

## Effect of Pranayama on cognition and other higher mental functions

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### ABSTRACT

**Introduction:** Yoga and pranayama are the ancient Indian life style practices which has no limits for age or gender. The main aim of this study is to evaluate the effect of pranayama on cognition.

**Materials and methods:** This is a pre-post study which includes 100 healthy medical students of 18-25 years age group with equal male to female ratio. They practised daily pranayama (anulom vilom) for 10 minutes; two hours post lunch for 12 weeks in clinical laboratory, department of physiology, Prathima institute of medical sciences. Their cognitive function is assessed by trail making test and mini mental state examination at the beginning and at the end of 12 weeks period in which they regularly practised pranayama, and the results were compared.

**Results:** There is no significant gender difference in the results obtained. After 12 weeks regular practise of pranayama, there is a significant reduction in the time taken for trail making test ( $P < 0.001$ ) and also significant improvement in the scores of mini mental state examination ( $P < 0.001$ ).

**Conclusion:** This study shows that, there is a significant improvement of cognition with regular daily practise of pranayama.

### INTRODUCTION

Yoga and pranayama are one of the best exercises designed by mankind to improve the health of the human body. Day to day Pranayama helps in improving one's memory, concentration, attention, sequential learning, eye-hand coordination, calculation ability etc., thereby improving cognitive functions. If continued to practice with discipline throughout the life pranayama may help to combat the impairment of cognition in the elderly people.<sup>1</sup> Pranayama also helps in stress reduction and reduction of anxiety status by mainly checking on the sympathetic over activity along with other lifestyle changes.<sup>2</sup>

Regular practice of pranayama in those healthy young adult individuals showed significant improvement in rapid fire arithmetic deviation and playing card test scores. Subjects also

showed a significant reduction in time taken for letter cancellation test concluding pranayama helps in improving ones cognitive processes.<sup>1</sup> In human body, both the nostrils (right and left) do not function simultaneously. One nostril will be always more congested than the opposite, even when the nasal passages are clean and not obstructed by mucus. This nasal congestion alternates between the right and left nostrils throughout the day and night.<sup>3</sup>

The cognitive abilities of individuals changes with advancing age. Whereas other cognitive functions like short term memory, brain processing speed, attention, reasoning and assertion will gradually deteriorate with advancing age. From 3rd decade of life individual's processing speed (i.e., speed with which various tasks involving cognitive brain performance) declines. This accounts most of the cognitive changes in elderly people. This slowing can impact the individual day to day performance of tasks or works that involves cognition. Memory retrieval is majorly affected with old age. Even visuo-spatial constructive abilities declines in older people. Reduced grey matter volume. Even loss of corpus callosum integrity mediating cognitive decline in ageing has been an evidence to show that cognition is negatively related to advanced age in older age group people.<sup>4</sup>

Kyizom et al studied the effect of pranayama on brain cognitive functions in diabetic patients (type 2). They measured P300 (P3) an evoked potential in diabetic patient and the effect of pranayama on this P300 which is a measure of brain higher function. With practice of pranayama and yoga there is a significant improvement in P300 latency concluding pranayama and yoga helps in improving cognitive functions of brain in diabetic patients.<sup>5</sup> Bhattacharya et al study showed, after regular practice of pranayama the lipid peroxide level reduced significantly, where as there was no significant increase in super oxide dismutase level concluding regular pranayama practice regulates the oxygen intake there by reduces the lipid peroxide levels in blood there by lowering the risks of damages caused by oxidative stress.<sup>6</sup>

Our main aim is to study the effect of pranayama on cognitive and higher mental functions in normal healthy young adults.

## METHODS & MATERIALS

Institutional ethical clearance was obtained for the current study. 100 apparently healthy medical students with equal male to female ratio (i.e., 50 males and 50 females) participated in this experimental pre-post study, voluntarily. The sample size was derived from the previous original research studies<sup>1,3,7&8</sup> by using open-epi software.<sup>9</sup> Informed consent had been taken from the participants after explaining the study procedure and they were free to leave the study with prior notice.

