



## To Study the Effect of Classical Hata Yoga on Cognitive Functions among Adolescents.

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**ABSTRACT:** Background: Adolescence is a critical period of neurobiological processes that underlie higher cognitive functions and social and emotional behaviour, executive functions are important skills for academic performance. Techniques to improve these skills are not taught either in education courses. Any system which can systematically improve these skills will be of value in schools, universities, and workplaces. Aims: To investigate possible improvements in executive functions as measured by the SLCT, DLST, DVT, due to practice of classical hata yoga. Material and Methods: forty adolescents who had enrolled in a 30 days classical hata yoga intervention. Their ages ranged between 13 and 17 years (group average  $\pm$ S.D., 13.4 $\pm$ 0.5 years, both genders). Those who have any chronic illness and mental illness, and those who are not willing to participate were excluded. Classical hata yoga is given for 30 days, 1hour/day. At baseline and following 30 days, all participants completed DLST, DVT and SLCT. Results: Classical hata yoga practice showed significant change in DLST scores, increase (P-value< 0.000) in total attempted score, significant increase (P-value<0.000) in net score, non-significant reduction in wrongly attempted score (P-value<0.07). Significant change in SLCT scores, significant increase (P-value<0.000) in total attempted score, Similarly, significant increase (P-value<.000) in net score, significant reduction in wrongly attempted score (P-value<0.001) and significant change in DVT scores, reduction in error percentage (P-value<0.000) was significant. Conclusions: The 30 days of classical hata yoga practice was successful in enhancing the executive functions among adolescents.

**KEYWORDS:** Executive function (EF), Classical hata yoga, Cognitive functions, SLCT, DLST, DVT.

### I. INTRODUCTION

Adolescents in today's world face numerous expectations and constant stimulation through technological advancements. Globalization is exposing the newer generation to various new demands and options. There is also an increased academic pressure to succeed in school, partly due to increased competition and also due to a diverse range of options available. Further the society offer plenty of distractions and unwelcome attractions[1]. Psychological stress during adolescence may cause enduring cognitive deficits and anxiety in humans, accompanied by rearrangement of numerous brain structures and functions. The brain does not grow in size much during adolescence. In spite of that, up to the late teens the creases in the brain continue to become more complex. Prefrontal cortex in the brain, some of the most developmentally significant changes occur which is involved in decision making and cognitive control, as well as other higher cognitive functions. Myelination and synaptic pruning in the prefrontal cortex increases, improving the efficiency of information processing, and neural connections between the prefrontal cortex and other regions of the brain are strengthened during adolescence[2]. The prefrontal cortex acts as a controller of executive functions. The executive functions, which help us to organize thoughts, tend to be interrupted when the stressors load is too high [3]. Predicting the effect of executive functions on academic performance is important for adequate adaptation of the individual to the specific requirements of the academic context. The association between stress and academic performance might be mediated by the effects of cortisol in the prefrontal cortex, which promotes impairment in cognitive functions. Prolonged exposure to stress during different stages of development interferes with both academic achievement and executive functions that provide a basis for learning [4, 5]. Yoga shows benefit in



improving their in physical fitness, cognitive performance, self-esteem and social behavior [6]. Yoga based intervention shows benefits in managing negative emotions which in turn helps improving greater kinesthetic awareness and improved self-image [7]. Survey based research shows Yoga comprises of all the tailor made therapy techniques which would help in an overall personality development of a child which in turn helps in adapting and coping to the situation[1]. This suggests that yoga-based programs are well received by children and can improve their Academic performance. Hence, the present study was designed to assess whether thirty days classical hata yoga practice would enhance the performance in executive functions among adolescents.

## II. MATERIAL AND METHODS

Forty adolescents who had enrolled in a 30 days classical hata yoga intervention. Their ages ranged between 13 and 17 years (group average  $\pm$ S.D., 13.4 $\pm$ 0.5 years, both genders). We have fully explained the potential risks and benefits in the study before written informed consent was obtained from the participants, the study was approved by the ethics committee of the institution, Lakulish yoga university, located in Ahmadabad, Gujarat, India. The selection criteria included: Subjects who were healthy, age between-12-18yrs, those knowing English, willing to participate were included. Those having neurological and psychiatric disorders (based on case history), those who have practiced Yoga for the last 3 months and those who have major eyesight problems (in vision) were excluded from the study. In this study we adopted a convenient sampling method to recruit the subjects who were undergoing 30 days Classical Hata yoga practice. Both genders, Age group 12 to 18 years, a single group pre-post design was used.

