

SHORT COMMUNICATION

IMMEDIATE EFFECTS OF SURYANAMASKAR ON REACTION TIME AND HEART RATE IN FEMALE VOLUNTEERS

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Abstract : Suryanamaskar (SN), a yogic technique is composed of dynamic muscular movements synchronised with deep rhythmic breathing. As it may have influence on CNS, this study planned to investigate immediate effects of SN on reaction time (RT) and heart rate (HR). 21 female volunteers attending yoga classes were recruited for study group and 19 female volunteers not participating in yoga were recruited as external-controls. HR, auditory reaction time (ART) and visual reaction time (VRT) were recorded before and after three rounds of SN in study group as well as 5 minutes of quiet sitting in both groups. Performance of SN produced immediate decrease in both VRT and ART ($P < 0.001$). This was significant when compared to self-control period ($P < 0.001$) and compared to external-control group, it decreased significantly in ART ($p = 0.02$). This was pronounced when $\Delta\%$ was compared between groups ($P < 0.001$). HR increased significantly following SN compared with both self-control ($p = 0.025$) and external-control group ($p = 0.032$). Faster reactivity may be due to intermediate level of arousal by conscious synchronisation of dynamic movements with breathing. Rise in HR is attributed to sympathetic arousal and muscular exertion. We suggest that SN may be used as an effective training means to improve neuro-muscular abilities.

Key words : yoga suryanamaskar reaction time heart rate

INTRODUCTION

Beneficial effects of Yoga have been reported in peripheral and central neuronal processing (1, 2, 3, 4). Reaction time (RT) is simple and effective method of studying central neuronal processing and is a simple

means of determining sensory-motor association, performance and cortical arousal (3).

It has been reported that changes in breathing period produced by voluntary control of inspiration are significantly

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correlated to changes in RT (5). Some studies on yoga have shown that regular practice of yoga over a period of few weeks to a few months can significantly decrease both visual reaction time (VRT) and auditory reaction time (ART) (2, 3, 6). Previous studies by Bhavanani et al have reported a significant and immediate decrease in RT following the practice of nine rounds of mukha bhastrika, a bellows type of pranayama in normal school children as well as mentally challenged adolescents (7, 8).

Suryanamaskar (SN) is a sequential combination of yogic postures performed dynamically in synchrony with the breath. Energy cost and physiological changes during the practice as well as after training have been reported (9, 10, 11, 12).

Keeping the above in mind, this study was planned to investigate the acute effects of SN on RT and heart rate (HR) in trained female volunteers.

METHODS

Twenty-one female volunteers (mean age 28.29 ± 1.71 years) were recruited from those attending regular yoga classes at CYTER in Mahatma Gandhi Medical College and Research Institute, Puducherry. Another group of 19 female volunteers (mean age 32.11 ± 1.41 years) not attending yoga classes were recruited as external-controls. Informed consent was obtained from all participants and ethical clearance was obtained from Institutional Human Ethics Committee.

Numerous variations of the SN are taught and the one used in the present study is known as Aruna SN. This is an integral

part of the Gitananda Tradition and involves dynamic performance of a sequential combination of yogic postures in synchrony with breathing (13). The speciality of this variation is the usage of nasarga mukha bhastrika, a bellows type of yogic breathing done with internalized awareness of diaphragmatic actions.

The keywords for SN are “stretch” and “breathe” and the breathing must be deep and regular with the movements flowing with the breath. From a standing position (samasthiti asana) both arms are stretched up breathing in, and the palms brought together in anjali mudra. While exhaling, stretch down with palms flat to the ground and forehead to knees in pada hastha asana. Lift the head while breathing in and then blast out with a “whoosh” jumping back with the whole body parallel to the ground in chatur danda asana. On the next in-breath, lift the head and bend back as much as possible (kokila asana). Come into meru asana by lifting the buttocks up, keeping the knees tight and straight while pushing down on the heels. In this position, inhale through the nose and “whoosh” out forcefully through the mouth (nasarga mukha bhastrika). Breathe in and jump forward bringing both feet between the hands placed firmly on the ground. Stretch the head up and feel a stretch through the entire back. Breathe out and lower the head down to knees. Breathe in and lift back up to anjali mudra and finally return and relax in samasthiti asana.

RT apparatus manufactured by Anand Agencies, Pune was used with built in 4 digit chronoscope and display accuracy of 1ms. Simple ART was recorded for auditory beep sound and simple VRT for red light. Subjects

were instructed to release response key with dominant hand as soon as they perceived the stimulus given from the front to avoid effect of lateralised stimulus (14). All subjects were given adequate exposure to the equipment on 2 different occasions to familiarize them with the procedure. To ensure objectivity, HR was recorded using non-invasive semi-automatic BP monitor (CH – 432, Citizen Systems, Tokyo, Japan) having range from 40 to 180 beats/min and accuracy $\pm 5\%$.

