

Elevating Minds: How Yoga and Diet Transform Cognitive Functions in Engineering Students

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Cite this paper as: Parthiban Veda, Lakshmi Kandhan, S, Bharutty Ramguttee, Giridharan Parthiban, Ilamathi, S, Sukumaran, C (2024) Elevating Minds: How Yoga and Diet Transform Cognitive Functions in Engineering Students. *Frontiers in Health Informatics*, 13 (3), 10184-10192

Abstract

Objectives: To evaluate the effectiveness of four months of yoga practice and yoga with diet practice on attention, memory ability, memory satisfaction, and memory strategies among undergraduate engineering students.

Methods: 141 undergraduate engineering students were divided into three groups: Yogic Practices Group (YPG), Yogic Practices with Diet Group (YPDG), and the Control Group (CG). YPG received yoga practice, YPDG received yoga with diet for one hour for four months, and the control group did not receive any practice and maintained their usual lifestyle. Pre- and post-intervention data were collected through standardized questionnaires for all cognitive functions.

Results: Data were analyzed using ANOVA and Bonferroni post hoc test. The yoga group demonstrated significant improvement in attention, memory ability, and memory satisfaction with a p-value of 0.05. The yoga with diet group exhibited more significant improvement in attention, memory ability, and memory satisfaction than the yoga practice group, and a significant reduction in the usage of memory strategies compared to the yoga practice group, with a p-value of 0.05.

Conclusion: Both yoga and yoga with diet practice improved attention and memory among undergraduate students. However, yoga with diet was found to be superior in achieving greater improvement compared to yoga practice alone.

Keywords: Yoga, diet, attention, memory and undergraduate students.

Introduction

Cognitive abilities encompass various mental capacities and functions that enable individuals to think, reason, solve problems, remember information, and process stimuli. These abilities include basic cognitive functions such as perception, attention, and memory, as well as higher-level cognitive functions like emotion regulation, problem-solving skills, decision-making, judgment, and impulse control (Psychodynamic Formulation: An Expanded Approach 2022). Memory is defined as the ability to encode, maintain, and retrieve

information (Zlotnik, G., & Vansintjan, A., 2019), while attention is characterized as the focus of consciousness on one of several objects in terms of modern psychology. It involves focalization and concentration of consciousness, which entails withdrawal from certain stimuli to effectively engage with others (James, W., 2007).

The capacity for memory retention is a crucial cognitive skill that influences both general well-being and academic achievement of undergraduate engineering students. Research indicates that memory span and fluid intelligence, along with impulsiveness, sensation seeking, and lack of fear, affect academic performance (Colom, R et al., 2007). However, the practice of yoga has been increasingly recognized as a potential intervention to enhance memory among various populations, including engineering students.

There is substantial scientific evidence supporting the positive effects of yoga practices on attention and memory. Yoga practices significantly enhance working memory, learning, attention, and processing speed in elderly individuals with Mild Cognitive Impairment (Chobe et al., 2022). Meditation practices, as a component of yoga, aid in mitigating age-associated attentional deficits in the temporal domain (Van Leeuwen et al., 2009). Furthermore, yoga improves short-term memory, attention, executive functioning, and perceptual speed (Prakash et al., 2012). Studies on older adults and individuals with neurodegenerative disorders have demonstrated that meditation approaches enhance attention levels, memory ability, verbal fluency, and cognitive flexibility (Marciniak et al., 2014). Yogic practices improve attention and memory not only in older adults but also in younger individuals. Through yoga practice, students can potentially enhance their memory, attention, and cognitive abilities, which can subsequently positively impact their academic performance and overall well-being (Molina et al., 2020). Additionally, a study found that yoga practice for five months had positive effects on memory, attention, and cognitive functioning among engineering students (Nagendra et al., 2015). While numerous studies have examined yoga interventions on cognitive abilities, further research in the field of yoga combined with dietary regulation among college students is necessary to achieve improvements within a shorter duration.

Moreover, research findings indicate that regular exercise combined with dietary modifications has been shown to increase brain plasticity and cognitive function. Exercises such as yogic practices improve learning ability and memory span, whereas high-fat-induced obesity reduces these abilities (Woo et al., 2013). Consequently, this study primarily focuses on investigating the effects of yogic practices in conjunction with dietary modification on the memory and attention levels of college engineering students.

