

**INTEGRATED APPROACH
TO YOGA THERAPY AND
AUTISM SPECTRUM DISORDER**

Thesis submitted by

SHANTHA RADAHAKRISHNA

Towards the partial fulfillment of

DOCTOR OF PHILOSOPHY (YOGA)

NOVEMBER 2010

SWAMI VIVEKĀNANDA

YOGA ANUSANDHANA SAMSTHANA

(Declared as Deemed-to-be University Under Section 3 of UGC Act, 1956)

19, Eknath Bhavan, Gavipuram Circle, K.G.Nagar, Bengaluru

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CERTIFICATE BY THE GUIDE

This is certify that Shantha Radhakrishna who has been given Ph.D. registration with effect from January 11, 2010 by the Swami Vivekananda Yoga Anusandhana Samsthana, Deemed University under the Division of Yoga and Life Scienses has successfully completed the required ‘training’ in acquiring the relevant background knowledge in Physiology, Neurology and Psychology related to *Yoga* and has completed the required ‘course of research for not less than two years to submit this thesis **entitled “INTEGRATED APPROACH TO *YOGA* THERAPY FOR AUTISM SPECTRUM DISORDER”** as per the regulation of the University.

We also declare that the subject matter of the thesis entitled **“INTEGRATED APPROACH TO *YOGA* THERAPY FOR AUTISM SPECTRUM DISORDER”** has not previously formed the basis of the award of any degree, diploma, associate-ship, fellowship or similar titles.

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DECLARATION

I, hereby declare that this study was conducted by me at Swami Vivekananda Yoga Anusandhana Samsthana (S-VYASA), Bangalore, under the guidance of Dr. H.R. Nagendra, Vice-Chancellor, Swami Vivekananda Yoga Anusandhana Samsthana, Bangalore and Dr. R. Nagarathna, Dean, Divisio of Yoga and Life Sciences S-VYASA and I also declare that the subject matter of my thesis entitled **“INTEGRATED APPROACH TO YOGA THERAPY FOR AUTISM SPECTRUM DISORDER” A RANDOMIZED CONTROL STUDY** has not previously formed the basis of the award of any degree, diploma, associate ship, fellowship or similar titles.

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CONTENTS

Abstract	i-iv
CHAPTER 1 : INTRODUCTION	1-10
1.1. Definition and characteristics of Autism Spectrum Disorders (ASD)	2-4
1.2. Prevalence	4
1.3. Causes	5
1.4. Interventions	5-9
1.4.1 Education and Medical Intervention	6
1.4.2. Complementary and Alternative Medicine (CAM)	8
1.4.3. Yoga for ASD	9
1.5. Why this study?	9-10
CHAPTER 2 : REVIEW OF LITERATURE -TRADITIONAL SCRIPTURES	11-45
2.1 Autism according to Ayurveda	11
2.1.1. Autism and Balagraha	12
2.1.2 Sthayi Buddhi Dusti	13
2.1.3 Asthayi Buddhi Dusti	13-14
2.2 Aetipathogenesis of Jada	14-15
2.3 Management	16
2.3.1 Preventive Measures	16-17
2.3.2 Specific Treatment	18
2.4 Definitions of Unmada	18-19
2.4.1 Types of Unmada	18-21
2.4.2 Causes of Unmada	21-22
2.5 Treatment of Autism according to Ayurveda	23
2.6 Treatment of Autism according to Yoga	23
2.6.1 Concept of body	23-24

2.6.2	Concept of Mind	24-25
2.6.3	Mind-Body Interactions	25
2.6.4	Pancha Koshas	26
2.6.5	Consciousness based approach	26
2.6.6	Three Gunas	27-28
2.6.7	Gunas and Disorders	28-29
2.6.8	Yoga, the science of holistic living	30
2.6.9	Yoga and ASD	30-31
2.6.10	Development of IAYT and ASD	31
2.7	Description of Autism according to Puranas	32-33
2.8	Review of literature according to modern science	33
2.8.1	Neuropsychological theory	34
2.8.2	Neurochemical theory	34
2.8.3	Neurobiologic theory	34-35
2.8.4	Structural and functional abnormalities of brain	35-36
2.8.5	Genetics and ASD	36
2.8.6	Vaccination and Autism	36
2.8.7	Environmental factors	37
2.8.8	Others	37
2.8.8.1	Studies of other biomedical factors	37-38
2.8.8.2	Theory of Mind	38
2.9	Management of ASD	38
2.9.1	Applied behavior analysis	38-40
2.9.2	Concept IAYT	40
2.9.3	Why IAYT	40-42
2.9.4	Effects of meditation on brain	42-45
2.9.5	Theory behind the study	45-46
CHAPTER 3 : AIMS AND OBJECTIVES		47-48
3.1.	Research Questions	47

3.2	Aim	47
3.3	Objectives	47
3.4	Hypothesis	47
3.5	Null Hypothesis	48

CHAPTER 4 : METHODOLOGY AND DESIGN **49-56**

4.1.	Overview	49
4.1.1	Subjects:	49-50
4.2.	Inclusion / Exclusion criteria	50
4.3.	Ethical clearance and informed consent	50
4.4.	Design	50
4.4.1	Structure of Sessions	50-51
4.5.	Assessments	51-53
4.6.	Data Analysis	53
4.7.	Data Collection / Extraction	53-54
4.8.	Intervention	54
4.8.1.	ABA therapy module	54
4.8.2	Yoga intervention	55-56

CHAPTER 5 : RESULTS **57-78**

5.1	Qualitative results	57
5.1.1.	Observations by therapists and parents	57-59
5.2	Quantitative results	59-60
5.2.1	Eye to eye gaze	60-61
5.2.2	Sitting Tolerance	61-62
5.2.3	Body Posture	62-63
5.2.4	Body Awareness	63-64
5.2.5	Depth Perception and Balance	64-65
5.2.6	Imitation Skills	65-71
5.2.7	Self Stimulatory Behavior	71-72

5.2.8 Self Injurious Behavior	73
5.2.9 Restricted Behavior	74
5.2.10 Sameness Behavior	75
5.2.11 Repetitive Behavior	76
5.2.12 Receptive Skills regarding Spatial Relation	77
5.2.13 Other Behavior changes	78
CHAPTER 6 : DISCUSSIONS	79-84
6.1 Neural Plasticity and ASD	80
6.2 Immune system and ASD	81-82
6.3 Neuromuscular system and ASD	82
6.4 Homeostasis and arousal in ASD	82-83
6.5 CNS and ASD	83
6.6 Sensory nervous system and ASD	83
6.7 Eye gaze and ASD	83-84
6.8 Spatial relation and ASD	84
CHAPTER 7 : APPRAISAL	85-88
7.1 Summary	85
7.2 Conclusion	85-86
7.3 Strength of the study	86
7.4 Limitation of the study	86-87
7.5 Suggestions for future	88
REFERENCES	89-96
APPENDICES	97-140
APPENDIX 1 Raw data of Yoga group	97-116
I. Raw score Data – Baseline Session 1	97
II. Raw score Data – Baseline Session 2	98

III.	Raw score Data – Baseline Session 3	99
IV.	Raw score Data – Baseline Session 4	100
V.	Raw score Data – Baseline Session 5	101
VI.	Raw score Data – Baseline Session 6	102
VII.	Raw score Data – Baseline Session 7	103
VIII.	Raw score Data – Baseline Session 8	104
IX.	Raw score Data – Baseline Session 9	105
X.	Raw score Data – Baseline Session 10	106
XI.	Raw score Data – Baseline Session 11	107
XII.	Raw score Data – Baseline Session 12	108
XIII.	Baseline Average of 12 Sessions	109
XIV.	Raw score Data –Mid Session 1	110
XV.	Raw score Data – Mid Session 2	111
XVI.	Raw score Data – Mid Session 3	112
XVII.	Raw score Data – Mid Average of 3 Sessions	113
XVIII.	Raw score Data –Post Session 1	114
XIX.	Raw score Data – Post Session 2	115
XX.	Raw score Data – Post Session 3	116
XXI.	Raw score Data – Post Average of 3 Sessions	117

APPENDIX 2 Raw data of Non- Yoga group 118-137

I.	Raw score Data – Baseline Session 1	118
II.	Raw score Data – Baseline Session 2	119
III.	Raw score Data – Baseline Session 3	120
IV.	Raw score Data – Baseline Session 4	121
V.	Raw score Data – Baseline Session 5	122
VI.	Raw score Data – Baseline Session 6	123
VII.	Raw score Data – Baseline Session 7	124
VIII.	Raw score Data – Baseline Session 8	125
IX.	Raw score Data – Baseline Session 9	126

X.	Raw score Data – Baseline Session 10	127
XI.	Raw score Data – Baseline Session 11	128
XII.	Raw score Data – Baseline Session 12	129
XIII.	Raw score Data – Baseline Average of 12 Sessions	130
XIV.	Raw score Data –Mid Session 1	131
XV.	Raw score Data – Mid Session 2	132
XVI.	Raw score Data – Mid Session 3	133
XVII.	Raw score Data – Mid Average of 3 Sessions	134
XVIII.	Raw score Data –Post Session 1	135
XIX.	Raw score Data – Post Session 2	136
XX.	Raw score Data – Post Session 3	137
XXI.	Raw score Data – Post Average of 3 Sessions	138

PLATES

139-140

ABSTRACT

Background and need for the study: Yoga programmes implemented with special children have demonstrated that yoga intervention lasting for few weeks to months resulted in increased working efficiency and ability to concentrate in children with special needs. Improvement in concentration/focus, organization, relaxation, tolerance for sitting, posture, ability to balance, understanding directions, better gross motor activities, imitate poses without assistance, increased eye contact and intelligence was found after implementation of a yoga program for some children with developmental disabilities. Researcher's previous ten years experience of working with Autism Spectrum Disorder (ASD) children suggested similar findings. Although research is minimal, results thus far support use of Yoga for therapists working with children with special needs.

Objective:

- (i) To study the effect of a twenty month non-residential yoga program in ASD children's behavior.
- (ii) To study the effect of a comprehensive non-residential yoga-based program on eye to eye gaze, sitting tolerance, body posture, body awareness, depth perception and balance, imitation, repetitive self-stimulatory and self-injurious behavior and receptive skills related to spatial relationships.

Design: Crossover randomized control study.

Setting: Non-residential special schools in Bangalore, South India.

Subjects: 42 children with established ASD were profiled ; 12 from four special schools satisfying the inclusion criteria were selected. 6 from School A, 5 males and one female formed the yoga group (experimental group). 2 from males from School B, 2 males from School C and 1 male and 1 female from School D formed the non-yoga group (control group). These subjects were recruited for the study.

Inclusion criteria included diagnosis of autism according to ICD-10 criteria, age 8-14 years initially, parents educational background minimum graduates, socio-economic background middle class. A semi-structured interview was used to obtain both demographic and vital clinical data, including personal, family and ASD behavior history. The study was approved by both SVYASA's review board and ethical committee. Signed informed consent was obtained from all the parents of the subjects. Twenty-month's yoga intervention for five days weekly, one hour a day was implemented with the yoga group. Subjects in the yoga group received regular Applied Behavior Analysis (ABA) based intervention program in the regular class room. All the subjects were in pre-nursery training program. Subjects in the non-yoga group received only ABA based intervention program in the special schools.

All the parents in both yoga and non-yoga group were interviewed using standardized E-2 autism checklist and recorded. The researcher trained eight special educators (2 from each school) to observe different behavioral parameters. The behavior was graded by using a rating scale.

Intervention: The intervention consisted of a twenty month- intensive day school yoga program comprising of *warmup practices, loosening practices, strengthening asanas, calming asanas, yoga breathing practices and chanting*. Parents of yoga group children practiced meditation, dhyana and also attended counseling sessions.

Outcome Measures:

- (i) ASD behavior was assessed using E-2 autism checklist, questionnaire based on parents' interview, modified test of Repetitive Stereotyped Behavior Test Battery (RSBTB) and Imitation Test Battery (ITB).
- (ii) Base-line data was collected during the first twelve sessions, mid session data collected between 200 and 202 sessions and post data collected between 389 and 391 sessions.
- (iii) Data were analyzed by drawing a column graph taking the average value of observers.

Results: Results are presented in three parts: first, baseline characteristics; second, impact on ASD symptoms and perceived child outcomes; third, effects on a wide range of behaviors, nonverbal skills, social interaction, imitation, and repetitive stereotyped behaviors (RSB). Despite small sample size, consistency across tests and subjects make the results significant

Behavior characteristics addressed in the research were significant to parents and staff. Parents find lack of eye contact, hyperactivity, and resistance to change difficult to endure; staff emphasize those impacting learning negatively: lack of eye contact to gain attention, lack of imitation skills, poor sitting tolerance, and temper tantrums.

Behaviors manifesting during Yoga and in class were consistent with baseline reports of parents and staff. After the first 12 sessions, no observable changes in eye-to-eye gaze, sitting tolerance or imitation skills occurred. Thereafter, subtle changes in behavior were recorded by observers and parents. Children initially unaware of their breath gradually learned to breathe in and out, and to deepen their breathing. Hand held mirrors, blowing toy materials, candles, soap bubbles, straw to drink water, etc. were used at this stage. Noticeable changes to slower and quieter breathing patterns were observed in the last few sessions.

By mid-session assessments, observed behavioral changes included eye-to-eye gaze (focus retained on objects: lighted candle, focus circle, color mat); sitting tolerance; and body posture. Improvements were noted in receptive skills to verbal commands concerning spatial relationship during *trikonasana* (triangle position) and *uttanasana*; imitation skills; self-stimulatory activity; and self-injurious behaviors. Teachers reported increased alertness after sessions.

During the post-assessment, children previously unable to connect with the therapist started coming closer during continuous chanting of mantras; they seemed to enjoy chants as they encouraged a sense of rhythm and a means to work on coordination. Slow mantra chanting witnessed appreciable increases in oral-facial movement imitation skills. Children who initially sat outside the mat, or span or jumped

on the mat, demonstrated discipline by sitting in *vajrasana* when gentle touch was applied on their lower back. Significant changes occurred in communication, language, play, and joint attention. Patterns of eye contact steadily improved, e.g., focusing on the therapist's counts by drumbeat. Over the intervention, children started to trust, share, initiate, and reciprocate. By the 372nd session, all children showed increased vocal imitation skills by imitating vowels "a, e, i o, u" and "OM." They greeted the therapist with a smile, vocalizing "namaste." Parents reported improvement in ability to interact with other children and family members.

Conclusion: A long-term intensive school based yoga-program improves ASD behaviors such as eye to eye gaze, sitting tolerance, body posture, body awareness, depth perception and balance, imitation, repetitive self- stimulatory and self-injurious behavior and receptive skills related to spatial relationships. Yoga therapy may offer families an effective management tool for family-oriented treatment of childhood ASD.

CHAPTER 1

INTRODUCTION

Yoga affects us in ways that are more direct and substantial than just about any other stimulus. We don't know why. We can only begin to understand how. Somewhere between yoga practice and the fullness of our relationships to yoga as an art form lay the pieces of a complex neurological phenomenon. At the interaction of yoga, neurobiology, diverse cognitive processes, and Autism, is the opportunity to construct therapeutic solutions that can simultaneously leverage findings from all of these areas, and direct an experience that can be maximally therapeutic, creative, adaptable, and measurable.

In this thesis I describe a yoga module developed to provide individuals with autism spectrum disorders the opportunity to participate in yogic tasks that directly engage cognitive areas known to be dysfunctional in this population. The result is a technique that can describe cognitive changes that might occur during yoga practice, with implications for innovative treatments and cognition research.

Chapter two reviews the relevant literature according to Indian traditional scriptures and modern science and to describe the current state of autism, yoga therapy, and cognitive training.

Chapter three outlines the aims, objectives and hypothesis for the current research.

Chapter four presents' experimental data used to justify the methodology and design decisions made in the development of the current research.

Chapter five introduces results from the use of assessment tools with autism spectrum disorder children.

Chapter six describes the research results.

Lastly, Chapter seven concludes the thesis by summarizing research study, in addition to outlining strengths and limitations of the study and suggestions for future work.

1.1 Definition and characteristics of Autism Spectrum Disorders (ASD)

Autism is a debilitating condition, but easy to spot when fully manifested. Historically, Kanner L ^[1] (1943), a child psychiatrist at John Hopkins University, characterized 11 children with a previously undescribed syndrome. These children shared a fundamental inability to relate to others, failed to use language to convey meaning, and had an obsessive desire for maintenance of “sameness.” All children exhibited anxiety and fears about common things (e.g. tricycle, running water, egg beaters). Kanner felt that the children were “endowed with good cognitive potentialities, as evidenced by their astounding vocabulary, excellent memory, visual spatial skills, strong interest in numbers, letters and often, precocious literacy”. We have learnt a great deal about ASD since Kanner’s work. Soon after, Hans Asperger described similar behavioral symptomology, decoupled from abnormal intelligence (Asperger, 1944 ^[2]). Although, only in 1994 was Asperger’s syndrome distinguished from autism in a large field trial that brought Asperger’s within the context of pervasive developmental disorders, Asperger’s remains distinct from autism, but within the autism spectrum of diagnoses (Volkmar et al., 1994 ^[3]). Today, it is understood that autism is a complex series of diseases, all with distinct cognitive, etiological, and neuropathological features. In this thesis, unless otherwise specified, autism refers to the entire spectrum of the disease, including subtypes such as Asperger’s syndrome and pervasive developmental disorder-not otherwise specified. Major advances in understanding the biological basis of ASD have taken place. Research on the behavioral cognitive phenotype has expanded, leading to more refined diagnostic practices and better educational and therapeutic interventions.

Table 1 lists DSM-IV-TR criteria for autistic disorders.

Table 1: Diagnostic Criteria for Autistic Disorder

The following criteria are from the 2000 Revision of the Diagnostic and Statistical Manual, Fourth Edition, Text Revision (DSM-IV-TR). See the DSM-IV-TR manual for details and examples.

- A. A total of Six (or more) items from (1), (2), and (3), with at least two from (1), and one each from (2) and (3).
1. Qualitative impairment in social interaction, as manifested by at least two of the following:
 - a. marked impairment in the use of multiple nonverbal behaviors such as eye-to-eye gaze, facial expression, body postures, and gestures to regulate social interaction
 - b. failure to develop peer relationships appropriate to development level
 - c. a lack of spontaneous seeking to share enjoyment, interest, or achievements with other people (e.g., by a lack of showing, bringing, or pointing out objects of interest)
 - d. lack of social or emotional reciprocity
 2. qualitative impairments in communication as manifested by at least one of the following:
 - a. delay in, or total lack of, the development of spoken language (not accompanied by an attempt to compensate through alternative modes of communication such as gesture or maim)
 - b. in individuals with adequate speech, marked impairment in the ability to initiate or sustain a conversation with others
 - c. stereotyped and repetitive use of language or idiosyncratic language
 - d. lack of varied, spontaneous make-believe play or social imitative play appropriate to developmental level
 3. restricted repetitive and stereotyped patterns of behavior, interests, and activities, as manifested by at least one of the following:
 - a. encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus
 - b. apparently inflexible adherence to specific, nonfunctional routines or rituals
 - c. stereotypes and repetitive motor mannerisms (e.g., hand or finger flapping or twisting, or complex whole-body movements)

d. persistent preoccupation with parts of objects

- B. Delays or abnormal functioning in at least one of the following areas, with onset prior to age 3 years: (1) social interaction, (2) language as used in social communication, or (3) symbolic or imaginative play.
- C. The disturbance is not better accounted for by Rett's Disorder or Childhood Disintegrative Disorder

Autism is defined as a spectrum of social impairments, ranging from sheer lack of awareness when Autism and Mental retardation co-exist, to the high functioning Autism or Asperger Syndrome, in which a computer specialist has no interest in social interactions outside his computer screen.

In the social domain, symptoms include impaired use of non-verbal behaviors (e.g. eye contact, facial expression, gestures) to regulate social interaction, failure to develop age appropriate peer relationships, lack of interest to share enjoyment or interests with other people and limited social emotional reciprocity.

Communication deficits include delay in development/ absence of spoken language, difficulty in initiating or sustaining conversation, repetitive language, and imitation and pretend play.

In behavior and interest domain, there are often encompassing/ unusual interests; inflexible adherence to nonfunctional routines; stereotyped body movements; and preoccupation with parts or sensory qualities of objects. To meet criteria for autistic disorders, an individual must demonstrate at least six of the twelve symptoms, with at least two coming from social domain and one each from the communicative and restricted behavior/interests categories. At least one symptom must have been present before thirty-six months of age.

1.2 Prevalence

Studies focusing on preschool children utilizing standardized diagnostic measures of established reliability and validity have given prevalence estimates of 60-70 per

10,000 or 1 in 150 across the spectrum of Autism Disorders and 1 in 500 for children with the full syndrome of Autistic disorder. (Baird G et al, 2001 ^[4])

Despite being the second most populous country in the world, there is a serious dearth of epidemiological research on ASD in India. While estimates suggest that India might have more than 2 million people with ASD, this has never been clinically tested. Using a prevalence figure of 1/250, it may be estimated that there are around 40 lakh individuals with this disorder. It is also estimated that, for every one female with this disorder there are four affected males.

It is also observed that, over the last four decades, there has been a significant increase in the number of persons diagnosed with these problems. Several reasons for this increase have been proposed, such as increased awareness among clinicians, better identification and referrals, more sensitive diagnostic tools, broader classification system etc.

1.3 Causes

A comprehensive theory of causation is still incomplete. Many still believe in the psychogenic causation, majority of experts in the field agree that neurobiological and environmental factors are important causes of autism. A review of literature on causation is somewhat disappointing as the exact cause(s) remain unclear. A variety of causes have been listed in the literature, as given in Table 2.

Table 2: Causes

Prenatal Environment	Perinatal Environment	Postnatal Environment
Teratogens		Autoimmune disease
Pesticides		Leaky gut syndrome
Folic acid		Viral infection
Stress		Excessive hygiene
Maternal antibodies		Oxidative stress
Fetal testosterone		Amygdala neurons
Ultrasound		Vitamin D
		Lead

		Mercury
		MMR vaccine
		Paracetamol
		Television watching
		Wireless devices
		Refrigerator mother
		Other psychogenic theories

1.4 Interventions

According to Schopler E (2001) ^[5], intervention claims range all the way from science to pseudo-science and anti-science. A plethora of treatment techniques often attended by anecdotal reports of dramatic improvement, receives greater publicity. Any treatment technique claiming usefulness needs to address the following questions.

Was the recovery attributable only to the use of this technique, or to one among many other influences on the child's life?

Was the recovery due to the intensity or duration of the treatment?

Was the diagnosis reliably established or were there other conditions or variations of the disorder?

Will the recovery last overtime?

1.4.1. Education and medical intervention

From a medical perspective, ASD does not yet have either specific established cause or treatment. A host of drug therapies to special diets have been tried. The medical model involves an emphasis on the etiology or underlying causal mechanism for Autism. Interventions in this category usually include various anti psychotics such as Hszsaloperidol or Fluphenazine, which have, sometimes resulted in clinically meaningful improvements in hyperactivity, aggression and peer relations.

According to Siegel B (1998)^[6] psychoactive medication treats only symptoms. There are no medications that have been found effective in the treatment of autism as a whole. Small size and heterogeneity of study samples precludes meaningful analysis.

There is no evidence that any particular pharmacologic treatment will dramatically change the core symptoms or course of Autism. However, suggestions that very early treatment with agents such as the selective serotonin reuptake inhibitors may have more profound effects are promising.

There are many therapeutic interventions based on Behavioral Intervention Models such as Pre-school Education Programs for Children with Autism (McClannahan LE and Krantz PJ, 2001 ^[7]); The Princeton Child Development Institute (Harri S and Handleman JS, 1996 ^[8]) and the Young Child Project at UCLA (Lovass IO, 1987 ^[9]). In the UCLA program, Discrete Trail Training (DTT), intensive therapy (40hours/week) and home based therapy is emphasized. The goal is to move the child ahead by main streaming him/her. All these programs derive from the behavioral framework and tradition whose roots lie in the work of B.F. Skinner and the leading theorists and researchers.

Intervention models differ from one another greatly, depending on the cultural, economic, educational philosophies and one's conceptualization of the causes of autism. US Health Care Policy and Research (AHCPR) have formulated an accepted methodology for evaluating treatments ([Jacobson JW](#) & [Mulick JA](#) (2000) ^[10]), wherein over 8000 research reports were reviewed and evaluated using objective criteria for sound research methodology. This process resulted in a group of research studies given in Table 3.

