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## Exploring the long-term effect of yoga on cognitive benefits for children with learning disabilities

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### Abstract

**Background:** Neurodevelopmental disorders impact cognitive and learning processes. Children with learning disabilities face health disadvantages and have shorter lifespans. Research shows that yoga benefits neurodevelopmental disorders like autism.

**Aims:** This study explores long term yoga's therapeutic impact on cognitive functions in children with learning disability.

**Settings and Design:** Two group pre-post design.

**Methods and Materials:** This study employed a convenient sampling with 60 participants aged 9 to 17 years from Institute for Communicative and Cognitive Neuroscience, (ICCONS), Shoranur, Kerala. They were divided into a yoga (N=30, Mean  $\pm$  SD;12.43 $\pm$ 2.04) and a physical training (N=30, Mean  $\pm$  SD;13.07 $\pm$ 2.33) groups. The yoga group received 60-minutes sessions once a week for 32 weeks, while the physical training group followed their regular routine. Exclusion criteria included cerebral palsy, developmental challenges, Down syndrome, autism, or psychiatric problems. The yoga intervention included asana, Sukshma vyayama, pranayama, kriya, and relaxation techniques. Attention was assessed using the Trial Making Test (TMT 1 & TMT 2) before and after the intervention.

**Results:** The yoga group showed significant improvement in Trial Making Test I and II compared to the physical training group, with a significant difference between the groups ( $p = 0.001$ ).

**Conclusion:** Long-term yoga interventions improved cognitive function in children with learning disabilities, enhancing attention, visual scanning, and mental flexibility more than the physical training group.

**Keywords:** Learning disabilities, children, learning skills, cognitive functions, yoga

### Introduction

#### Learning Disability

Learning disabilities are a generic term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning, or mathematical abilities. These disorders are intrinsic to the individual and are presumed to be due to central nervous system dysfunction. Even though a learning disability may occur concomitantly with other handicapping conditions (e.g., sensory impairment, mental retardation, social and emotional disturbance) or environmental influences (e.g., cultural differences, insufficient/inappropriate instruction, psychogenic factors), it is not the direct result of those conditions or influences <sup>[1]</sup>.

#### Types of Learning Disability

Learning disabilities encompass broad categories determined by the four stages of information processing involved in learning: input, integration, storage, and output. <sup>[2]</sup> Many learning disabilities comprise a combination of several types of abnormalities occurring simultaneously, along with social difficulties, and emotional or behavioral disorders <sup>[3]</sup>.

#### Prevalence of learning disabilities

Evidence from a variety of sources suggests that there has been an increase of around 1% per annum in the prevalence of learning disability (LD) in adults over the last 35 years, mainly due to increases in survival. This trend is likely to continue for at least another ten years. Ninety-six percent of adults with LD registered have an estimated IQ below 50 or require supervision every day to remain safe. Three-quarters have additional significant disabilities, including behavior problems, psychological symptoms, physical

dependencies, or epilepsy. In one quarter, the behavior problem poses a major challenge to achieving an ordinary life. Two-thirds indicate a need for help from one specialist or another.

Informal caregivers are actively providing care for nearly half of the adults, but a quarter are not content with caregiving. Caregivers report 40% more limiting health problems than their counterparts in the general population [4].

### **Complications of Learning disability**

Research suggests that adolescents with learning disabilities experience poorer academic outcomes even compared to peers who began high school with similar levels of achievement and comparable behaviors. The negative effect of being labeled with LDs on adolescents' educational expectations is partially mechanized through parents' and particularly teachers' lower expectations. National data show teachers hold expectations for students labeled with learning disabilities that are inconsistent with their academic potential (as evidenced by test scores and learning behaviors) [5].

Certain subgroups of adolescents with learning disabilities (i.e., those with nonverbal learning disabilities and/or those who are less academically adept) manifest higher rates of depression. Also, some evidence exists to support an increased risk of suicide among this population [6].

### **Complementary & alternative therapies on children with learning disability**

Sixty-minute sessions conducted over eight sessions, utilizing verbal self-instruction of art therapy teaching, contribute to enhancing social, emotional, and educational adjustment among students afflicted with mathematical disorder. This method presents itself as a suitable interventional approach [7]. Hypnotherapy has shown promising results, with both parents and children reporting improvements in speech and language abilities following the therapy. Notably, three boys aged 9, 10, and 12 years, along with their parents, participated in the study. Overall, responses to hypnotherapy were notably favorable, with additional benefits such as improved motivation and attention observed [8].

