Scholars International Journal of Anatomy and Physiology
Abbreviated key title: Sch. Int. J. Anat. Physiol.
A Publication by "Scholars Middle East Publishers"
Dubai, United Arab Emirates

ISSN: 2616-8618 (Print)
ISSN: 2617-345X (Online)

Influence of Short Term Practice of Yoga on Cognition among Pre-University Students

Varsha SV*
Assistant Professor, Department of Physiology, Sri Siddartha Institute of Medical Science and Research centre, T.Begur, Nelamangala Tq, Bengaluru – 562 123, Karnataka, India

Original Research Article

***Corresponding author**
Varsha SV

Article History
Received: 12.10.2018
Accepted: 24.10.2018
Published: 30.10.2018

Abstract: Yoga is one of the six orthodox systems of Indian philosophy which is viewed as a physical, mental and spiritual discipline that confers a sound body and sound mind. One of the main aims of practice of yoga is to have good cognitive control. Pre-University education is a very important stage in the educational ladder of students. At this stage students are in need of good cognitive abilities. While there are no studies done on this group about the effects of yoga, this study was undertaken to assess the effect of short term practice of yoga among Pre University students. Executive function was tested with Golden version - Stroop Color and Word test in control group, before and after the intervention among yoga group. Results were statistically analyzed using Bonferroni post hoc test. Students in yoga group had performed better than the control group. Short term practice of yoga had a beneficial effect on cognition – selective attention and cognitive flexibility in the Pre-university students.

Keywords: Cognition, Yoga, Attention, Executive function, Stroop test.

INTRODUCTION

Yoga is one of the six orthodox systems of Indian philosophy which is viewed as a physical, mental and spiritual discipline that confers a sound body and sound mind. One of the main aims of practice of yoga is to have good cognitive control.

The higher order of cognitive processes, such as cognitive flexibility, working memory, attention and inhibition control which allow individuals to engage in planning, to be conscious and goal-directed problem solving are called Executive Function (EF) [1].

In adolescents, EF is related to emotion regulation [2], conscience [3], also math and literacy ability [4]. EF is very important factor for physical and mental health [5], making friendship [6], and for success in school [7]. It is believed that the higher order cognitive functions may play an important role in balancing emotional arousal, cognitive processing [8].

Various activities are suggested to improve adolescent's EF. The best evidences exist are computer based training programs for enhancing memory and reasoning [9], task-switching computer-based training [10], traditional martial arts [11], aerobics [12], and Yoga [13]. Yoga is an ancient Indian science and the way of life which includes practice of specific postures, breathing regulation, and meditation [14]. Earlier studies on Yoga including physical postures, Yogic breathing, meditation and guided relaxation technique have been shown its efficacy in improving delayed recall of spatial information and verbal memory [15], in reducing planning and execution time [13], and cognitive processes [16] in adults. It is also proved that there was an improvement in cognitive performance of 7–9 year-old school children in South India after three months of Yoga [17]. Yogic life style has also a positive impact in planning ability [18]. There is also evidence of the positive impact of Yoga on cognitive functions in children with attention deficit and hyperactive disorder [19]. In addition, Yoga is an effective method to improve various cognitive functions of remote memory, mental balance, attention, concentration, attention span, processing speed, attention alternation ability, delayed and immediate recall, executive functions, verbal retention, and recognition tests in healthy young subjects [20].

Pre-University education is a very important stage, in the educational ladder of students. At which students are in need of good cognitive abilities. Thus, understanding the effect of Yoga on cognitive functions of Pre-University students may be necessary in providing avenues for promoting the mental strength to overcome various tragedies in their upcoming life. Hence, the present study was intended to evaluate the

effect of Short term practice of Yoga on cognitive performances of Pre-University students.

MATERIALS AND METHODS

Participants

Sixty four normal healthy male pre-university students from an institution of Bengaluru with ages ranging from 16-18 years participated in the study. Only male subjects volunteered, so because of lack of subjects, female subjects were not included in the study. The subjects were randomly allocated to two groups i.e., Experimental (Yoga) and Control with 32 subjects in each group using a random number table (group mean age ± SD, 17.07±2.09 years and 16.67±1.27 years respectively). A routine clinical examination showed that they all had normal health. Untreated refractory errors, history of medical/surgical illness, Sleep disorders, and psychiatric disorders were pre-set conditions for exclusion from the study. And those who perform other regular physical activity were also dropped from the study. Institutional ethical clearance was obtained prior to the study. All participants expressed their willingness to participate in the intervention. The study protocol was explained to the subjects and the guardians and their signed consent was obtained.