Table 3: Educational Interventions and Medical Management

E <u>d</u> ucational Interventions	<u>M</u> edical Management
Applied behavior analysis	
Pivotal response therapy	<u>P</u> rescription medication
TEACCH	Supplements
<u>D</u> IR/Floor time	Diets
Communication interventions	Cannabis

Sensory integration	Craniofacial therapy
Animal-assisted therapy	Hyperbaric oxygen therapy
Neurofeedback	Prosthetics
Son-Rise	Stem cell therapy
Packing	Chelating therapy
Patterning	

1.4.2 Complementary and Alternative Medicine (CAM) therapies for ASD

Many parents appear to be using Complimentary and Alternative Medicine (CAM), as no single intervention has proved effective in alleviating the core symptoms of autism spectrum disorders (Hyman S and Levy S, 2000 ^[11]). The reasons for opting for CAM are many- Poor access to treatment, lack of agreement as to what treatment or combination of treatments is the best in terms of outcomes, unacceptable side effects with prescription medications (Roger SJ, 1998 ^[12]). Though there is no agreed cause for autism and to date, no cure, yet reports exist of significant recovery through various combinations of mainstream and alternate medicine treatments. Available drug therapies, at best, can only alleviate some of the symptoms and sometimes cause undesirable side effects. Many parents often tell us that there is no time to wait for the science to prove the efficacy of a particular treatment as they are racing against the clock to take advantage of the early childhood neuro-plasticity and are willing to try CAM treatments, especially Yoga therapy (YT), which is non-invasive and without any harmful side effects. It is widely known that, yoga can enhance our physical and emotional well being, but when yoga is practiced as a therapeutic intervention in the form of yoga therapy, it can help prevent and aid recovery from physical and mental ailments. Yoga has long been practiced with therapeutic intention as a way of transforming both the body and mind.

Yoga therapy falls under CAM therapies and these therapies are based on a wide variety of conventional and unconventional medical and philosophical belief systems. CAM has been defined by the National Centre for Complimentary and Alternate Medicine (NCCAM) as a “group of diverse health care systems, practices and products

that are not presently considered to be part of conventional medicine". It has been reported that up to 50% of children with autism use CAM in USA (Nickel R, 1996^[13]). There have been reports about YT being used with children with autism in conjunction with some conventional intervention but not in isolation. Major rehabilitation hospitals and clinics have adopted YT with various conditions, but little is written to describe these practices and their outcomes with reference to ASD.

1.4.3 Yoga for ASD

Behavior of ASD children and adolescents has a negative impact on their families, schools, and communities. Common treatments include medication, behavior management, psychosocial and family programs in various combinations. These treatments have some success, but there is need for improvement in response and relapse rates following treatment. Yoga encourages participants to be actively and independently involved in their own treatment and self-management through respiratory awareness and manipulation, postures and cognitive control. Yoga practices have a positive effect on brain wave frequencies (Banquet JP , 1973^[14]), glucose metabolism (Herzog H et al, 1990^[15]), neurotransmitter activity (Newberga AB and Iversenb J, 2003^[16]) and the autonomic nervous system (Uyterhoeven S,2006^[17]) all of which are affected in disruptive behavior. In young people, yoga and similar mind - body approaches have been shown to increase sitting tolerance, eye gaze, and imitation, improve posture and balance and reduce repetitive stereotyped self-injurious behavior. However, there are not many research studies clearly indicating the efficacy of yoga with ASD children. (Pauline S J & Kenny DT, 2009^[18])

1.5 Why this study?

Yoga may prove to be a useful tool for children with ASD because it has the potential to meet many of their needs. After observing difficulties that ASD children face, it was thought yoga could provide a sound basis for helping these children to get

in touch with their bodies. Visualizations used with most asanas may help to engage the mind and relax the body, strengthen muscles and improve flexibility (Goldberg L, 2004 ^[19]). It addresses those who are floppy and those who are rigid (Molly K, 2002 ^[20]) and helps achieve co-ordination and balance (Betts DE, 2006 ^[21]). Our observations while working with ASD children for the past ten years has pointed to many positive benefits and success at every stage. Through yoga, children were able to learn to identify tension within their bodies and breathing exercises helped them to recognize when they were experiencing agitation. By slowing down the breathing rate, hyperactivity would reduce. The language of yoga is very simple and can, in fact, be conducted without words at all. Although these techniques were used regularly and the observations were encouraging, there were no publications on the documented efficacy of yoga in ASD. Hence this study was planned to systematically document the effect of integrated yoga program in treating ASD.

CHAPTER 2

REVIEW OF LITERATURE- TRADITIONAL SCRIPTURES

“(केन) किं तज्ञानं एन अश्रुतं श्रुतं भवति,
अविज्ञातं विज्ञातं भवति,

अमतं मतं भवति ।” (छान्दोग्योपनिषद्)

kena kim tajñāna yena aśruta śruta bhavati

avijñāta vijñāta bhavati

amata mata bhavati | chandogyopani ad |

“Which is that knowledge by which the unheard becomes heard, the unknown becomes known and the unaccepted becomes accepted?”

2.1 AUTISM ACCORDING TO AYURVEDA

Ayurvedic medicine is one of the world’s oldest and most complete systems of natural healing which offers comprehensive and holistic treatment for physical and mental disorders. It promotes physical health and healing of the mind through diverse methods focused on treating all the physical, psychological, and spiritual aspects of each individual affected with physical and mental disorders.

Ayurvedic medicine offers the opportunity to understand the nature of the mind in a way that is completely unique and quite different from the Western Psychological and Psychiatric medicine models. “Ayurvedic medicine views psychotic disorders (unmada) as the imbalance of energies on an inner level. According to Ayurveda and occult science, behind the gross physical body, there is a subtle or astral body composed of the life-forces, emotions and thoughts. The “Astral” is a subtle form or underlying energy pattern of the physical form, from which the physical body is produced . (Frawley, 2004 ^[22])

Ayurveda, the health science of India, does not refer to autism as a specific entity under classification of diseases. It is not mentioned in any of the major ayurveda texts

including Charaka Samhita (चरक संहिता) and Kashyapa Samhita(काश्यप संहिता) [23] . However, certain signs and symptoms seen in an adult autistic individual are described under Unmada (उन्माद). There is no description of childhood autism. The entire description may be grouped under Schizophrenia (present day terminology). Some of the features that we now recognize as ASD in children are described under the term with different types of seizures of childhood epilepsy.

2.1.1 “Autism “,in Ayurveda can be correlated to Balagraha/ Jada/ Unmada.

Definition of Autism in ayurveda can be- Any imbalance in the form of bhramsa of dhi, dhrti or smrti, whether collectively or singularly; if caused, an indulgence in unwholesome action, it is termed as prajnaparadha. Its direct consequence is sarvadosa prakopa and various types of derangements in buddhi as well as in physiological functioning and ultimately it becomes an important causative factor of the diseases.

Acarya Caraka has enumerated the causative factors of all the diseases in a nutshell under the three heads viz. asatmyendriyarthasamyoga, prajnaparadha and parinama. Out of these, highest significance has been attached to prajnaparadha (Ca. Su.1/54; Sa. 1/102,109).

A consolidated specialty of prajnaparadha has been mentioned by Caraka that the visama or anucita (improper or imperfect) knowledge and visama pravrtti is collectively known as prajnaparadha and it is an object of manas.

Other than the three types of buddhi dosas which have been held responsible in causing various types of pathologies, there are certainly other types of buddhidusti, which has been discussed at various places in Ayurvedic classics in a scattered manner. Generally speaking these buddhi dosas may be identified as purely psychological derangement. So, for psychological type of buddhidusti ,examples of unmada, apasmara, mada, murcha, sanyasa, moha etc. can be cited. Acarya Susruta has mentioned different types of buddhidustis which are psychological viz. krodha, soka, bhaya, harsa,visada, ersya, abhyasa, dainya, matsarya ,kama, lobha etc. and they have originated from iccha or dwesa (Su. Su.1/25). On screening of the Ayurvedic references , the following types of buddhi dushtis may be identified.

2.1.2 Sthayi Buddhi Dusti:

Person and specially children, may be witnessed having a defect in the buddhi right from birth and that generally extend to the end of life in greater or lesser degree .Various factors that may be responsible for sthayi buddhi dushti may be :

- (1) Complete buddhi nasa or abuddha,
- (2) Buddhi jadata,
- (3) Buddhi mandya
- (4) Nirbuddhi.

Out of these a complete buddhinasa or abuddham is the condition where the children are totally idiots and this condition is supposed to be incurable. (Ca.Sa.8/21; As.Sm..Sa. 2/37).

Jadata and buddhimandya are the conditions where the mental development is found to be impaired, children either understand little or understanding is delayed, or there is no sharpness in the intelligence. This condition, by appropriate treatment, may be corrected to some extent. Perhaps with this ideology, various buddhi sharpening recipes e.g. Medhya rasayana etc. have been prescribed by the ancient Acaryas. Nirbuddhi is also a condition where the absence of dhi, dhrti and

Smrti is witnessed. However, such children recognize the pain and desire or satisfaction of natural urges. These persons may also be corrected by appropriate treatment to some extent, just to enable them partially adjusted in society.

2.1.3 Asthayi Buddhi Dusti:

The other type of buddhi dusti, which may be of temporary nature , is acquired through various narcotic substances and dusta ahara. This will be evident from the reference given in the context of madatyaya as well as the definition of madaka substances.

Accordingly the asthayi buddhi dusti may be termed as under –

1. Buddhi lopa
2. Muhur smrti, Muhur moha.
3. Samjna sammoha

4. Samjna akulata
5. Manas cesta aksepa
6. Dhi vibhramsa
7. Smrti apagama

All these conditions are caused either due to excessive consumption of madya or rakta dusti or the tridosa. Giving appropriate treatment prescribed for madatyaya, mada , murcha, unmada and apasmara may correct these conditions if they are of very acute nature and necessitate emergency attention. However, in mild conditions, as soon as the last remnants of narcotics are excreted out of the body, the individual may regain the normal state of the dhi, driti and smrti. Only a beneficial diet has to be arranged and a little psychotherapy has to be applied. Prajnapradha is also a temporary type of buddhidusti, if it is caused by the above mentioned causative factors and the same may be corrected by the appropriate treatment.

2.2 Aetiopathogenesis of Jada

Jada is a condition of buddhi, where there is impaired perception, retention and recollection of the knowledge. It has been mentioned by Acaryas that atiyoga, mithyayoga and hinayoga of any entity as kala, buddhi, indriyarthas can produce this disease. Even Acarya Caraka has separately emphasized **that atiyoga, mithyayoga or hinayoga** of the manas together with buddhi can make the etiology of the disease. Here, in **jada** also, there is poor genesis of knowledge due to hypofunction (hinayoga) of manas and buddhi (with its sub component i.e. dhi, dhrti and smrti).

The genesis of knowledge is not a mono faculty phenomenon. Many other factors play their role equally. The indriyadhistanas are first entity, which receives the objects, but for the production of knowledge the participation of indriyas and manas is necessary; in the process of the genesis of the knowledge buddhi becomes a functional state. But indriyas, buddhi and manas can not work

absolutely, they are also dependent on pranavayu and udanavayu. Sadhaka pitta, alocaka pitta (buddhi vaishesika), avalambaka kapha and oja have been described in the Ayurvedic classics. Hypo activities of all these entities can impress upon the hypo function of buddhi.

Keeping this in mind, pathogenesis of mandabuddhitva can be described as follows:

The manas and buddhi are derived from atmaja and satvaja bhava and their qualities depend upon the deeds of the previous birth and the ratio of satva, rajas and tamas guna at the time of fertilization. The higher concentration of tamasa guna ,either due to previous karma or other conditions at the time of fertilization ,can have an impact on the normal physiology of buddhi, resulting in its hypo functioning and the foetus affected is born mentally deficient. This condition may also be possible in case of abnormality of bija, bijabhaga or bijabhaga avayava, especially the part which is responsible for buddhi.

Various etiological factors like dishonored longings of a pregnant woman, excessive consumption of vata vardhaka ahara, intake of alcohol, excessive sleeping by a pregnant lady vitiate the dosas (the vata dosa mainly). This provoked vata either directly reaches the foetal heart through nabhinadi or may form an avarana i.e. pranavrta Samana, which results in jada or aggravated vata, vitiates kapha and the two reaches the foetal heart, through the nabhinadi. The dosic predominance in balyavastha is that of kapha; hrdaya too, is a seat of kapha dosa. Thus vata

along with kapha obstruct the functions of entities having their seat in the hrdaya such as manas, buddhi, pranavayu, udanavayu, sadhaka pitta, alocaka pitta (buddhi vaisesika) and oja. On the other hand, kapha itself is dominated by tamobhava. The hypo function of all these entities and higher concentration of tamasa guna can manifest into the hypo functioning of buddhi.

During delivery, if there is any trauma (abhighata) especially on head, which is also a seat of indriyas, it may effect the indriyas leading into hypo functioning of the buddhi In the postnatal period, kaphaja milk feeding to a child provokes the kaphadosa and this aggravated kapha creates sanga (obstruction) in the manovaha srotas in the hrdaya which is the seat of buddhi and its functional units. It results in impaired genesis of knowledge and causes jada.

2.3 MANAGEMENT

In Ayurveda, not only the physical disease, their prevention or treatment are given importance, but also the mental diseases and their prevention and treatment have been given equal importance. In this context, various rules of mental hygiene such as 'sadvritta' and various drugs such as Medhya rasayanas have been prescribed by Ayurvedic Acaryas. Regarding the psychological disorders of a child, Acaryas have indicated to prevent the psychological disorders of a child, not only since birth but also since before birth and various drugs have been prescribed to stimulate the intellectual ability of a child. In this direction, Ayurveda has thought on step further. Even during the rtukala, women have been advised to follow certain codes to have intelligent progeny.

All these measures can be divided into two groups as under –

1. Preventive Measures
2. Specific Measures

2.3.1 Preventive measures:

They can be further subdivided into –

a). Before conception

In Ayurveda, the consanguineous marriage has been prohibited, not only by Caraka and Susruta, but even modern sexologists and biologists have described it. Acarya Bhela has clearly mentioned that to prevent the disease of medhadi the consanguineous marriage should be avoided. Before going for conception, the Acaryas have prescribed an extensive and exhaustive list of restrictions and rules for a woman which may affect the child's psychology. To have a healthy and intelligent progeny they should be followed strictly.

b). Prevention during Pregnancy

In the context of Garbhopaghatakara bhavas, Acarya Caraka has advised to avoid various dietetic regimens, habits and trauma; otherwise they can lead to abortion of birth of a child and various psychological disorders e.g. excessive sleep. An excessive consumption of alcohol by a pregnant woman may deliver an idiot with poor memory or hyper activated or mentally impaired child. In the fourth month of pregnancy, the

foetus heart which is the seat of consciousness, becomes active, hence it expresses its desires through the mother, this state is called dauhrda. The wishes and desires of Dauhrdini, if not honoured and gratified, may lead to various congenital abnormalities such as kubja, khanja and jada a mental derangement, and therefore importance should be given to the fulfillment of dauhrdya.

c). Prevention during Delivery

During the second stage of labour, Susruta has pointed out that, on not following the instructions for bearing down the pains by an asannaprasava, women may lead to congenital abnormalities such as trauma etc. and it may result in psychological abnormality.

d). Prevention during the neonatal period of child

In this respect, in Ayurvedic Neonatology, there are two terms viz. Jatakarma and Jatamatra. The jatakarma is a samskara that should be performed after establishment of the respiration in a neonate. During this madhu, ghrta and swarna in an equal proportion with chanting of the Vedic mantras are fed to the child for promoting medha and bala. The basic aim behind this jatakarma is to stimulate the intellectual ability of the child from the neonatal period. The other term, jatamatra, refers to the stage of recently born infant and for protection of child from infections, and cleansing methods are adopted to establish the normal life. At the same time, prana pratyagamana (resuscitation) in the form of physical stimuli, mukha sleshma shodhana etc. are carried out; the aim of these methods being to provide pranavayu in sufficient quantity to prevent the asphyxia which is a common cause for mental abnormality and sometimes for the untimely death of the infant. Further, the Acaryas have also described various other necessary methods to prevent the physical and mental disorders. They are raksakarma, dhupanakarma etc. Various dharana drugs have been mentioned to improve the ayu, medha and smrti.

2.3.2 Specific Treatment:

In Ayurveda, various remedies have been described by the Acaryas to improve the mental ability. Acarya Caraka has mentioned four Medhya rasayanas which are

Mandukaparni, Madhuyasti, Guduci and Shankhapushpi. Acarya Kasyapa has mentioned some lehas - Kalyanaka ghrta, Brahmi ghrta, Pancagavya ghrta, Samvardhana ghrta.

Acarya Vagbhata (A.Hr.Ut1/47-48) has advocated four yogas to promote the medha, bala and varna of a child. They are as under –

1. Fine powder of Swarna with Ghrta, Vaca and Kusta.
2. Matsyaksi, Swarna, Vaca, Ghrta with Madhu.
3. Arkapuspi, Ghrta, Swarna and Vaca with Madhu.
4. Swarna curna, Kaidarya, Swetadurva and Ghrta with Madhu.

Acarya Susruta opines that continuous practice of learning i.e. following abhyasa, also improves medha and buddhi. This principle of Susruta can be very fruitful for the mentally deficient child in form of special education and teaching.

Apart from these drug therapies, there are certain other methods of improving the memory about which Acaryas have discussed in different contexts. One of them is abhyasa, which refers to continuous practice. Similarly samadhi and yoga also sharpen the memory and elevate the level of buddhi. This principle of Susruta is very much important and is a fundamental factor behind all the learning processes.

2.4 Definitions of unmada

The following excerpts from Charaka Samhita explain several features that seem to point to the symptoms in ASD under the heading of Unmada Dhee Vibhrama (धीविभ्रमः) The intellectual confusion, Paryakula Drsti (पर्याकुला दृष्टि) unsteady vision, Satwa Pariplawa (सत्त्वपरिप्लव) fickle mind, Adheerata (अधीरता) Lack of courage, Aabadha Vaaktvam (अबद्ध वाक्त्वम्) indistinct and incoherent speech, Hridayam Cha śunyam (हृदयं च शून्यम्) lack of insight or imagination or inability to process sensory information. These are the general signs and symptoms of Unmada.

2.4.1 Types of Unmada

धीविभ्रमः सत्त्वं परिप्लवश्च
पर्याकुला दृष्टिरधीरता च ।
अबद्धवाक्त्वं हृदयं च शून्यं

सामान्यमुन्मादरादस्य लिङ्गम् ॥ (च. सं. चि. ९/६)

dhīvibhrama satva pariplavaśca

paryākula diradhīratā ca |

abadhavāktva hdaya ca śoonya

sāmānyamunmādarādasya ligam || (ca saṁ ci 9/ 6)

Such a person with indecisive mind becomes incapable of experiencing emotions, conducting himself appropriately and his memory (स्मृति), intellect (बुद्धि), and cognition (संज्ञा) get altered (sloka 6, chapter 9).

स मूढचेता न सुखं न दुःखं नाचार

धर्मो कुत एव शान्ति ।

विन्दत्यपास्तस्मृति विद्ध संज्ञो

भ्रमत्ययं चेत इतस्ततश्च ॥ (च. सं. चि. ९/७)

sa mooacetā na sukha na dukha nācāra

dharmo kuta eva śāntim |

vindatyapāstasmti viddha sañño

bhramatyaya ceta itastataśca || (ca sa ci 9/7)

Further Charaka explains the term Unmada as,

समुद्भ्रमं बुद्धिमनः स्मृतीनामुन्मादमागन्तुनिजोत्थमाहुः । (च. सं. चि. ९/८

samudbhrama buddhimana smṛtīnāmummadamāgantunijotthamāhu | (ca saci 9 / 8)

Unmada refers to indiscriminant knowledge. The texts mention that in unmada, all the three major cognitive functions including Buddhi-the discriminatory knowledge, the manas-perceptual ability of the mind and smṛti-the memory of the knowledge about the objects and experiences of the past, are all disturbed.

In Charaka Nidana, the state of Unmada is further explained under the following sloka:

उन्मादं पुनर्मनो बुद्धि संज्ञा ज्ञानस्मृति

भक्तिशील चेष्टाचार विभ्रमं विद्यात् ॥ (च. सं. नि. ७/५)

unmāda punarmano buddhi samjñā jñānasm ti

bhaktiśīla ce ācāra vibhrama vidyāt | (ca sa ni 7/5)

Unmada means altered function of Manas, Buddhi the discriminatory power, samgna (संज्ञा) -the sense organ perception, Gyana- (ज्ञान) the knowledge, Smrti (स्मृति)- the memory, Bhakthisheela (भक्तिशील). -devotion or any form of emotional expression and Chešta (चेष्टा) -physical activity level with hyperactivity.

In the ancient texts of Ayurveda, there are detailed descriptions of mental disorders known as “Unmada” and schizophrenia can be correlated with many of the types of “Unmada”. Ayurveda physicians describe schizophrenia as a disorder of the mind caused by the doshas (pitta, kapha, and vata) moving in the wrong paths due to increased toxicity.

Three types of insanity (unmada) are described under Wind Insanity (vayu), Choleric Insanity (pitta),and Phlegmatic Insanity (kapha) .Conjunctive Insanity (trisdosha) is a combination of all three.

Frawley ^[22] states that “Wind gives rise to the following: an emaciated body; inappropriate lamenting, **shouting, laughing**, and smiling, as well as dancing, singing, playing music, talking, posturing, bursting out; repeatedly and tunelessly imitating the sound of a flute, veena, or other instrument; frothing at the mouth; **constantly wandering about**; ceaseless talking; using things which are not ornaments as decoration; trying to travel on things which are not vehicles; being greedy for food, but spurning it once it has been obtained; bulging, bloodshot eyes and illness after food had been digested.”

When vata is in excess ,it makes us ungrounded, spaced-out and unrealistic. High vata in the mind manifests as fear, alienation, anxiety and possible nervous breakdown. There is **insomnia**, tremors, palpitations, unrest and **rapid shifts of mood**.

Choleric Insanity: (pitta) : Pitta results from indigestion, excess of hot, pungent, sour, or burning foods and liquids; excess pitta afflicts the heart of the person leading

to lack of self-control. High pitta in the mind **causes agitation, irritation, anger, and possible violence.**

Phlegmatic Insanity: (kapha) Phlegm causes the patient to lose any **desire for food.** It causes the patient to enjoy solitude. This aggravated kapha afflicts the heart, troubling the mind and memory.

Frawley et al ^[22] stated that “ kapha evolves attachment and lack of motivation leading to depression, sorrow and clinging. The mind may be incapable of **abstract, objective or impersonal thinking.** There is lack of **drive and motivation** along with passivity and dependency”.

Conjunctive Insanity: (tridosha) when there is a conjunction of all the sources of disease and symptoms, then the resulting problem is dreadful. Unmada is caused by the excessive presence of all three doshas.

2.4.2 Causes of unmada according to ayurveda

i. Diet

Causes of Unmada or autistic feature is described in Vimanasthana of Charaka Samhita 5th chapter in the following śloka.

विरुद्ध दुष्टाशुचि भोजनानि

उन्मादहेतुर्भयहर्षपूर्वो

मनोऽभिघातो विशमाश्चचेष्टः ॥

viruddha du āśuci bhojanāni

unmādaheturbhayahar apoorvo

mano'bhighāto viśamāścace ā ॥

unmada is caused by consuming food or drink which are Viruddha (विरुद्ध) (mutually contradictory), Dushta (दुष्ट) (polluted) and Asuchi (अशुचि) (impure).

ii. Personality trait

Further causative factors mentioned for Unmada is explained in the following śloka :

तैररूपसत्वस्य मलाः प्रदुष्टा

बुद्धेर्निवासं हृदयं प्रदूश्य ।

स्रोतांस्यधिष्ठाय मनोवहानि

प्रमोहयन्त्याशु नरस्य चेतः॥ (च. चि. ५/९)

tairarupasatvasya malā pradu ā

buddhernivāsa hdaya pradoośya |

srotā syadhiāya manovahāni

pramohayantyāśu narasya ceta || (ca ci 5/9)

Purusha is made up of small channels or micro channels called “SROTAMSI” (स्रोताम्सि) through which body gets nourishment. Disease occurs because of vitiation of these Srotamsi due to mithyahara. In the context of Unmada Samprapthi it is stated that the vitiated dosas (Vata, Pitta, Kapha) afflict the Manovahasrotas thus afflicting the intellect of a person having **less of Sattva (Alpa Satva) resulting in Unmada.**

iii. Maternal stress during pregnancy

Sushruta’s explanation about the cause of Unmada is explained in the following shloka

दौहृदविमाननात् कुब्जं कृणिं खञ्जं जडं ।

वामनं विकृताक्षमनक्षं वा नारीसुतं जनयति ॥

तस्मात् सा यद् यदिच्छेत्तस्यै दापयेत् ।

लब्धदौहृदा हि वीर्यवन्तं चिरायुशं च पुत्रं जनयति ॥ (सु. सं. शा. ३/१५)

dauh davimānanāt kubjki khañjajaam|

vāmanaviktākamanaka vā nārīsuta janayati ||

tasmāt sā yad yadicachettattasyai dāpayet |

labdhadauhṛdā hi vīryavanta cirāyūśa ca putra janayati || (su sa śā 3 / 15)

The desires of the fetus are expressed through the mother. Hence Daurda (दौहृद) should always be fulfilled, because the negligence or non-fulfillment can cause

abnormalities or even death of the fetus. Whatever Daurda the woman desires, it should be fulfilled , except those that are likely to be injurious to the fetus.

