YOGA BREATHING THROUGH A PARTICULAR NOSTRIL INCREASES SPATIAL MEMORY SCORES WITHOUT LATERALIZED EFFECTS1

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Summary- Uninostril breathing facilitates the performance on spatial and verbal cognitive tasks, said to be right and left brain functions, respectively. Since hemispheric memory functions are also known to be lateralized, the present study assessed the effects of uninostril breathing on the performance in verbal and spiritual memory tests. School children (N= 108 whose ages ranged from 10 to 17 years) were randomly assigned to four groups. Each group practised a specific yoga breathing technique: (i) right nostril breathing, (ii) left nostril breathing, (iii) alternate nostril breathing, or (iv) breath awareness without manipulation of nostrils. These techniques were practised for 10 days. Verbal and spatial memory was assessed initially and after 10 days. An age-matched control group of 27 were similarly assessed. All 4 trained groups showed a significant increase in spatial test scores at retest, but the control group showed no change. Average increase in spatial memory scores for the trained groups was 84%. It appears yoga breathing increases spatial rather than verbal scores, without a lateralized effect.

The nasal cycle is an ultradian rhythm characterized by alternating patency of the left and right nostrils with a periodicity of 1 to 8 hours (Keuning, 1968). Some reports suggested a connection between the phases of the nasal cycle and the cerebral hemisphere which is dominant, mediated through a neural reflex (Werntz, Bickford, Bloom, & Shannahoff-Khalsa, 1983).

This was based on studies using the electroencephalogram (EEG). Forced unilateral nostril breaching modified EEG activity over the two hemispheres, with a greater amplitude on the side contralateral to the patent nostril. This was also believed to influence performance on specific tasks (Beubel, 1977; Klein, Pilon, Prossner, & Shannahoff-Khalsa, 1986; Jella & Shannahoff-Khalsa, 1993). In the report by Klein, et al (1986) adult volunteers tended to exhibit right-nostril dominance during normal breathing, to perform better on simple perceptual tasks with verbal information and known to be carried out by the left hemisphere, compared with subjects whose left nostril was dominant. Similarly during the left nostril-dominant phase subjects performed better on simple perceptual tasks using spatial information inferred to activate the right hemisphere. Both verbal and spatial tasks involved deciding whether stimulus pairs were same or different. For the verbal tasks stimuli were pairs of upper and lower case letters, while for the spatial task the stimuli were pairs of random seven dot patterns. There was no significant effect of forced uninostril breathing on performance of these tasks. In contrast, a subsequent study of undergraduate students whose group average age was 20.7 yr. (Jella & Shannahoff-Khalsa, 1993) showed that forced left-nostril breathing increased spatial performance on a cognitive task. This paper and pencil task tested mental rotation, manipulation and twisting of two-and three-dimensional stimulus objects; however, it did not validate that forced right-nostril breathing increased verbal performance on a task modeled after the Miller Analogies and SAT tests. Perhaps the difference in results obtained with normal breathing and with forced uninostril breathing may be related to forced uninostril breathing using an uncomfortable nose plug.

There are specific yoga breathing practices (pranayamas) which involve breathing selectively through a particular nostril. These techniques can be practiced effortlessly for prolonged periods and allow the effects of unilateral nostril breathing to be studied. The effects of three pranayama practices (which involve left nostril, right nostril, and alternate nostril breathing) on autonomic functions and metabolism have been reported to be similar to the effects of forced uninostril breathing (Shannahoff-Khalsa, 1991; Telles, Nagarathna, & Nagendra, 1994). The present study was carried out to assess whether practicing these three pranayama practices, i.e., left, right, or alternate nostril breathing pranayamas, or breath awareness four times a day for ten days would alter the performance of school children on verbal and spatial memory tests, compared to those of a control group who did no specific practice.

METHOD

Subjects

The subjects in the four trained groups were 108 school children whose ages ranged from 10 to 17 years and who were attending a 10-day residential yoga training course during their vacation. There was also a control group of 27 children who were matched with the other four groups on age and who were attending an English medium school. They were similarly assessed before and after 10 days during which they carried on with their routine activities. Hence, performance of this group primarily is pertinent to answering the question of whether an observed effect is merely a retest effect. All subjects were judged right-hand dominant, based on their self-reports as well as actual observation of the hand used by the subject to hold a pen while writing.

Design

The subjects were given the memory test on the first morning of the 10-day camp. The subjects were grouped by age; then subjects of a particu1ar age, e.g., 10 years, were randomly assigned to four training groups (ns = 27). Hence the four groups were of comparable average ages (see below). They had the same routine and learned the same yoga practices, with one difference. Each group was given a different pranayama technique to practice four times a day. The four techniques involved (i) breathing exclusively through the left nostril-chandra anuloma viloma (group's M age was 13.4, SD = 1.4 yr.), (ii) breathing exclusively through the right nostril surya anuloma viloma (group's average age was 14.0, SD = 1.5 yr.), (iii) breathing through both nostrils alternately-nadishudhi pranayama (group's M age was 13.8, SD = 1.2 yr.), or (iv) breath awareness without nostril manipulation (group's M age was 14.6, SD = 1.6 yr.). The fifth control group (group's M age was 13.6, SD=0.9 yr.) of 27 children continued their routine activities for ten days.