### **Effect of yoga on children with ADHD (Attention Deficit Hyperactivity Disorder)**

Yoga, as an add-on intervention, led to a significant improvement in ADHD symptoms. In eight yoga training sessions, a total of 9 children (8 males, 1 female) were able to learn yoga reasonably well. [9] Yoga, mindfulness-based interventions, and/or meditation had a statistically significant effect on the outcomes of ADHD symptoms [10]. The effect of yoga was assessed in children with ADHD in a pre-post experimental study. A 16-session yoga program indicated a decrease in Child Symptom Inventory Score (ADHD Score) in both the Yoga and Control groups [11] Six weeks of combined yoga/meditation with a multimodal behavioral therapy program for children aged 6 to 11 years showed a 90% improvement in children's performance impairment score, a measure of academic performance [12]. A pilot study examined the feasibility, attitudes toward, and outcomes of a 5-week mindfulness meditation intervention administered to 34 learning-disabled adolescents aged between 13 to 18 years. Results showed decreased state

anxiety, decreased trait anxiety, increased social skills, and improved academic performance [13].

### **Effect of yoga on Autism children**

An experimental pre-post control group design examined the effectiveness of the "Get Ready to Learn" classroom yoga program among children with Autism Spectrum Disorder (ASD). A six-week yoga practice showed a decrease in behavior irritability, lethargy, social withdrawal, hyperactivity, and noncompliance [14].

### **Effect of yoga on behavioral disorder**

Thirty-seven children with Emotional and Behavioral Disorders (EBD) in an urban school completed a yoga intervention in small groups (7-10 students) twice per week for 3.5 months. Teachers, parents, and students completed pre- and post-intervention systematic assessments of behavior using a checklist. Teachers reported improved attention in class, adaptive skills, and internalizing symptoms [15].

### **Yoga on Intellectual disability**

Three months, 5 hours every week showed improvement in adaptive behavior, cognitive ability, and memory in children with intellectual disability [16]. The regular practice of yoga for sixty minutes daily in the morning for a total period of twelve weeks is beneficial in improving health-related physical fitness and psychomotor performance among children with intellectual disability [17]. The experience of yoga sessions made a positive impact on differently-abled children and also resulted in a significant increase in overall mindfulness. [18] There was a significant improvement in health, learning ability, cognitive ability, behavior, and positive emotions, and a decrease in negative emotions after yoga and mindfulness practices [18].

### **Yoga on learning disability**

Thirty children with learning disorders were randomly assigned to three groups: a multisensory teaching intervention group, a combined multisensory teaching and yoga training group, and a waitlist control group. Including yoga training as an adjunct to multisensory teaching greatly enhances school academic self-esteem and prosocial behavior [19]. Thirty school girls from a school in Chennai district, aged between 10 and 13 years, engaged in eight weeks of yogic practices from Monday to Friday each week, showing significant improvement in study skills and stress among school girls with learning disorders due to yogic practices [20]. Seventy intellectually disabled children attended one-hour sessions for twelve weeks of yoga intervention. Results revealed significant improvement in static balance, eye-hand coordination, agility, and reaction time in the yoga group compared to the control group [17].

A single-arm observational study demonstrated that seven hundred and sixty-eight schools across fifty talukas in Karnataka, with around seven thousand six hundred higher primary and high school children, were assessed for improvements in learning, cognition, behavior, and health following two months of yoga intervention. There was a significant improvement in health, learning ability, cognitive ability, behavior, and positive emotions, and a decrease in negative emotions after yoga intervention [21].

Earlier studies have shown significant improvements in ADHD, autism, emotional behavioral disorder, and

depression with yoga. In this present field, only one pilot study has been done on adolescents with learning disabilities, giving mindfulness meditation intervention. Results showed decreased state anxiety, decreased trait anxiety, increased social skills, and improved academic performance. However, no study has been done on long-duration yoga intervention in children with learning disabilities. Therefore, the present study aims to investigate the effects of long-term yoga practice in children with learning disabilities.

