



However, the ancient scriptures of Svara yoga contained vivid descriptions on the relationship of nasal cycle with the psychophysiological state of the body (1).

Ida svara (left nostril dominance) was described as female, Sakti and Moon and Pingala svara (right nostril dominance) as male, Siva and Sun, Similarly the traditional Indian description of Ardha narisvara consisted of female element on left and male element on the right side of the body (4). Such notion of left-right female-male duality was common in oriental traditional medicine and philosophy as well as in western alchemy (5). The symbolic representation indicated the possible pattern of psychophysiological function of the body; Ida svara - rest and relaxed state and Pingala svara - active state. Similarly performance of passive activities (soumya karya) in Ida svara and vigorous activities (roudra karya) in Pingala svara were recommended. Susumna svara which was referred to as madhyama or middle one was considered to be krura and dushta (destructive) indicating its lack of suitability for the performance of the worldly activities.

The present study intended to check the validity of these assumptions. The cyclical nature of the congestion and decongestion of the nasal mucosa was demonstrated to be under the control of sympathetic nervous system (3). It meant that the sympathetic tone to the two sides of the nose was unequal. Such a possibility of variation in the sympathetic activity between the sides of the body elsewhere and its relation to nostril dominance pattern or svara deserved to be studied. The galvanic skin resistance was perhaps the most widely used index of the level of activation of the sympathetic nervous system (6). The GSR was dependent on the activation of sweat glands by sympathetic nervous system and thus reflected the sympathetic activity (6, 7). The GSR was sensitive even to the minor changes in sympathetic activity due to variations in arousal, emotion and stress (6, 8). Forehead, palms, fingers and soles were commonly used sites for electrode placement. Volar electrodes being small, made good contact with the skin

surface and were convenient for bilateral recording of GSR (7, 9). Recently Telles et al (10) used volar GSR to demonstrate the long term changes in sympathetic activity due to pranayamic breathing practices. Hence bilateral volar galvanic skin resistance (GSR) in individuals demonstrating Ida, Pingala and Susumna svara was studied in this investigation.

## METHODS

The experiments were conducted in two instalments.

*Experiment 1:* Field studies were carried out in 107 male subjects with mean age of  $25.8 \pm 8.0$  SD who came to visit and exhibition in the university campus. The subjects comprised of university students as well as outsiders. They were moving in the exhibition premises for at least 15 min and the observations were made when they arrived at the yoga stall. These subjects had no opportunity to rest physically. Hence these observations were considered to be taken under field conditions. The subject was seated on a wooden chair. The procedure was briefly mentioned and consent was obtained. The GSR electrodes were applied on two fingers of each hand. The nostril dominance was determined in them by the hygrometric method as the paper recording oscillograph could not be transported to the field. It was followed by recording of the bilateral volar GSR.

*Experiment 2 :* As the subjects in the experiment 1 were in the field condition and were not allowed time to physically relax, the observations were made in the laboratory on another group of 51 male subjects who were university students with a mean age of  $24.2 \pm 2.8$  SD. The subjects were brought to the laboratory and were allowed to relax in supine position for atleast 15 min. Each subject was thus given the opportunity to rest physically and mentally. During the rest period, the phenomenon of svara and the experimental procedure was explained to him and his consent was obtained. The details of the subject were taken and the instruments were connected to him. The nostril dominance was assessed from paper recording

of two channels of an oscillograph (Model EEG 10, Medicare, Chandigarh) as it was more sophisticated than the hygrometric method.

*Handedness* : The subjects who used right hand for writing and hence were considered as right handers were allowed in the above experiments.

*Recording of volar GSR* : A pair of disc (1 cm diameter) type, silver/silver chloride electrodes were applied to the fore and middle fingers of each hand with electrode paste (Cardi-jelly, BPL-INDIA) between the electrode and the skin (7, 9). The volar GSR of left and right hand were noted in k ohm from the digital output of GBF 2000 (MEDICAID, Chandigarh).