Inclusion criteria:

- 18-25 years age
- Non-Alcoholic
- Non-Smokers

Exclusion criteria:

- People with hypertension, diabetes mellitus and respiratory illnesses
- Any clinical history of psychological or neurological disease or drug abuse etc.,
- Subjects who used to play sports or do regular exercise or practice yoga or pranayama previously.

**Study Design:** The study was conducted in clinical laboratory, department of physiology, Prathima institute of medical sciences. The participants daily attended the laboratory 2 hours post-lunch i.e., around 4.00 pm without fail for practising the pranayama. For the first 6 weeks they practised surya anulomvilom pranayama (right nostril breathing), 5 seconds deep inhalation followed by 5 seconds deep exhalation through right nostril only continuously for 10 minutes closing left nostril with the opposite hand index finger.<sup>1, 10 & 11</sup>

The next 6 weeks they practised chandra anulomvilom pranayama (left nostril breathing), 5 seconds deep inhalation followed by 5 seconds deep exhalation through left nostril only continuously for 10 minutes closing right nostril with the opposite hand index finger.<sup>1, 10 & 11</sup> the above subjects were not allowed any other physical athletic activities or sports in that particular study period.

**Assessment of cognitive function:** The cognitive functions of participants before and after 12 weeks of practise of pranayama were assessed mainly by three tests. They are

1] Trail making test A:

Trail Making Test A of 25 circles distributed over a sheet of paper. The circles are numbered 1 – 25, and the subject should draw lines to connect the numbers in ascending order. The subject should be instructed to connect the circles as quickly as possible, without lifting the pen or pencil from the

paper. Record the final time taken by the subject to connect the "trail."<sup>12, 13</sup>

2] Trail making test B:

In Part B, there are 25 circles similar to Trail making test A, but the circles include both numbers (1 – 13) and letters (A – L). As in Part A, the subjects draws lines to connect the circles in an ascending pattern, but with the added task of alternating between the numbers and letters (i.e., 1-A-2-B-3-C, etc.). The difficulty of Trail Making Test B is higher than Trail Making Test A and Trail Making Test B is the better tool at assessing cognitive function.<sup>12, 13 & 14</sup>

Results for both Trail Making Test A and B are reported as the number of seconds required to complete the task; therefore, lower scores reveal greater cognition. Trail Making Test is a simple and quick technique to assess visual attention and eye-hand coordination components of cognitive functions.<sup>12</sup>

3] Mini-mental state examination: "It consists of simple questionnaire with each question carrying 1 point and max score is 30. Orientation – 10 points, Registration – 3 points, Attention and calculation – 5 points, Recall – 3 points, Language and praxis – 9 points and for a Total score of 30 points

Mini mental state examination can be used to assess one's orientation, registration, calculation, memory & recall, even language & praxis as a simple questionnaire and easy to do tasks with maximum scoring set at 30."<sup>15, 16 & 17</sup>

Interpretation of the test:

1. for trail making tests A & B the results were reported as time taken to complete the task. The lower the score (time taken to complete) the better is the cognition of participant.

2. Single cut-off value for mini-mental state examination is 24; if it is less than 24 the cognition is impaired, the higher the scores better is the cognition of participant.

The statistical analysis of results before and after 12 weeks of pranayama practise was done with help of statistician and SPSS 16 software using student-t test with P significance set at (P<0.05).

## RESULTS

In males, after 12 weeks of regular pranayama practice, there is statistically highly significant (P<0.001) reduction in time taken to complete both trail making test a and trail making test b. At the end of 12 weeks, there is statistically highly significant (P<0.001) improvement in Mini mental state examination scores (table 1).

Table: 1, Comparison of Trail making test A, Trail making test B and Mini mental state examination scores in 50 males before and after 12 weeks of pranayama practise

Assessment	Before 12 Weeks [MEAN±S.D]	After 12 Weeks [MEAN±S.D]	t	P
Trail Making Test A	32.44±2.85	32.00±2.55	-4.83	0.000**
Trail Making Test B	75.52±2.84	75.08±2.5	-4.83	0.000**
Mini Mental State Examination	24.96±0.78	25.32±0.62	+3.67	0.000**

S.D = standard deviation, \*P<0.01 = statistically significant, \*\*P<0.001 = statistically highly significant

In females, after 12 weeks of regular pranayama practice, there is statistically highly significant (P<0.001) reduction in time taken to complete both trail making test a and trail making test b. At the end of 12 weeks, there is

statistically highly significant (P<0.001) improvement in Mini mental state examination scores (table 2).

