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Nadi-Shodhana Pranayama and its Effect on Verbal and Spatial MemoryScores

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Abstract: *T*he present study examines the effects of Nadi shodhana pranayama, a technique that involves inhaling and exhaling through alternate nostrils, on mental functions related to spatial and verbal abilities. The study involved 100 subjects, specifically first-year medical and dental students aged between 17-21 years. These subjects were divided into two groups: the study group (n=50) and the control group (n=50). The study group underwent a twelve-week program of Nadi shodhana pranayama, practicing it for twenty minutes daily. Verbal and spatial memory scores were assessed on the first day and after the twelve-week period for both groups. The findings of the study revealed a significant improvement in both spatial and verbal memory scores ($p<0.001$) in the study group compared to the control group. Therefore, it can be concluded that Nadi shodhana pranayama has a positive impact on spatial and verbal memory.
Keywords: Memory scores, Nadi-shodhana pranayama.

INTRODUCTION

Yoga, an ancient practice that originated in India thousands of years ago, encompasses various techniques and principles. One of these techniques is Pranayama, which involves regulating the breath's inhalation and exhalation movements. Pranayama is considered an art of controlling the life force of breath and serves as a spiritual and physical practice that harmonizes the mind, body, and soul.

Among the different types of Pranayama, Nadi Shodhana Pranayama, also known as Alternate Nostril Breathing (ANB), holds significant recognition. This particular technique focuses on purifying the energy pathways, known as Nadis, through which the vital energy, or Prana, flows. The term "Nadi" refers to these channels, while "Shodhana" signifies the process of purification. Hence, Nadi Shodhana Pranayama translates to "channel cleaning."

Nadi Shodhana Pranayama involves the practice of inhaling and exhaling through alternate nostrils in successive respiratory cycles. By breathing through the right nostril, known as Surya Anuloma Viloma Pranayama, the activation of the "Pingala" subtle energy channel occurs, which is associated with sympathetic arousal. On the other hand, breathing through the left nostril, known as Chandra Anuloma Viloma Pranayam, corresponds to the activation of the "Ida" svara and parasympathetic response. Nadi Shodhana Pranayama combines both of these techniques into one cycle.

The ultimate objective of Nadi Shodhana Pranayama is to achieve a slow and rhythmic breath, alternating between the left and right nostrils during inhalation (puraka) and exhalation (rechaka). It is worth noting that humans naturally tend to breathe through one nostril at a time, with a simultaneous congestion-decongestion cycle. Interestingly, unilateral forced nostril breathing can have differential effects on the

cerebral hemispheres, influencing relative EEG activity and spatial and verbal performance. Research suggests that right nostril dominance is associated with improved verbal performance.

"Right nostril dominance is associated with better verbal performance and left nostril dominance is associated with better spatial performance" (9) . Further, few studies reveal that there is a relationship between the breathing techniques such as uni-nostril (right and left nostril) and alternate nostril breathing on enhanced spatial memory performance (10).

Today"s ever-changing, technologically advanced & highly competitive environment causes persistent stress to students. Pranayama is known since ancient times to relieve stress and to stabilize autonomic function of the body and to increase the concentration power which in turn increase the retaining and recalling capacity in students. With this background, the present study was undertaken to study the effect of nadi-shodhana pranayama on verbal and spatial memory scores.

METHODS

The current cross-sectional study was conducted on a sample of 100 healthy first-year medical and dental students, aged between 17 and 21 years, at A J Institute of Medical Science in Mangalore. Prior to the study, written informed consent was obtained from all participants, and clearance was obtained from the Institutional Ethics Committee. Individuals with a history of respiratory disorders, congenital heart diseases, epilepsy, recent trauma, spinal deformities, exposure to yoga training, and those who were not interested in pranayama were excluded from the study.

All participants were provided with a detailed explanation of the study's objectives, and a self-structured questionnaire was administered to collect information on age, occupation, and previous exposure to yoga training. Participants were informed that their parameters would be measured on day 1 and after 12 weeks of practicing Nadi Shodhana Pranayama.

a) The participants were randomly assigned to two groups: the study group (n=50), who practiced Nadi Shodhana Pranayama for twelve weeks, and the control group (n=50), who did not engage in any form of yoga or meditation during the study period. The Nadi Shodhana Pranayama training sessions were conducted daily between 5.30pm and 6pm, consisting of twenty cycles lasting twenty minutes each. The practice took place in a well-lit, properly aerated, calm, and quiet room. Participants in the study group were instructed to sit in the comfortable posture of Sukhasana and regulate their breathing by following these steps:

b) 1. Open the right hand and bend the index and middle fingers against the palm. Use the thumb to close the right nostril and the fourth and fifth fingers to close the left nostril.

c) 2. Begin the exercise with a relaxed attitude and focus, exhaling slowly and deeply without closing the nostrils. Inhale slowly and quietly through the left nostril while closing the right. After inhalation, close

d) both nostrils and hold the breath briefly (not exceeding 1-2 seconds).Keep the left nostril closed and exhale through the right as quietly as possible. After exhaling completely, inhale slowly and quietly through the right nostril. At the end of the inhalation, close both nostrils and hold the breath for a while (not more than 1-2 seconds) and continue.