## III. INTERVENTION

The classical hata yoga practice: consisted of a single sessions each day 5 days a week for four weeks. In a day participant practiced shithilikaranavyayamas (loosening practices) followed by yogasanas and relaxation techniques with pranayama practices. The practices used in this study were taken from the classical hata yoga scripture of Lakulish yoga tradition [8], one of the oldest schools of hata yoga in India.

## IV. OUT COME MEASURES

### SLCT- Six letter cancellation test

SLCT -Cancellation tests require visual selectivity and a repetitive motor response. A six-

letter cancellation test was administered to assess functions such as selective and focused attention, visual scanning, and the activation and inhibition of rapid responses. The six letter cancellation test has been used in similar type of design on Indian population [9]. The six letter cancellation task worksheet consists of an array of random alphabets, A-Z, in 14 rows and 22 columns. Participants were asked to sit with the worksheet distributed to each one. The instructions are given asking them to cancel as many target digits as possible in the specified time. They are asked to cancel as their wish whether horizontally, vertically, or selecting a particular letter one at a time randomly in the row. Finally, after knowing the test instructions they are asked to start the test, each test was conducted for 90 seconds on a standard stopwatch.

### DLST- Digit letter substitution test

DLST contains flexibility at mind level, visual scanning, attention and psychomotor speed of processing information. It is used with same type of design on Indian population [9]. DLST worksheet consists a row of random digits,1-9, in 8 rows and 12columns. The coding sheet contains instructions about the test with example of substituting a specific letter for specific digit 1-9, the same code is applicable to entire test. Subjects were instructed to make their choice of letter substitution process, whether horizontally, vertically, or selecting a particular digit randomly in the row one at a time. In given time of 90 seconds' substitute as many target digits as possible.

### DVT- Digit vigilance test or sustained attention

Sustained attention was measured using a digit vigilance test (DVT) of proven validity and reliability [10], which consisted of the numbers 1 to 9 arranged randomly in rows. Each sheet had 50 rows with 30 digits per row. The participants were instructed to cancel only 2 digits (6 and 9) as quickly as they could. They were asked not to: (i) cancel other digits or (ii) miss any of the target digits (6 and 9). The total time taken to complete the test and the number of errors made were noted.

## V. DATA ANALYSIS

The data taken on the last day and on the first day of the classical hata yoga practice were compared with wilcoxon signed rank test using SPSS version 16.0.

## VI. RESULTS

**DLST: Digit letter substitution test:** After yoga training program it showed that 8.2% significant



increase ( $P < 0.000$ ) in total attempted score on DLST. Similarly, there was 8.6% significant increase ( $P = 0.000$ ). However, there was 53%

decrease in wrongly attempted score but statistically not significant [Table 1].

**Table-1 : DLST Changes after Classical hata yoga training program**

DLST scores	Classical hata yoga training		% change	P- value
	Before	After		
Total attempt	43.8 ±8.8	47.4 ±8.6	8.2	0.000***
Wrong attempt	0.47 ±0.67	0.22 ±0.47	53	0.072
Net score	43.3 ±8.7	47.25 ±8.6	8.6	0.000***

\*significant at  $P < 0.05$ , \*\* significant at  $P < 0.01$ , \*\*\*significant at  $P < 0.00$  (paired sample test and Wilcoxon Signed Ranks Test)

**SLCT: Six Letter Cancellation Task:** After yoga training program it showed that 11.2% significant increase ( $P < 0.000$ ) in total attempted score on

DLST. Similarly, there was 13.8% significant increase ( $P = 0.000$ ) in NS. However, there was 69.5% decrease in wrongly attempted score which was highly significant ( $P = 0.001$ ) [Table 2].