2.5 Treatment of autism according to Ayurveda

Ayurvedic medicine is a holistic system of medicine that treats mental disorders from mild stress to severe condition, including insanity (psychosis). “Ayurveda employs whole series of yogic and spiritual therapies, including meditation, pranayama, mantra, prayers and visualizations”.

Ayurvedic treatment method reportedly works on balancing the biological humors through appropriate physical remedial methods of diet, herbs and exercise. One of the best Ayurvedic treatments for Unmada includes panchakarma chikitsa. According to Frawley^[22], all psychological disorders, including psychotic disorders ,reflect imbalances of the three biological humors. He says, “Health problems, whether physical or mental, are not merely personal problems, but energetic problems in the mind-body complex. They are not so much personal or moral failings as an inability to harmonize the forces within us”. The imbalances caused by the lack of harmony in our lives weaken the doshas that afflict the heart where there is less sattwa in one’s life and the mind. The disease develops through the manovaha srota that sends psychic energy to the mind.”

2.6 Treatment of autism according to Yoga

2.6.1 Concept of Body

Medical science studies the human body starting from complex DNA and RNA molecules forming the cells which are the fundamental units of life. Distinguishing the dead and living cells, it postulates that the functioning of cells with locomotion and reproductive capabilities makes it different from a dead cell which has neither of these activities. The study of dead cell is the subject matter for physics and that of living ones is biology. The laws of physics are well understood: The structure of the physical world is contained ultimately in Quarks or packets of energy and the famous equation $E=MC^2$ describes the quantum of energy contained in each matter. The functioning of physical objects follows certain well defined laws - Newtonian laws called classical mechanics for all normal macroscopic operations and Quantum mechanics describe

atoms, protons, neutrons and fundamental particles, the microscopic objects. Extremely high speed functions also follow laws of Relativity which boil down to normal Newtonian mechanics when the speeds are far away from that of light.

The living systems are studied in biology and the human systems in Anatomy and Physiology to understand the structure and functions of human body. The cells being the fundamental units of life, the study starts with them; they form the tissues which in turn come together to form organs and systems are the result of several complex permutations and combinations of these organs, tissues and cells. The systems are knit together to form the physical body. Modern physiology on the other hand looks at the functioning of these systems and the laws that govern them are not very well understood in terms of mathematics or those tools used in Physics. Biological system analysis is being attempted in the same way as physical system analysis.

If it be true that matter creates life, then it should be possible to create life out of matter. This was fervently attempted as Scientists and biologists did their lot in all top research laboratories to create matter by replicating a DNA and RNA molecules in 1970s and 80s. As we progressed successfully in replicating a DNA with all its complex structure, neither did it develop any characteristic of life nor did it show any feature of biological systems. By 1990s Scientists were convinced that there is something else which makes the dead cell live and probably it cannot be created by matter. Something like life should come from outside of matter, it looked.

2.6.2 Concept of Mind

According to modern medical science mind is nothing but functioning of brain cells. Contained in this definition is the matter based paradigm that everything originates from physical body and there is nothing apart from matter. The functioning of the brain which is nothing but mind can be measured by EEG, FMRI, etc.

As trials to create life out of matter failed, attempts to create mind out of brain through studies on brain functioning brought no success. A dead brain cannot make it function or replicate robotic brain powered by electrical power cannot bring the creative dimensions of mind. Seminars and workshops debated the question "Whether

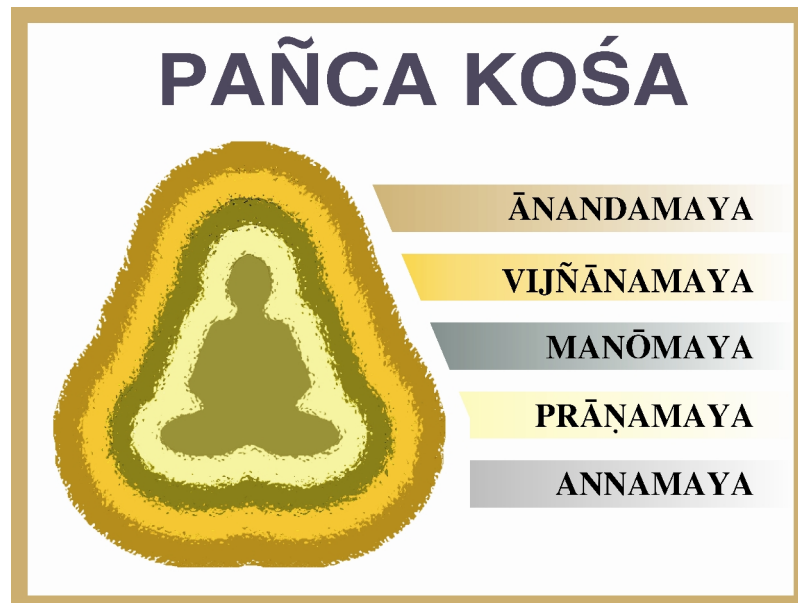
brain can create consciousness? Can a robot equal a living brain? Can artificial intelligence with sophisticated software instilled in brain networks function as a living brain? Can brain as a super computer with its tremendous capacities of memory, software to control the whole body be indicative of emergence of consciousness? etc." has clearly brought out the conclusion that consciousness is something different from mere functioning of brain. Consciousness as an independent substance is being considered and consciousness studies have started becoming more and more popular even in conferences on Physics.

2.6.3 Mind-Body Interactions

The mutual interaction of mind and body is well recognised today. A restless mind or an anxious mind can bring about sympathetic arousal through triggering of higher centers of the brain has become well known. Similarly the changes at body level bring profound changes in the mind as a patient with diagnosed cancer in the body has tremendous fear of death. A person with migraine cannot do his normal functioning using his mind. A disturbed mind reduces the efficiency of action. There are disorders of mind as neuroticism or anxieties which can bring lot of electrical and chemical changes in every part of the body including the cells and genes. A calm state of mind induced by techniques like Transcendental meditation can induce deep rest to the body can set its problems right, increase efficiency in action, promote positive health, etc. Similarly there are several Physical techniques as Asanas, Pranayama, Bandhas, Mudras, in Yoga which can induce calm state of mind. The interaction of mind-body is well known and mind-body medicine is becoming more and more popular than modern medicine which is based in the matter based paradigm.

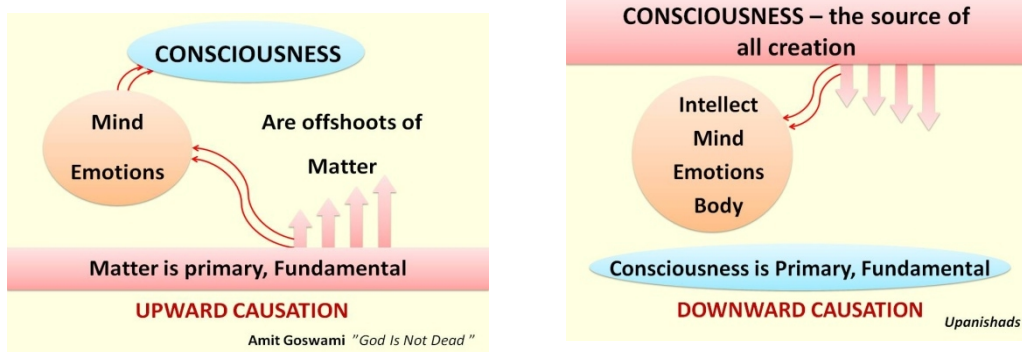
2.6.4 Pancha Koshas

The concept of body in Yoga and spiritual lore takes us to deeper understanding than mere physical body. There are unseen layers of subtle and causal bodies which encompass the gross physical body. The panchakosha description contained in upanishads give a vivid picture of the five bodies which we all possess.



2.6.5 Consciousness based approach

In contrast to matter based paradigm described earlier, Yoga and Spiritual lore of



Indian wisdom base postulates an opposite world perspective. According to Upanishads, Consciousness is primary and matter is the end product. From unchanging reality which is all fullness, with infinite power, knowledge, bliss and freedom brings out creation to show off as if, it's innate power by its mere will. [Asad va idamagra aasit. Sa tapo tapyata, sa tap[as taptva idam sarvam asrjata - taittireya] From pure consciousness emerge the five layers of its causal, subtle and gross manifests appear. They show up as five layers of consciousness - Anandamaya, vijnanana maya, Manomaya, pranamaya and Annamaya koshas. Creation, sustenance and destruction is the tri fold law that governs all layers of consciousness. It is known today that every day a billion cells get created and a billion get destroyed even in the physical body. Every minute we are different human beings.

There is continuous interaction of all the five Koshas. Any change in any of the koshas will reflect in other four koshas also. It is a single cognitive consciousness network, we can say. So it is not only body-mind interaction but all koshas working together as a single entity that makes all of us.

2.6.6 The Three Gunas

We are all made of permutations and combinations of three fundamental personality traits called Gunas. Tamas is the grossest which leads to inactivity, lethargy, drowsiness, sleepiness, slow learning, and resistance to any action in general, etc. Tamas is darkness and ignorance. Rajas, the next, are to shine. A person who is rajasik is brilliant, dynamic, full of energy and vitality, always ready to work and often becomes a workaholic. But his actions are all governed by selfish actions to amass wealth, acquire name and fame, etc. He is fully focused. But this type of action will lead him to great stresses and tensions which in turn can be the cause of modern life style diseases. Sattva, the third is the best of the three. Sattvik personalities are having reduced selfishness, full of divine virtues - love, magnanimity, compassion, service attitude, sharing with others, etc.

New age life style disorders as Asthma, Diabetes, cancer, mental disorders including Autism etc are essentially due to rajs; may be excessive Rajas. They are all related to our life styles. Rajasik life style of Speed and Greed bring great stresses which result in these diseases. The personality traits ,Gunas, show up as Heredity tendencies which play a great role in all our actions and behavior patterns, They show up even in our life style. While this is an important subjective factor, there is also an influence of external forces which can modify the life styles effectively. For example, a born sattvik person can become rajasik under the influence of modern life style. Similarly if a proper atmosphere is created, a Rajasik sick person can regain his health and move towards Sattvik personality and change his entire life style.

There is yet a third factor in all of us. That is freedom to change consciously. That freedom can be used to make or mar ourselves. If we use it constructively to improve ourselves, it becomes Yoga.

2.6.7 Gunas and Disorders

The modern life style disorders can be effectively handled using right techniques of Yoga. Similarly some disorders such as MR, CP, Slow learners, ASD, etc look as having all influence due to hereditary or born deficits. The modern life styles do not appear to influence them or we can say that the influence is marginal. However it is heredity on one hand and life style on the other hand which make the human system go out of balance called disease or disorders. They show up as imbalanced Gunas and Doshas in our Koshas.

Yoga goes deeper in its understanding of heredity as manifests of deeper personality traits of Tamas ,Rajas and Sattva at manomaya kosha. These traits descend down to Pranamaya kosha as Doshas and show up as disorders in the annamaya kosha, called vyadhis. And there is continuous interaction of freedom in all of us and these gunas every moment. Using our freedom we can change our Gunas effectively.

Gross changes in the body can be detected, diagnosed and measured for their severity by modern diagnostic tools very effectively. However, subtle changes in the Pranamaya and manomaya koshas where diseases originate , go undiagnosed by modern diagnostic tools.

Table : 3.1

Comparison of different learning / behavior disorder

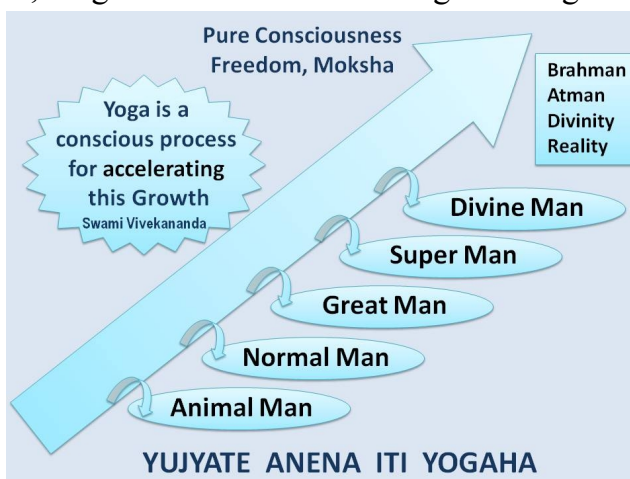
Normal : +, Good : ++, Excellent : +++

Deviant : -, Severe : --, Highly deviant : ---

Sl No	Variable	ADHD	Down's	Others types Of MR	ASD
1	Sense perception (MANAH)	+	-	-	-
2.	IQ (BUDDHIH)	+++/+/ -	-	-	+ /+++
3.	Memory (CHITTAH)	-	--	---	+ /+++ /+++
4.	Emotions (BHAVANA)				
4.1	Negative emotions - aggressive	-	+	+/-	+/-
	Self injurious	+	+	+/-	--
	Agitation-Meaningful	+	+	--	--
	Meaningless	+	-	--	--
4.2	Positive emotions				
	Happy-Meaningful	+/-	++	+/-	-
	Meaningless	+	+	-	-
	Socializing	+	++	+	---
	Loving	+	++	+	+/-
5.	Creativity	+	--	--	+++
	(SRJANASHEELATA)				
	Music	+	+	+/-	++
	Art,	+/-	+/-	+/-	+++
	Dance	+/-	+/-	+/-	+/-
6.	MOTOR				
	(KARMENDRIYA)				
	Stereotypy	+++	+	+	---
	Repetitive movements	++	++	++	---
	Co-ordination, Dexterity	-	--	---	--
GUNAS					
TAMAS	Sleep	+	+	+	-
	Dullness	+	-	--	+/-
	Lethargy	+	--	---	++/--
	Obstinate	-	--	--	---
	No touch with reality	+	-	--	---
	Uncontrollably destructive	+/-	-	--	+/-
RAJAS	Aggressive	+/-	+/-	-	+/-
	Restless	-	-	--	---
	Unstructured activity	-	-	-	---
SATVA	Happy	+	+	+/-	+/-
	Comfortable	-	+	+/-	-
	Loving	+/-	++	+/-	+/-
	Soft	+/-	+	+/-	+/-
STATES OF MIND					
1	CHANCHALATA	--	--	--	---
2.	Capacity for EKAGRATA	--	--	--	---
3.	DHARANA	---	---	---	---

2.6.8 Yoga, the science of holistic living

Yoga is a conscious process for elevating ourselves from our animalistic level to normal human levels to become great human beings, super and divine human beings, ultimately reaching divinity itself. While most of us learn through our interactions with the surroundings and with experience, Yoga uses the innate intelligence to grow. This conscious process with intelligence featured by creativity leads to acceleration of one's growth. The four streams of Yoga - Jnana Yoga, Bhakti Yoga, Raja Yoga and Karma Yoga work at the level of logic/Analysis, emotions, will power and action levels respectively. The innate freedom in all of us, help to grow fast and accelerate our growth. Used at all levels, our life style will change and become holistic. Yoga as a science of Holistic living can manifest more and more power inherently present within all of us can remedy many of the disorders which appear to be essentially heredity or born deficits as ASD, MR, etc.



2.6.9 Yoga and Autism spectrum disorders

Looking at the symptoms of ASD as described in modern medical terminology presented in Chapter 1 of this thesis, it looks that the connection between Annamaya and Manomaya Koshas are impaired. In Schiz also a similar thing happens and often Autism is called as childhood Schizophrenia. The mind instead of flowing down through the pranamaya Kosha to Annamaya Kosha, gets stuck into a whirl pool like Obsessions. The mind is in its transition to full Rajas from Tamas at this stage. It has the dimension of activity going on in one hand and has an element of stagnation of Tamas on the other hand, which makes it get stuck into a circle unable to come out of it.

The Bhagavadgita describes this first state as follows:

Dhyayato vishayan punsah sangah teshu upajayate

When mind goes on thinking on a subject or an event it gets attached to that thought stream. This is called attachment. When it gets too strong ,it becomes obsession. Like swimmers getting stuck in a swirl and getting sucked down the river. The example of Abhimanyu getting stuck in Chakra vyuha. The children with ASD belong to this category.

The yoga techniques such as pranayama, which bridge the body- mind effectively, are very useful in remedying these problems. To use Yoga at all 5 Kosha levels by bringing awareness will be the best remedy. This is called IAYT- Integrated Approach of Yoga Therapy.

2.6.10 Development of IAYT for ASD

Operations at Annamaya Kosha :

- Anuloma, Viloma Pranayama
- Asanas like Simhasana, Vajrasana, Pashchimotthanasana and its modifications based on the individual child's need.

Operations at Pranamaya Kosha :

- Pranayama
- Om and A, E, U chanting
- Asanas

Operations at Manomaya Kosha :

- Shavasana
- Deep breathing

Operations at Vijnanamaya Kosha and Anandamaya Kosha :

This was mainly done by parents, while children observed them.

- Meditation
- Bhajans
- Vedantic Talks
- Pranayama with holding of breath

2.7 DESCRIPTIONS OF AUTISM IN PURANAS AND HISTORICAL ANECDOTES

An incident describing the qualities of an autistic child is cited in śankaravijaya which is explained in the following śloka

वर्षाण्यतीयुर्भशवन्नमुष्यं पञ्चाष्ट जातस्य विनाऽवबोधम् ।
नाह्यैष्ट बेदानलिखच्च नार्णानचीकरं चौपनयं कथञ्चित् ॥
क्रीडापरः क्रोशति बालवर्गस्तथापि न क्रीडितुमषं याति ।
बालाः शठा मुग्धमिमं निरीक्ष्य सन्ताडयन्तेपि न रोषमेति ॥
भुङ्क्ते कदाचिन्नतुजातुभुङ्क्ते स्वेच्छविहारी न करोति चोक्तम् ।
तथापि रुष्टेन न ताडयतेऽयं स्वकर्मणा वर्धत एव नित्यम् ॥

varāyatīyurbhaśavannamuya pañcāa jātasya vinā'vabodham |
nāhyaia vedāalikhacca nārānacīkara caupanaya kathañcit ||
krīāpara krośati bālavargastathāpi na krīditumaa yāti |
bālā śahā mugdhamima nirīkya santāayantepi na roameti ||
bhuke kadācinnatujātubhuke svecchāvihārī na karoti coktam |
tathāpi ruena na tāayate'ya svakarmaā vardhata eva nityam ||

This is with reference to one of the disciples of Sri ādi śankara named Hasthamalacharya. ādi śankara was at [Kollur](#), he accepted invitations by [brāhmaṇas](#) to have Bhikṣa (alms or food) at their houses. On such an occasion, he visited a village called Śrī Bali (present day [Shivalli](#)). In that village there lived a brāhmaṇa, Prabhākara, who was noted for his learning. He had a son, who though appearing quite handsome, behaved rather like an idiot. Other children would call him to play with loud noises, yet he did not go for playing. He never expressed any emotions; had no general knowledge of anything. He used to eat at wrong times or go off food for several days together. He acted according to what he pleases. He did not perform what people asked him to do. Though [upanayanam](#) was performed, he did not take to studying the Vedas; instead he preferred to sit around doing nothing; no socializing; no talking; no eye to eye contact; appeared to live in his own world Hearing about ādi śankara's visit to the village, Prabhākara approached the master ([ācharya](#)) with a load

of fruits and prostrated before him. He also made his son prostrate before him. Prabhākara explained to ādi śankara that his son behaved rather like an idiot and sat idle throughout the day.

Then, ādi śankara addresses that young boy and asked him ‘who are you?’. The boy suddenly opened his mouth and started talking and replied in 12 verses, the gist of the Advaita philosophy. Thus ādi śankara was immensely impressed with him and accepted him as his disciple. He was named Hastāmalaka (one with the āmalaka fruit in his hand) since the knowledge of the Self was natural to him like an āmalaka fruit in one's hand. ādi śankara took the boy into his party and started towards his next destination.

Another incident is from Gurucharithre. Narasimhasaraswathi, who became a great sage, was not speaking till the age of seven years. He exhibited all the signs and symptoms of an autistic child. One day he made a sign indicating that he should be given the sacred thread through upanayana. Accordingly parents performed his upanayanam and when the father recited the Gayathri mantra in his ears, instantaneously he started speaking and reciting Gayathri mantra. Later on, when he grew up he became a saint.

2.8. Review of literature according to modern science

Causes of Autism

A theory of causation is still incomplete. Many still believe in the psychogenic causation, most authorities in the field agree that neurobiological and environmental factors are of crucial importance in terms of causes of autism. A review of literature on causation is somewhat disappointing as the exact cause(s) remain unclear. A variety of causes have been listed in the literature studied, as given below.

2.8.1 Neuropsychological theory

Studies on neuropsychological factors is based on two hypotheses, the first, which considers a primary cortical dysfunction in autism, emphasizes the autism symptoms of language and communication and assumes an underlying specific cognitive disorder, more specifically, a disorder of hemispheric lateralisation; i.e. the

natural substrates in the left hemisphere necessary for sequential forms of information processing fail to develop.

The second hypothesis proposes a primary brainstem dysfunction in autism. This hypothesis based on the observation of the impaired ability of children with autism in modulating their own responses to sensory input and consequently their own motor output. The cortical dysfunction hypothesis of autism has received some support through EEG, vestibular nystagmus studies and brainstem auditory evoked-potential studies. (Tsai LY, 1999 ^[24])

2.8.2 Neurochemical theory

Studies of neurochemical factors indicate a surge in interest as other studies have failed to show any gross brain pathology, suggesting that microscopic or functional factors may be responsible for autism. There is now evidence supporting the notion that abnormal behavior involves abnormal neural communication in the form of abnormal metabolism or function of neurotransmitters. Serotonin, Dopamine, epinephrine and norepinephrine studies reveal variety of neurochemical abnormalities in autism, the neurochemical variables being examined are usually collected from blood or urine samples which are rather remote from either brain function or structure. Thus the meaning and significance of the findings are not clear. (White BB ,1987 ^[25])

2.8.3 Neurobiological theory

Neurobiological causation theory is based on the observation that 3 out of 4 individuals with autism demonstrate lower cognitive functioning, severe impairments in speech-language development, associated neurological conditions like epilepsy, sensory impairments, hypo or hypertonic, disturbances in body schema, clumsiness, abnormal posture and gait, emotional facial paralysis, strabismus, and dystonic posturing of hands and fingers.(Tsai LY, 1999 ^[24], Rutter M et al 1996 ^[26])

There has been a great deal of speculation regarding the role of “mirror neurons” and autism. The mirror neuron system (MNS) theory of autism hypothesizes that distortion in the development of the MNS interferes with imitation and leads to the core features of social impairment and communication difficulties. The MNS operates

when an animal performs an action or observes another animal perform the same action. The MNS may contribute to an individual's understanding of other people by enabling the modeling of their behavior via embodied simulation of their actions, intentions, and emotions (Williams JHG, 2008 ^[27]). Several studies have tested this hypothesis by demonstrating structural abnormalities in MNS regions of individuals with ASD, delay in the activation in the core circuit for imitation in individuals with Asperger syndrome, and a correlation between reduced MNS activity and severity of the syndrome in children with ASD (Iacononi M et al, 2006 ^[28]). However, individuals with autism also have abnormal brain activation in many circuits outside the MNS (Frith U, 2003 ^[29]) and the MNS theory does not explain the normal performance of autistic children on imitation tasks that involve a goal or object (Hamilton AF , 2008 ^[30])

There are very few studies reported on neuropathology. Bauman and Kemper (1994) ^[31] believe that the cerebellar cortical abnormalities have their onset prior to birth, 30 weeks of gestation. But this is not supported by any **neuroanatomical studies**. Neuro imaging studies with emphasis on brain functions such as blood flow, metabolism, and receptor activity utilizing FMRI, MRS, PET and SPECT have not yielded any link between any cerebellar function and autism. (Tsai LY ,1999 ^[24])

2.8.4. Structural and functional abnormalities of brain

Many immunological studies have been reported suggesting that depressed immune function and autoimmune mechanism or faulty immune regulation may be associated with the etiology of autism. However, the interpretation of the reported data is hampered by the conceptual and methodological differences in the studies; but the clinical significance of immune changes and autistic symptoms remain to be elucidated by more extensive studies.(Zager D, 2005 ^[32])

2.8.5 Genetics and ASD

Genetic study in autism is complex. Linkage analysis has been inconclusive; many association analyses have had inadequate power. More than one gene may be implicated; different genes may be involved in different individuals; and the genes may interact with each other or with environmental factors. (Freitag CM, 2007 ^[33])

Though autism's genetic factors explain most of autism risk, they do not explain all of it. A common hypothesis is that autism is caused by the interaction of a genetic predisposition and an early environmental insult. Several theories based on environmental factors have been proposed to address the remaining risk. Some of these theories focus on prenatal environmental factors, such as agents that cause birth defects; others focus on the environment after birth, such as children's diets.