The participants from both groups underwent assessments for verbal and spatial memory on the first day and again after twelve weeks. They were informed that the memory evaluations were meant for their own self-assessment to gauge the improvements they had made from the program. Following the tests, they received feedback, which left them feeling enthusiastic and engaged. The participants were seated approximately one meter apart to minimize distractions. Test materials were displayed on a screen, with

each slide visible for 10 seconds. After viewing the 10 slides, a mathematical problem was presented on the screen, and participants were asked to solve it. Subsequently, they were instructed to recall and write down (or draw, in the case of spatial memory) the 10 test items within a 60-second time frame.

1) Standard nonsense syllables consisting of three letters, such as "xol," were chosen from a predetermined list to assess verbal memory.

2) Geometrical shapes and other figures that could not be easily described verbally, such as a square or a circle, were not utilized to evaluate spatial memory. The drawings were kept simple and easy to replicate.

3) In both verbal and spatial memory assessments, a correct response was awarded one point, while an incorrect response received zero points. The maximum score achievable for each test was ten.

Statistical analysis: Statistical analysis: The mean ± SD was used to express all the data collected. The study group's pre and post training values were compared using Student's paired 't' test. Furthermore, Student's unpaired 't' test was conducted to compare the study group with the control group.

RESULTS

Nadi shodhana pranayama training

g of twelve weeks produced a highly significant (P<0.001) improvement in verbal and spatial memory scores in study group (Table III). It also showed a highly significant (P<0.001) increase in both verbal andspatial memory scores in study group compared to the control group (Table IV).

Table I: Age (in years) comparison between study group and control group

Group	N	Mean	S D	
Study group	50	18.16	0.618	t = 0.9299
Control group	50	18.26	0.443	P = 0.3547

Unpaired t test, p > 0.05, SD-Standard deviation.

The above table shows age of the studied subjects. Mean age observed in study group was 18.16 (±0.618) years and in controls was 18.26 (±0.443) years. No significant difference is seen in age between the two groups (p > 0.05).

Table II: Gender Distribution

	Males	Females	Total
1. Study Group	23	27	50
2. Control Group	9	41	50
			100

Table III: Comparison of Verbal and Spatial Memory Scores Before (day 1) and After doing Pranayama (after 12 weeks) in StudyGroup

Variables	Pre		Post		95% confidence interval	P value
	Mean	SD	Mean	SD		
VMS	5.34	1.96	7.06	2.23	(-2.32, -1.12)	<0.001**

SMS	4.58	1.75	8.32	2.02	(-4.32, -3.16)	<0.001**

Paired t test ** Highly Significant, **VMS: verbal memory scores, SMS: spatial memory scores.**

Table IV: Comparison of Verbal and Spatial Memory Scores in Study Group with Control Group.

Variables	**Control group**		**Study group**		**95% CI**		**P value**
	Mean difference	**SD**	**Mean**	**SD**			
VMS	0.34	1.80	-1.72	2.12	1.28	2.84	<0.001**
SMS	0.76	2.05	-3.74	2.04	3.69	5.31	<0.001**

Unpaired t test **** Highly Significant**

DISCUSSION

The current cross-sectional study was conducted to assess the impact of nadi shodhana pranayama on verbal and spatial memory scores among undergraduate students aged 18.21 years. The results of this study revealed that the group that underwent training in Nadi shodhana pranayama demonstrated a significant improvement in both spatial and verbal memory test scores (P<0.001). Khalsa et al. also reported an enhancement in spatial performance during a cognitive task after 30 minutes of unilateral forced nostril breathing among 51 right-handed undergraduate students with an average age of 20.7 years (15). Furthermore, a study involving 108 school children aged between 10-17 years showed a substantial increase in spatial memory scores across all four trained groups following ten days of specific yoga breathing techniques, including right nostril breathing, left nostril breathing, alternate nostril breathing, and breath awareness without nostril manipulation. However, there was no significant improvement observed in verbal memory scores (12).

There are several possible explanations for the improvement in spatial and verbal memory scores observed after practicing Nadi shodhana pranayama. One reason could be the reduction in anxiety, which is known to enhance performance on tasks involving learning and memory. Additionally, studies have shown that humans and other mammals exhibit ultradian rhythms of alternating cerebral dominance during waking and sleep. These rhythms are closely linked to the nasal cycle, which is regulated by the autonomic nervous system. The nasal cycle involves greater airflow in one nostril, which later switches to the other side. When one nostril is activated by increased parasympathetic activation, the mucous membranes become engorged with blood, resulting in decreased airflow in that nostril and increased airflow in the other nostril. This unilateral forced nostril breathing can have differential effects on the ipsilateral and contralateral cerebral hemispheres, leading to changes in relative EEG activity and influencing spatial and verbal performance. Specifically, it has been suggested that right nostril dominance is associated with better verbal performance, while left nostril dominance is associated with better spatial performance. However, further research is needed to fully understand how unilateral breathing improves sustained attention and whether there are other significant factors involved aside from increased mental energy.

CONCLUSION

The study's findings indicate that Nadi Shodhana Pranayama can lead to enhancements in spatial and verbal memory. These positive results could be implemented in educational settings to boost memory function in students. Dedicate a few minutes each day to practice this technique to improve concentration on tasks and studies. Integrating this daily practice into physical fitness and lifestyle programs can help maintain optimal physical and mental health for a better future.

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