Table:2, Comparison of Trail making test A, Trail making test B and Mini mental state examination scores in 50 females before and after 12 weeks of pranayama practise

Assessment	Before 12 Weeks [MEAN±S.D]	After 12 Weeks [MEAN±S.D]	t	P
Trail making test A	31.76±2.49	31.4±2.34	-4.52	0.000**
Trail making test B	74.52±3.24	74.12±2.92	-4.09	0.000**
Mini mental state examination	24.96±0.72	25.36±0.69	+3.74	0.000**

S.D = standard deviation, \*P<0.01 = statistically significant, \*\*P<0.001 = statistically highly significant

There is no significant difference in the Trail making test A, Trail making test B and Mini mental state examination scores between males and females. (Table 3 & 4)

Table: 3, Comparison of Trail making test A, Trail making test B and Mini mental state examination scores between males and females before 12 weeks of pranayama practise.

Assessment	Before 12 Weeks		t	P
	Males	Females		
Trail Making Test A	32.44±2.85	31.76±2.49	-1.27	0.2
Trail Making Test B	75.52±2.84	74.52±3.24	-1.78	0.08
Mini Mental State Examination	24.96±0.78	24.96±0.72	0	1

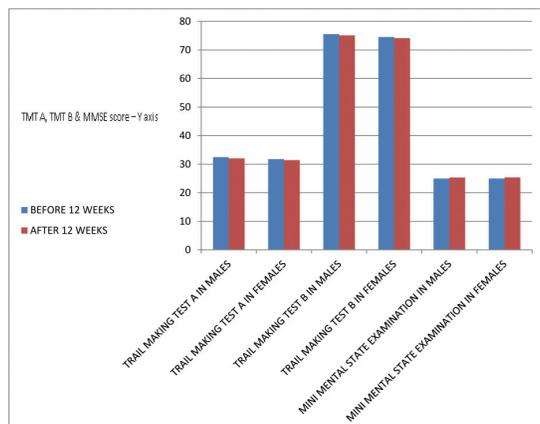
Table: 4, Comparison of Trail making test A, Trail making test B and Mini mental state examination scores between males and females after 12 weeks of pranayama practise.

Assessment	After 12 Weeks		t	P
	Males	Females		
Trail Making Test A	32.00±2.55	31.4±2.34	-1.24	0.2
Trail Making Test B	75.08±2.5	74.12±2.92	-1.94	0.6
Mini Mental State Examination	25.32±0.62	25.36±0.69	0.38	0.6

## DISCUSSION

In the current study, by the end of 12 weeks of practice of pranayama in both males and females there is highly significant reduction in the time taken to complete TMT A and TMT B (P<0.001\*\*) (table 1 & 2). So the above tests results show overall improvement in one's cognitive functions. Similar

result was seen in the study conducted by Vivek et al.<sup>18</sup> There was no significant difference in the TMT A, TMT B & MMSE scores in-between males and females recorded before or after 12 weeks of pranayama practice, concluding there is no much difference in the cognitive functions between two sexes [Fig: 1] (table 3 & 4).



Similar result was seen in studies conducted by S Soni et al and Vivek et al. 1, 18 but the present study showed that daily practice of pranayama helped in improving hand-eye coordination, orientation, registration, attention, calculation, memory & recall and problem solving ability components of cognition. The exact underlying mechanism how this simple breathing technique improved the cognitive functions of subject is not known but we hypothesized that this voluntary breathing technique improved oxygen supply to the brain there by improved the cerebral cortex function. 1 Pranayama is a simple manipulation in breathing that increases parasympathetic tone accompanied by improving the attention and also alertness. Pranayama also helps in reducing stress related mental disorders like depression and anxiety. 19