Design

Participants were assessed for their executive function on day 1 (pre-assessment), and day 90 (post-assessment) of the intervention using Golden version Stroop Color and Word test. The intervention was supervised by two yoga teachers who also marked their daily attendance. The investigators were not aware of the groups which received the intervention and which was control till the data analysis was over as the data were coded. Hence, it was a single blind Randomized Control Trial.

Assessment

Subjects were asked to relax for 30min on day1 and day90. The participants were then tested for selective attention and cognitive flexibility – executive functions with Golden version Stroop Color and Word test in a noise free surrounding [21].

Stroop Color and Word test

It consists of 3 pages, a Word Page with 100 color words (red, green, blue) printed in black ink, a Color Page with 100 Xs printed in either red, green, or blue ink, and a Color-Word Page with 100 words from the first page (red, green, blue) printed in colors from the second page (the color and the word do not match). The subject looks at each sheet and moves down the columns, reading words or naming the ink color as quickly as possible within a time limit (45 seconds). The test extracts three basic scores, namely Stroop Word (STROOP_W) score, Stroop Color (STROOP_C) score and Stroop Color-Word (STROOP_CW) score based on the number of items completed on each of the three stimulus sheets. Errors of the participants were indicated and asked to be corrected by the examiner before continuing. The task was administered individually and test instructions were explained before starting the test.

Intervention

Yoga group: The Yoga group received a combined approach of Yoga activities of 90 min, 4 days per week, for 3-months**.** The Yoga program was conducted by two certified Yoga teachers from SVYASA (one with a master's degree in Yoga and other with a post-graduation diploma in Yoga therapy). The principle and concept of an integrated approach of the Yoga program was based on the research works of SVYASA [22]. The details of the intervention (Yoga program) are given in Table-1.

Control group

The participants were asked to follow the same routine activity. They were asked not to indulge in any sports or physical activity.

There were no differences in the routine activity between the groups except the yoga programme. The total number of hours slept was same (7 hours 30 minutes) for both the groups.

Data Analysis

The Descriptive statistics were used, i.e. mean and standard deviation (SD) for describing the parameters. The data was analyzed using SPSS V.16.0. The Independent Sample‘t’ test was used to check the difference between groups for demographic measures. Analysis of repeated measure followed by Bonferroni post-hoc was performed for all the cognitive functions and Anthropometric outcome measures.

FINDINGS

The baseline mean age between groups was matched ($p = 0.78$, Independent‘t’ test). There were no dropouts from the study.

Repeated measures of ANOVA showed that there were no significant differences between the groups mean score of baseline ($p > 0.05$) for all except STROOP_CW.