For SN group, RT measurements and HR recordings were done twice; before and after a control period of 5 minutes of quiet sitting and then before and after practice of SN. Control period was 5 minutes, equivalent to duration taken to perform SN. To avoid influence of recording on different days and order of recording, half subjects performed self-control recordings on day-1 and others did SN recordings. This was reversed on day-2. For external-control group, RT measurements and HR recordings were done before and after 5 minutes of quiet sitting with half recording on day-1 and others on day-2. Ten trials were recorded and average of lowest three similar observations were taken as single value (14).

Statistical analysis

Data are expressed as mean \pm SEM. Statistical analysis was done using GraphPad InStat version 3.06 and all data passed normality testing by Kolmogorov-Smirnov Test and hence analyzed using Students t test for paired data for intra-group comparisons and Students t test for unpaired data between groups. P values less than 0.05 were accepted as indicating significant differences.

RESULTS

Mean age of subjects in the SN group was 28.29 \pm 1.71 and in external-control group was 32.11 \pm 1.41 years and difference between groups was not significant.

Comparison of self-control HR, ART and VRT recordings in SN group showed no significant differences ($P>0.05$) when compared with external-control group recordings both at baseline and after 5 minutes of quiet sitting.

The mean \pm SEM values of HR, ART and VRT recordings and their statistical comparison between SN, self-control and

TABLE I: Immediate effect of suryanamaskar on heart rate (HR), auditory reaction time (ART) and visual reaction time (VRT) in 21 female volunteers before (B) and immediately after (A) three rounds of suryanamaskar and a self-control period of 5 minutes of quiet sitting.

	Suryanamaskar (n=21)			Self-Control period (n=19)			Comparison (P value)		
	B	A	Δ %	B	A	Δ %	B	A	Δ %
HR	76.71 \pm 2.04	80.52 \pm 2.47**	5.00 \pm 1.67	76.67 \pm 1.67	75.29 \pm 1.66	-1.44 \pm 1.95	0.982	0.025	0.072
ART	225.04 \pm 8.23	193.44 \pm 8.66***	-14.28 \pm 1.75	236.63 \pm 9.06	234.14 \pm 8.78	-0.94 \pm 0.68	0.012	< 0.001	< 0.001
VRT	245.80 \pm 6.93	213.72 \pm 6.80***	-13.08 \pm 1.03	249.52 \pm 5.49	244.69 \pm 5.83	-1.88 \pm 1.13	0.359	< 0.001	< 0.001

Values are given as mean \pm SEM. ** $P<0.01$ by paired t test, *** $P<0.001$ by paired t test.

TABLE II: Immediate effect of suryanamaskar on heart rate (HR), auditory reaction time (ART) and visual reaction time (VRT) in 21 female volunteers before (B) and immediately after (A) three rounds of suryanamaskar and in an external- control group of 19 female volunteers performing 5 minutes of quiet sitting.

	Suryanamaskar (n=21)			External-Control period (n=19)			Comparison (P value)		
	B	A	Δ %	B	A	Δ %	B	A	Δ %
HR	76.71±2.04	80.52±2.47**	5.00±1.67	76.16±1.53	74.37±0.99	-1.89±1.69	0.831	0.032	0.004
ART	225.04±8.23	193.44±8.66***	-14.28±1.75	223.89±10.42	223.21±9.51	-0.10±1.32	0.931	0.026	< 0.001
VRT	245.80±6.93	213.72±6.80***	-13.08±1.03	242.90±7.61	234.08±8.71*	-3.74±1.38	0.779	0.070	< 0.001

Values are given as mean±SEM. **P<0.01 by paired t test, ***P<0.001 by paired t test.

external-control groups are given in Tables I and II.

The changes were significant with regards to a rise in HR and fall in ART and VRT following SN as compared with both self-control and external-control group data. This was more pronounced (P<0.001) in ART and VRT data when the baseline adjusted percentage changes (Δ %) were compared between groups.

DISCUSSION

To the best of our knowledge, this is the first report on the immediate effects of SN on RT. Previous studies on immediate/acute effects of SN have focussed on energy cost and cardio-respiratory changes during the practice or cardiorespiratory and metabolic responses to four rounds of the practice (9, 12). Both these studies lacked control groups whereas our present study analyses immediate effects of RT with reference to both self-control data as well as data from a separate external-control group.

HR increased significantly following performance of three rounds of SN (P<0.01). This was statistically significant when

compared to both self-control period (p=0.025) and external-control group (p=0.032). The Δ % difference in HR between SN and external-control group was statistically significant (p=0.004) and just missed significance with self-control period (p=0.072). This rise in HR can be attributed to sympathetic arousal as well as muscular exertion and this is in agreement with another report that average intensity during SN was 80% HRmax, sufficient to elicit a cardio-respiratory training effect (12). It has been previously reported that SN produces an increase in VO₂ max indicating improved aerobic capacity and that it exerts only moderate stress on cardio-respiratory system as it keeps the practitioner within their lactate and anaerobic threshold (9, 10).