Yoga and pranayama improves the mental health mainly by down regulating the HPA axis responses to stress and also by suppressing the sympathetic activity. Yoga and pranayama improves the mood, reduces the tension and anxiety in elderly patients and women who practice regularly. The effect of slow and fast pranayama on various cognitive functions was studied by Vivek et al. In this study, they observed that both slow and fast pranayama techniques are beneficial for improving cognitive functions and stress reduction. 18

In addition the fast pranayama technique also helped in improving the sensory motor performance of the participants. There was significant improvement in the scores of both TMT A and TMT B in both males and females, which is same in the current study. 18 TMT is a simple and quick technique to assess visual attention and eye-hand coordination components of cognitive functions. 12,13 the difficulty of TMT B is higher than TMT A and TMT B is the better tool at assessing cognitive function. 14

The study conducted by Plotek W et al concluded that trail making test as a simple tool to assess cognitive components like visual attention, task switching, speed processing etc., based on Functional MRI evidence of increased activity of frontal lobe during the TMT test. 20 Ashendorf et al demonstrated the clinical use of TMT in assessing the

individuals for dementia evaluation mainly in geriatric population. 21

A Nemati study showed a significant positive effect of pranayama on test anxiety and test performance in the students who practiced pranayama daily for one full semester. The results also showed a negative correlation between final test performance and test anxiety. 22 Salthouse et al studies showed that TMT reflects cognitive abilities & also demonstrates the importance of TMT as a tool to investigate the neuropsychological & cognitive functions. 23

MMSE can be used to assess one's orientation, registration, calculation, memory & recall, even language & praxis as a simple questionnaire and easy to do tasks with maximum scoring set as 30. 15, 17 In his study Onwenkwe assessed the cognitive functions of Nigerian population using MMSE and demonstrated 5.2 % of the population in southeast zone have mild cognitive impairment especially language expression, attention and calculation. 24

Gluhm et al used both MMSE and MoCA to screen normal population for evidence of cognitive impairment and found out the importance of both tests as tools to measure cognitive functions. 25 The use of MMSE as a tool to screen dementia and mild cognitive impairment in older individuals was studied by O'Bryant et al. They observed, even highly educated Caucasian elders with scores <27 on MMSE are at higher risk for dementia and MCI. They also established the importance of MMSE as a simple tool to assess cognitive dysfunction. 26

So the regular practice of pranayama and yoga might help for older age individuals should be engaged in various intellectual and social activities that might help in fighting against the cognitive decline and dementia. Daily practicing pranayama is highly effective in both maintenance and improvement of higher mental functions like cognition, as subjects concentrates mainly on ventilation. The cerebral cortex voluntarily works that indirectly improve concentrating ability which is an important cognitive function. Pranayama breathing has been appeared to fine-tune autonomic function. Moderate and profound breathing itself has a quieting impact and helps a person to improve. 8, 27 With daily yoga and pranayama practice, the anxiety levels of individual reduce and this also helps in management of stress. Especially in middle aged population who find difficulty in adapting to stress also shows reduced trait anxiety with yoga and pranayama practices. 28 Yoga and pranayama helps in reducing state anxiety in females. 29

The main limitation of this study is that the subjects are apparently healthy individuals and are young. The study should be extended to the elder age groups suffering with senile dementia to observe the actual health beneficial effects of pranayama. Study should be undertaken in all age groups

with highly co operative subjects to further extrapolate the beneficial effects of pranayama a simple and easy breathing technique that can be practiced by any human being irrespective of age and gender. Our study mainly gives the evidence how pranayama can be beneficial to people to improve their higher mental functions, especially for the medical students who are constantly under stress and cannot spend much time for physical activities in their busy schedule. But a simple breathing practicing technique like pranayama does not take much time and can be practiced at any place any time preferably two hours after taking food.

### CONCLUSION

Pranayama is a short and simple breathing technique which can be easily practiced by individuals irrespective of gender, age etc. Pranayama can improve the cognitive functions and if continued on long term basis might help in preventing the age related dementia and mild cognitive impairment. This study should be further extended to the elderly age group people. How this voluntary breathing practice is improving the cerebral cortex higher intellectual performance should also be established and further research should be done over a long period of time to see the actual beneficial effects in combating age related mental issues.

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