Table-1: Yoga Program as intervention

Order No	Intervention components	No. of rounds	Approx. time (Total 90 min)
1	Yogic prayer, Session on basic concepts of yoga and instructions for the class		10 min
2	**Preparatory practices:** a) Warm up: jogging, jumping, hopping, forward & backward bending, side bending, twisting b) Loosening: for toes, ankle, knee, hips, fingers, wrist, elbow and neck c) Stretching with breathing exercises: hands in and out, hands stretch, ankle stretch, hip stretch, backstretch, tiger stretch (spinal ups- down), supine straight leg raising, cycling, lumber stretch, rocking and rolling	1 each	10 min
3	Sun salutation (Suryanamaskar)	10-12	10min
4	**Asana** (Postures): A. Standing postures a)Half waist rotation posture (*Ardhakati Chakrasana*) b) Foot palm posture (*Padahastasan*) c)Half wheel posture *(Ardha chakrasana*) d) Triangle posture (*Trikonasana*) e) Tree posture (*Vrikshana*) f) Eagle posture (*Gasudasana*) B. Sitting postures a) Diamond (*Vajrasana*) b) Rabbit posture (Shasahankasana) c)Sleeping diamond posture (*Suptavajrasana*) d) Camel posture (*Ustrasana*) e)Posterior stretch (*Paschimotasana*) f)Spinal twist posture (*Ardhamatsyendrasana*) g) Cow face posture (*Gomukhasana*) C. Prone posture: a) Cobra posture (*Bhujangasana*) b)Grasshopper posture(*Salabhasana*) c) Bow posture (*Dhanurasana*) d) Shoulder stand (*Sarvangasana*) e) Plow posture (*Halasana*) D. Supine postures a) Fish posture (*Matsyasana*) b) Boat posture (*Naukasana*)	1 each	20 min (around 1 min each posture)
5	Deep relaxation technique (DRT)	1	10min
6	**Pranayama (voluntary regulation of breath)**: a)Breathing with forceful exhalation with passive inhalation (*Kapalabhati*- 3 types) b)Breathing with rapid inhalation & exhalation (*Bhastrika*) c)Slow & rhythmic alternate nostril breathing (*Nadisodhana*) d)Exhalation, with a honey bee sound (*Bharamari*) e)*Ujjayi* (Hissing in thought while exhaling)	1 each	15min
7	**Concentration Techniques:** a)Eye exercises (*Netra shakti vikasana*) b)Practice to improve collective motivation (*Dhruti shakti vikashaka*) c)Activity to improve intellect (*Dhi shakti vikasaka*) d)*Trataka* e)Palming	1 each	15min
8	**Yogic games** (games for memory, awareness and creativity)		15min
Schedule : All Intervention components were done 4 days/week (Wednesday, Thursday, Saturday and Sunday) except Concentration techniques and Yogic games which were conducted 2 days/week (Wednesday and Saturday)			

There were significant difference ($p < 0.001$) found in times (pre-post) score for STROOP_C ($p < 0.001$), STROOP_W ($p < 0.001$), STROOP_CW ($p < 0.001$). The group by time interaction showed (Table-2) significant differences ($p < 0.05$) in STROOP_C, STROOP_W and STROOP_CW. This suggests performance of the Yoga group is better than Control Group. Within the Yoga group, post-hoc test with Bonferroni adjustment showed (Table-2) significant improvements ($p < 0.001$) in score for STROOP_C (12.95%), STROOP_W (17.69%), and STROOP_CW (19.98). Within Control group, post-hoc test with Bonferroni adjustment showed (Table 2) significant improvement in STROOP_C (5.14%), STROOP_CW (5.24%). Students who were practicing yoga had performed better than the control group.

Table-2: Comparison of test for Executive function of Yoga and Control group

Cognitive Function test	Yoga (n=32)		Control (n=32)		Group Time interaction
	Pre	Post	Pre	Post	
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	
STROOP_W	62.18±22.36	73.18±21.67†	69.44±23.59	72.06±25.13	0.001
STROOP_C	48.65±10.57	54.95±11.86†	53.47±11.38	56.22±12.44*	0.017
STROOP_CW	27.90±7.12	33.43±8.71†	32.78±6.99	34.50±8.20 $^{\gamma}$	0.034
STROOP_W = Stroop Word, STROOP_C = Stroop Color, STROOP_CW = Stroop Color Word, * $p < 0.05$, $^{\gamma}$ $p < 0.01$, † $p < 0.001$; when pre compared with post					

DISCUSSION

The present study was intended to study the effect of three months of short term practice of Yoga as compared to a Control group on the executive functions of Pre University students. The effect of the Yoga program provides evidence on improving cognition of Pre University students. The result showed that the EF of the yoga group improved significantly ($p < 0.05$) in STROOP_W, STROOP_C, STROOP_CW whereas Control group exhibited improvement STROOP_C, as compared to their baseline. The group by time interaction analysis showed significant differences ($p < 0.05$) in STROOP_C, STROOP_W, and STROOP_CW. This suggests performance of the Yoga group is better than Control group.

Earlier findings of studies on Yoga were aligned with the present study in Stroop [23]. 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 [24], and reduction in depressive symptoms. When yoga postures performed with a gap in between, provides relaxation to body, 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 [25]. *Suryanamakara*, an important part of intervention given, performed with rhythmic breathing develop internal awareness which might have influenced the cognitive outcome measures in the present study.