## Materials and Methods

**Design:** Two group pre-post experimental Design.

**Setting and participants:** A convenient sampling method was conducted on sixty-four children with learning disabilities, aged between 9 and 17 years, recruited from the Institute for Communicative & Cognitive Neuroscience (ICCONS) in Shoranur, Kerala. They were divided into a yoga group (34 children) and a physical training group (30 students). Participants were selected by psychologists, excluding those with chronic health issues, cerebral palsy, mental retardation, Down syndrome, autism, or psychiatric problems. The yoga group received 60-minute sessions every Saturday for 32 weeks (8 months), consisting of asanas, sukshma vyayama, pranayama, kriya, and relaxation techniques. The physical training group followed their routine schedule as prescribed by the psychiatrist. The attention component was assessed using the Trail Making Test (TMT), with baseline and post-test assessments conducted before and after the 32-week intervention period. Participants who engaged in yogic therapy expressed their willingness to participate, and consent was obtained from the Head of the Department of Neurology, considering the participants were school children. The information of participants involved in yogic therapy will be kept highly confidential.

The study followed the guidelines of Helsinki declaration 1964 and its later amendments involving human subjects. Signed consent from parents and assent from students were taken prior to data collection. Additionally, the study was approved by experts of the internal review board of Centre for distance and online learning department of the university.

## Intervention

Children in the Yoga group received yoga sessions lasting 60 minutes each, held once a week on Saturdays, over a period of 32 weeks (8 months). The yoga intervention included asanas, sukshma vyayama, pranayama, kriya, and relaxation techniques. The physical training group followed their routine schedule prescribed by the psychiatrist. Classes were conducted every Saturday, and parents were requested to ensure practice on the remaining days of the week [22].

## Assessment Tools

**Trail Making Test (TMT)** was assessed the participant's cognition level before and after Yoga intervention [23, 24].

The Trail Making Test (TMT) is a brief paper-and-pencil neuropsychological test often used for screening cognitive impairment. The TMT was a standard component of the Halstead-Reitan Battery, [24] which measures cognitive dysfunction. Some authors [24] interpret the TMT, specifically Part B, as an executive task. Part A appears to be dependent primarily on the efficiency of visual scanning and psychomotor speed. In contrast, Part B consists of circles, some containing numbers and others letters. The alternation between serial sequences of letters and numbers is thought to require executive control, specifically flexibility of thinking and a greater demand for working memory.

**Table 1:** Yoga Intervention

Sl. No	Yogic practices	Frequency	Duration (60 min)
1	Kapalabhati Kriya	3 Rounds (1 Round = 60counts)	10 Min
<b>Sukshma Vyama Total 3 Min</b>			
2	Slow Jogging	40 counts	
3	Forward Jogging	40 counts	
4	Backward Jogging	40 counts	
5	Sideways Jogging	40 counts	
6	<b>Quick Relaxation Technique</b>		2 Min
<b>Asanas</b>			
<b>Standing Asanas</b>			
7	Tadasana	3 times	
8	Trikonasana	3 times both side	
9	Ardha Chakrasana	3 times	
10	Pada Hasthasana	3 times	
<b>Sitting Asanas</b>			
11	Vajrasana	once	
12	Shashankasana	3 Times	
13	Bhadrasana With Butterfly	20 Times	
14	Camel Pose	3 Times	
<b>Prone Posture</b>			
15	Bujangasana	3 Times	
16	Shalabhasana	5 Times	
17	Tiger Breathing	10 Rounds	
	Supine Posture	Total	30 min

18	Ardha Shalabhasana	3 Times	
19	Sethubandasana (Bridge Pose)	5 Times	
20	Shavasana (Deep Relaxation)		5 Min
	Pranayama	Total	60 Min
21	Nadi Shudhi	7 Times	
22	Bhramari	3 Rounds (1 Round = 60counts)	10 Min

**Procedure:** Trail Making Test Instructions:

**Trail A Sample:**

Provide the person with a sample Trail A first and ensure they complete it correctly with the given instructions. Instruct them to draw a line connecting the numbers 1, 2, 3, 4, etc., in order until they reach the end, aiming to complete the task as quickly as possible. If mistakes occur during the sample, immediately point them out and provide correction instructions. Repeat the sample until it is completed correctly or until it becomes evident that the individual cannot complete the task. Once the sample is completed correctly, proceed to the actual Trail A and repeat the instructions. Start timing immediately upon instruction to begin.

**Trail B Sample**

Similarly, provide the individual with a sample Trail B and ensure correct completion with the given instructions. Instruct them that this part is slightly more difficult, requiring them to alternate between numbers and letters. Ask them to draw a line from 1 to A, A to 2, 2 to B, and so forth, until they reach the end, while drawing the lines as fast as possible. If mistakes occur during the sample, immediately point them out, provide explanation, and repeat the sample until it is completed correctly or inability to complete is evident. After correct completion, proceed to the actual Trail B and repeat the instructions. Start timing immediately upon instruction to begin.