Previous studies have utilized the following yogic practices to achieve memory improvement: Surya Namaskar, Padmasana, Paschimottanasana, Padahasthasana, Sarvangasana, Vajrasana, Vrikshasana (PP, S. J et al., 2018), Super brain yoga (Jois, S. N. et al., 2017, PP, S. J et al., 2018, Thomas, J. I., & Venkatesh, D., 2017) and savasana (PP, S. J et al., 2018, Bhogal, R. S., 2016), Sasangasana, trikonasana, Marjery asana (Fakhary Nejad, S., 2019), Ushtrasana, Halasana, Setubandasana, Ujjai Pranayama, Bhrammari Pranayama, Kapalabhati, Surya beda pranayama (Nagendra, H. et al., 2015) Nadi sodhan pranayama, OM chanting (Joshi, K., 2012), meditation of body parts awareness in supine lying pose (Bhogal, R. S., 2016). Additionally, the yogic practices employed to enhance attention include sukshma vyayama or loosening exercises, Tadasana, vrikshasana, ardha chakrasana, padmasana, Vajrasana, Paschimothasana, Ushtrasana, Sethubandasana, Parvathasana, savasana (Sreenivas, S. B., 2022) surya namaskar, bhrammari (Sreenivas, S. B., 2022 & Sethi, J. K., 2013), Super brain yoga (Jois, S. N. et al., 2017, PP, S. J et al., 2018, Thomas, J. I., & Venkatesh, D., 2017), Nadisuddhi Pranayama and Kapalabhati, (Sethi, J. K., 2013).

Based on the aforementioned research findings, the yogic practices incorporated in the present study are loosening the joints, Surya Namaskar, Super brain yoga, Tadasana, vrikshasana, ardha chakrasana, padmasana, Vajrasana, Sasangasana, Ushtrasana, Parvathasana, Sarvangasana, Sethubandasana, Ujjai Pranayama, Bhrammari Pranayama and Kapalabhati. In addition to these practices, uttana padasana, viparretakarani, chin mudra and jnana mudra were also included.

In addition to yogic practices, certain food items have been found to contribute to the enhancement of cognitive functions. According to numerous scientific studies, *Centella Asiatica*, also known as Asiatic

pennywort or Indian pennywort (Vallarai in Tamil), enhances learning, memory, and executive functions (Rao, S. B et al., 2005, Matthews, D. G et al., 2019 and Gray, N. E et al., 2018). *Abelmoschus esculentus*, commonly known as okra (Ladies finger), improves memory and cognitive functions (Prom-In, S et al., 2020). Food flavonoids have demonstrated positive effects on the central nervous system by reducing neuroinflammation and protecting neurons from stress-induced damage, thereby enhancing memory and neurocognitive performance. Dietary flavonoids are found in onions, leeks, broccoli, parsley, celery, soybean, citrus fruit and tomatoes, green tea and berry fruits (Spencer, J. P., 2008). Furthermore, a diet high in soya has been shown to enhance mental flexibility, short-term memory, and long-term memory (File, S. E., 2001). Glucose-rich food enhances memory, particularly in individuals with memory deficits (Korol, D. L., & Gold, P. E., 1998).

Based on the aforementioned nutritional research, the food items utilized in this study include Indian pennywort chutney, Ladies finger, carbohydrate-rich foods, citrus fruits such as orange, grapes, mosambi (Sweet lime), and soybean, in addition to a nutritionally balanced diet. Moreover, soaked almonds, honey, goat liver, spleen, and green leafy vegetables were incorporated.

Methods

Participants

The study is a simple random control study involving male college students aged between 18 to 20 years who are pursuing B.Tech engineering courses in ECE, EEE, CSE, EIE, and civil engineering at SRM Institute of Science and Technology, Chengalpattu district, Tamil Nadu. Prior to the commencement of the study, 476 male students from various disciplines of B.Tech, including ECE, EEE, CSE, EIE, and civil engineering, were assembled and informed about the study design, yoga intervention, and diet patterns. Based on voluntary participation, 141 students agreed to take part in the research. After obtaining informed consent forms, the 141 students were randomly allocated to three groups, with each group comprising 47 students. The three groups were designated as the Yogic Practices Group (YPG), Yogic Practices with Diet Group (YPDG), and the Control Group (CG). During the intervention period, nine students withdrew from the research, resulting in a total of 132 participants.