*Determination of nostril dominance by hygrometric method* : The hygrometric method of nostril dominance determination was earlier used by Keuning (11) and Krishnarao et al (12). The flat reflecting surface of a stainless steel mirror was held in the path of the expired air of the subject while taking care not to tilt the mirror to either left or right side. The time taken for the condensed vapour of the expiratory air from left and right nostrils to disappear was measured to the nearest second by a digital electronic stop watch. Readings were taken from atleast 5 breaths. Relative proportion of time taken for condensed vapour from either nostril to disappear from the surface of the mirror reflected the relative amount of expired air coming out from the two nostrils. The percentage of air passing through the left nostril (L%) was calculated by the following formula:

Time taken in seconds for the evaporation of condensed vapour from left nostril.

$$L\% = \frac{\text{Time taken in seconds for the evaporation of condensed vapour from left nostril}}{\text{Sum of the time taken in seconds for the evaporation of condensed vapour from left and right nostrils}} \times 100$$

Sum of the time taken in seconds for the evaporation of condensed vapour from left and right nostrils.

R% (percentage of air passing through right nostril) = 100 - L%

*Recording of nostril dominance on oscillograph*: Two respiratory transducers which sensed the variation in the temperature of inspiratory and expiratory air were used. They were fixed at a distance of 5 mm and at the same level so that their tips could be inserted into the nostrils on either side of the nasal septum. The subject did not complain of any discomfort or inconvenience in nasal breathing. The sensitivity of both channels of the oscillograph was adjusted in such a way that the pen deflections were equal for the same amount of respiratory air movement. Similar technique was used by Werntz et al (13). The nostril dominance was assessed from smooth record of atleast 10 consecutive uninterrupted breaths. The height of the pen deflection for each breath corresponding to left and right nostril was measured and the averages were taken. The left and right nostril respiratory record was summed and the percentage of breathing through each nostril (L% and R%) was calculated. These observations were compared with nostril dominance assessment by the hygrometric method during the pre-experimental trial sessions to find that the nostril dominance tallied.

## RESULTS

The subjects in each experiment were divided into 3 groups. Ida svara or left nostril dominance group consisted of subjects demonstrating 60% to 100% of respiratory air moving through the left nostril. In the Pingala svara or right nostril dominance group, the subjects showed 60% to 100% of respiratory air moving through the right nostril. The subjects who showed 41% to 59% of air moving through either of the nostrils (undecided nostril dominance) were included in Susumna svara group.

The volar GSR of left and right sides for Ida, Pingala and Susumna svara groups taken under field conditions and laboratory conditions were presented in Table I A and B.

An overall survey of the results showed that the volar GSR of left and right sides in any

TABLE I : Bilateral GSR in Ida, Pingala and Susumana svara groups under field and laboratory conditions.

	Svara groups*			$\$p$ , when compared between					
	Ida	Pingala	Susumna	Svara groups			Left and right sides in		
				I-P	I-S	P-S	I	P	S
A. Experiment 1 (Field condition):									
Number of subjects	37	50	20						
L% Nostril dominance	77.0 ± 9.3	25.5 ± 10.8	50.8 ± 4.4	<0.001	<0.001	<0.001			
				<0.001	<0.001	0.217			
R% Nostril dominance	23.0 ± 9.3	74.5 ± 10.8	49.2 ± 4.4	<0.001	<0.001	<0.001			NS
Left volar GSR	02.0 ± 49.8	101.6 ± 47.4	82.8 ± 30.1	0.488	0.061	0.052			
(k ohm)				NS	NS		0.451	0.017	0.136
Right volar GSR	102.7 ± 67.8	91.5 ± 46.4	75.2 ± 28.6	0.181	0.045	0.075	NS		NS
(k ohm)				NS		NS			
B. Experiment 2 (Laboratory condition) :									
Number of subjects	11	28	12						
L% Nostril dominance	72.3 ± 8.6	22.4 ± 9.9	48.7 ± 6.3	<0.001	<0.001	<0.001			
				<0.001	<0.001	<0.001			
R% Nostril dominance	27.7 ± 8.6	77.6 ± 9.9	51.3 ± 6.3	<0.001	<0.001	<0.001			NS
Left volar GSR	119.9 ± 56.3	109.8 ± 69.0	82.3 ± 42.2	0.334	0.041	0.105			
(k ohm)				NS			NS	<0.001	<0.005 0.015
Right volar GSR	212.6 ± 110.8	136.0 ± 91.9	107.1 ± 65.5	0.017	0.003	0.166			
(k ohm)							NS		