Yoga breathing techniques have influence on brain cortex area. For example, high frequency yoga breathing practice (*Kapalabhati*) enhances blood flow to pre frontal cortex [26], and cortical electrical activity measured through electroencephalogram [27]. Pre-frontal cortex is associated with memory, attention, and EF [28]. Yoga breathing (*Pranayama*) regulated the autonomic functions by dominating sympathetic [29] or parasympathetic tone [30] based on the types of techniques. Different yoga breathing techniques were found to be important contributors for significant improvement in various cognitive domains [31]. *Bhramari Pranayama* may enhance inhibition response and cognitive control in healthy participants [32].

Trataka is a yogic technique in which a person practices focusing and defocusing on a chosen object [22]. This improves the concentration of mental thought process which channelizes action toward given task/test. A recent study on *Trataka* for one month showed there were beneficial effects by enhancing cognitive functions tests in elderly [33]. The mechanisms in *Trataka* practice involve *Dharana* (focusing) and *Dhyana* (defocusing) which also contributes in enhancing cognitive measures.

Evidence for the effectiveness of three months yoga on EF was demonstrated in this study, which may be a useful tool for the young individuals, to be practiced for cognitive health on a daily basis. The sustained effect of Yoga on EF seen in the present study may have potential implications on learning, classroom behavior and in handling the adverse circumstances and stand as a preventive measure for mental health problems.

CONCLUSION

Short term practice of yoga has a beneficial effect on selective attention and cognitive flexibility – executive functions among Pre-university students. Including yoga in the curriculum of Pre University education might help the students have better cognitive

abilities and promoting the mental strength to overcome various tragedies in their upcoming life.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding publication of this paper

SOURCE OF FUNDING - Self

REFERENCE

1. Diamond, A. (2013). Executive functions. *Annu Rev Psychol*, 64, 135–168.
2. Carlson, S. M., & Wang, T. S. (2007). Inhibitory control and emotion regulation in preschool children. *Cognitive Development*, *22*(4), 489-510.
3. Kochanska, G., Murray, K. T., & Harlan, E. T. (2000). Effortful control in early childhood: continuity and change, antecedents, and implications for social development. *Developmental psychology*, *36*(2), 220.
4. Blair, C., & Razza, R. P. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child development*, *78*(2), 647-663.
5. Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., ... & Sears, M. R. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences*, *108*(7), 2693-2698.
6. Rotenberg, K. J., Michalik, N., Eisenberg, N., & Betts, L. R. (2008). The relations among young children's peer-reported trustworthiness, inhibitory control, and preschool adjustment. *Early Childhood Research Quarterly*, *23*(2), 288-298.
7. Alloway, T. P., & Alloway, R. G. (2010). Investigating the predictive roles of working memory and IQ in academic attainment. *Journal of experimental child psychology*, *106*(1), 20-29.
8. Blair, C., & Diamond, A. (2008). Biological processes in prevention and intervention: The promotion of self-regulation as a means of preventing school failure. *Development and psychopathology*, *20*(3), 899-911.
9. Bergman Nutley, S. (2011). *Development and training of higher order cognitive functions and their interrelations*. Inst för neurovetenskap/Dept of Neuroscience.
10. Karbach, J., & Kray, J. (2009). How useful is executive control training? Age differences in near and far transfer of task-switching training. *Developmental science*, *12*(6), 978-990.
11. Lakes, K. D., & Hoyt, W. T. (2004). Promoting self-regulation through school-based martial arts training. *Journal of Applied Developmental Psychology*, *25*(3), 283-302.
12. Kamijo, K., Pontifex, M. B., O'Leary, K. C., Scudder, M. R., Wu, C. T., Castelli, D. M., & Hillman, C. H. (2011). The effects of an afterschool physical activity program on working memory in preadolescent children. *Developmental science*, *14*(5), 1046-1058.
13. Manjunath, N. K., & Telles, S. (2001). Improved performance in the Tower of London test following yoga. *Indian journal of physiology and pharmacology*, *45*(3), 351-354.
14. Taimini, I. (2005). The Science of Yoga. Madras, The Theosophical Publishing House.
15. NK, M., & Telles, S. (2004). Spatial and verbal memory test scores following yoga and fine arts camps for school children. *Indian J Physiol Pharmacol*, *48*(3), 353-356.
16. Sarang, S. P., & Telles, S. (2006). Changes in P300 following two yoga-based relaxation techniques. *International Journal of Neuroscience*, *116*(12), 1419-1430.
17. Chaya, M. S., Nagendra, H., Selvam, S., Kurpad, A., & Srinivasan, K. (2012). Effect of yoga on cognitive abilities in schoolchildren from a socioeconomically disadvantaged background: a randomized controlled study. *The Journal of Alternative and Complementary Medicine*, *18*(12), 1161-1167.
18. Rangan, R., Nagendra, H. R., & Bhat, G. R. (2008). Planning ability improves in a yogic education system compared to a modern. *International journal of yoga*, *1*(2), 60.
19. Krisanaprakornkit, T., Ngamjarus, C., Witoonchart, C., & Piyavhatkul, N. (2010). Meditation therapies for attention-deficit/hyperactivity disorder (ADHD). *Cochrane Database of Systematic Reviews*, (6).
20. Chattha, R., Nagarathna, R., Padmalatha, V., & Nagendra, H. R. (2008). Effect of yoga on cognitive functions in climacteric syndrome: a randomised control study. *BJOG: An International Journal of Obstetrics & Gynaecology*, *115*(8), 991-1000.
21. Esther, S., Elisabeth, M. S., Shermann, O. S. (2006). A compendium of neuropsychological tests. 3rd ed. New York: Oxford University press.
22. Nagarathna, R., & Nagendra, H. R. (2006). Integrated approach of yoga therapy for positive health Swami Vivekananda Yoga Prakashana.
23. Telles, S., Singh, N., Bhardwaj, A. K., Kumar, A., & Balkrishna, A. (2013). Effect of yoga or physical exercise on physical, cognitive and emotional measures in children: a randomized controlled trial. *Child and Adolescent Psychiatry and Mental Health*, *7*(1), 37.
24. Streeter, C. C., Whitfield, T. H., Owen, L., Rein, T., Karri, S. K., Yakhkind, A., ... & Jensen, J. E. (2010). Effects of yoga versus walking on mood, anxiety, and brain GABA levels: a randomized