Measurements

Attention Control Scale (ACS)

The Attention Control Scale (ACS), developed by Derryberry, D (Derryberry, D., & Reed, M. A., 2002), is a self-report instrument utilized to assess attention. It comprises 20 items structured on a four-point Likert scale. The scale incorporates two subscales: attentional focusing and attentional shifting. The internal consistency of the total scale is $\alpha = 0.84$, indicating good reliability of the ACS. The validity of the scale is corroborated by the research findings of Judah et al (Judah et al., 2014).

Multifactorial Memory Questionnaire (MMQ)

The Multifactorial Memory Questionnaire (MMQ) is also a self-report instrument consisting of three subscales: memory satisfaction, memory ability, and memory strategy. It encompasses 57 items structured on a five-point Likert scale. Cronbach's alpha for Satisfaction is $\alpha = .95$, for Ability is $\alpha = .93$, and for Strategy is $\alpha = .83$, demonstrating excellent internal consistency reliability. The instrument also exhibits excellent content and convergent validity (Troyer, A. K., & Rich, J. B., 2018). Scores were calculated for each subscale independently.

Data collection

The study was conducted in accordance with ethical considerations for human subjects as outlined in the Declaration of Helsinki, revised in 2013. Upon obtaining informed consent from the participants, the study commenced. Prior to the intervention, baseline data were collected from all three groups: the Yogic Practices Group (YPG), Yogic Practices with Diet Group (YPDG), and the Control Group (CG) using the aforementioned questionnaires. YPG participants underwent a four-month intervention consisting of one hour of yoga practice training, while YPDG participants underwent a four-month intervention comprising one hour of yogic practice combined with a dietary program. The training protocols for yogic practices for both groups are delineated in Table 1. YPDG participants were instructed to consume 50 grams of Indian pennywort chutney thrice weekly, 100 grams of okra twice weekly, and 50 grams of soya beans or soya-containing food twice weekly. They were

advised to consume five soaked, skinless almonds every morning, green leafy vegetables twice weekly, and one teaspoon of honey daily before bedtime. Additionally, they were instructed to consume goat liver and spleen. Participants were also directed to consume one citrus fruit daily after dinner for four months and to include carbohydrate-rich food in one of their daily meals. They were advised to avoid high-fat foods due to their potential negative impact on cognitive task performance (Woo et al., 2013). The control group participants did not receive any intervention and maintained their regular daily routines. After four months, post-intervention data were collected from all groups using the same questionnaires. During the intervention period, nine participants withdrew, resulting in a final sample size of 132. Statistical analyses were conducted using one-way analysis of variance (ANOVA) and Bonferroni post-hoc tests.

Table 1. Yogic practices for both YPG and YPDG

First and second-month				Third and fourth-month			
No.	Yogic Practices	Sets	Duration	No.	Yogic Practices	Sets	Duration
1.	Opening Prayer	1	2 minutes	1.	Opening Prayer	1	2 minutes
2.	Loosening the joints	1	20 minutes	2.	Loosening the joints	1	10 minutes
3.	Surya Namaskar	2	6 minutes	3.	Surya Namaskar	4	6 minutes
4.	Super brain Yoga	11	2 minutes	4.	Super brain Yoga	21	3 minutes
5.	Tadasana	2	2 minutes	5.	Tadasana	2	2 minutes
6.	Vrikshasana	4	2 minutes	6.	Vrikshasana	2	2 minutes
7.	Ardha Chakrasana	2	2 minutes	7.	Padmasana	1	1.5 minutes
8.	Vajrasana	1	1.5 minutes	8.	Ushtrasana	2	2 minutes
9.	Padmasana	1	1.5 minutes	9.	Sasangasana	1	1 minute
10.	Chin mudra	1	2 minutes	10.	Uttana padasana	6	2 minutes
11.	Bhrammari Pranayama	7	2 minutes	11.	Vipareeta karani	1	1.5 minutes
12.	Relaxation in savasana	1	15 minutes	12.	Sarvangasana	1	2 minutes
13.	Closing Prayer	1	2 minutes	13.	Setubandasana	1	2 minutes
	Total Duration		60 minutes	14.	Ujjai breath	7	2 minutes
				15.	Kapalbhati	1	3 minutes
				16.	Chin mudra	1	2 minutes
				17.	Jnana mudra	1	2 minutes
				18.	Bhrammari pranayama	7	2 minutes
				19.	Relaxation in savasana	1	10 minutes
				20.	Closing Prayer	1	2 minutes
				21.	Total Duration		60 minutes