2.8.6 Vaccination as cause of Autism

The issue of Thimerosal-containing vaccines as a possible cause of autistic spectrum disorders (ASD) and neurodevelopmental disorders (NDDs) has been a controversial topic since 1999. Although most practitioners are familiar with the controversy, many are not familiar with the type or quality of evidence in published literature that has addressed this issue. To assess the quality of evidence assessing a potential association between thimerosal-containing vaccines and autism and evaluate whether that evidence suggests accepting or rejecting the hypothesis, Parker SK et al systematically reviewed published articles that report original data pertinent to the potential association between thimerosal-containing vaccines and ASD/NDDs. (Parker SK et al 2004 ^[34]) and found what there was no connection between vaccination and autism???

2.8.7. Environmental factors

There is an association between various prenatal risk factors and autism (Larsson et al., 2005 ^[36] , Wilkerson et al., 2002 ^[37]). No specific or consistent link between pre-, peri-, or neonatal complications and autism (Hultman et al 2002 ^[41]).

In conclusion, it may be said that most of the studies are flawed by lack of replicability, sample size, and methodological limitations.

2.8.8. Others

2.8.8.1 Studies of other biomedical factors

Studies on other biomedical factors reveal linkage between gastrointestinal abnormalities, food allergy, pesticides, folic acid, vitamin deficiency, lead and mercury poisoning (Thiomersal) and Autism (Horvath K et al 1999 ^[35]).

More research is needed to determine what environmental factors influence susceptibility to autism and to what extent. There is an association between various perinatal risk factors and autism (Larsson et al., 2005 ^[36] , Wilkerson et al., 2002 ^[37]). Contradictory reviews contend that there is no specific or consistent link between pre-, peri-, or neonatal complications and autism (Nelson KB, 1991 ^[38]). Additionally, pre-natal, and peri-natal risk factors are difficult to analyze independently of whether they impinge upon an already compromised infant, or combine with genetic predisposition to lead to developmental disturbances during growth.

There is also a strong association between the psychiatric history of parents and autism. These findings are, of course, sensitive to comparison group, method of evaluating psychiatric illness, and are generally inconsistent (Yirmiya N and Shaked M, 2005 ^[39]).

In conclusion, most of the studies are flawed by lack of replicability, sample size, and methodological limitations. Researchers in the field have behaved like the blind persons who are eager to tell the world about the part of the elephant they have touched, although their reports may not tally.

Today it is widely accepted that there is an organic basis for autism. Support for this suggestion is based on evidence of neurological impairments and genetic involvement in autism. Neurologically there is an elevated rate of epilepsy in

individual with Autism, abnormalities of brain function as reflected in abnormalities of EEG, visual and auditory evoked potentials and brain imaging. In addition, macrocephally, abnormalities in cerebellar histology and various brain mal functions have been described in Autism.

2.8.8.2 Theory of mind

It is the understanding that all individuals have “minds” of their own, and are therefore capable of independently developing their own needs, accounts of a situation and beliefs. Theory of Mind was attributed to autism in the mid eighties. Autistic individuals have difficulty understanding that other people maintain separate minds with independent beliefs, needs and intentions. As a result, they cannot evaluate the effect of their behaviors on others in the social environment. (Baron-Cohen S et al., 1985^[40]).

2.9 Management of ASD

2.9.1 Applied Behavior Analysis (ABA)

Applied Behavior Analysis (ABA) has been the most popular, scientifically validated educational intervention model. Interventions based on applied behavior analysis (ABA) focus on teaching tasks one-on-one using the [behaviorist](#) principles of stimulus, response and reward, and on reliable measurement and objective evaluation of observed behavior. There is wide variation in the [professional practice of behavior analysis](#) and among the assessments and interventions used in school-based ABA programs. Many interventions rely heavily on discrete trial teaching (DTT) methods, which use stimulus-response-reward techniques to teach foundational skills such as attention, compliance, and imitation. However, children have problems using DTT-taught skills in natural environments. In functional assessment, a common technique, a teacher formulates a clear description of a problem behavior, identifies antecedents, consequents, and other environmental factors that influence and maintain the behavior, develops hypotheses about what occasions and maintains the behavior, and collects observations to support the hypotheses. A few more-comprehensive ABA programs use multiple assessment and intervention methods individually and dynamically.

ABA has demonstrated effectiveness in several controlled studies:

Most recently, Remington et al., (2007) ^[42] compared the effectiveness of early intensive behavioral intervention (EIBI) with a standard 'eclectic' preschool provision. Results showed that EIBI led to significant, positive changes amongst the children with autism, including gains in intelligence, language and daily living skills, as well as in motor and social skills. In addition, these positive changes in children were achieved without negative impact on the psychological wellbeing of parents. Remington et al. argue that further research is required to identify factors that best predict the effectiveness of the intervention, factors that increase its impact, and factors that ensure its benefits are maintained in the longer term.

Reed, Osborne & Corness (2006) ^[43] compared home-based interventions for young children using applied behavior analysis models. Hi- intensity (mean of 30 hours per week) and low-intensity (mean of 12 hours per week) applications were compared. Children in the high-intensity group made more gains in educational progress and cognitive functioning than the children in the low-intensity group. Additionally, when the three types of hi-intensity applications were compared, the CABAS[R] approach was found to produce superior gains "...in terms of statistical significance and effect sizes..."

Case studies have been documented in which independent evaluators used objective measurement instruments to track children's progress (Green, Brennan, & Fein, 2002 ^[44] ; Perry, Cohen, & De Carlo, 1995 ^[45]). For example, Perry et al. report the effectiveness of early intensive behavioral intervention with two siblings with autism diagnoses. The intervention involved up to 35 hours of intensive 1:1 teaching sessions. Professionals who diagnosed the children evaluated their progress systematically and reported that both no longer met the criteria for diagnosis of autism.

ASD children have been shown to make sustained gains in academic performance, [adaptive behavior](#), and language, with outcomes significantly better than control groups. A 2008 review of educational interventions for children, whose mean age was six years or less at intake, found that the higher-quality studies all assessed ABA, that ABA is well-established and no other educational treatment is considered probably-efficacious, and that intensive ABA treatment, carried out by trained therapists, is

demonstrated effective in enhancing global functioning in pre-school children. A 2008 evidence-based review of comprehensive treatment approaches found that ABA is well-established for improving intellectual performance of young children with ASD. A 2008 comprehensive synthesis of early intensive behavioral intervention (EIBI), a form of ABA treatment, found that EIBI produces strong effects, suggesting that it can be effective for some children with autism; it also found that the large effects might be an artifact of comparison groups with treatments that have yet to be empirically validated, and that no comparisons between EIBI and other widely recognized treatment programs have been published. (Skinner, 1950^[46])

2.9.2 Concept of Integrated Approach to Yoga Therapy

Yoga therapy is that facet of the ancient science of yoga that focuses on health and wellness at all levels of the person, physical, psychological and spiritual. Yoga therapy focuses on a path of yoga as a healing journey that brings balance to the body and mind. The healing journey is unique to each individual and yoga therapy therefore selects, adapts and modifies the practices of yoga appropriately for the individual with respect to age, culture, religion, and specific physical challenges and conditions to facilitate optimal health and healing of the body/mind. Yoga is more than an adjunctive therapy as it is practiced throughout a lifetime. Therapies are generally discontinued after a particular condition is corrected. In the case of ASD children Yoga needs to be practiced all through their lifetime.

2.9.3 Why Integrated Approach to Yoga Therapy (IAYT)?

Some research studies indicating the beneficial aspect of yoga have been reported. Health benefits of yoga are grouped under three categories - physiological, psychological and biochemical.

There have been some studies reporting the efficacy of IAYT in special children. Uma, et al^[47] assessed the effect of IAYT on IQ, in Mentally Retarded (MR) children in a one year controlled study. 90 children with MR of mild, moderate and severe degree were selected from four special schools in Bangalore, India. 45 children underwent yogic training for one academic year with an integrated setup of yogic

practices, including pranayama, asanas and meditation. Significant improvement was reported in the IQ and social adaptation parameters in the yoga group compared to the control group.

Pag F et al 2001 ^[48] reports one controlled open trial led by Michael Linden, in 1996, with Attention Deficit Hyperactivity Disorder (ADHD) children. Result showed a 9-point IQ increase over a 40-week period.

In a study reported by Harrison J (2004) ^[49], 48 children with ADHD were subjected to a family treatment method using the techniques of Sahaja Yoga Meditation (SYM). Parents and children participated in a 6-week programme of twice-weekly clinic sessions and regular meditation at home. Pre- and post-treatment assessments included parent ratings of children's ADHD symptoms, self-esteem and child-parent relationship quality. Perceptions of the programme were collected through parent questionnaires and child interviews. Results showed improvements in children's ADHD behavior, self-esteem and relationship quality. Children described benefits at home (better sleep patterns, less anxiety) and at school (ability to concentrate, reduced conflict). Parents reported feeling happier, less stressed and manage their child's behavior better. Indications from this preliminary investigation are that SYM may offer families an effective management tool for family-oriented treatment of childhood ADHD.

Telles S et al ^[50], in her review of literature on yoga for rehabilitation, reports that yoga practice benefited MR children by improving their mental ability, motor coordination and social skills. Physically handicapped subjects had a restoration of some degree of functional ability after practicing yoga. Visually impaired children showed a significant decrease in their abnormal anxiety levels when they practiced yoga for 3 weeks, while a program of physical activity had no such effect.

There have been studies reported on the effect of Uni-nostril breathing on cognitive performance. A study was done with 127 subjects, using breathing through dominant uni-nostril and Forced Uni-Nostril Breathing (UFNB). This showed that there was tendency for subjects exhibiting base-line right nostril dominance to perform verbal task better (relative to special performance) than subjects exhibiting left nostril dominance. These results showed that at least in base-line (not forced breathing)

condition the functions of the contra lateral hemisphere are enhanced. This observation is supported by an earlier investigation where in unilateral forced nostril breathing influences spatial and verbal performance in both males and females. (Block RA et al ^[51]).

Jella SA et al ^[52] studied the effects of unilateral forced nostril breathing on cognitive performance. This study describes the effect of 30-minutes of unilateral forced nostril breathing on cognitive performance in 51 right-handed under graduate psychology students. A verbal analogies task modeled after the Miller Analogies and SAT tests was used as a test of left-hemispheric performance and a mental rotation task based on the Vandenburg and Kuse adaptation of Shepard and Metzler's test were used as a spatial task for testing right-hemispheric performance. Spatial task performance was significantly enhanced during left-nostril breathing and verbal task performance was greater during right nostril breathing.

2.9.4 EFFECTS OF MEDITATION ON THE BRAIN

One key aspect of using yoga is that it not only involves postures, but also requires breathing techniques that stimulates concentration in the brain. There are several studies that have used specific meditation techniques for children and families with and without disabilities.

Werntz D et al (1983) ^[53] performed a qualitative research study that examined hemispheric functions after implementing selective nostril breathing. The concept was to see if controlling the breathing of one nostril would impact the cognitive functioning in the brain.

The methodology for conducting the experiment was first to measure the airflow of the nostrils through a unit called a thermistor. Airflow was measured in conjunction with an EEG for brain activity to see where the brain activity was occurring. A baseline of activity from the nostrils was measured in order to normalize the current airflow for each individual. Further, it was noted which nostril produced the majority of the airflow, so a more accurate airflow could be determined for the dominant nostril. The baseline would then be compared to altering nostril breathing and cerebral hemispheric activity.

The length of the recording was determined by the subject's ability to stay awake and remain immobile.

The results indicate that hemispheric activity is correlated with airflow in the opposite nostril. The significance of this work is that students with ADHD are believed to have specific hemispheric activity on one side of the brain that constantly keeps them active. Thus, depending on which side of the brain is more active, students can be taught to decrease their breathing activity on the controlateral nostril and increase their breathing using the other nostril. This would create more of a balance in the two brain hemispheres. As a result of the study, cognitive processes and behavior may be influenced by regulation in breathing patterns depending on the location of activity in the brain.

In a follow up study conducted by Werntz D et al (1987) ^[54] the authors confirmed that cognitive performance was correlated with forced breathing through the controlateral nostril. Using the same methodology, they determined that by having a subject breathe through one nostril, it generated more activity on the opposite side of the brain. Thus, verbal skills were enhanced while the subjects were breathing primarily out of their right nostril and spatial skills were enhanced during left nostril dominance. Breathing techniques have been shown to be effective in conducting more activity in the brain, thus increasing concentration and academic performance.

Similarly, in a review of the literature by Zipkin D (1985) ^[55] it was shown that relaxation techniques have been extremely effective for children with disabilities. Research indicated that progressive muscle relaxation, isometrics, yoga, movement exercises, massage, guided fantasy, meditation, concentration, music, breathing control, and biofeedback training have all been successful at decreasing hyperactivity and impulsivity. At the same time, academic achievement, interpersonal relationship, and increased attention span have resulted from these techniques. The yoga research as described in Zipkin's (1985) ^[55] review suggested that yoga positively effects mental states. It promotes self-control, attention, and concentration through breath control, and deep relaxation.

Additional research has shown that with deep breathing, the body's overall circulation is improved resulting in the release of tension as well as increasing levels

of blood and oxygen through the entire body, which then affects the central and autonomic nervous systems. Both systems control heartbeat, respiration, and conserve energy. Through breath and meditation, yoga works to produce calming effects, emotional balance, and increases concentration (Harrison J et al 2004 ^[48] ; Pag F et al 2001 ^[49] ; Peck H et al 2005 ^[56] ; Shannahoff-Khalsa D, 2004 ^[57] ; Zipkin D, 1985 ^[55])

Harrison J et al 2004 ^[48] used Sahaja Meditation for families of children with ADHD and showed positive results with both children with ADHD and their parents. In this research, families participated in a Sahaja meditation program for duration of 6 weeks, for two days each week in a clinic session. The sessions each lasted 90 minutes. Children and parents contributed to the data collection, which consisted of several questionnaires, examiner testing and interviews, medication checks, and self-esteem measures. Data were collected throughout the treatment in weeks 1, 3 and 6. Results indicated significant improvements in children's self-esteem, academic achievement, parent-child relationships, and a reduction in several symptoms of ADHD. Based on the results, anxiety, poor confidence, hyperactivity, and impulsivity were significantly reduced over the course of the meditation treatment. At some points, children either quit or reduced the use of stimulant medication because they felt more in control of their bodies. The research indicated children who either quit taking or reduced medication showed more improvement in ADHD-related behaviors than those who continued to take their medication.

In a single study reported at Orange County school CA, with 8 children diagnosed with ASD, heart rates were measured, pre and post yoga sessions and correlated with improved test scores in certain skill areas such as turn taking, receptive language following verbal directions, body awareness and proximity, following routines, regulating and self monitoring. (Conner C, 2005 ^[58]).

A study reported by Oldenburg L (2004) ^[59] with ASD children reports increased concentration, focus, organization and relaxation after 25 yoga sessions.

Studies quoted above suggest that yoga may have merit as a complimentary treatment but remains as an investigational treatment despite positive results reported,

methodological and procedural problems raise questions about the efficacy of the practice with young children.

IAYT is ideal for ASD population because of the prevalence of social behavioral, cognitive and neurobiological deficits. It was observed that preference for repetitive movements that stimulate the vestibular system, such as spinning and swinging, sudden mood changes, under responsiveness to spoken language, temper tantrums, unprovoked aggression, self-injurious behavior, short attention span and hyperactivity reduced dramatically with yoga. This is only an observation. There has not been any scientific study regarding the efficacy of IAYT with ASD children. This study will provide a scientific basis and technical framework for simultaneously investigating multiple domains of cognition, their relationship to symptomatic behaviors and subsequent improvement over these behaviors.

2.9.5 Theory behind the study

We now know autism is not a unitary disease with a single etiology. It is a heterogeneous behavioral syndrome found in association with many etiologies. We also know that there is no single treatment or intervention; even the most established methods may not work well for some children. There is no “one size fits all” treatment. There is yet no established protocol for relating specific child, family, and target behavior and treatment variables to individualized treatment regimens. Recent research regarding brain function in autism suggests core deficits in functions that are thought to be controlled by cortical structures in the brain.

Dysfunction of reticular brain stem mechanisms and their projection to higher centers could account for autistic person’s inability to modulate sensory input, resulting in under and over responsiveness to sensory stimuli and impairment in the ability to direct and sustain attention. Given autistic impairment in social understanding, the disorder may involve dysfunction in the limbic system, particularly cells in the amygdale that are responsive to social-emotional stimuli. Dichotic listening studies confirm that the right hemisphere is overactive in persons with autism; stimuli that evoked left hemispheric responses in normally developing individuals evoke right hemispheric responses or a lack of response. Several studies of autonomic

(cardiovascular) responses to novel stimuli have suggested that autistic individuals show abnormal orienting responses; they react to mild novel stimuli as if they are averse to heart rate acceleration and less habituation. Compared to normal children, autistic children have elevated heart rates, increased peripheral blood flow, and greater heart rate variability. Such over arousal was thought to interfere with autistic person's ability to process and interpret information, contributing to deficits in language and social understanding. The pervasive nature of autism suggests that dysfunctions must occur in both cortical and sub cortical areas of the brain. Based on many years of observation and working with children diagnosed with ASD, it is natural to hypothesize that these children may have specific deficits in the frontal lobe and generally involving cortical and sub cortical areas of the brain. It is therefore seemed logical that working directly to improve the function of the brain (the likely cause) might improve the observed behaviors more efficiently, than the more conventional model of focusing on the problem itself (the symptoms).

IAYT to ASD children is focused to capitalize on the positive effects of Yoga involving Asanas (physical posture),Pranayama(voluntary regulated breathing/normal functioning at the subtle energy level),Healthy yoga diet, loosening exercises & Relaxation techniques to directly affect frontal lobe efficiency, thereby increasing physical and cognitive functions of children with ASD.

CHAPTER 3

AIMS AND OBJECTIVES

3.1 Research questions

Critical research questions addressed were:

Is it possible to teach yoga as an add-on in a special school for children with ASD
What can these modules of yoga add to the conventional modules of educational interventions used presently?
3. Can Cognitive, Physical and Socio-emotional changes during yoga practice be scientifically measured /quantified?

3.2 Aim

To study the efficacy of yogic intervention in inducing changes in autistic behavior in children with ASD.

3.3. Objectives

- A. To cull out the reference to ASD & related conditions in ancient Indian scriptures.
- B. To study the efficacy of yoga practice through a control design in:
 - 1. Increasing sitting tolerance,
 - 2. Improving imitation skills,
 - 3. Reducing hyper-activity and
 - 4. Reducing of repetitive/stereotyped behavior.

3.4 Hypothesis

- 1. Integrated yoga practices can be taught to children with ASD in a special school setting
- 2. Regular practice of yoga will help in reducing the autistic behavior.
- 3. Regular practice of yoga will help in increasing the imitation behavior of autistic children.
- 4. Regular practice of yoga will help in reducing the repetitive stereo typed behavior of autistic children.

3.4.1 Null hypothesis

1. There will be no significant improvement in autistic behavior after the practice of yoga. There will be no significant increase in imitation behavior of autistic children after yoga intervention.
2. There will be no significant decrease in repetitive stereo typed behavior of autistic children after yogic intervention.

CHAPTER 4

METHODOLOGY AND DESIGN

4.1 Overview

The following section provides details regarding the methodology used for this study in order to answer the proposed research questions. This study was designed to discover if yoga was beneficial for children with ASD. The setting, selection, data collection tools and design of yoga implementation is explained in the following sections.

4.2 Subjects:

Admission register and medical records of children admitted between the years 2000-2007 to four special schools in Bangalore, India, were examined. 42 children with established ASD were profiled; 12 from four special schools satisfying the inclusion criteria were selected: 6 from school A formed the yoga group; 2 matching children from each of the schools B, C and D formed the non-yoga group. Demographic details of the subject is given in Table 4.

Table 4: Demographic details

No.	School	Mean IQ Range	Mean Age	Sex M/F	SEB	EB
1.	School A – Yoga Group	76.5	12.7	5/1	Middle Class	Graduate
2.	School B- Non-yoga Group	82.3	12.5	2/0	Middle Class	Graduate
3.	School C- Non-yoga Group	79	11.4	2/0	Middle Class	Graduate
4.	School D- Non-yoga Group	84	13.2	1/1	Middle Class	Graduate

SEB : Socio-economic background (minimum Rs. 8,000) EB : Educational background (graduate mothers)

The subjects were mostly from middle class socioeconomic background and commuting to the school from their house was an issue in the school community. All subjects received some instruction in the general education classroom (preparatory) and all received special education under ABA model. In yoga group – School A subjects were 5 boys and 1 girl with a mean age of 12.7 years. In non-yoga group – School B subjects were 2 boys with a mean age of 12.5 years, School C subjects were 2 boys with a mean age of 11.4 years and School D subjects were 1 boy and 1 girl with a mean age of 13.2 years.

4.2.1 Inclusion / Exclusion criteria

- (a) Diagnosis of autism according to ICD-10 criteria (World Health Organization, 1993^[60])
- (b) Age 8-14 yrs initially.
- (c) Parents' educational background - minimum graduates.
- (d) Parents' socio-economic background - middleclass, income of Rs. 8,000 (\$160) /month).
- (e) Record indicating that the child had received between 15 and 20 hours per week of one- to-one treatment for a year at the special school.
- (f) Exclusion criteria: presence of neurological disorders of known etiology; significant sensory or motor impairment; major physical abnormalities; and history of head injury and /or neurological disease. The demographic data of the participants is given in Table 4.

4.2.2 Ethical clearance and informed consent

Swami Vivekananda Yoga Anusandhana Samsthana's (SVYASA) Institutional Ethical Committee and Review Board approved the study protocol. Signed, informed consent to participate in the study was obtained from all parents.

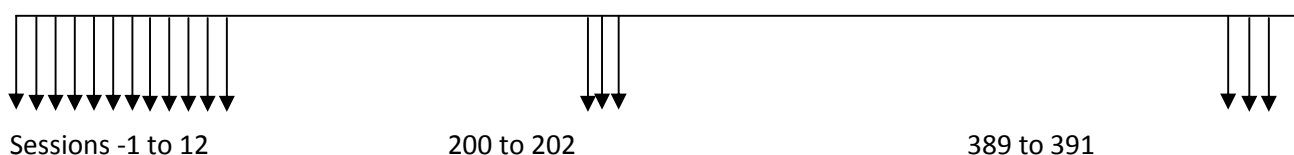
4.3 Design

4.4 Structure of Sessions

This was a prospective matched control design lasting 22 months. All 12 children attended regular elementary classes at special schools, receiving weekly and 15hrs of

ABA-based training. The experimental group received, additionally, weekly 5hrs IAYT (1hr /day) for two, 10-month academic years, with two months summer holiday gap. IAYT was implemented everyday in the morning before the regular classes commenced. This was conducted in an open, green, serene environment overlooking a temple and an ashram. Most teaching sessions involved one-to-one instruction with one parent present. Children used their own mats, marking their own boundary of operation in the same place every day. Special educators and parents contributed to a range of data collection procedure through questionnaires and tests of assessment. Assessment was conducted at three stages pre (1st month), mid (11th month) and post (20th month). Eight special educators completed assessment and co-related at every point. The assessment schedule is given in figure 1.

Figure 1 : Assessment Schedule for Yoga and Non-Yoga Group



4.5 Assessments

All the parents both in Yoga and Non Yoga group who gave consent to participate in the study were interviewed using modified E-2 check list. Their observation was recorded at the beginning and end of the research project.

Following behaviors modifiable through yoga based on DSM criteria and previous reports and studies were selected for the study. Six target behaviors were:

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

In addition, imitation skill was further studied under following parameters:

- Imitating gross motor actions (IGMA)

- Imitating vocalization (IV)
- Imitating complex motor actions (ICMA)
- Imitating oral facial movements (IOFM)
- Imitating breathing exercises (IBE)

Similarly, repetitive stereotyped behaviors (RSB) were studied under following parameters:

- Restricted behavior
- Sameness behavior
- Repetitive behavior

Special educators, parents contributed to a range of data collection procedure through questionnaire and tests. These were,

1. The modified form of Autism Research Institutes' form E-2 check list (check list– 1) (Rimland 2007 ^[61]),
2. Imitation Test Battery (ITB) (check list 2),
3. Repetitive Stereotyped Behavior Test Battery (RSBTB) (check list 3)
4. Check list of special educators' observation and parents' interviews.

Test battery and parameters measured is given in Table 5.

