent with a poorly regulated immune response have been reported in autistic children (Ashwood P et.al, 2006 [65]). It is possible that aberrant immune activity is regularized during IAYT. Several neurotransmitter abnormalities have been detected in autism, notably increased blood levels of serotonin (Penn HE 2006 [66]). Some data suggest an increase in several growth hormones; other data argue for diminished growth factors. Also, some inborn errors of metabolism are associated with autism but probably account for fewer cases (Manzi B et al 2008 [67]). Health benefit of yoga has been grouped into three categories: physiological (Harrison LJ 2004 [49], Davis J 2009 [68]), psychological (Iyengar BKS 2001 [69]) and biochemical (Rossignol DA 2009 [70]). It is obvious that results seen in this study may be attributed to IAYT.

Research shows that stimulation exercise and environmental enrichment can all stimulate an increase in brain cells in the hippocampus, where the brain stores information. Stress is known to restrict the number of newly generated neurons in the hippocampus. This helps explain why anxious children with ASD have such difficulty learning and retaining information. (Goldberg L 2004[19]). IAYT when it starts early in life calms the physical body; child becomes more focused and organized. There is not a great deal of research on exactly how early intervention work but we know that the brain has the capacity for reduplication of function or transferability, allowing information to come from an area in the brain not usually used for that purpose. (Siegel B 1996 [71]).

A feeling of safety is essential to relaxation. Individual mats and carpets helped children to identify their personal space and assume Shavasana (supine relaxation posture). Combining physical exercises during asanas and warming up exercises with speech and language stimulation seems to enhance recall abilities, increased imitation skills, verbal receptive skills and expression. Ardhashirasana (half inverted position), Ardhachakrasana (half wheel position) and trikonasana (triangular position) were
significant in stimulating vestibular and proprioceptive awareness. *Parivrittatrikonasana* (*modified triangular position*) and variations seem to stimulate the parasympathetic nervous system, or the calming part of the nervous system, through integration of the right and left sides of the brain. Even our children who demonstrated the most extreme deficits in attention, concentration and sensory integration were able to slow and calm their breath with direct instruction, and to use control of the breath to control superfluous and unwanted movement of the body and mind.

6.3 Neuromuscular system and ASD

According to Goldberg L[^19^] “the autistic child senses input from his muscles and joints better than he does through his eyes and ears”. Very heavy touch pressure is the kind of tactile stimulation that often produces a positive response in an autistic child. This was a unique encouraging observation during the therapy that accelerated the process of reducing RSB.

6.4 Homeostasis and arousal in ASD

Traditionally, the literature that has sought to explain the existence of repetitive behavior in autism has taken one of two different lines. The first has been that these behaviors are invoked by the individual as a coping mechanism to modulate levels of arousal and thus maintain homeostasis. The second has been to explain these behaviors in operant terms. Although these accounts have been widely cited, there have been few critical considerations of whether they can adequately explain the essential characteristics of repetitive behavior in autism. Any comprehensive and viable theory must be able to explain the high degree of repetition, invariance, and inappropriateness that characterizes this behavior. It should be able to account for the wide spectrum of repetitive behavior that is observed in autism and explain why this behavior is so prevalent, pervasive, and enduring across ability, time, and often across attempts to reduce it.

The notion that repetitive behavior serves to reduce chronically high arousal levels in autism has endured for over three decades. Hutt and Hutt (1965, 1970)[^72][^73] were the
first proponents of this theory. They hypothesized that nonspecific activity of the
ascending reticular activating system is at a chronically high level in autism, and that the
individual strives to lower this by engaging in simple movement stereotypies that serve as
displacement activities to block further sensory input relating to the arousing situation.
They further suggested that novel objects and situations are also arousing, and thus are
strongly avoided, leading to an apparent insistence on sameness. (Turner M, 1999) 

6.5 Central Nervous System (CNS) and ASD

The other explanation may be children with autism often are thought to have abnormal
central nervous system processing, which in turn contributes to either over-or-under
arousal. Various authors (Guess D and Carr EG 1991; Schneck CM 2000) have
proposed that repetitive stereotyped behaviors provide a calming influence to an over-
aroused nervous system and have an alerting affect on an under-aroused system. Thus, a
powerful motivator for children with autism engaging in repetitive behavior may be that it
makes them feel “better” (i.e., more calm or more awake) after IAYT.

6.6 Sensory nervous system and ASD

An important finding of this study is that when the environmental world is changing
too fast in one or several sensory modalities, slowing down facial, vocal, motor and
auditory cues would impact imitative and cognitive performance in autistic children.

A study by Gepner B and Fe’ron F (2009) report that slowing down the speed of
facial and vocal events enhance imitative, verbal and cognitive skills of some ASD
children. Our finding supports the rapid visual-motion integration deficit hypothesis of
Autism (Gepner B and Mestre D 2002).

6.7 Eye gaze and ASD

Another important finding of this study was that there was a significant change in the
eye gaze. Impairments in using eye gaze to establish joint attention and to comprehend
the mental states and intentions of other people are striking features of autism. In a study
by Pelphrey KA et al (2005) \cite{79} using event-related functional MRI (fMRI), with autistic children, they found that brain regions involved in gaze processing, including the superior temporal sulcus (STS) region, were not sensitive to intentions conveyed by observed gaze shifts. IAYT perhaps contributes to develop sensitivity in these areas.

### 6.8 Spatial relation and ASD

Improved comprehension of verbal commands related to spatial relationship (right, left, front, back, up and down) noticed during the practice of asanas may be attributed to the fact that some children used the body as a visual tool as the yoga therapist always assumed position on the student's eye level. Kinesthetic/tactile experience was always given during these asanas which, helped children to learn these challenging concepts.

We hypothesize that the reinforced experience of imitating the ‘being’ aspect of each yoga asana (posture) gave each child a greater sense of his or her ‘self’, and that this slowly established sense of ‘self’ enabled them to learn to relate better to others. Thus, the children slowly progressed to the stage of being able to interact with others as more normal people. Overall, this study revealed positive significant changes in overall ASD behaviors of the participant in the yoga group scores. It is difficult to say with any certainty that changes in ASD symptoms were due to the yoga intervention only. However, the significance of this study is that it could be done in the school setting with consistency and little intrusion.