**Table-2: SLCT Changes after Classical hata yoga training program**

SLCT scores	Classical hata yoga training		% change	P- value
	Before	After		
Total attempt	33.25 ±10.0	37.22 ±10.2	11.2	0.000***
Wrong attempt	0.82 ±1.3	0.25 ±0.64	69.5	0.001***
Net score	32.4 ±9.59	36.95 ±9.97	13.8	0.000***

\*significant at  $P < 0.05$ , \*\* significant at  $P < 0.01$ , \*\*\*significant at  $P < 0.00$  (paired sample test and Wilcoxon Signed Ranks Test)

**DVT: Digit Vigilance Test :**The data analysis showed 1.6% decrease ( $P < 0.94$ ) in total time

taken and 70% decrease ( $P < 0.0001$ ) in error scores for DVT [Table 3].

**Table -3 : DVT Changes after Classical hata yoga training program**

Variables	Pre Mean± SD	Post Mean± SD	% Change	P-value
DVT task: Time Taken (in minutes)	12.28 ±0.08	12.08 ±0.08	1.6	0.94
DVT task: No. of errors	1.55 ±3.337	0.45 ±1.21	70	0.000***

\*significant at  $P < 0.05$ , \*\* significant at  $P < 0.01$ , \*\*\*significant at  $P < 0.00$  (Wilcoxon Signed Ranks Test)

## VII. DISCUSSION

The purpose of this study was to investigate the efficacy of classical hata yoga intervention for improving cognition, particularly executive function among adolescents. Completion of this program was associated with overall significant improvement in measures of executive functions. Substitution tests are essentially speed dependent tasks that require the subject to match particular signs – symbols, digits, or letters - to

other signs within a specified time period. Substitution tasks involve visual scanning, mental flexibility, sustained attention, psychomotor speed, and speed of information processing [11,12]. Classical hata yoga practice has emerged as a better non-invasive modality to enhance the executive functions, which are very crucial for adolescents to excel in their academic performance, yoga found to reduce cognitive deficits, with the expectation that improvement of cognition would result in



improvement of psychosocial functioning [13]. Two recent studies have demonstrated 12 weeks of yoga sessions were positively associated with acute increase in thalamic GABA levels, improvement in mood and anxiety scales, and reduction in depressive symptoms [14]. Improvement of psychosocial functioning not only requires sustain attention, but also cognitive flexibility, working memory, and inhibition control. Decrease in total time taken and error scores in SLCT, DLST and DVT following Classical hata yoga practice suggest improvement in Executive Function (EF). The mechanism underlying the improvement of EF may be related to the fact that hata yoga involves the practice of physical postures in conjunction with awareness of the breath to help develop mental focus and to connect the mind, body, and spirit [15]. Yoga postures are performed with a gap in between, provide relaxation to mind and body, and then ultimately enhances cognition. Previous studies on yoga techniques which consisted of sequence of yoga postures interspersed with relaxation techniques, found improvement in selective attention [16], and inhibition of the cortical region [17]. Classical hata yoga requires focused effort in moving through the poses, controlling the body, and breathing at a steady rate, this focus on one's body and mind during the practices, breathing and meditation exercises are practiced to calm and focus the mind and develop greater self-awareness [18] high frequency yoga breathing practice (Kapalabhati) enhances blood flow to pre frontal cortex, [19] Pre-frontal cortex is associated with memory, attention, and EF [20, 21]. Kapalabhati and Bhastrika Pranayama had influence on auditory working memory, and central neural processing and sensory-motor performance [22], Bhramari Pranayama may enhance inhibition response and cognitive control in healthy participants [23]. The present study throw light on how classical hata yoga practice helps to enhance the academic performance by enhancing the executive functions among adolescents, longer study duration with larger sample size would suggest for future consideration.

### VIII. CONCLUSIONS

The classical hata yoga practice was successful in improving sustain attention, working memory capacity among adolescents, a longer follow-up period will enable researchers to thoroughly examine neuro-cognitive changes. Although this was limited by small sample size, these findings suggest rigorous systematic approaches and advanced imaging techniques to examine classical hata yoga practice as a means to

enhance executive function to promote academic performance among adolescents.

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#### Conflict of interest

None

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