Assessment

The subjects were told that the memory tests were for their self-assessment to understand the benefit they derived from the course. They were subsequently given a report, so they were enthusiastic and interested. They were not given further details about the study. The control group were also told that the tests were for their self-assessment and were also given a report. For both verbal the spatial tests a correct response was scored as 1/1 and an incorrect response as a practice trial showed that many subjects got a maximum score (with no scope for further change) when a free-recall test was used, so for the actual assessment a delayed recall test was used as this is known to be more difficult (Russell, 1979). However, there was no special interest in assessing the effect of interference on recall.

On both tests 20 subjects were assessed at a time while seated approximately a meter apart to avoid distraction. The test material was projected on a screen, allowing 10 sec. for each slide. After the 10 slides were shown, a mathematical problem (e.g., 7 minus 4 plus 9 minus 3 plus 6 minus 5 minus 8 plus 2) was projected on the screen: immediately after this, the subjects were asked to recall and write down (or in the case of spatial memory, to draw) within 60 sec. the 10 test items which had been shown to them.

To test verbal memory standard nonsense syllables of three letters, e.g., xol, were selected from a prepared list (Baddeley, 1993). Two different sets of 10 nonsense syllables were presented on Days 1 and 10. The test for spatial memory consisted of 10 simple line drawings. Geometrical or other shapes which could be described verbally, e.g., a square or a circle, were not used. The drawings were very simple and easy to reproduce. As described for verbal memory, there were two separate, similar sets of 10 line drawings each for Days 1 and 10.

Subjects were asked to make a note of which nostril was dominant, i.e., the phase of the nasal cycle, when completed the test. The subjects were asked to test this by occluding the nostrils, one at a time, to cheek which nostril was more congested and which was more easy to breathe through.

Pranayama Practices

The four separate pranayama practices given to each group were practiced as 27 rounds, four times a day (Nagendra, Mohan, & Shriram 1988). The four practices are described below.

(i) The surya anuloma viloma pranayama, or heat-generating breathing practice, involves breathing exclusively through the right nostril while the left nostril is gently occluded. (ii) Chandra anuloma viloma pranayama, or heat dissipating breathing practice, involves breathing through the left nostril whole the right nostril is occluded. (iii) Nadisudhi pranayama or cleansing-breathing practice requires the nostrils to be manipulated with the right hand so that breathing is alternately through left and right nostrils. During practices i, ii, and iii a cross-legged posture is assumed and awareness of the breath is maintained. During the fourth practice, i.e., (iv) Breath awareness, the subject maintained awareness of the breath without manipulation of nostrils.

Analysis

For both verbal and spatial memory tests a correct answer was scored as 1, whereas a wrong answer was scored 0. For each of the five groups separate two-factor analyses of variance were used to test for significance between the verbal and spatial memory test scores, between scores obtained on Days 10 and 1 and for the interaction of tests by days. Data of the 27 subjects in each group were used for analysis, hence there were 27 replicates.

The multiple-comparison Tukey test was used to assess the least significant difference in different comparisons of the groups means for each of the five groups, separately.

RESULTS

The group means ± SDs of memory test scores obtained by all five groups for both verbal and spatial tests at initial and final assessments are given in Table 1. The F values given below were derived by linear interpolation from df = 1,100 and 1,120 in the standard table, to get the F values for df=1,104 (Zar, 1984). The two-factor analysis of variance showed a significant difference between the means for verbal and spatial memory test scores, i.e., Factor A for groups practicing the second and third pranayamas. For left nostril breathing $F_{1.104}$= 4.58 (F= 3.94 at p <.05, one-

Table 1 Means and standeard deviations of Memory scores of Five Groups (NS = 27) on verbal and spatial memory test for daily 1 and 10.

Group		Verbal Test Rating (Out of 10)		Spatial Test Rating (Out of 10)	
		Day 1	Day10	Day 1	Day 10
Right Nostril	M	3.8	4.6	3.1	5.9
	SD	2.2	2.1	1.7	2.0
Left Nostril	M	4.0	5.0	3.6	6.7
	SD	1.9	1.7	1.8	1.6
Both Nostrils	M	2.9	3.8	3.3	5.9
	SD	2.0	2.2	1.9	1.3
Breathing Awareness	M	3.4	4.4	3.1	5.6
	SD	2.1	1.8	1.6	1.8
Control	M	3.5	4.4	3.4	4.3
	SD	1.7	1.6	0.7	1.2

tailed), was significant as was the $F_{1,104}$ of 11.30 ($F=9.60$ at $p<.005$, two-tailed) for breathing with both nostrils. The difference between the tests was not significant for breathing with the right nostril, breath awareness, and the control group (PS >.05).