Table 2 Results of ANOVA between post-test values of YPG, YPDG, and CG

Parameter s	YPG Post Mean ±SD	YPDG Post Mean ±SD	CG Post Mean± SD	Categor y	Sum of Square	df	Means Squar e	f	p
Attention level	45.52±12.53	52±12.42	39.07±10.6	Factor	3679.11	2	1839.55	13.03	<.001
				Residual	18217.77	129	141.22		
Memory ability	47.32±9.05	54.02±7.94	38.82±11.84	Factor	5109.56	2	2554.78	26.87	<.001

				Residual	12267.07	129	95.09		
Memory satisfaction	50.07±10.12	56.05±8.62	42.45±9.88	Factor	4083.32	2	2041.66	22.31	<.001
				Residual	11803.61	129	91.5		
Memory strategy	36±9.76	28.68±10.98	40.02±7.12	Factor	2909.2	2	1454.6	16.37	<.001
				Residual	11464.52	129	88.87		

Table 3 Bonferroni Post-hoc-Tests for ANOVA expressed in Table 2.

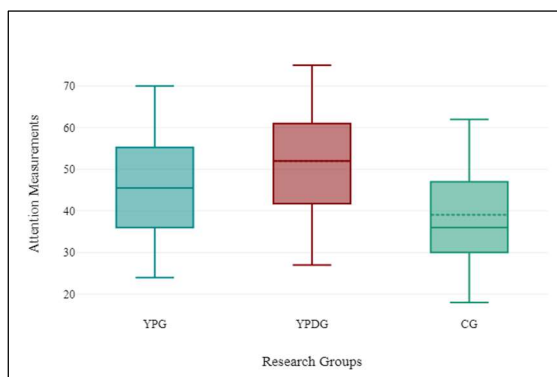
Parameter	Between Groups	Mean Differences	t	p	95% CI lower limit	95% CI upper limit
Attention level	YPG-YPDG	-6.48	-2.56	.035	-12.68	-0.27
	YPG-CG	6.45	2.55	.036	0.25	12.66
	YPDG-CG	12.93	5.1	<.001	6.72	19.14
Memory ability	YPG-YPDG	-6.7	-3.22	.005	-11.8	-1.61
	YPG-CG	8.5	4.09	<.001	3.41	13.59
	YPDG-CG	15.2	7.31	<.001	10.11	20.3
Memory satisfaction	YPG-YPDG	-5.98	-2.93	.012	-10.97	-0.98
	YPG-CG	7.61	3.73	.001	2.62	12.61
	YPDG-CG	13.59	6.66	<.001	8.59	18.59
Memory strategy	YPG-YPDG	7.32	3.64	.001	2.39	12.24
	YPG-CG	-4.02	-2	.142	-8.95	0.9
	YPDG-CG	-11.34	-5.64	<.001	-16.27	-6.42

Results

Attention level

Post data scores on attention level. A one-way analysis of variance (ANOVA) in Table 2 demonstrated that the difference between YPG, YPDG and CG groups on attention level was statistically significant. The results indicated $F = 13.03$ and $p < .001$, leading to the rejection of the null hypothesis. A Bonferroni Post hoc test (BPHT) was conducted to compare and evaluate the three groups in pairs to determine which pair exhibited significant differences.

Figure 1 Post data scores on attention level.