Table 5: Test Measures

Behavior Check list	Items	Scale
Check list– 1: The Autism Research Institutes' form E-2 check list	Eye to eye gaze (EEG), sitting tolerance (ST), body posture (BP), body awareness (BA), depth perception and balance (DPPB), imitation skills (IS), self-stimulatory behavior (SSB), receptive skills related to spatial relationships (RSRSR) and self-injurious behavior (SI).	3-point rating scale (0=little, 1=moderate 2= a lot).

Check list -2 :Imitation Test Battery (ITB)	Imitating Gross Motor Actions (IGMA), Imitating Vocalization (IV), Imitating Complex Motor Actions (ICMA), Imitating Oral Facial Movements (IOFM), Imitating Breathing Exercises (IBE)	3-point rating scale: (0= rarely imitated, 1= occasional imitation, 2= exact imitation).
Check list – 3 : Repetitive Stereotyped Behavior Test Battery (RSBTB)	stereotyped behavior, self-injurious behavior, restricted behavior, sameness behavior and repetitive behavior	4-point rating scale: (0= behavior does not occur, 1= behavior occurs mild, 2 = behavior occurs moderate, 3= behavior occurs severe)

4.6 Data Analysis

In order to determine if a relationship existed between the yoga intervention and behaviours associated with ASD column graph was drawn taking the average value of the observers to determine the impact of the intervention. Behavioural change in terms of percentage change was calculated from base-line to mid to post and from base-line to post. This improvement at baseline, mid and post-intervention and the relationship between yoga intervention and sub parameters with reference to imitation skills and RSB. was indicated visually in the Graphs 1 – 17 and Table 10 – 25.

4.7 Data Collection / Extraction

8 observers, 2 each from school A, B, C, D were trained for a week to observe the behaviors and to grade them according to a grading system developed by the author during pilot study was used. These gradings were collected from the observers

periodically. Summary of the parents interviews analysed at the beginning and end of the Yoga intervention.

Baseline data collection using the test batteries mentioned above began one week prior to implementing the yoga intervention. Following eighty weeks of yoga implementation, the test battery was used again to determine the present levels of performance in the same category. Eight special educators completed assessment and co-related at every point.

Eight observers collected data at baseline, mid, and post sessions as per the schedule given in figure 1. Raw data was entered in spread sheet using Microsoft excel. Percent change was calculated and a graphic representation in the form of Bar chart is depicted in Graphs 1-17 and Tables 10-25.

Data was collected for all the parameters selected for intervention, for all subjects, by all observers, both in the non-yoga group and the yoga group.

4.8 Intervention

4.8.1 ABA therapy module

Both experimental and control group received ABA therapy module in the regular school is given in Table 6.

Table 6: ABA Therapy Module

Yoga intervention Group(exp)	Non Yoga Group(con)
Developing perceptual & cognitive behavior	Expressive communication
Increase attention & focusing	Receptive language
Increase imitative behavior	Visual performance
Increasing symbolic play	Academic
Memory & recall	Social & behavioral skills
Increase interactive behavior	Life learning skills
Developing daily living skills	Play & socialization
Reducing self injurious, repetitive behavior	

4.8.2 Yoga intervention

The integrated yoga module used in this study was based on ancient yoga text, to bring about a total development at physical, mental, emotional, social and spiritual levels. The techniques include physical practices (Kriyas, asanas, satvik diet, breathing practices with body movements and pranayama, devotional songs, and life style change). The set of yoga practices selected for the yoga intervention for specific benefits is listed in Table 7. The sequence consisted of warm-up practices, strengthening asanas, loosening practices, calming asanas , yogic breathing practices and chanting. The integrated yoga module was selected from the integrated set of yoga practices used in earlier studies on yoga for positive health.((Nagendra and Nagaratna,1985 ^[62])

The yoga intervention consisted of ten different asanas that promote breathing, posture training, relaxation and focusing. During first 4 weeks of yoga therapy children were exposed to a chart depicting yoga schedule from beginning to the end. Typically, the sessions started with bell ringing ,signaling that they have to spread their mat and sit in vajrasasna with namaskara mudra and listen to prayer rather than reciting the prayer. The yoga intervention consisted of ten different asanas that promote breathing, posture training, relaxation and focusing. This was followed by warm-up exercises, loosening practices, strengthening asanas, calming asanas, yogic breathing practices and chanting. The sequences of yoga practices were same for each child initially and later they were tailored to the individual child. During yogic breathing practices children were not aware of breath. Parents held hand-held mirrors below the nostrils and showed them how it gets fogged when they breathe out. Children were asked to blow candles, soap bubbles, dry leaves, paper, pitch pipes and wind instruments to understand “breathing out”. Children were asked to feel the bulging of the belly when they were breathing in. When once children started imitating these actions and became aware of breath, they were asked to just breathe in and out calmly for total of one to two minutes. Later, they were taught the regular breathing exercises. Asanans were used in conjunction with breathing for 2 to 3 minutes. All the yoga sessions ended up with shavasana and shanthi mantra. Initially children could never assume shavasana with closed eyes. Blindfolds were used to close their eyes with soft music playing in the background.

Table 7: Yoga Intervention

Warm-up practices	Loosening practices	Strengthening asanas	Calming asanas	Yogic Breathing practices	Chanting
a. Jogging b. Forward & backward bending in standing posture	a. Neck exercises b. Waist-back bending exercises c. Waist forward bending	a. Trikonasana (triangle pose) b. Veerabhadrasana (warrior pose) c. Parvathasana (mountain pose) d. Sasankasana (moon pose)	a. Sukhasana (cross legged pose) b. Shavasana (corpse pose) c. Makarasana (crocodile posture)	a. Preparatory Blowing exercises b. Sasha swasa (rabbit) c. Vyaghra swasa (tiger) d. Simha mudra (lion pose) e. Hasta Prasarita Swasa (Hands In and out breathing)	a. AAAA b. UUUU c. MMM d. OMM e. short mantras

CHAPTER 5

RESULTS

5.1. Qualitative Results

5.1.1. Observations by therapists and parents

The yoga intervention took place over a period of two years between June and March, with a gap of 2 months summer holidays (April and May). There were minor interruptions during the regular school days, such as holidays and sudden closure of the school for some reasons. Unique feature of the study is that there was no dropout.

This section presents the results of the assessments done, using the test battery mentioned in Table 5. The behavioural parameters selected for the study were Eye to Eye Gaze (EEG), Sitting Tolerance (ST), Body Posture (BP), Body Awareness (BA), Depth Perception and Balance (DPB), Imitation (IM), Repetitive Self-stimulatory and Self-injurious Behaviour (RSB), Receptive Skills Related to Special Relationships (RSSR). During a pilot study done by the researcher (Radhakrishna S, 2006 ^[63]) obvious changes in the Imitation (IM) and Repetitive Self-stimulatory and Self-injurious Behavior (RSB) were noted. An in-depth study of these behaviours was carried out by administering a modified IM and RSB Battery with sub scale given in Table 5 (checklist 2 and 3). IAYT effects are examined in relation to a wide range of behaviors mentioned above. Analyses are descriptive because of the small sample size. Qualitative baseline data for both yoga and non-yoga group is given in the Table 8.

Table 8: Qualitative Baseline Data for both Yoga and Non-Yoga Group

- All displayed poor eye contact and sitting tolerance.
 - All displayed poor balance and awkward body posture.
 - None could identify or point to their own body parts.
 - None could climb stairs without falling.
 - All displayed poor imitation skills.
 - All displayed object, body and hand stereotypes such as body rocking, hand flapping and twiddling sticks.
 - All displayed self-injurious behavior such as hitting and biting self, pulling hairs.
- All displayed poor receptive skills related to spatial relationships

The core behavior characteristics addressed in the research was a significant issue for parents and staff. From the parental perspective, lack of eye contact, hyperactivity, resistance to change (a child exhibited high resistance by head banging and other self injurious behavior when there was slight change in the color of the clothes that he wore, food and place. He insisted on the same clothes, same food and same classroom), was something they found particularly difficult to cope with. From the staff perspective, more emphasis was placed on the lack of eye contact to gain attention, lack of imitation skill, poor sitting tolerance and temper tantrums, as this was likely to have a negative impact on their learning.

By the end of the research substantial qualitative changes were reported by the parents and the class – teachers in response to the questionnaire given and is given in Table 9.

Table 9: Qualitative post Data for Yoga Group

- All displayed good eye contact and sitting tolerance.
- All displayed better balance and improved body posture.
- All could identify and point to their own body parts.
- All could climb stairs without falling.
- All displayed better imitation skills.
- None displayed object, body and hand stereotypes such as body rocking, hand flapping and twiddling sticks in classroom situation.
- None displayed self-injurious behavior such as hitting and biting self, pulling hairs in classroom situation.
- All displayed good receptive skills related to spatial relationships.

According to parents and teachers children started responding to their names when called, could respond to their names by raising hands during attendance and look at the person during conversation. Parents could take children to social functions where they could sit for some time and teachers report that children could sit in the classroom for 45 minutes at length. Body posture and balance improved to such an extent that strangers could not make out that they are autistic by the way they walk. Parents also reported that they could play games with their peers imitating the action of other children. There was a reduction in the stereotyped repetitive restricted behavior in terms of not becoming anxious when there is a change in the routine. Hand biting and head banging behaviors reduced dramatically and parents felt comfortable to handle children.

5.2 Quantitative Results

Many behaviors emerged during IAYT and in the classroom, in the experimental group, which were consistent with the response given by staff and parents during initial interviews.

In the initial 12 sessions there was no observable change in the eye-to-eye gaze, sitting tolerance and imitation skills. As the number of sessions increased, subtle changes in behavior were reported and recorded by observers and parents.

5.2.1. Eye to Eye Gaze

Graph 1 and table 10 demonstrates changes in the eye gaze from base to mid and post sessions. During midsession, observable behavioral changes were seen in eye-to-eye gaze (by training the eyes to stay focused on an object such as lighted candle, focus circle or color mat). By the end of the yoga intervention, all the participants would look at the person or object with a steady gaze. Children started focusing on the yoga therapist as she gave counts with a drumbeat. Children also started responding their names by looking at the person calling them.

Graph 1

Change in Eye to Eye Gaze at pre, mid and post of yoga and non-yoga group

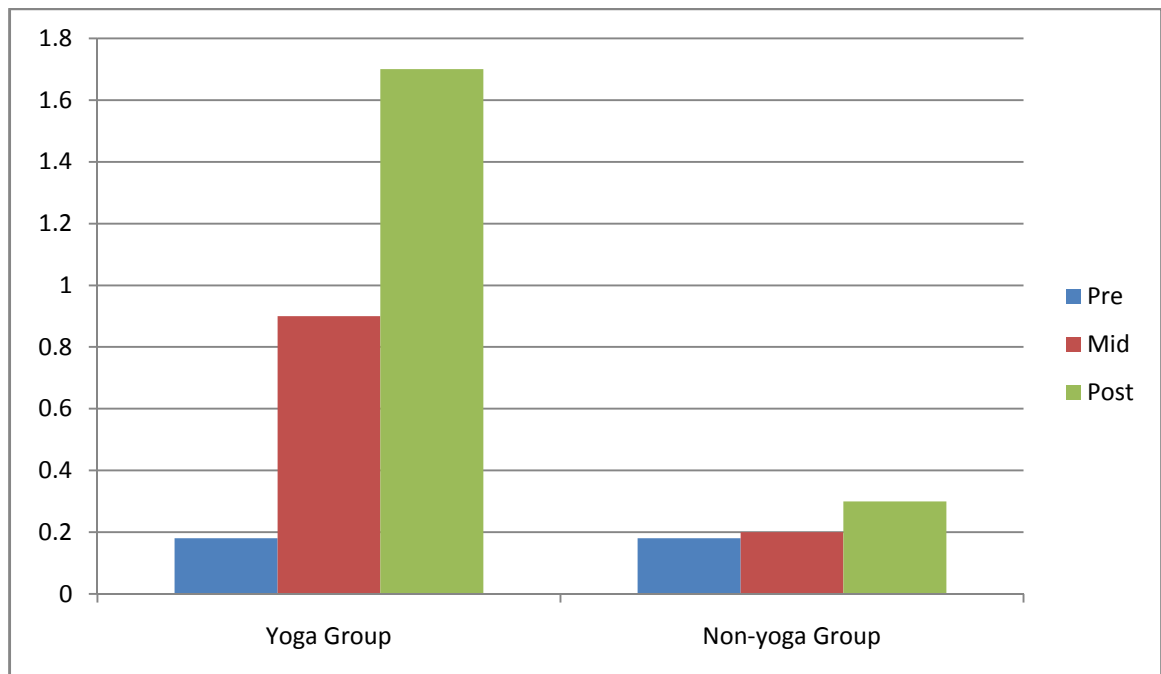


Table 10
Percentage of change in Eye to Eye Gaze from Baseline – Mid – Post
Yoga and Non-Yoga Group

Eye to Eye Gaze	Baseline	Mid	% change	Post	% change	% change from base-line to Post
Yoga Group	0.17	0.9	429	1.75	94.44	929
Non-Yoga Group	0.17	0.25	47.05	0.3	20	76.47

5.2.2. Sitting Tolerance

Graph 2 and Table 11 demonstrate changes in the sitting tolerance from base to mid and post sessions. At baseline, participants' sitting tolerance was very poor (less than 5 min). By midsession, they could sit in vajrasana for a period of 10 min. and by the end of the yoga intervention, they could complete the yoga session of one hour. Class teacher reported reduction in requests for breaks during the period by the participants. All six children in yoga group were enjoying 30 to 45 minutes of IAYT therapy. During this period they all displayed increased intention to remain in close proximity to the therapist and could participate in performing most of the asanas and breathing exercises.

Graph 2
Change in Sitting Tolerance at pre, mid and post of yoga and non-yoga group

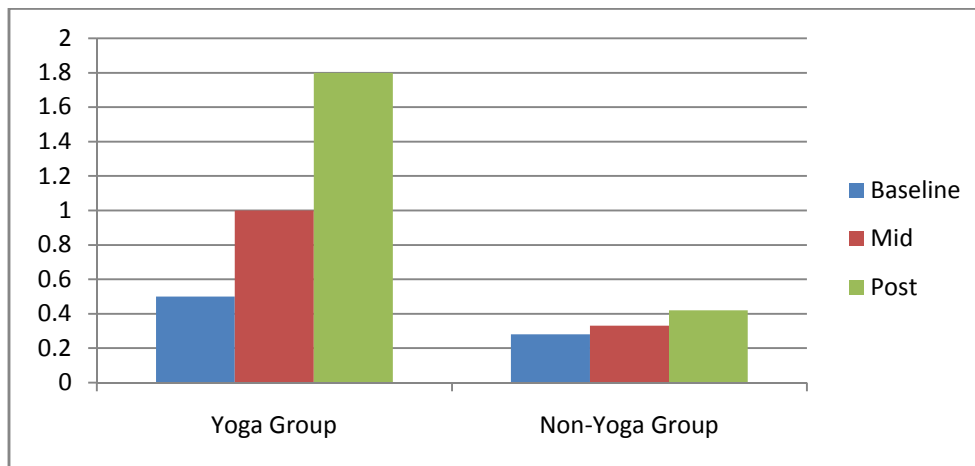


Table 11
Percentage of change in Sitting Tolerance from Baseline – Mid – Post
Yoga and Non-Yoga Group

Sitting Tolerance	Baseline	Mid	% change	Post	% change	% change from base-line to Post
Yoga Group	0.5	1	100	1.8	80	260
Non-Yoga Group	0.25	0.33	32	0.40	21.21	60

5.2.3. Body Posture

Graph 3 and Table 12 demonstrate changes in the body posture from base to mid and post sessions. At baseline, children were awkward and clumsy in appearance. They had difficulty in walking, throwing, kicking, running and jogging. By midsession there was an appreciable change in their walking and posture and by the end of the yoga intervention, their body posture was normal. As reported by parents, strangers could not make out that they are differently abled.

Graph 3
Change in Body Pasture at pre, mid and post of yoga and non-yoga group

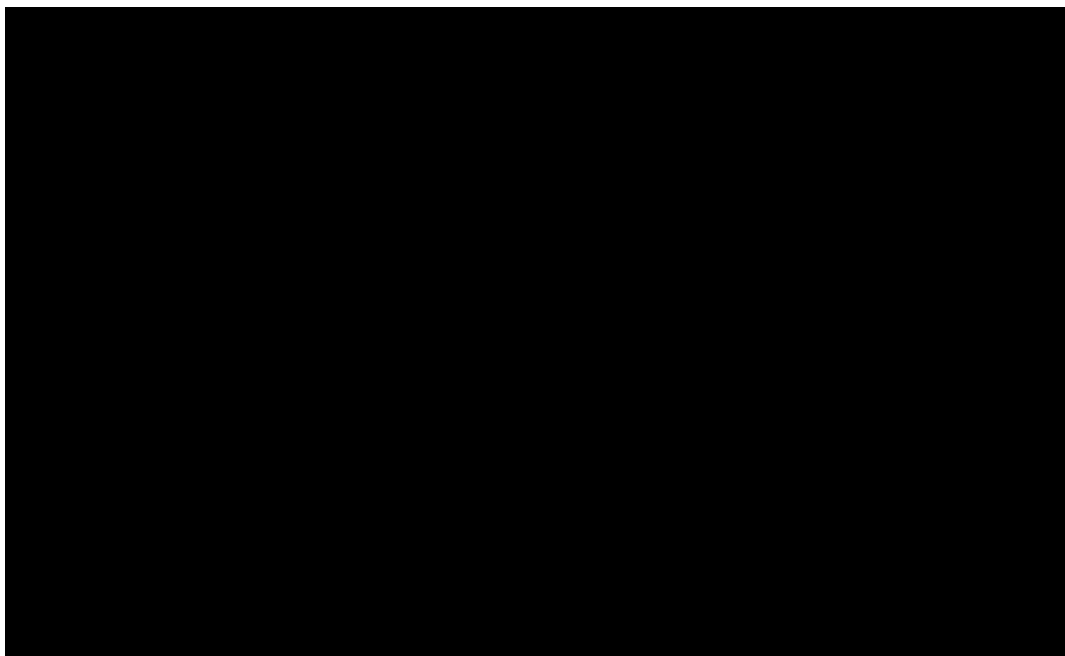


Table 12
Percentage of change in Body Posture from Baseline – Mid – Post
Yoga and Non-Yoga Group

Body Posture	Baseline	Mid	% Change	Post	% Change	% change from base-line to Post
Yoga Group	0.5	1	100	1.75	75	250
Non-Yoga Group	0.4	0.41	2.5	0.50	21.95	25

5.2.4. Body Awareness

Graph 4 and Table 13 demonstrate changes in the body awareness from base to mid and post sessions. At baseline, children could not identify or point to their body parts in response to verbal request. By the end of the intervention, all the participants in the yoga group identified and pointed to their own body parts as well as pictures.

Graph 4
Change in Body Awareness at pre, mid and post of yoga and non-yoga groups

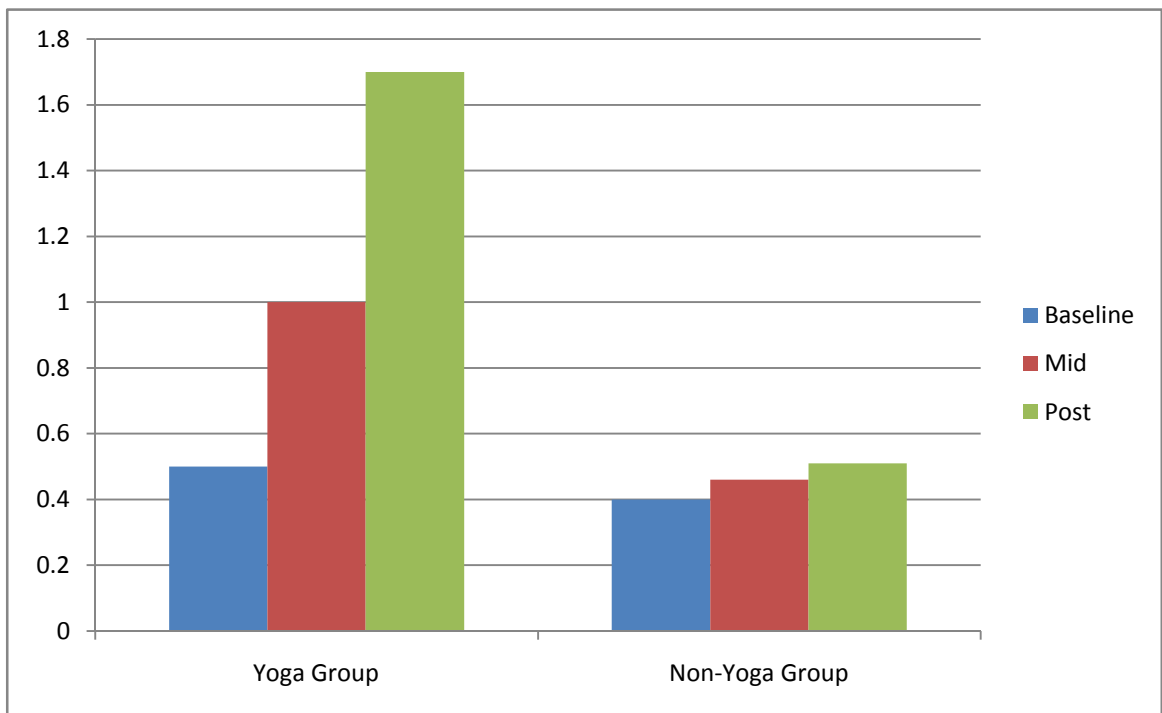


Table 13
Percentage of change in Body Awareness from Baseline – Mid – Post
Yoga and Non-Yoga Group

Body Awareness	Baseline	Mid	% Change	Post	% Change	% change from base-line to Post
Yoga Group	0.17	0.6	252.94	1.75	191.66	929.41
Non-Yoga Group	0.17	0.17	0	0.17	0	0

5.2.5. Depth Perception and Balance

Graph 5 and Table 14 demonstrate changes in the body awareness from base to mid and post sessions. At baseline, children could not climb and get down the stairs without any assistance, displayed fear of climbing spiral ladder, chair or bench. By the end of yoga intervention, these behaviors disappeared.

Graph 5
Change in Depth Perception and Balance at pre, mid and post of yoga and non-yoga group

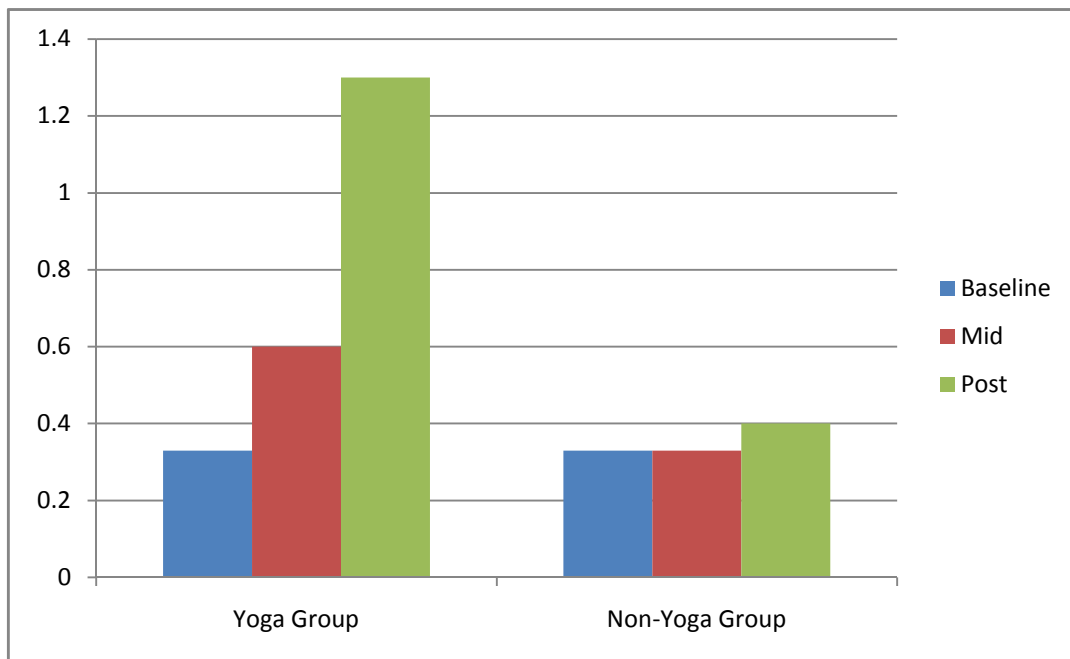


Table 14

**Percentage of change in Depth Perception and Balance from Baseline – Mid – Post
Yoga and Non-Yoga Group**

Depth Perception and Balance	Baseline	Mid	% Change	Post	% Change	% change from base-line to Post
Yoga Group	0.33	0.6	81.82	1.3	116.67	293.93
Non-Yoga Group	0.33	0.33	0	0.4	21.21	21.21

5.2.6. Imitation Skills

Graph 6 to 11 and Table 15 to 20 demonstrate changes in the imitation skills from base to mid and post sessions. At baseline, children never imitated gross motor action, vocalizations, two phase complex movements, or oral facial movements. They could not imitate adult “breathing in and breathing out” model. By the end of the yoga intervention, there was a dramatic change in the imitation behavior in the yoga group. Children could run, walk in a line, imitate a “two to three phase” action, exhibited increased vocal imitation skills by imitating vowels “a, e, i o, u” and “OM”. As the vocalization improved, their social interaction showed significant improvements. Children could greet the therapist with a smile and vocalize the word “**namasthe**” (with folded hands) and they could verbalize “**om shanthi**” (let there be peace) at the end of the therapy session. Those who were not aware of their breath gradually learnt to breathe in and breathe out and also deepen their breathing. Hand held mirrors, blowing toy materials, candles, soap bubbles, straw to drink water etc., were used at this stage. A noticeable change in the breathing pattern (slower and quieter) was seen in the last few sessions. During slow mantra chanting, there was an appreciable increase in the imitation skills of oral-facial movements. Efforts were made to make yoga a fun. For example: during tiger breathing children smiled or roared and imitated the therapist. During Sarvangasana the teacher blew candles and children enjoyed and imitated her. During the post sessions, a significant change in communication, language, play and joint attention was seen in the yoga group. Initially mothers manually guided the child to imitate the movement. Slowly,

manual manipulation decreased and children started imitating complex motor movements spontaneously.