**Alert for Errors**

Be vigilant for mistakes throughout the test. If a mistake is made, point it out immediately and return to the last correct circle. Continue timing and record errors until completion.

**Interpretation**

**Table 1:** TMT Trial 1 has improved in yoga group (36.15 %) compared to physical training group (8.24 %) with significant difference between groups (P= 0.001)

Variable	Groups	PRE			POST			ES	% Changes	Within Gps (Wilcoxon-sign rank) Sig- P value	Between Gps (Mann-whiney) Sig- P values.	
		Mean /S.D.	LB	UB	Mean /S.D	LB	UB				Pre/post	Pre/pre
TMT-Trial 1	Yoga N= 34	84.94 ±8.81	88.23	81.65	54.19 ±13.29	59.15	49.22	2.72	36.15	0.001	0.912	0.001
	PT N=30	84.90 ±7.17	87.80	82.00	77.90 ±9.04	81.28	74.52	0.83	8.24	0.001		

Abbreviations: TMT: Trail making Test, PT: Physical training, LB: lower bound, UB: upper bound, ES-effect size.

Legend: There is significant improvement in TMT- Trial-1 in yoga group compared to Physical Training group.

After completion, score Part A and B separately based on the time taken in seconds. More than one error or scoring below the 10th percentile in completion time raises concerns. Typically, completion time over 3 minutes or more than one error is considered a failure [25, 24].

**Data Analysis**

All the data were checked for normality using Kolmogorov-Smirnov. Within group analysis was performed using Wilcoxon Signed Rank Test (data that were not normally distributed) and between group analysis was performed using Mann-Whitney U test (data is not normally distributed) with the use of Statistical Package for the Social Sciences (SPSS), Version 16.

**Results**

**Demographic Details**

One hundred (N=60) school children learning Disability both girls and boys of age group 9 – 17 years were participated in the study.

**Gender:** Male and female school children

Yoga group: 30 (Male=12, Female=18)

(yoga=30: Mean ± SD;12.43±2.04)

Control group: 30 (Male=09, Female=21)

(Control=30: Mean ± SD;13.07±2.33)



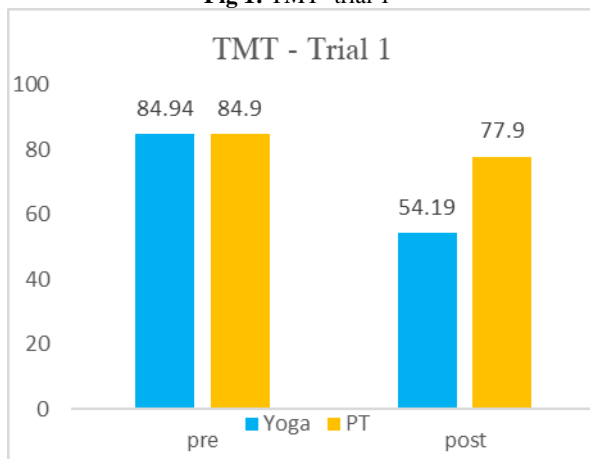
**Table 2:** TMT- trial 2 TMT Trial 2 has improved in yoga group (32.19 %) compared to physical training group (4.57 %) with significant difference between groups (P= 0.001)

Variable	Groups	PRE			POST			ES	% Changes	Within Gps (Wilcoxon-sign rank) Sig- P value	Between Gps (Mann-whiney) Sig- P values.	
		Mean /S.D.	LB	UB	Mean /S.D	LB	UB				Pre/Post	Pre/pre
		TMT-Trial 2	Yoga N= 34	229.84 ±25.64	239.42	220.26	155.85 ±29.50			166.87	144.84	2.67
PT N=30	230.55 ±25.67		220.96	240.13	220.01 ±22.85	228.54	211.48	0.43	4.57	0.015		

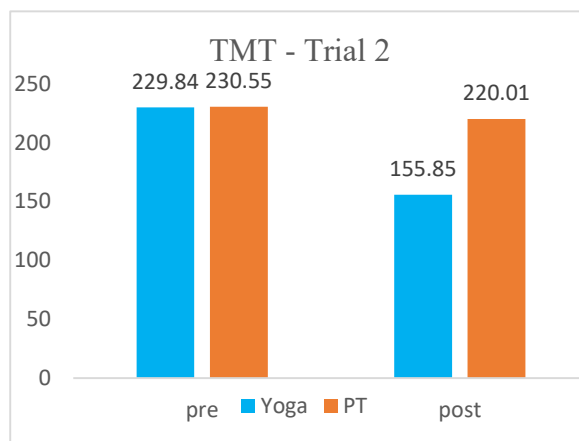
Abbreviations: TMT: Trail making Test, PT: Physical training, LB: lower bound, UB: upper bound, ES-effect size.