The BPHT in Table 3 revealed that the pairwise group comparisons of YPG – CG, YPDG – CG and YPG – YPDG had p-values less than 0.05, indicating statistically significant differences between these pairs. Given that the

Post mean value (45.52) of YPG was higher than the Post mean value (39.7) of CG (Table 2), it can be concluded that yogic practice alone significantly improved the attention level compared to the CG. The Post mean value (52) of YPDG was higher than the Post mean value (39.7) of CG, suggesting that yogic practice combined with diet also significantly improved the attention level compared to the CG. The results further indicate that YPDG significantly differed from YPG. Analysis of their Post mean values reveals that YPDG demonstrated a significantly higher attentional level than YPG. Therefore, the findings suggest that yogic practices in conjunction with diet improve attentional level more effectively than yogic practices alone.

Memory Ability

ANOVA (Table 2) revealed a significant difference in memory ability between the groups. Here $F = 26.87$ and $p = <.001$. And hence, the null hypothesis was rejected. The groups were compared in pairs using BPHT to determine which was significantly distinct. The BPHT (Table 3) showed that the pairwise group comparisons of YPG – CG, YPDG - CG and YPG - YPDG had a p-value less than 0.05 and thus, these groups were each significantly different pairwise. From Table 2, the Post mean value (47.32) of YPG is higher than the Post mean value (38.82) of CG. Since results proved a significant difference between YPG and CG, now it can be concluded that yogic practice alone significantly improved memory ability than the control group. There is a significant difference between YPDG and CG (Table 3) and the Post mean value (54.02) of YPDG is higher than the Post mean value (38.82) of CG. Hence yogic practices with diet also significantly improved memory ability than the control group. From Table 2 and Table 3, while comparing two experimental groups YPDG and YPG, Yogic practices with diet significantly improved memory ability than the yogic practices.

Memory Satisfaction

An analysis of variance (ANOVA) in Table 2 indicates a statistically significant difference in memory satisfaction across the groups. Here $F = 22.31$ and $p = <.001$. And hence, the null hypothesis was rejected. To find out which of the two groups was substantially different, again BPHT were employed to compare them in pairs. According to the above BPHT in Table 3 the pairwise group comparisons of YPG - CG, YPDG - CG and YPG - YPDG had a p-value less than 0.05 and thus, these groups were each significantly different pairwise. From Table 2, the Post mean value (50.07) of YPG is higher than the Post mean value (42.45) of CG. results proved a significant difference between YPG and CG, now it can be concluded that yogic practice alone significantly improved memory satisfaction than the control group. Also, there is a significant difference between YPDG and CG (Table 3), and the Post mean value (56.05) of YPDG is higher than the Post mean value (42.45) of CG. Hence yogic practices with diet also significantly improved memory satisfaction than the control group. From Table 2 & 3, a comparison of YPDG and YPG reveals that Yogic practices with diet significantly improved memory satisfaction levels than the yogic practices.

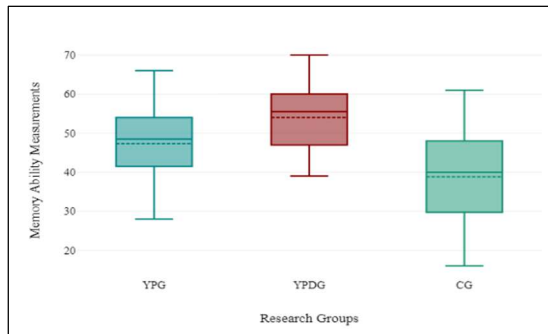


Figure 2 Post data scores on memory ability. can be

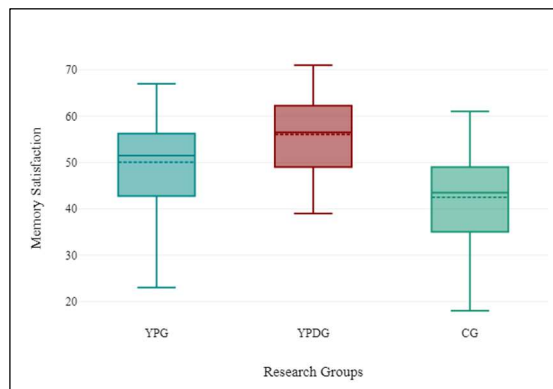


Figure 3 Post data scores on memory satisfaction.