Graph 6
Change in Imitation Skills at pre, mid and post of yoga and non-yoga group

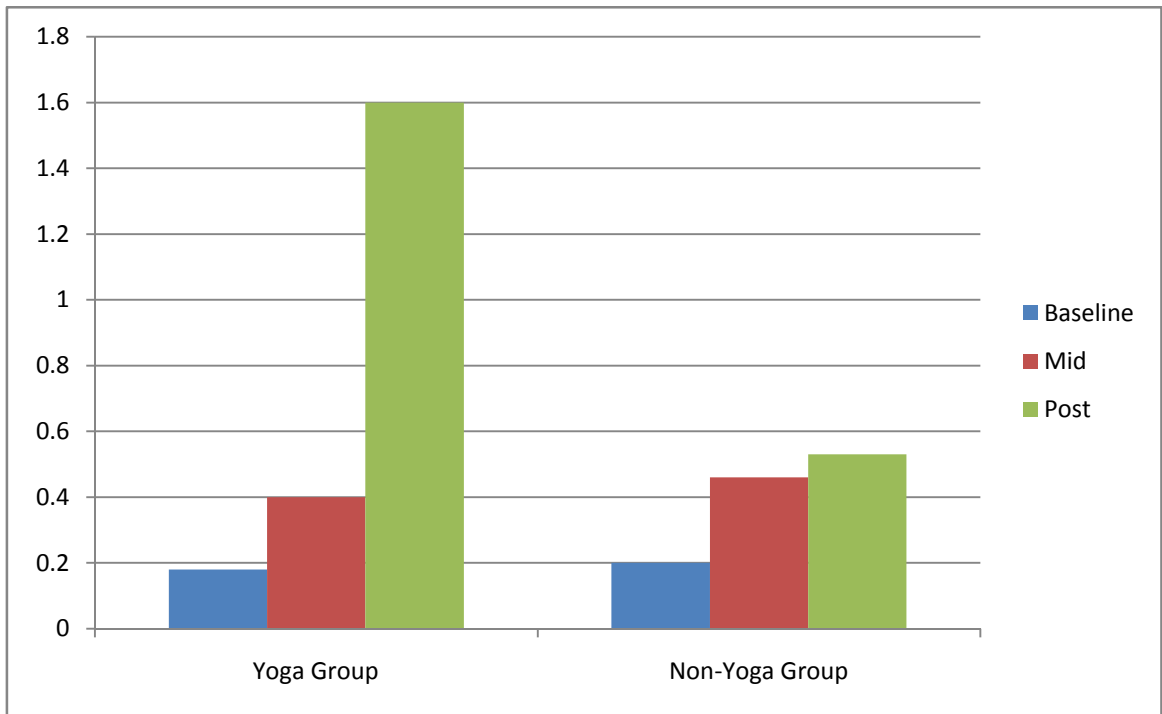


Table 15
Percentage of change in Imitation Skills from Baseline – Mid – Post
Yoga and Non-Yoga Group

Imitation Skills	Baseline	Mid	% Change	Post	% Change	% change from base-line to Post
Yoga Group	0.17	0.4	135.29	1.6	300	841.17
Non-Yoga Group	0.25	0.41	64	0.5	21.95	100

Graph 7

Change in Imitating Gross Motor Action (IGMA) at pre, mid and post of yoga and non-yoga group

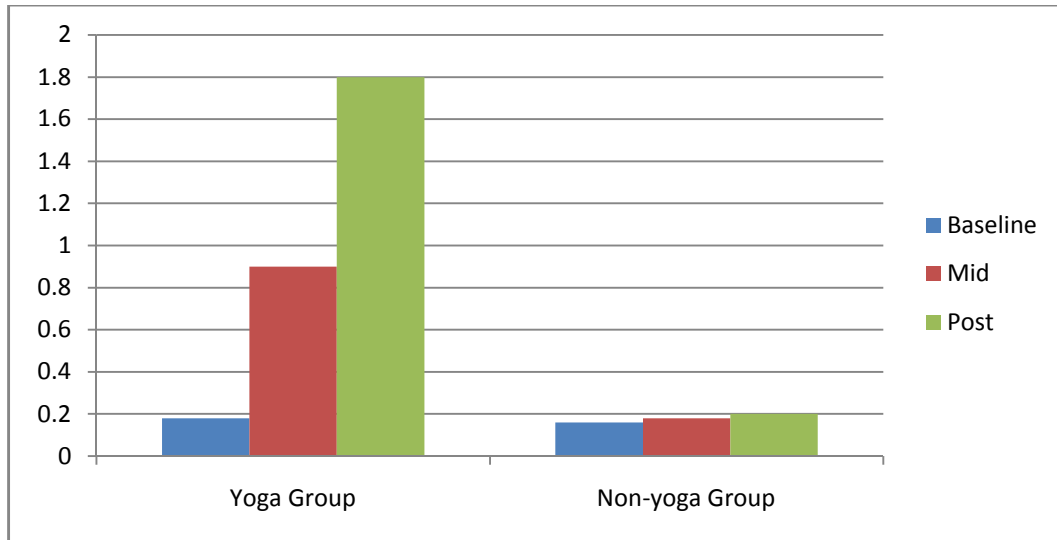


Table16

Percentage of change in Imitating Gross Motor Action (IGMA) from Baseline – Mid – Post Yoga and Non-Yoga Group

Imitating Gross Motor Action (IGMA)	Baseline	Mid	% Change	Post	% Change	% change from base-line to Post
Yoga Group	0.18	0.9	400	1.8	100	900
Non-Yoga Group	0.16	0.18	12.5	0.2	11.11	25

Graph 8

Change in Imitating Vocalization (IV) at pre, mid and post of yoga and non-yoga group

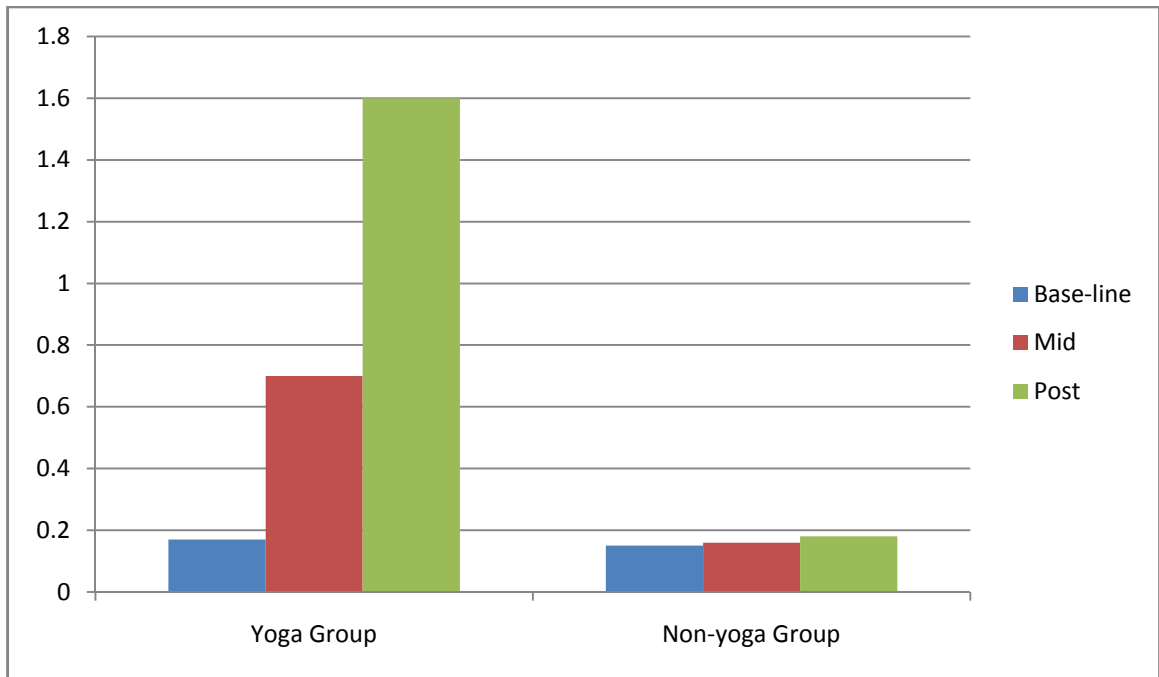


Table 17

Percentage of change in Imitating Vocalization (IV) from Baseline – Mid – Post Yoga and Non-Yoga Group

Imitating Vocalization (IV)	Baseline	Mid	% Change	Post	% Change	% change from base-line to Post
Yoga Group	0.17	0.7	311.76	1.6	128.57	841.17
Non-Yoga Group	0.15	0.16	6.6	0.18	12.5	20

Graph 9

Change in Imitating Complex Motor Action (ICMA) at pre, mid and post of yoga and non-yoga group

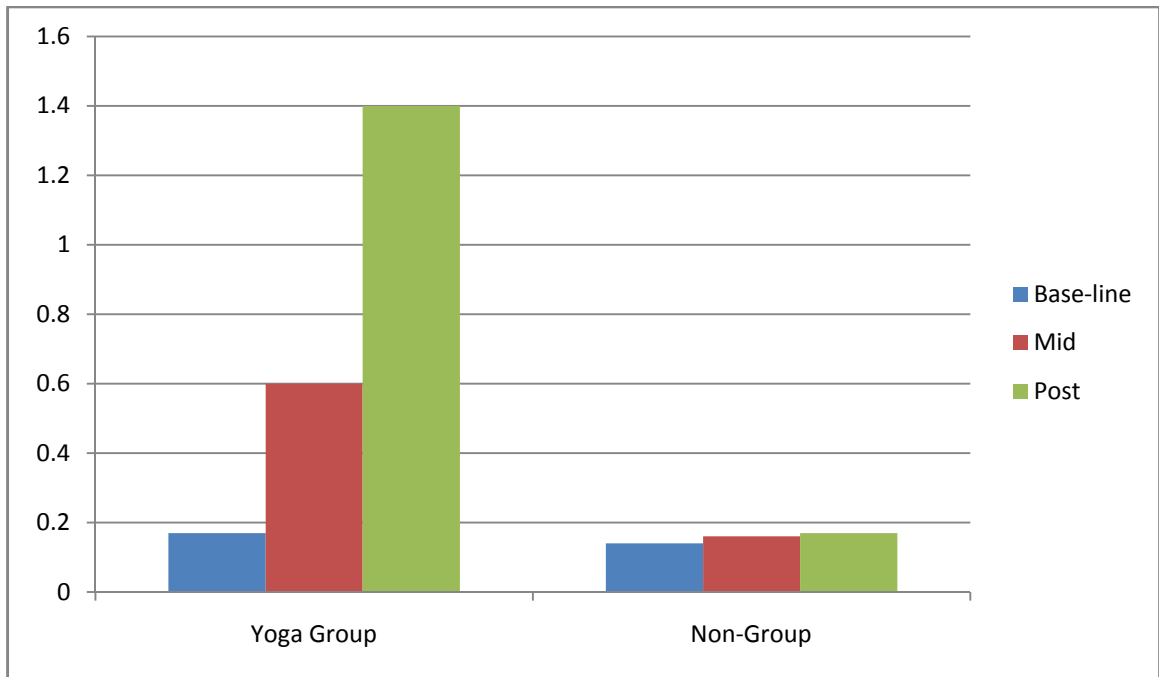


Table 18

Percentage of change in Imitating Complex Motor Action (ICMA) from Baseline – Mid – Post Yoga and Non-Yoga Group

Imitating Complex Motor Action (ICMA)	Baseline	Mid	% Change	Post	% Change	% change from base-line to Post
Yoga Group	0.17	0.6	252.94	1.4	133.33	723.52
Non-Yoga Group	0.14	0.16	14.28	0.17	6.25	21.42

Graph 10

Change in Imitating Oral Facial Movements (IOFM) at pre, mid and post of yoga and non-yoga group

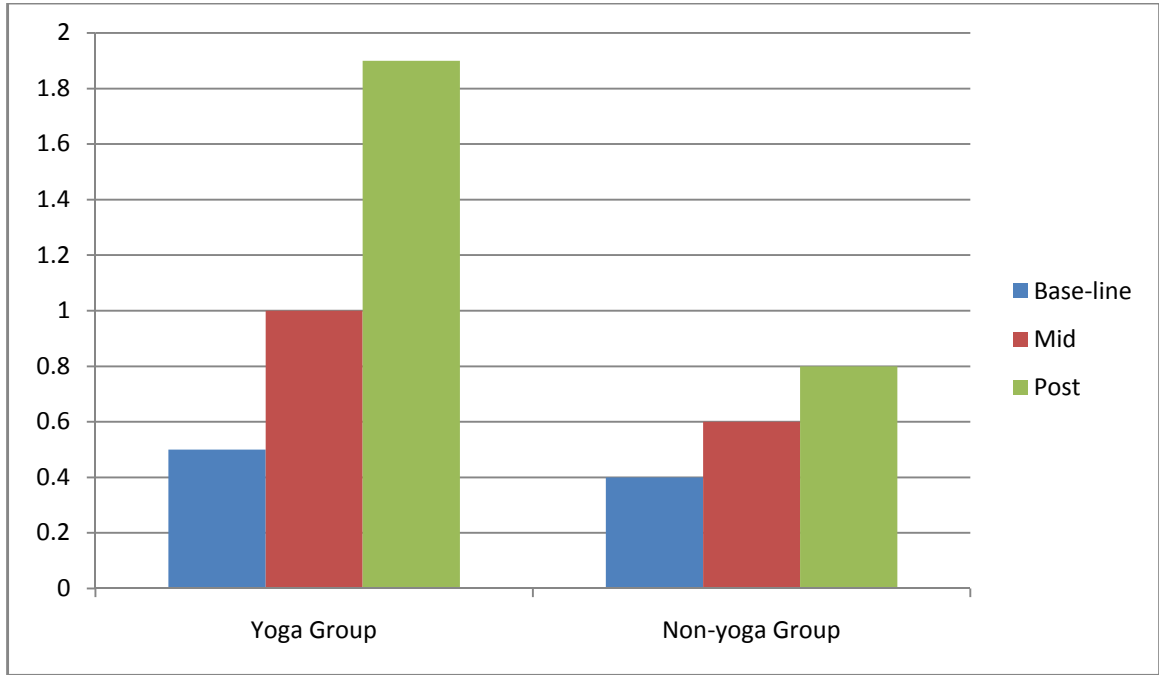


Table 19

Percentage of change in Imitating Oral Facial Movements (IOFM) from Baseline – Mid – Post Yoga and Non-Yoga Group

Imitating Oral Facial Movements (IOFM)	Baseline	Mid	% Change	Post	% Change	% change from base-line to Post
Yoga Group	0.5	1	100	1.9	90	280
Non-Yoga Group	0.4	0.6	50	0.8	33.33	100

Graph 11

Change in Imitating Breathing Exercises (IBE) at pre, mid and post of yoga and non-yoga group

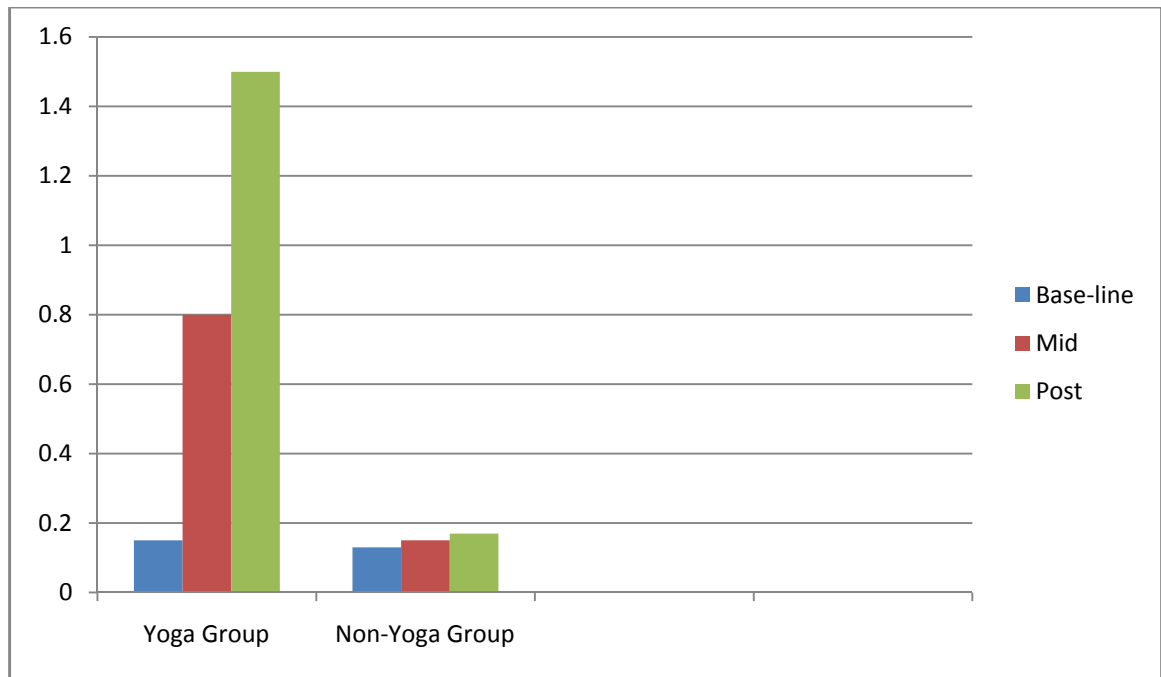


Table 20

Percentage of change in Imitating Breathing Exercises (IBE) from Baseline – Mid – Post Yoga and Non-Yoga Group

Imitating Breathing Exercises (IBE)	Baseline	Mid	% Change	Post	% Change	% change from base-line to Post
Yoga Group	0.15	0.8	433.33	1.5	87.5	900
Non-Yoga Group	0.13	0.15	15.38	0.17	13.33	30.76

5.2.7. Self Stimulatory Behavior

Graph 12 and Table 21 demonstrate changes in the self stimulatory behavior from base to mid and post sessions. At baseline, participants in both groups demonstrated body rocking, hand flapping, turning in circles and twidling objects. By the end of the yoga intervention, these behaviors disappeared in the classroom. Children who sought to sit out

of the mat, spin or jump on the mat in the initial sessions, demonstrated discipline by sitting in *vajrasana* whenever a gentle touch was given on their lower back. With this decreased RSB in the therapeutic sessions, we could move on to use additional inputs from peer model. Children started looking at peer models resulting in higher control over their RSB.

Graph 12
Change in Self Stimulatory Behavior at pre, mid and post of yoga and non-yoga groups

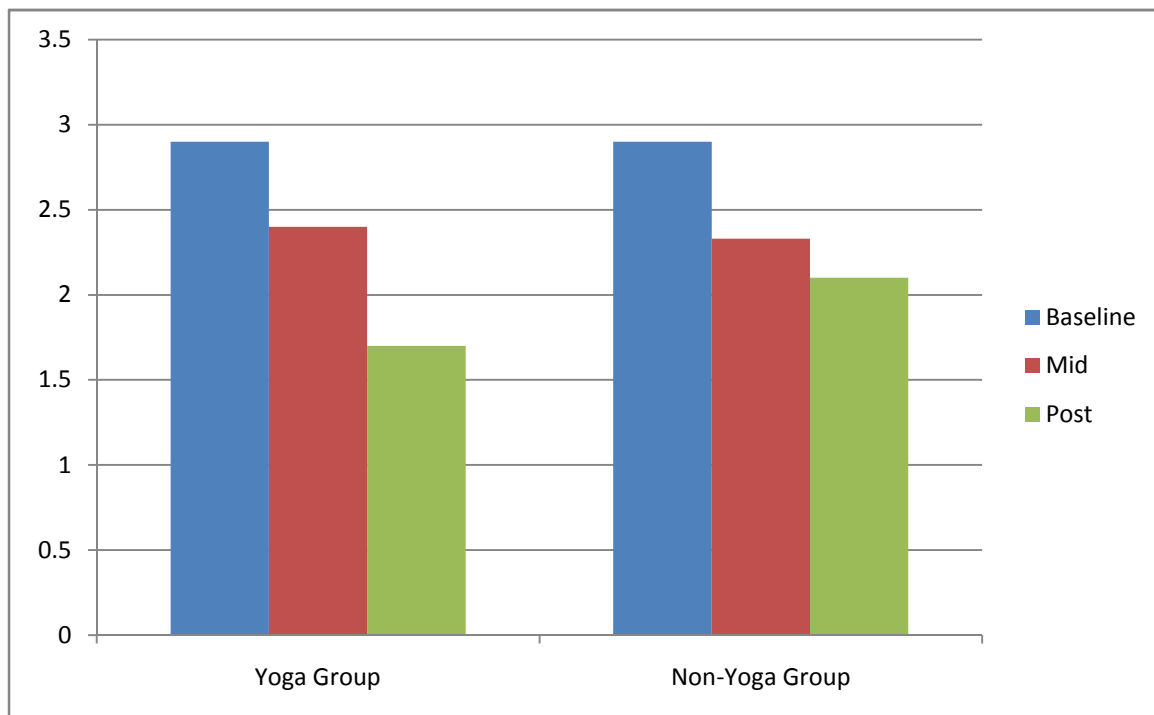


Table 21
Percentage of change in Self Stimulatory Behavior from Baseline – Mid – Post
Yoga and Non-Yoga Group

Self Stimulatory Behavior	Baseline	Mid	% Change	Post	% Change	% change from base-line to Post
Yoga Group	2.9	2.4	17.24	1.75	27.08	39.65
Non-Yoga Group	2.9	2.33	19.66	2.1	9.87	27.58

5.2.8. Self Injurious Behavior

Graph 13 and Table 22 demonstrate changes in the self injurious behavior from base to mid and post sessions. At baseline, participants in both groups demonstrated self injurious behavior like hitting head, hitting self against a surface, biting self and pulling hair. By the end of the yoga intervention, these behaviors were not observed in the classroom.

Graph 13
Change in Self Injurious Behavior at pre, mid and post of yoga and non-yoga group

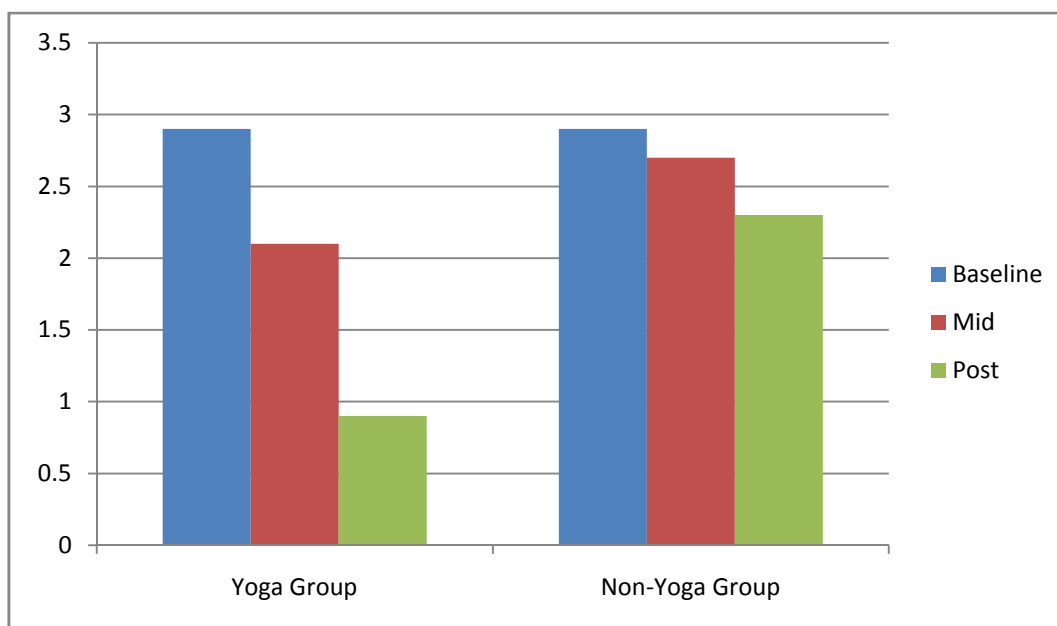


Table 22
Percentage of change in Self Injurious Behavior from Baseline – Mid – Post Yoga and Non-Yoga Group

Self Injurious Behavior	Baseline	Mid	% Change	Post	% Change	% change from base-line to Post
Yoga Group	2.9	2.1	27.87	0.9	57.14	68.96
Non-Yoga Group	2.9	2.33	6.90	2.1	14.81	27.58

5.2.9 Restricted Behavior

Graph 14 and Table 23 demonstrate changes in the restricted behavior from base to mid and post sessions. At baseline, participants in both groups demonstrated pre-occupation with one activity (e.g. Lining cars obsession with tearing paper etc.), strongly attached to one teacher and fascination to things that move. By the end of the yoga intervention, these behaviors disappeared in the classroom. Children managed to work with other teachers fascination to moving objects reduced and they could play with different materials.