\*Mean ± SD

‡ t-Test; unpaired between svara groups and paired between left and right sides in the same group.

L - Left, R - Right, I - Ida svara group, P - Pingala svara group, S - Susumna svara group.

svara group were lower in the Experiment 1 than in the Experiment 2.

The volar GSR was maximum in the Ida svara group followed by Pingala svara group and the lowest GSR was found in the Susumna svara group of Experiment 1 and 2. Significant difference was present for left volar GSR between Pingala and Susumna svara groups and for right volar GSR between Ida and Susumna svara groups in experiment 1 (Table IA). In Experiment 2 (Table IB), the difference was significant for left and right volar GSR between Ida and Susumna svara groups and also for right volar GSR between Ida and Pingala svara groups.

The comparison of the left and right side volar GSR of subjects belonging to Ida, Pingala and Susumna svara groups in the Experiment 1 and 2 could be found in Table IA and B.

Under the field conditions (Table IA), the volar GSR of Experiment 1 significantly varied

between left and right sides only in Pingala svara group but not in Ida or Susumna svara groups. The volar GSR between left and right sides was similar in Ida svara group, but the volar GSR on right side was lesser than that on left side in Pingala svara group with similar tendency in Susumna svara group.

However, under the laboratory condition, the physically rested subjects of Experiment 2 (Table IB) exhibited significant difference between volar GSR of left and right sides in all svara groups. The volar GSR was more on the right side than on the left side in all svara groups. It might be noted that when there was a difference between left and right sides in Experiment 1, the right volar GSR was lesser than the left volar GSR. Thus there seemed to be a paradox in the right volar GSR behaviour in Experiment 1 and 2.

Further, analysis of the data in Experiment 1 and 2 (Table II) showed that there was no

TABLE II : Correlation coefficients between nostril dominance and bilateral GSR

	Experiment 1 (Field condition)		Experiment 2 (Laboratory condition)	
	Left volar GSR	Right volar GSR	Left volar GSR	Right volar GSR
L% Nostril dominance	-0.027	+0.074	-0.092	+ 0.125
R% Nostril dominance	+0.027	-0.074	+0.092	- 0.125
Critical value :				
1 tail, 0.05		±0.160		± 0.233
2 tail, 0.05		±0.190		± 0.276
Number of subjects		107		51

significant correlation between the nostril dominance percentage of left and right nose with the bilateral GSR. However, the sign of the correlation coefficient suggested the possibility of an inverse relationship between nostril dominance and volar GSR on ipsilateral side.

#### DISCUSSION

Overall comparison of the volar GSR between Experiment 1 and 2 indicated that the subjects under the field condition in Experiment 1 were active and the physical rest given to the subjects in Experiment 2 under the laboratory condition allowed them to relax.

Comparison of the volar GSR on left and right sides in between svara groups of Experiment 1 and 2 revealed the maximum GSR in Ida svara group and hence Ida svara (left nostril dominance) could be interpreted as a relaxed/rest state. Less volar GSR in Pingala svara (right nostril dominance) showed relatively more sympathetic activity reflecting an active state. The lowest GSR in Susumna svara (undecided nostril dominance) pointed out to a high sympathetic activity reflecting the turbulence of the transitional stage of the nasal cycle. These observations were in line with the symbolic descriptions of Ida, Pingala and Susumna svara as female, male and destructive respectively. Similarly the notion that Ida svara being suitable for the performance of passive activities (soumya karya) could be accepted because it was the resting state with reduced

sympathetic activity. The Pingala svara (right nostril dominance) being an active state with enhanced sympathetic activity, it was more suitable for the performance of vigorous activities (roudra karya). The maximum sympathetic activity in Susumna svara (undecided nostril dominance) indicating the turbulent state could only be considered as unsuitable for successful performance of worldly activities.