Legend: There is significant improvement in TMT- Trial-2 in yoga group compared to Physical Training group.

**Fig 1:** TMT- trial 1



**Fig 2:** TMT- trial 2



**Discussion**

The purpose of this study was to assess the long term effects of Yoga on attention in children with learning disability. Findings suggested that the practice of Yoga has a greater effect on attention in children with learning disability.

**Comparison with earlier study**

A pilot study examined the feasibility, attitude towards, and outcome of a 5-week mindfulness meditation intervention administered to 34 learning disability adolescents aged between 13 to 18 years. Results showed a decrease in state anxiety (6.76%), trait anxiety (14.70%), an increase in social skills (4.57%), and academic performance (5.84%) [26]. Combined multisensory teaching with yoga training interventions effectively enhanced general higher self-esteem, social self-esteem, and school-academic domain in children with learning disorders [19]. Eight weeks of yogic practices showed a significant improvement in study skills and stress among school girls aged between 10 to 13 years with learning disorders [20]. Twelve weeks of yoga were effective in improving psycho-motor abilities of intellectually disabled children [17]. Yoga practice can improve mental and motor skills in children with learning and developmental disabilities [27]. Yoga intervention in higher primary and high school children showed significant improvement in health, learning ability, cognitive ability, behavior, and positive emotions and a decrease in negative emotions after yoga intervention [21].

These results support our present findings. TMT Trial 1 has improved in the yoga group (36.15%) compared to the physical training group (0.52%) with a significant difference between groups (P= 0.001). TMT Trial 2 has improved in the yoga group (32.19%) compared to the physical training group (0.52%) with a significant difference between groups (P= 0.001).

**Possible Mechanism**

Another explanation may be that children with LD often are thought to have abnormal central nervous system processing, which in turn contributes to either over-or-under arousal [28]. Various authors [29, 30] have proposed that repetitive stereotyped behaviors provide a calming influence on an over-aroused nervous system and have an alerting effect on an under-aroused system [31, 32]. Heavy touch pressure often produces positive responses. This enhanced RSB reduction during therapy. Some suggest that the central nervous system in ASD children processes information abnormally, causing over- or under-arousal. Repetitive stereotyped behavior may calm over-aroused nervous systems and alert under-aroused ones. Engaging in repetitive IAYT procedures may thus make ASD children feel more calm and more awake, becoming a powerful motivator [31, 32]. 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 [31, 32]. A study by Melillo, R. on 2011, reports

that slowing down the speed of facial and vocal events enhances imitative, verbal, and cognitive skills of some LD Children<sup>[33]</sup>. 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 LD children.

Yoga practices have a positive effect on brainwave frequencies,<sup>[34]</sup> neurotransmitter activity,<sup>[35, 36]</sup> and the autonomic nervous system,<sup>[37 38]</sup> all of which are affected in disruptive behavior. Behavior of LD 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 a need for improvement in response and relapse rates following treatment. Yoga encourages participants to be actively and independently involved in their treatment and self-management through respiratory awareness and manipulation, postures, and cognitive control.

Strengths of the present study encompass the inclusion of both male and female participants, consistent attendance of students in yoga sessions within their school schedule, an extended intervention duration, and the novelty of being the pioneering investigation in this particular population.

Study limitations comprise the absence of objective measurements, reliance on weekly sessions supervised by a teacher with parental involvement for additional sessions, and a relatively small sample size. Recommendations for future research entail prolonging intervention durations with regular sessions, augmenting cognitive assessments, conducting awareness programs in specialized educational settings, broadening research scope to encompass other specific learning disability subgroups, providing enhanced support and time allocation for parental involvement, and implementing individualized care strategies, which may yield more favorable outcomes.

### Conclusion

An eight-month long-term yoga interventions enhance cognitive function in children with learning disabilities, enhancing attention, visual scanning, and mental flexibility more than the physical training group.

**Conflict of Interest:** We would like to express that there is no conflict of interest among the authors of this research study.

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