Graph 14

Change in Restricted Behavior at pre, mid and post of yoga and non-yoga group

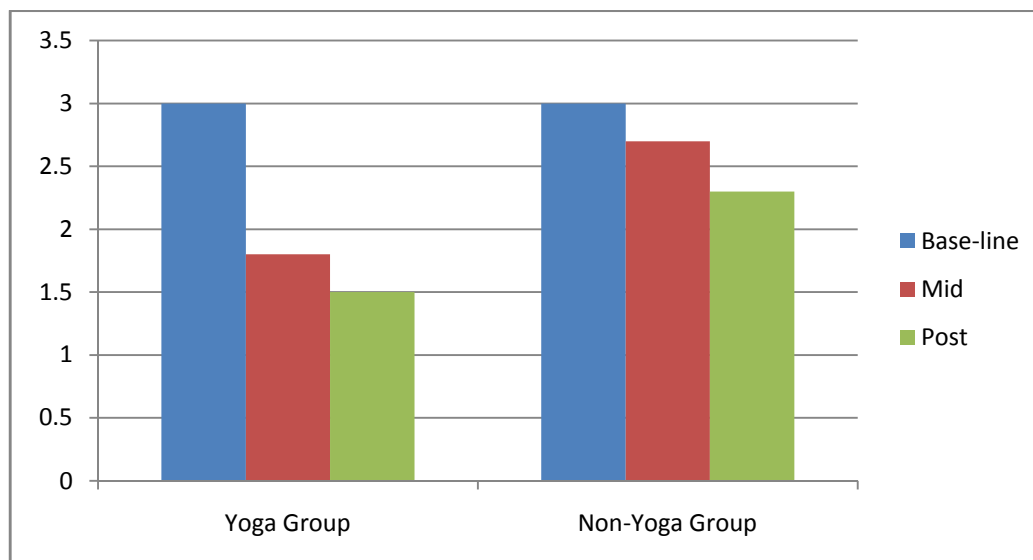


Table 23

Percentage of change in Restricted Behavior from Baseline – Mid – Post Yoga and Non-Yoga Group

Restricted Behavior	Baseline	Mid	% Change	Post	% Change	% change from base-line to Post
Yoga Group	3	1.8	40	1.5	16.66	50
Non-Yoga Group	3	2.7	10	2.3	14.81	23.33

5.2.10. Sameness Behavior

Graph 15 and Table 24 demonstrate changes in the sameness behavior from base to mid and post sessions. At baseline, participants in both groups’ insisted that things remain in the same place (for e.g. furniture in the home, chair in the classroom etc.), insisted to sit in the same place, disliked changes in dress (same uniform all days), difficulty with transition from one activity to other, insisted walking on the same route from school to home etc. By the end of the yoga intervention, these behaviors reduced. Parents reported that they are in a better position to handle the day today affairs.

Graph 15

Change in Sameness Behavior at pre, mid and post of yoga and non-yoga group

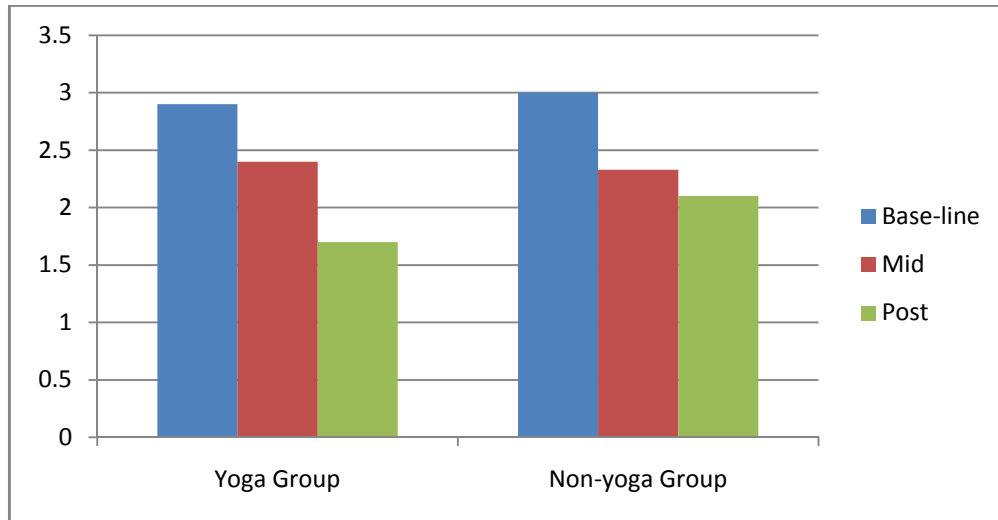


Table 24

Percentage of change in Sameness Behavior from Baseline – Mid – Post Yoga and Non-Yoga Group

Sameness Behavior	Baseline	Mid	% Change	Post	% Change	% change from base-line to Post
Yoga Group	3	2.4	20	1.7	29.19	43.33
Non-Yoga Group	3	2.33	22.33	2.1	9.87	30

5.2.11. Repetitive Behavior

Graph 16 and Table 25 demonstrate changes in the repetitive behavior from base to mid and post sessions. At baseline, participants in both demonstrated repetition of words, sentences and even events. They simply repeated the question asked (for e.g. what is your name? is repeated instead of giving name.) By the end of the yoga intervention, this behavior was not seen in the school situation. However, Parents reported moderate reduction in this behavior at home and other situations.

Graph 16

Change in Repetitive Behavior at pre, mid and post of yoga and non-yoga group

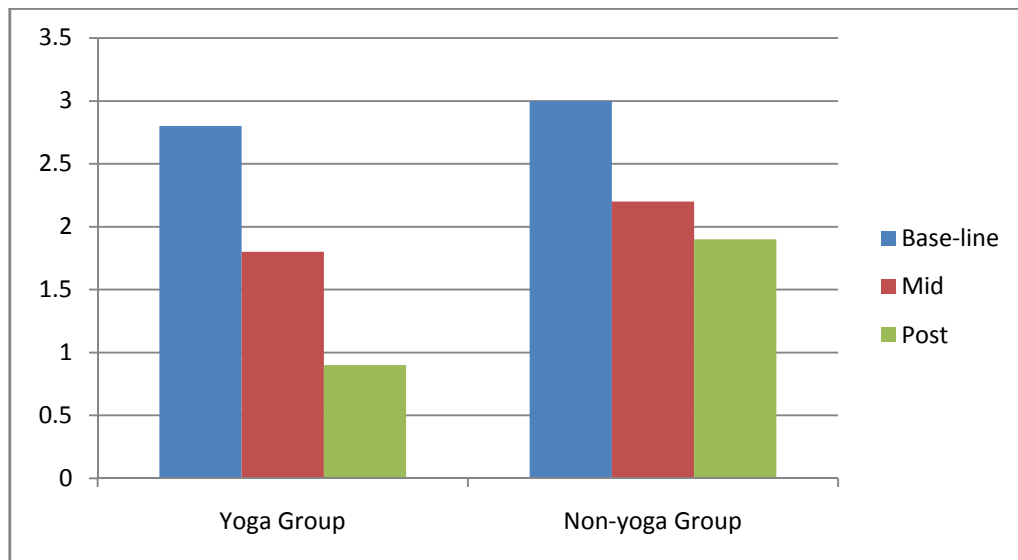


Table 25

Percentage of change in Repetitive Behavior from Baseline – Mid – Post Yoga and Non-Yoga Group

Repetitive Behavior	Baseline	Mid	% Change	Post	% Change	% change from base-line to Post
Yoga Group	2.8	1.8	35.71	0.9	50	67.85
Non-Yoga Group	3	2.2	26.66	1.9	13.63	36.66

5.2.12. Receptive Skills regarding Spatial Relation

Graph 17 and Table 26 demonstrate changes in the receptive skills regarding spatial relation from base to mid and post sessions. At baseline participants in both groups demonstrated difficulty in understanding verbal commands such as turn right, left, down, up, below, under, back, front etc... While performing *trikonoasana* (triangle position) and *uttanasana*, Class teachers reported difficulty in drawing simple lines. By the end of the yoga intervention, all the participants demonstrated an understanding of the above commands and class teachers reported commencement of the basics of writing skill.

Graph 17
Change in Receptive Skills regarding Spatial Relation at pre, mid and post of yoga and non-yoga group

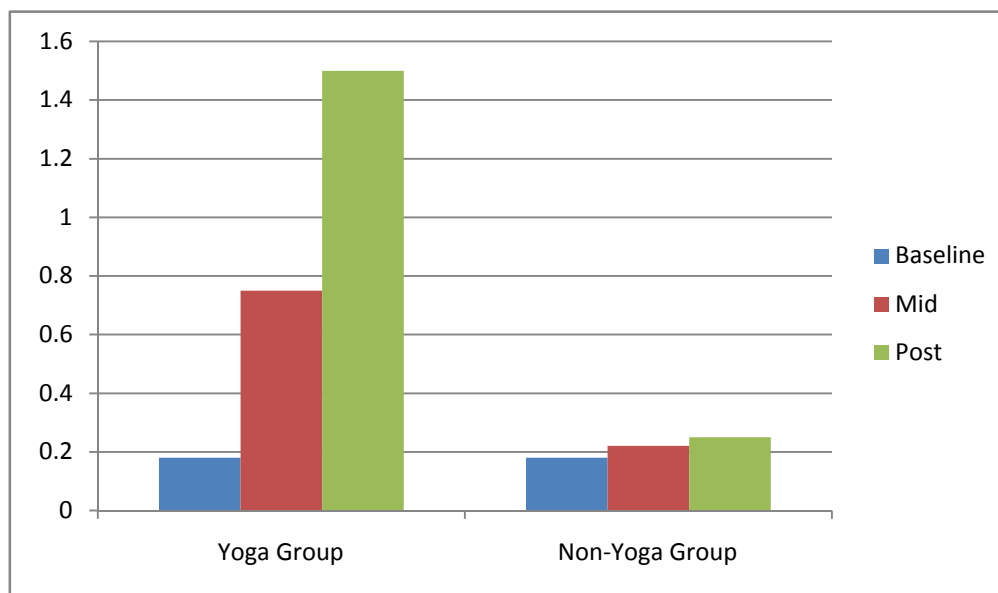


Table 26
Percentage of change in Receptive Skills regarding Spatial Relation from Baseline – Mid – Post Yoga and Non-Yoga Group

Receptive Skills regarding Spatial Relation	Baseline	Mid	% Change	Post	% Change	% change from base-line to Post
Yoga Group	0.17	0.75	341.17	1.5	100	782.35
Non-Yoga Group	0.17	0.25	47.05	0.25	0	47.05

5.2.13. Other Behavior Changes

During the post assessment session children demonstrated certain observable behavior change such as enjoying the proximity of adults. Those who could not connect with the therapist started coming closer to the therapist when continuous chanting of mantras took place. They seemed to have fun with chants, as it encouraged a sense of rhythm and a means to work on co-ordination.

A gentle touch or pressure gave them a different experience and the mother could use tactile stimulus to help them learn to control head banging behavior. The child started enjoying and developed interest in the therapy sessions because of this change in the perceptual dynamics. Consequently, all children started to display early shared attention behaviors such as looking at the peers, making eye contact with the therapist, offering no resistance to the therapist to guide their hand movements. All the six children in the yoga group started to indicate their preferences for asanas for e.g.: Shavasana (corpse pose), Parvathasana (mountain pose), a progressive change indicating needs. They progressed from the early resistance to passive tolerance to active participation and enjoying the therapy sessions. Over the course of yoga therapy children started to trust, share, initiate and reciprocate.

Children could indicate their basic needs better by using gestures. They reported improvement in their ability to interact with other members of the family and other children during play situation and increased sitting tolerance during all activities including feeding, playing, watching TV etc.

No significant changes were seen in any of the domains discussed above in the control group as reported by the special educators of the three schools.

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. *Parivrittatrikonâsana* (*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 ^[74])

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 ^[75]; Schneck CM 2000 ^[76]) 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) ^[77] 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 ^[78]).

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) ^[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 students 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.

CHAPTER 7

APPRAISAL

7.1. Summary

The effect of a long-term intensive yoga program on 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 was studied in two groups of ASD children (yoga and non-yoga). It was a control study in a school setup in Bangalore, South India. Twelve subjects (n = 12) with ASD, whose parents consented to participate in the study were assigned to two groups to receive yoga or no yoga. The intervention consisted of a twenty-months intensive yoga program comprising of warm-up practices , loosening practices, strengthening asanas, calming asanas, yogic Breathing practices and chanting. The non-yoga group received traditional ABA based training in a special school. In the yoga group there was significant improvement in the mid session (200th session) followed further by a significant improvement in most of the parameter by the end of yoga intervention (390th session). There was no significant change in any of the parameters in the non-yoga group.

Uniqueness of the study: This is a first comprehensive intensive scientific study conducted with ASD children along with their parents compared to reports which showed better results in changing the ASD behavior. Duration of yoga practices in the present study was 1 hour per day for five days. The integrated yoga module used in this study included mind management techniques like OM meditation, cyclic meditation, deep relaxation technique, mind sound resonance technique, yogic hymns, yogic counseling and devotional sessions to the parents of the ASD children who participated in the study.

7.2. Conclusion

1. Improvement in autistic behavior of ASD children after the practice of yoga resulting in better quality of life for parents.
2. Increase in imitation behavior

3. Decreased repetitive stereotyped behavior

Overall, this study revealed significant positive changes in overall participant scores in all the ASD behaviors. It is difficult to say with any certainty that changes in ASD symptoms were due to the yoga intervention only. Yoga allows for simple asanas to be used in class as part of the curriculum. However, the benefits of yoga are that it not only uses simple asanas as a way to release excess energy, but it also teaches participants how to focus their energy and concentration through deep breathing and relaxation techniques. Further, research has shown that meditative deep breathing exercises have a calming and focusing effect and relaxation exercises have shown positive effects on reduced hyperactivity, increased imitation and decreased repetitive stereo typed behavior.

7.3. Strength of the study

This was a long-term, twenty month study without any drop out in either control group or the experimental group. Data were also taken at the mid-point. Furthermore, to the author's knowledge, this is the first behavioral study in ASD children with a control group. Study design also included parental participation; such a family oriented treatment has not previously been reported in any conventional intervention modules. Finally, the consistency of the results enabled statistical significance to hold.

7.4. Limitation of the study

Despite the overall positive results of using yoga in the classroom, there are certain issues to consider, particularly methodological issues. The sample size, though extremely small, was homogenous with respect to age and gender. The participants themselves had different characteristics with reference to ASD behavior; I.Q. and learning capability. There were also variations in the number of yoga sessions attended and the amount of time each participant received. Yoga intervention varied from 30 to 45 minutes, depending on the participant's motivation to continue.

Autism Rating Scale, ITB, RSBTB and Teacher- parent Rating Scales used in this study are subjective. Given that both the teachers and parents knew the questions guiding the study, it may have been difficult to be as objective as possible when completing the test battery. Further, because different teachers gave inputs for the pre-, mid- and post-rating, different teachers might have had different perceptions regarding the behavior and severity of behavior, in spite of the initial training of these teachers by the researcher. As a result, the scores could have been affected by inter rater reliability. In future studies, inter and intra rater reliability could be incorporated. Another variable was the parent questionnaire. It was discovered that most of the parents did not have significant knowledge of the participant's reason for being in a special education classroom and in one instance; a parent did not have the ability to answer specific questions due to inadequate knowledge about ASD. Thus, teachers and parents used other information from academic records to complete missing pieces of the questionnaire. Some medical information was not disclosed in school records – as medication, or changes in medication, were not mentioned. Because of the variations in information gathered from many schools, miscommunications could have occurred between among parents, teachers, administrators, and medical professionals, resulting in incomplete student records.

The use of yoga as a complementary, as opposed to alternative, treatment for students with ASD appears to have some merit in the classroom. In order to have the opportunity to discover more about yoga intervention in the classroom, there are several opportunities for future exploration and study. First and foremost, it would be beneficial for the research to be continued for a longer time and collect data using rating scales periodically in order to determine any progressive benefits of the yoga intervention. This study needs to be replicated with larger numbers and more reliable measures need to be employed. Because of the success of the summed participant data, the yoga intervention should be replicated in a classroom for students in a special education setting.

7.5. Suggestions for future

- Standardize and validate the test battery (ITB and RSBTB) modified by the researcher for the Indian populations
- Continued use of the research methodology for an extended time period
- More controlled time intervals for yoga intervention
- Use of more reliable measures such as an outside observer recording data at specific intervals to record targeted behaviors
- Gather parental input regarding the effects of the yoga intervention after school to determine generalization effects

This area of research is extremely promising and could result in an effective way to help all ASD students to increase their communication skill. Many people have tried to explain the benefits of yoga, but few actually have data to back up anecdotal evidence.

References

1. Kannar L (1943). Autistic disturbances of affective content. *Nervous Child*; 2: 217–250. Reprinted in *Childhood Psychosis: Initial Studies and New Insights*, ed. Leo Kanner (Washington, D.C.: V. H. Winston, 1973). Also reprinted in *Classic Readings in Autism*, ed. Anne M. Donnellan (New York: Teacher's College Press, 1985).
2. Asperger H (1944). Die 'autistischen psychopathen' im kindesalter. *Archiv fur Psychiatrie und Nervenkrankheiten*; 117 :76–136.
3. Volkmar FR, Klin A, Siegel B, Szatmari P, Lord C, Campbell M, Freeman BJ, Cicchetti D V, Rutter M, and Kline W(1994). Field trial for autistic disorder in dsm-iv. *Am J Psychiatry*; 151(9):1361–1367.
4. Baired G, Charman T & Santhosh PJ (2001). Clinical considerations in the diagnosis of ASD; *Indian Pediatrics*; 68: 439-449.
5. Schopler E (2001). Treatment for Autism : From Science to Pseudo-Science or Anti-Science. *The Research Basis for Autism Intervention*. Kluwer Academics/Plenum Publishers, New York; 9-24.
6. Siegel B (1996). *The world of the autistic child : Understanding and treating autistic spectrum disorders*. Oxford University Press, New York.
7. McClannahan LE & Krantz PJ (2001). Behavior analysis and intervention for preschoolers at the Princeton Child Development Institute. In J.S.Handleman &S.L.Harris (Eds.), *Preschool education programs for children with autism* (2nd ed.). Austin, TX: Pro-Ed.
8. Harri LS and Handleman JS (1996). Age and IQ at Intake as Predictors of Placement for Young Children with Autism: A Four- to Six-Year Follow-Up. [Journal of Autism and Developmental Disorders](#); 30(2) : 137-142.

9. Lovass IO (1987). Behavioral Treatment and Normal Educational and Intellectual Functioning in Autistic Children. *Journal of Consulting and Clinical Psychology* ; 55(1) : 3-9.
10. [Jacobson](#) JW & [Mulick](#) JA (2000). System and Cost Research Issues in Treatments for People with Autistic Disorders . [Journal of Autism and Developmental Disorders](#); 30(6) : 585-593
11. Hyman S & Lavy S (2000), When traditional medicine is not enough? *Contemporary Paediatrics*;77:100- 114.
12. Roger SJ (1998). Empirically supported comprehensive treatments for young children with autism. *Journal of Autism and Developmental Disorders* ; 27: 168-172.
13. Nickel R (1996). Controversial therapies for young children with developmental disabilities. *Infants Young Children* ;8:29–40.
14. **Banquet JP (1973)**. Spectral analysis of the EEG in meditation. [Electroencephalography and Clinical Neurophysiology](#), 35(2). 143-151.
15. Herzog H, Lele V R, Kuwert T, Langen K J , Rota Kops E, Feinendegen L E (1990). Changed pattern of regional glucose metabolism during yoga meditative relaxation. *Neuropsychobiology*; 23(4):182-187.
16. [Newberga](#) AB and [Iversenb](#) J (2003). The neural basis of the complex mental task of meditation: neurotransmitter and neurochemical considerations. *Medical Hypotheses* . 61 (2). 282-291.
17. Uytterhoeven S (2006). Yoga and the Autonomic Nervous System: Re-Educating the Mind. *International Association of Yoga Therapists* 23-26.
18. **Pauline S J & Kenny DT (2009)**. The effects of **yoga** on the attention and ... in Children and Adolescents With **Autism** Spectrum Disorder: Symptom or Syndrome? *Journal of Attention Disorder* ;13: 207-210.
19. Goldberg L (2004). Creative relaxation a yoga based program for regular & exceptional children. *SIYT*;14: 67-78

20. Molly K (2002). Integrated Movement Therapy. *International Journal of Yoga Therapy*;12:71-79.
21. Betts DE (2006). *Yoga for children with autism spectrum disorder*. Jessica Kingsley Publishers, London.
22. Frawley (2004) *Ayurvedic Healing Course for Health Care Professionals Part IV* . Santa Fe, N.American Institute of Vedic Studies.
23. Charakasamhita and Kashyapasamhita (2006). Charaka. *Charaka Samhita chikitsa Sthana*, Delhi. Choukamba Sanskrit Parishthan, 24th Ed.
24. Tsai LY (1999). Recent neurobiological research in autism. In Diane Zager (3rd Eds). *Autism Spectrum Disorder*. Lawrence Erlboun Associated Inc. ;50-59.
25. White BB (1987). Autism from the inside. *Medical Hypothesis*; 24(3).
26. Rutter M (1996). Causes of infantile autism: Some considerations from recent research. [Journal of Autism and Developmental Disorders](#); 1(1): 20-32
27. Williams JHG (2008). Self–other relations in social development and autism: multiple roles for mirror neurons and other brain bases. *Autism Res.*;1(2):73–90.
28. Iacoboni M & Dapretto M (2006) The mirror neuron system and the consequences of its dysfunction. *Nat Rev Neurosci.*;7(12):942–51.
29. Frith U & Frith CD (2003). Development and neurophysiology of mentalizing [PDF]. *Philos Trans R Soc Lond B Biol Sci.*;358(1431):459–73.
30. Hamilton AF (2008). Emulation and mimicry for social interaction: a theoretical approach to imitation in autism. *Q J Exp Psychol.*;61(1):101–15.
31. Bauman ML & Kemper TL (2005). Neuroanatomic observations of the brain in autism: a review and future directions. *International Journal of Developmental Neuroscience*; 23 : 183–187.
32. Zager D (2005). *Autism Spectrum Disorders: Identification, Education, and Treatment*. Lawrence Erlbaum Associates.
33. Freitag CM (2007). The genetics of autistic disorders and its clinical relevance: A review of the literature. *Molecular Psychiatry*; 12: 2-22.

34. Parker SK, Schwartz B, Todd J & Pickering LK (2004). Thimerosal-Containing Vaccines and Autistic Spectrum Disorder: A Critical Review of Published Original Data. *PEDIATRICS* ;114 (3): 793- 804
35. Horvath K, Papadimitriou JC, Rabsztyl A & Drachenberg C (1999). Gastrointestinal abnormalities in children with autistic disorder. *The Journal of Pediatrics* ; 135 (3);559 -563.
36. Larsson HJ, Eaton WW, Madse KM, Vestergaard M, Olesen AV, Agerbo E, Schendel D, Thorsen P, & Mortensen PB (2005). Risk factors for autism: perinatal factors, parental psychiatric history, and socioeconomic status. *Am J Epidemiol*; 161(10):916– 925.
37. Wilkerson DS, Volpe AG, Dean RS, and Titus JB. (2002). Perinatal complications as predictors of infantile autism. *International Journal of Neuroscience*; 112(9):1085–1098.
38. **Nelson KB (1999). Prenatal and Perinatal Factors in the Etiology of Autism.** *PEDIATRICS*;87(5) : 761-766.
39. Yirmiya N & Shaked M. (2005). Psychiatric disorders in parents of children with autism: a meta-analysis. *J Child Psychol Psychiatry*; 46(1): 69–83.
40. Baron-Cohen S, Leslie AM & Frith U. (1985). Does the autistic child have a 'theory of mind'? *Cognition*; 21: 37-46.
41. Hultman CM, Sparén P & Sven (2002). Perinatal Risk Factors for Infantile Autism. *Epidemiology*; 13 (4): 417-423.
42. Remington B, Hastings RP, Kovshoff H, Espinosa FD, Jahr E, Brown T, Alford P, Lemaic M & Ward N (2007). A field effectiveness study of early intensive behavioral intervention: Outcomes for children and their parents after two years. *American Journal of Mental Retardation* ;112 (6): 418-439.
43. Reed P, Osborne LA, & Corness M (2006). Brief report: Relative effectiveness of different home-based behavioral approaches to early teaching intervention. *Journal of Autism and Developmental Disorders*;37(9): 1815-1821.