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Memory Strategy

ANOVA in Table 2 revealed a significant difference in memory strategy between the groups. Here $F = 16.37$ and $p = <.001$ and hence, the null hypothesis was rejected. A BPHT was used to compare the groups in pairs to determine which was significantly different. The pairwise group comparisons of YPG - YPDG and YPDG - CG had a p-value less than 0.05, according to the results of the BPHT in Table 3 and thus, these groups were each significantly different pairwise. From Table 2, the Post mean value (28.68) of YPDG is smaller than the Post mean value (40.02) of CG. Based on Table 3, YPDG had a significant reduction in the usage of memory strategies than the control group (CG). It is noted that though the Post mean value (36) of YPG is lesser than the mean value (40.02) of CG, as per the results of Table 3, the difference is not up to the significant level. Also, based on Table 3, a comparison between two experimental groups reveals that these YPDG and YPG differ significantly. The Post mean value (28.68) of YPDG is less than the Post mean value (36) of YPG. Thus, it is obvious that Yogic practices with diet reduce the usage of memory strategies than the yogic practices.

Discussions

Based on the findings of this research, both four months of yoga practice and yoga practice with diet significantly increase attention levels, memory ability, and memory satisfaction among male engineering college students compared to the control group. This result aligns with a previous study conducted by Chobe et al. (2022), which demonstrated that an eight-week yoga intervention significantly improved working memory, verbal memory, attention, learning verbal fluency, executive functions, and processing speed (Chobe et al., 2022). Additionally, another study indicated that balancing asanas, including tadasana and vrikshasana, improved attention levels among college students (Thakur, G., 2018). The present study also incorporated balancing asanas such as tadasana, vrikshasana, and ustrasana, which demonstrated an increase in attention levels. A study by Kodidala, S et al. (2022) revealed that a three-month practice of Surya namaskar alone resulted in significant improvement in attention and orientation, memory, fluency, and visuospatial function among college students (Kodidala, S et al., 2022). The current research utilized Surya Namaskar as one of the yoga practices, and the results were consistent with the aforementioned study. Numerous scientific studies have demonstrated that super brain yoga practice improves attention and memory (Jois, S. N. et al., 2017, Thomas, J. I., & Venkatesh, D., 2017, PP, S. J et al., 2018). As the current research employed super brain yoga and other yogic practices previously shown to improve attention and memory, the findings of this study are substantiated. According to the results of the current research, yoga practices with diet regulation significantly reduced the usage of memory strategies. This reduction can be attributed to the increased memory ability, which diminishes the need for memory strategies. Thus, four months of yoga practice alone demonstrated a significant improvement in attention, memory ability, and memory satisfaction compared to the control group. Yogic practice with diet regulation exhibited a more significant improvement in attention, memory ability, and memory satisfaction than both the yoga practice group and control group, while also reducing the usage of memory strategies compared to the yogic practices group among college students. The limitation of this study is the small sample size. Future studies may benefit from larger sample sizes to further validate these findings.

Conclusion

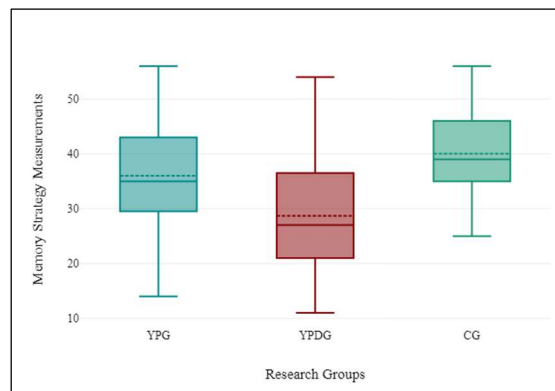


Figure 4 Post data scores on memory strategy.

Post

The present study investigated the effectiveness of four months of yoga training and yoga training with diet regulation on college students' attention level, memory ability, memory satisfaction, and utilization of memory strategies. The research findings indicated that yoga practice is beneficial for enhancing memory and attention levels. Yoga practice combined with diet regulation demonstrated superior efficacy in improving memory and attention levels compared to yoga practice alone, and it reduced the utilization of memory strategies relative to the yogic practices group among college students.

Conflict of interest

The author has no conflicts of interest in the material presented in this article.

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