The present observations on nostril dominance and bilateral GSR could be supported by other studies on the effect of forced unilateral nostril breathing on sympathetic nervous activity. Forced unilateral left nostril breathing was shown to decrease the blood glucose levels while forced unilateral nostril breathing through right nostril increased the blood glucose levels (14). It was demonstrated that intra-ocular pressure was increased by forced unilateral left nostril breathing but decreased by forced unilateral right nostril breathing (15). Forced unilateral left nostril breathing was shown to increase the involuntary blink rates and right nostril breathing to decrease the voluntary blink rates (16). These studies showed that the sympathetic nervous activity was less during left nostril breathing (Ida svara) and more during right nostril breathing (Pingala svara).

The comparison of left and right volar GSR in various svara groups showed that GSR varied in between the two sides of the body. Since

variation was significant in all svara groups in Experiment 2 but only in Pingala svara group in Experiment 1, it could be said that the variation was clear when the subjects were given physical rest as in Experiment 2 under laboratory condition.

This seemingly contradictory behaviour of the right volar GSR in Experiment 1 and 2, i.e. the right volar GSR being lesser than left volar GSR if at all there was any difference between them in Experiment 1 while the right volar GSR was always more than the left volar GSR in Experiment 2, could be explained as following. The overall view of the left-right differences indicated that the volar GSR varied more readily on the right side than on the left side in Experimental 1 and 2 (Table I A and B). While higher volar GSR in the laboratory condition was due to physical rest, the increase in the volar GSR in Experiment 2 was more on the right side than on the left side which meant that right volar GSR was more readily responding to the effect of rest. Similarly the volar GSR was not only less in the subjects of Experiment 1 but also that the volar GSR on right side was lesser than on left side. Again this meant that the activity in the subjects of Experiment 1 caused stronger effect in reducing the right volar GSR. Thus the possibility of variation in volar GSR with relaxation/activity mainly existed on right side of the body. Such preponderance in the variability of right volar GSR could be responsible for the paradoxical observations on left-right difference in volar GSR in Experiment 1 and 2. The observation that the right volar GSR was readily variable was note worthy because the subjects were right handed individuals. Further the right side could be recommended as preferable site for recording volar GSR to closely reflect the level

of sympathetic activity with regard to relaxation/activity. Such preference for right side was more in the physically rested condition. When the effect of voluntary physical activity was avoided, the variation in the right volar GSR was likely to represent the innate endogenous variation of the sympathetic nervous activity.

Though there was no significant correlation between the nostril dominance and bilateral GSR, there was a tendency for the inverse relation between the nostril dominance and volar GSR on the ipsilateral side. This might encourage the need to further study the proposal that the nostril dominance phenomenon could be used as an easily observable indicator of the relative dominance of the sympathetic nervous activity on the two sides of the body.

The possibility of the relation between nostril dominance phenomenon and bilateral sympathetic nervous activity was studied by Kennedy et al (17). They showed that the catecholamine levels in the arm venous blood varied in phase with the nasal cycle and reflected the relatively higher sympathetic activity on the ipsilateral side of svara (dominant nostril). The possibility of such variation on the two sides of the body might lead to variability in the blood flow to the two cerebral hemispheres and hence a variability in their lateralized specialization functions. Indeed it was proposed that the rest/activity cycle of Kleitman (18, 19) was related to the cyclical phenomenon of nostril dominance and the cyclical variation in the cerebral hemispherical EEG (13, 20) and their lateralized specialization functions (21, 22, 23). Thus cyclical variations in the bilateral sympathetic nervous activity might provide the basis for the cyclical bilateral variations in the functional activity of the nervous system (24, 25).

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