44. Green G, Brennan LC, & Fein D (2002). Intensive behavioral treatment for a toddler at high risk for autism. *Behavior Modification* ;26: 69-102.
45. Perry R, Cohen I & De Carlo R (1995). Case study: Deterioration, autism, and recovery in two siblings. *Journal of the American Academy of Child and Adolescent Psychiatry* ;34 :232-237.
46. **Skinner BF (1950).** Are theories of learning necessary?. *Psychological Review*;57: 193-216.
47. Uma K, Nagendra HR, Nagarathna R, Vaidehi S, & Seethalakshmi R. (1989). The integrated approach to yoga: a therapeutic tool for mentally retarded children: a one-year controlled study. *Journal of Ment Defic Res*; 33 : 415-21.
48. Pag F & Ruiz E (2001). Focusing on ADD: Adults and children living with attention deficit hyperactivity disorder. *Yoga Journal*, 1(1), 97-103.
49. Harrison LJ, Manocha R & Rubia K (2004). Sahaja yoga meditation as a family treatment programme for children with attention deficit- hyperactivity disorder. *Clinical Child Psychology and Psychiatry*; 9(4):479-497.
50. Telles S & Naveen KV. (1997). Yoga for rehabilitation: an overview. *Indian Journal of Medical Science*; 51(4): 123-127.
51. Block RA, Arnott DP, Quigley B, & Lynch WC. (1989). Unilateral nostril breathing influence lateralized cognitive performance. *Brain Cogn*; 9: 181-190.
52. Jella SA, & Shannahoff-Khalsa DS. (1993). The effects of unilateral forced nostril breathing on cognitive performance. *International Journal of Neuroscience*; Nov; 73(1-2): 61-68.
53. Werntz D, Bickford RG, Bloom FE & Shannahoff- Khalsa D (1983). Alternating cerebral hemispheric activity and the lateralization of autonomic nervous function.. *Human Neurobiology*; 2: 39- 43.
54. Werntz D, Bickford RG, & Shannahoff-Khalsa D (1987). Selective hemispheric stimulation by unilateral forced nostril breathing. *Human Neurobiology*; 6:165-171.

55. Zipkin D. (1985). Relaxation techniques for handicapped children: A review of the literature. *The Journal of Special Education*;19 (3): 283-289.
56. Peck HL, Kehle TJ, Bray MA, & Theodore LA (2005). Yoga as an intervention for children with attention problems. *School Psychology Review*; 34(3) : 415-424.
57. Shannahoff-Khalsa D (2004). An introduction to kundalini yoga meditation techniques that are specific for the treatment of psychiatric disorders. *The Journal of Alternative and Complementary Medicine* ;10(1) : 91-101.
58. Connor C (2005). So Much Stress; So Little Time. *Autism news orange county* ; 2(1) :19-20.
59. Oldenberg L (2004). Use of yoga with occupational therapy. *International Journal of Yoga Therapy*; 12: 71-77.
60. World Health Organization. (1993). ICD-10, the ICD-10 classification of mental and behavioral disorders: diagnostic criteria for research. Geneva: World Health Organization.
61. Rimland B (1971). Autism Research Institutes Form E-2. *Journal of Autism and Developmental Disorders*;12:97-98.
62. Nagarathna R and Nagendra R (1985). Yoga for bronchial asthma: a controlled study. *British Journal of Medical Research*; 291:1077-1099.
63. Radhakrishna S (2006). Using Yoga Therapy (YT) to increase communication, social and cognitive skills in children with autistic spectrum disorders. Available from:
<http://www.integralpsychology.in/texts/nsip/nsipabstracts/shantharadhakrishna.html> . [Last cited on 2007].
64. Hadjikhani N (2007). Mirror neuron system and autism. Nova Science Publishers. 159-160.
65. Ashwood P, Wills S, & Van de Water J (2006). [The immune response in autism: a new frontier for autism research](#). *J Leukoc Biol* ;80 (1): 1–15.

66. Penn HE (2006). Neurobiological correlates of autism: a review of recent research. *Child Neuropsychol*; 12 (1): 57–79.
67. Manzi B, Loizzo AL, Giana G, & Curatolo P (2008). Autism and metabolic diseases. *J Child Neurol*; 23 (3).
68. Davis J (2009). On Yoga Therapy & Autism. *Yoga Therapy Today*. 26-29.
69. Iyengar BKS (2001). *Yoga: The Path to Holistic Health*. London, Dorling Kindersley Press.
70. Rossignol DA (2009). Novel and emerging treatments for autism spectrum disorders: A systematic review. *Annals of Clinical Psychiatry* ;21(4):213-236
71. Siegel B (1996). *The world of the autistic child : Understanding and treating autistic spectrum disorders..* Oxford University Press, New York.
72. Hutt C & Hutt SJ (1965). Effects of environmental complexity on stereotyped behaviours of children. *Animal Behavior* ;13 :1–4.
73. Hutt C & Hutt SJ (1970). Stereotypies and their relation to arousal: A study of autistic children. In C. Hutt & S. J. Hutt (Eds.), *Behaviour studies in psychiatry*. Oxford: Pergamon Press; 175–204
74. Turner M (1999). Annotation: Repetitive Behavior in Autism: A Review of Psychological Research. *Journal of Child Psychology and Psychiatry*;40(6) : 839–849,
75. Guess D & Carr EG (1991). Emergence and maintenance of stereotypy and self-injury. *American Journal on Mental Retardation*; 96(3): 299–319.
76. Schneck CM (2000). The efficacy of a sensorimotor treatment approach by occupational therapists. In R. A. Huebner (Ed.), *Autism: A sensorimotor approach to management* Austin: PRO-ED INC.;139–178.
77. Gepner B & Fe'ron F (2009). Review Autism: A world changing too fast for a mis-wired brain? *Neuroscience and Biobehavioral Reviews*; 33: 1227–1242
78. Gepner B & Mestre D (2002). Rapid visual-motion integration deficit in autism. *Trends Cogn. Sci*; 6: 455.

79. Pelphrey KA, Morris JP & McCarthy G (2005). Neural basis of eye gaze processing deficits in autism. [Brain](#) a journal of neurology. Oxford University Press ;128(5) :1038-1048

APPENDIX 1

Raw Score Data - Yoga Group – Baseline Session 1

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	1	0	0	0	0	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	1	1	1	0	0	1	1	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	1	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	0
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data - Yoga Group – Baseline Session 2

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	1	0	0	0	0	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	1	1	1	0	0	1	1	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	1	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	0
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data - Yoga Group – Baseline Session 3

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	1	0	0	0	0	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	1	1	1	0	0	1	1	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	1	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	0
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data - Yoga Group – Baseline Session 4

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	1	0	0	0	0	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	1	1	1	0	0	1	1	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	1	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	0
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data - Yoga Group – Baseline Session 5

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	1	1	1	0	0	1	1	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	1	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	0
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data - Yoga Group – Baseline Session 6

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	1	1	1	0	0	1	1	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	1	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	0
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data - Yoga Group – Baseline Session 7

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	1	1	1	0	0	1	1	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	1	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	0
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data - Yoga Group – Baseline Session 8

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	1	1	1	0	0	1	1	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	1	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	0
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data - Yoga Group – Baseline Session 9

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	1	1	1	0	0	1	1	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	1	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	0
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data - Yoga Group – Baseline Session 10

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	1	1	1	0	0	1	0	0	1
3.	Body posture	0	1	0	1	0	0	1	1	0	1	1	0
4.	Body awareness	0	0	1	0	0	0	0	0	0	0	0	1
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	0
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data - Yoga Group – Baseline Session 11

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	1	0	0	0	1	0	0	0	0
2.	Sitting tolerance	1	0	0	1	1	1	0	0	1	0	0	1
3.	Body posture	0	1	0	1	0	0	1	1	0	1	1	0
4.	Body awareness	0	0	1	0	0	0	0	0	0	0	0	1
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	0
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data - Yoga Group – Baseline Session 12

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	1	0	0	0	1	0	0	0	0
2.	Sitting tolerance	1	0	0	1	1	1	0	0	1	0	0	1
3.	Body posture	0	1	0	1	0	0	1	1	0	1	1	0
4.	Body awareness	0	0	1	0	0	0	0	0	0	0	0	1
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	0
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data - Yoga Group – Baseline Average of 12 Sessions

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6		Average
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0	0.17
2.	Sitting tolerance	1	0	0	1	1	1	0	0	1	1	0	0	0.5
3.	Body posture	0	1	1	0	0	0	1	1	0	1	1	0	0.5
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0	0.17
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0	0.33
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	0	0.17
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3	2.9
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3	2.9
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0	0.17

Note : Rating scale for Sl. No. 7 and 8 refer to table 5.

O¹ - Observer 1

O² - Observer 2

Raw Score Data –Yoga Group – Mid Session 1

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	1	1	1	1	1	1	1	0	1	1	1	1
2.	Sitting tolerance	1	1	1	1	1	1	1	1	1	1	1	1
3.	Body posture	1	1	1	1	1	1	1	1	1	1	1	1
4.	Body awareness	1	1	0	1	1	0	1	0	0	1	1	0
5.	Depth perception and balance	1	1	0	1	1	0	1	0	0	1	1	0
6.	Imitation skills	0	1	1	0	0	0	1	1	0	1	0	0
7.	Self stimulatory behavior	2	3	3	2	2	3	3	2	3	2	2	2
8.	Self injurious behaviors	2	2	2	2	2	2	2	2	2	2	2	3
9.	Receptive skills related to spatial relationships	1	1	1	1	1	1	1	0	0	1	1	0

Raw Score Data –Yoga Group – Mid Session 2

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	1	1	1	1	1	1	1	0	1	1	1	1
2.	Sitting tolerance	1	1	1	1	1	1	1	1	1	1	1	1
3.	Body posture	1	1	1	1	1	1	1	1	1	1	1	1
4.	Body awareness	1	1	0	1	1	0	1	0	0	1	1	0
5.	Depth perception and balance	1	1	0	1	1	0	1	0	0	1	1	0
6.	Imitation skills	0	1	1	0	0	0	1	1	0	1	0	0
7.	Self stimulatory behavior	2	3	3	2	2	3	3	2	3	2	2	2
8.	Self injurious behaviors	2	2	2	2	2	2	2	2	2	2	2	3
9.	Receptive skills related to spatial relationships	1	1	1	1	1	1	1	0	0	1	1	0

Raw Score Data –Yoga Group – Mid Session 3

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	1	1	1	1	1	1	1	0	1	1	1	1
2.	Sitting tolerance	1	1	1	1	1	1	1	1	1	1	1	1
3.	Body posture	1	1	1	1	1	1	1	1	1	1	1	1
4.	Body awareness	1	1	0	1	1	0	1	0	0	1	1	0
5.	Depth perception and balance	1	1	0	1	1	0	1	0	0	1	1	0
6.	Imitation skills	0	1	1	0	0	0	1	1	0	1	0	0
7.	Self stimulatory behavior	2	3	3	2	2	3	3	2	3	2	2	2
8.	Self injurious behaviors	2	2	2	2	2	2	2	2	2	2	2	3
9.	Receptive skills related to spatial relationships	1	1	1	1	1	1	1	0	0	1	1	0

Raw Score Data –Yoga Group – Mid Average of 3 Sessions

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6		Average
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	
1.	Eye to eye gaze	1	1	1	1	1	1	1	0	1	1	1	1	0.9
2.	Sitting tolerance	1	1	1	1	1	1	1	1	1	1	1	1	1.0
3.	Body posture	1	1	1	1	1	1	1	1	1	1	1	1	1.0
4.	Body awareness	1	1	0	1	1	0	1	0	0	1	1	0	0.6
5.	Depth perception and balance	1	1	0	1	1	0	1	0	0	1	1	0	0.6
6.	Imitation skills	0	1	1	0	0	0	1	1	0	1	0	0	0.4
7.	Self stimulatory behavior	2	3	3	2	2	3	3	2	3	2	2	2	2.4
8.	Self injurious behaviors	2	2	2	2	2	2	2	2	2	2	2	3	2.1
9.	Receptive skills related to spatial relationships	1	1	1	1	1	1	1	0	0	1	1	0	0.75

Note : Rating scale for Sl. No. 7 and 8 refer to table 5.

O¹ - Observer 1

O² - Observer 2

Raw Score Data –Yoga Group – Post Session 1

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	1	2	2	2	2	1	2	2	1	2	2	2
2.	Sitting tolerance	1	2	2	2	2	1	2	2	1	2	2	2
3.	Body posture	1	2	2	2	2	1	2	2	1	2	2	2
4.	Body awareness	1	2	2	2	2	1	2	2	1	2	2	2
5.	Depth perception and balance	1	1	2	1	1	1	2	1	1	2	1	2
6.	Imitation skills	2	1	2	1	2	1	2	2	2	1	2	1
7.	Self stimulatory behavior	1	2	2	2	2	1	2	2	1	2	2	2
8.	Self injurious behaviors	1	1	1	1	1	1	1	0	1	1	1	1
9.	Receptive skills related to spatial relationships	1	2	2	1	1	2	2	1	2	1	2	1

Raw Score Data –Yoga Group – Post Session 2

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	1	2	2	2	2	1	2	2	1	2	2	2
2.	Sitting tolerance	1	2	2	2	2	1	2	2	1	2	2	2
3.	Body posture	1	2	2	2	2	1	2	2	1	2	2	2
4.	Body awareness	1	2	2	2	2	1	2	2	1	2	2	2
5.	Depth perception and balance	1	1	2	1	1	1	2	1	1	2	1	2
6.	Imitation skills	2	1	2	1	2	1	2	2	2	1	2	1
7.	Self stimulatory behavior	1	2	2	2	2	1	2	2	1	2	2	2
8.	Self injurious behaviors	1	1	1	1	1	1	1	0	1	1	1	1
9.	Receptive skills related to spatial relationships	1	2	2	1	1	2	2	1	2	1	2	1

Raw Score Data –Yoga Group – Post Session 3

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	1	2	2	2	2	1	2	2	1	2	2	2
2.	Sitting tolerance	1	2	2	2	2	1	2	2	1	2	2	2
3.	Body posture	1	2	2	2	2	1	2	2	1	2	2	2
4.	Body awareness	1	2	2	2	2	1	2	2	1	2	2	2
5.	Depth perception and balance	1	1	2	1	1	1	2	1	1	2	1	2
6.	Imitation skills	2	1	2	1	2	1	2	2	2	1	2	1
7.	Self stimulatory behavior	1	2	2	2	2	1	2	2	1	2	2	2
8.	Self injurious behaviors	1	1	1	1	1	1	1	0	1	1	1	1
9.	Receptive skills related to spatial relationships	1	2	2	1	1	2	2	1	2	1	2	1

Raw Score Data –Yoga Group – Post Average of 3 Sessions

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6		Average
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	
1.	Eye to eye gaze	1	2	2	2	2	1	2	2	1	2	2	2	1.75
2.	Sitting tolerance	1	2	2	2	2	1	2	2	1	2	2	2	1.75
3.	Body posture	1	2	2	2	2	1	2	2	1	2	2	2	1.75
4.	Body awareness	1	2	2	2	2	1	2	2	1	2	2	2	1.75
5.	Depth perception and balance	1	1	2	1	1	1	2	1	1	2	1	2	1.3
6.	Imitation skills	2	1	2	1	2	1	2	2	2	1	2	1	1.6
7.	Self stimulatory behavior	1	2	2	2	2	1	2	2	1	2	2	2	1.75
8.	Self injurious behaviors	1	1	1	1	1	1	1	0	1	1	1	1	0.9
9.	Receptive skills related to spatial relationships	1	2	2	1	1	2	2	1	2	1	2	1	1.5

Note : Rating scale for Sl. No. 7 and 8 refer to table 5.

O¹ - Observer 1

O² - Observer 2

APPENDIX 2

Raw Score Data – Non-Yoga Group – Baseline Session 1

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	0	1	1	0	0	0	0	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	0	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	1
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data – Non-Yoga Group – Baseline Session 2

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	0	1	1	0	0	0	0	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	0	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	1
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data – Non-Yoga Group – Baseline Session 3

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	0	1	1	0	0	0	0	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	0	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	1
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data – Non-Yoga Group – Baseline Session 4

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	0	1	1	0	0	0	0	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	0	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	1
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data – Non-Yoga Group – Baseline Session 5

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	0	1	1	0	0	0	0	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	0	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	1
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data – Non-Yoga Group – Baseline Session 6

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	0	1	1	0	0	0	0	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	0	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	1
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data – Non-Yoga Group – Baseline Session 7

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	0	1	1	0	0	0	0	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	0	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	1
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data – Non-Yoga Group – Baseline Session 8

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	0	1	1	0	0	0	0	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	0	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	1
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data – Non-Yoga Group – Baseline Session 9

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	0	1	1	0	0	0	0	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	0	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	1
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data – Non-Yoga Group – Baseline Session 10

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	0	1	1	0	0	0	0	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	0	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	1
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data – Non-Yoga Group – Baseline Session 11

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	0	1	1	0	0	0	0	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	0	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	1
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data – Non-Yoga Group – Baseline Session 12

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	1	0	0	0	1	1	0	0	0	0	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	0	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	1
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0

Raw Score Data – Non-Yoga Group – Baseline Average of 12 Sessions

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6		Average
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	
1.	Eye to eye gaze	0	0	0	0	0	1	0	0	0	1	0	0	0.17
2.	Sitting tolerance	1	0	0	0	1	1	0	0	0	0	0	0	0.25
3.	Body posture	0	1	1	0	0	0	1	1	0	1	0	0	0.4
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0	0.17
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0	0.33
6.	Imitation skills	0	0	0	0	0	1	0	0	0	1	0	1	0.25
7.	Self stimulatory behavior	3	3	3	2	3	3	3	3	3	3	3	3	2.9
8.	Self injurious behaviors	3	3	3	2	3	3	3	3	3	3	3	3	2.9
9.	Receptive skills related to spatial relationships	0	0	0	0	0	1	0	0	0	1	0	0	0.17

Note : Rating scale for Sl. No. 7 and 8 refer to table 5.

O¹ - Observer 1

O² - Observer 2

Raw Score Data – Non-Yoga Group – Mid Session 1

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	1	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	0	0	1	1	0	1	0	0	0	1	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	0	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	1	1	0	0	0	1	1	0	1	0	0
7.	Self stimulatory behavior	2	2	3	2	2	2	3	3	2	2	2	3
8.	Self injurious behaviors	2	2	3	2	2	2	3	3	2	2	2	3
9.	Receptive skills related to spatial relationships	0	1	0	0	0	1	0	0	0	1	0	0

Raw Score Data – Non-Yoga Group – Mid Session 2

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	1	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	0	0	1	1	0	1	0	0	0	1	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	0	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	1	1	0	0	0	1	1	0	1	0	0
7.	Self stimulatory behavior	2	2	3	2	2	2	3	3	2	2	2	3
8.	Self injurious behaviors	2	2	3	2	2	2	3	3	2	2	2	3
9.	Receptive skills related to spatial relationships	0	1	0	0	0	1	0	0	0	1	0	0

Raw Score Data – Non-Yoga Group – Mid Session 3

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	1	0	0	0	1	0	0	0	1	0	0
2.	Sitting tolerance	0	0	1	1	0	1	0	0	0	1	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	0	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0
6.	Imitation skills	0	1	1	0	0	0	1	1	0	1	0	0
7.	Self stimulatory behavior	2	2	3	2	2	2	3	3	2	2	2	3
8.	Self injurious behaviors	2	2	3	2	2	2	3	3	2	2	2	3
9.	Receptive skills related to spatial relationships	0	1	0	0	0	1	0	0	0	1	0	0

Raw Score Data – Non-Yoga Group – Mid Average of 3 Sessions

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6		Average
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	
1.	Eye to eye gaze	0	1	0	0	0	1	0	0	0	1	0	0	0.25
2.	Sitting tolerance	0	0	1	1	0	1	0	0	0	1	0	0	0.33
3.	Body posture	0	1	1	0	0	0	1	1	0	1	0	0	0.41
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0	0.17
5.	Depth perception and balance	0	0	1	1	0	1	0	0	0	1	0	0	0.33
6.	Imitation skills	0	1	1	0	0	0	1	1	0	1	0	0	0.41
7.	Self stimulatory behavior	2	2	3	2	2	2	3	3	2	2	2	3	2.33
8.	Self injurious behaviors	2	2	3	2	2	2	3	3	2	2	2	3	2.33
9.	Receptive skills related to spatial relationships	0	1	0	0	0	1	0	0	0	1	0	0	0.25

Note : Rating scale for Sl. No. 7 and 8 refer to table 5.

O¹ - Observer 1

O² - Observer 2

Raw Score Data – Non-Yoga Group – Post Session 1

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	1	1	0	1	0	0	0	1	0	0
2.	Sitting tolerance	0	1	1	0	0	0	1	1	0	1	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	1	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	1	1	0	0	0	1	1	0	1	0	0
6.	Imitation skills	0	1	1	0	0	0	1	1	0	1	1	0
7.	Self stimulatory behavior	2	2	2	2	2	2	2	2	2	2	2	3
8.	Self injurious behaviors	2	2	2	2	2	2	2	2	2	2	2	3
9.	Receptive skills related to spatial relationships	0	1	0	0	0	1	0	0	0	1	0	0

Raw Score Data – Non-Yoga Group – Post Session 2

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	1	1	0	1	0	0	0	1	0	0
2.	Sitting tolerance	0	1	1	0	0	0	1	1	0	1	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	1	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	1	1	0	0	0	1	1	0	1	0	0
6.	Imitation skills	0	1	1	0	0	0	1	1	0	1	1	0
7.	Self stimulatory behavior	2	2	2	2	2	2	2	2	2	2	2	3
8.	Self injurious behaviors	2	2	2	2	2	2	2	2	2	2	2	3
9.	Receptive skills related to spatial relationships	0	1	0	0	0	1	0	0	0	1	0	0

Raw Score Data – Non-Yoga Group – Post Session 3

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6	
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²
1.	Eye to eye gaze	0	0	1	1	0	1	0	0	0	1	0	0
2.	Sitting tolerance	0	1	1	0	0	0	1	1	0	1	0	0
3.	Body posture	0	1	1	0	0	0	1	1	0	1	1	0
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0
5.	Depth perception and balance	0	1	1	0	0	0	1	1	0	1	0	0
6.	Imitation skills	0	1	1	0	0	0	1	1	0	1	1	0
7.	Self stimulatory behavior	2	2	2	2	2	2	2	2	2	2	2	3
8.	Self injurious behaviors	2	2	2	2	2	2	2	2	2	2	2	3
9.	Receptive skills related to spatial relationships	0	1	0	0	0	1	0	0	0	1	0	0

Raw Score Data – Non-Yoga Group – Post Average of 3 Sessions

Sl. No.	Key Features	Child 1		Child 2		Child 3		Child 4		Child 5		Child 6		Average
		O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	O ¹	O ²	
1.	Eye to eye gaze	0	0	1	1	0	1	0	0	0	1	0	0	0.33
2.	Sitting tolerance	0	1	1	0	0	0	1	1	0	1	0	0	0.41
3.	Body posture	0	1	1	0	0	0	1	1	0	1	1	0	0.5
4.	Body awareness	0	0	0	0	1	0	0	0	0	1	0	0	0.17
5.	Depth perception and balance	0	1	1	0	0	0	1	1	0	1	0	0	0.4
6.	Imitation skills	0	1	1	0	0	0	1	1	0	1	1	0	0.5
7.	Self stimulatory behavior	2	2	2	2	2	2	2	2	2	2	2	3	2.1
8.	Self injurious behaviors	2	2	2	2	2	2	2	2	2	2	2	3	2.1
9.	Receptive skills related to spatial relationships	0	1	0	0	0	1	0	0	0	1	0	0	0.25

Note : Rating scale for Sl. No. 7 and 8 refer to table 5.

O¹ - Observer 1

O² - Observer 2