controlled MRS study. *The Journal of Alternative and Complementary Medicine*, *16*(11), 1145-1152.
25. Sarang, S. P., & Telles, S. (2007). Immediate effect of two yoga-based relaxation techniques on performance in a letter-cancellation task. *Perceptual and Motor Skills*, *105*(2), 379-385.
26. Bhargav, H., Raghuram, N., & HR, N. (2014). Frontal hemodynamic responses to high frequency yoga breathing in schizophrenia: a functional near-infrared spectroscopy study. *Frontiers in psychiatry*, *5*, 29.
27. Stancak, A., Alghamdi, J., & Nurmikko, T. J. (2011). Cortical activation changes during repeated laser stimulation: a magnetoencephalographic study. *PloS one*, *6*(5), e19744.
28. Gray, J. R., Braver, T. S., & Raichle, M. E. (2002). Integration of emotion and cognition in the lateral prefrontal cortex. *Proceedings of the National Academy of Sciences*, *99*(6), 4115-4120.
29. Telles, S., Singh, N., & Balkrishna, A. (2011). Heart rate variability changes during high frequency yoga breathingand breath awareness. *BioPsychoSocial Medicine*, *5*(1), 4.
30. Pramanik, T., Pudasaini, B., & Prajapati, R. (2010). Immediate effect of a slow pace breathing exercise Bhramari pranayama on blood pressure and heart rate. *Nepal Med Coll J*, *12*(3), 154-157.
31. Joshi, M., & Telles, S. (2008). Immediate effects of right and left nostril breathing on verbal and spatial scores. *Indian Journal Physiol Pharmacol*, 52, 197–200.
32. Rajesh, S. K., Ilavarasu, J. V., & Srinivasan, T. M. (2014). Effect of Bhramari Pranayama on response inhibition: Evidence from the stop signal task. *International journal of yoga*, *7*(2), 138.
33. Talwadkar, S., Jagannathan, A., & Raghuram, N. (2014). Effect of trataka on cognitive functions in the elderly. *International journal of yoga*, *7*(2), 96.