All four trained groups and the control group showed significant differences between values obtained on Day 10 and Day 1. For breathing with the right nostril $F_{1,104} = 21.48$ ($F = 12.88$ at $p < 001$, two-tailed) was significant as was the F of 33.43 for breathing with the left nostril, F of 21.76 for breathing with both nostrils, F of 23.32 for the breath awareness group, and F of 11.03 ($F=9.60$, two-tailed) for the control group.

Table 2: Comparisons of Difference Between means, q Values and Probabilities Based on Tukey Test for Verbal and Spatial Memory Scores for each of five Groups on Days 1 and 10

Comparisons		Differences	q_{124}	p
1. Spatial 10Vs Spatial 1	Group: Right Nostril	2.78	7.13	<0.001
2. Spatial 10Vs Spatial 1	Group: Left Nostril	3.07	8.77	<0.001
3. Spatial 10Vs Spatial 1	Group: Both Nostril	2.59	7.00	<0.001
4. Spatial 10Vs Spatial 1	Group: Breath awareness	2.48	6.89	<0.001
5. Spatial 10Vs Verbal 10	Group: Left Nostril	1.81	5.17	<0.001
6. Spatial 10Vs Verbal 1 0	Group: Bothe Nostril	2.11	5.70	<0.001

The Tukey multiple-comparison test showed significant differences for (i) spatial scores on Day 10 versus spatial scores on Day 1 and (ii) spatial scores on Day 10 versus verbal scores on Day 10 (groups breathing with left and both nostrils). The comparisons, q values and levels of significance are given in Table 2.

DISCUSSION

The present study showed that after ten days of yoga breathing practices (pranayamas) all four trained groups showed a significant increase in spatial memory scores but not the control group. On the verbal memory scores each of the five groups showed no significant increase but relatively large standard deviations were noted. The percentage increase in scores suggested some differences. Blakeslee (1980) stated that the left hemisphere is more involved with verbal memory, while the right hemisphere is more involved with the recall of non-verbal, spatial information. It appears here that there was no specific lateralized effect of breathing through a particular nostril over the 10 days of pranayama practice by these children. The performance also did not appear to be related to the nostril which was patent at the time of testing.

Several factors could have contributed to the increase in spatial memory scores of the four trained groups. Children were enthusiastic about performing well on tile tests, which they had been told were a way of assessing the benefits they had obtained during the course, but this may have been less applicable for the control group as they received no special treatment. The positive effects of motivation on learning and memory scores increased in the trained groups, while verbal scores did not, makes it unlikely that increased motivation could have contributed only to one set. Also, reduced anxiety can improve the performance on tasks requiring learning and memory (Saltz, 1970) and the anxiety-reducing effects of yoga practice, which are already known (Wallace, Benson, & Wilson, 1971) also could have facilitated this. The lack of higher spatial memory scores for the control group indicates that the increase was not due to familiar material given as a retest.

Although the scores on the verbal and spatial tests were not significantly different, on Day 1 and Day 10 means were significantly different for left and both nostril-breathing groups, so the practice of yoga improved delayed recall scores on the spatial task but not on the verbal task.

The absence of a lateralized effect of selective nostril breathing in the present study could be explained by different factors. Three previous studies reported lateralized effects of uninostril breathing on selective measures of hemisphere functions. The earliest report (Beubel, 1977) described relatively better verbal performance during both naturally occurring right nasal dominance and right forced uninostril breathing by practitioners of Kundalini yoga. In the study by Klein, et.al. (1986) naturally occurring shifts in the nasal patency were reported to be associated with modified performance on verbal or spatial tasks corresponding to the contralateral hemisphere. Both verbal and spatial tasks involved deciding whether stimulus pairs were same or different. For the verbal tasks stimuli were upper and lower case letter pairs, while for the spatial task the stimuli were pairs of random seven dot patterns. Forced unilateral-nostril breathing did not produce a change. In contrast, a subsequent study of undergraduate students whose group average age was 20.7 yr. (Jella & Shannahoff-Khalsa, 1993) showed that forced left- nostril breathing increased spatial performance on a cognitive task. This paper-and-pencil task tested mental rotation, manipulation, and twisting of two and three-dimensional stimulus objects. However, it did not confirm that forced right-nostril breathing increased verbal performance on a task modeled on the Miller- Analogies and SAT tests. Perhaps the difference between the results obtained with normal breathing and with forced uninostril breaching reflects that forced uninostril breathing using a nose plug may be uncomfortable. The present study indicated no lateralized effect following yoga breathing through a specific nostril. Assessments were made on Days 1 (before) and 10 (after) a period of practicing yoga breathing regularly. The 10 days may not have been adequate to produce lateralized changes in these children. Alternatively, the results suggest that the hemisphere-specific effect of selective nostril breathing might be immediate, measurable during or immediately after the selective nostril breathing. The effect was then not observed following regular practice for a specific period as in the present study. Further studies comparing the effect during or immediately after the practice with the effect over a period of time would make this point more clear, as might the application of sophisticated imaging techniques.

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