Performance of SN produced immediate and statistically significant decreases in VRT and ART. The faster reactivity is in agreement with previous studies on immediate effects of mukha bhastrika and three weeks of slow and fast pranayama training (7, 8, 14). Decrease in RT signifies improvement in central neuronal processing ability and this may be attributed to greater arousal and faster rate of information processing along with improved concentration. RT is fastest

with an intermediate level of arousal and deteriorates when subjects are either too relaxed or too tensed. Exercise improves RT and moderate muscular tension shortens pre-contraction RT while isometric contraction allows the brain to work faster (15). Alternate forward and backward bending movements as well as the jumping back and forth movements in SN may have influenced RT in a manner similar to isometric muscular exercise. Though RT shortening effect of exercise is normally lost in post exercise period as arousal diminishes (16), in our subjects shortening of RT was carried over into post SN period too. With the above in mind, we attribute faster reactivity of our subjects following SN to an intermediate level of arousal brought about by conscious synchronisation of dynamic muscular movements with slow, regular and deep breathing.

Previous studies have demonstrated EEG changes around somato-sensory and parietal areas of cerebral cortex suggesting affective arousal following agnisara, nauli and bhastrika and suggested such changes occur through strong stimulation of somatic and splanchnic receptors (17). The nasarga mukha bhastrika in meru asana, involving multiple forceful expirations done rapidly and consecutively may have prolonged and residual neuro-muscular effect influencing RT. It has been suggested that such forceful

expirations may alter afferent inputs from abdominal and thoracic regions, in turn modulating activity at ascending reticular activating system and thalamo-cortical levels (7, 8).

On the basis of the present study, it is concluded that three rounds of SN produce significant shortening of RT in female subjects as part of a generalised sympathetic arousal as evidenced by significant rise in HR. We suggest that SN may be used as an effective training means to improve neuromuscular abilities. As our study is limited by a small sample size, further studies with larger sample sizes may help to understand better underlying mechanisms involved in bringing about such an immediate benefit.

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REFERENCES

1. Malhotra V, Singh S, Tandon OP, Madhu SV, Prasad A, Sharma SB. Effect of yoga asanas on nerve conduction in type 2 diabetes. *Indian J Physiol Pharmacol* 2002; 46: 298–306.
2. Madanmohan, Thombre DP, Balakumar B, Nambinarayanan TK, Thakur S, Krishnamurthy N, et al. Effect of yoga training on reaction time, respiratory endurance and muscle strength. *Indian J Physiol Pharmacol* 1992; 36: 229–233.
3. Malathi A, Parulkar VG. Effect of yogasanas on the visual and auditory reaction time. *Indian J Physiol Pharmacol* 1989; 33: 110–112.

4. Telles S, Joseph C, Venkatesh S, Desiraju T. Alterations of auditory middle latency evoked potentials during yogic consciously regulated breathing and attentive states of the mind. *Int J Psychophysiol* 1993; 14: 189-198.
5. Gallego J, Perruchet P. The effect of voluntary breathing on reaction time. *J Psychosom Res* 1993; 37: 63-70.
6. Borker AS, Pednekar JR. Effect of pranayam on visual and auditory reaction time. *Indian J Physiol Pharmacol* 2003; 47: 229-230.
7. Bhavanani AB, Madanmohan, Udupa K. Acute effect of mukh bhastrika (a yogic bellows type breathing) on reaction time. *Indian J Physiol Pharmacol* 2003; 47: 297-300.
8. Bhavanani AB, Ramanathan M, Harichandrakumar KT. Immediate effect of mukha bhastrika (a bellows type pranayama) on reaction time in mentally challenged adolescents. *Indian J Physiol Pharmacol* 2012; 56: 174-180.
9. Sinha B, Ray US, Pathak A, Selvamurthy W. Energy cost and cardiorespiratory changes during the practice of surya namaskar. *Indian J Physiol Pharmacol* 2004; 48: 184-190.
10. Bhutkar PM, Bhutkar MV, Taware GB, Doijad V, Doddamani BR. Effect of suryanamaskar practice on cardio-respiratory fitness parameters: A Pilot Study. *Al Ameen J Med Sci* 2008; 1: 126-129.
11. Bhavanani AB, Udupa K, Madanmohan, Ravindra P. A comparative study of slow and fast suryanamaskar on physiological function. *Int J Yoga* 2011; 4: 71-76.
12. Mody BS. Acute effects of surya namaskar on the cardiovascular and metabolic system. *J Bodyw Mov Ther* 2011; 15: 343-347.
13. Bhavanani AB. Suryanamaskar: An expression of our gratitude to life. Puducherry, India: Dhivyananda Creations; 2011. P 54-58.
14. Madanmohan, Udupa K, Bhavanani AB, Vijayalakshmi P, Surendiran A. Effect of slow and fast pranayams on reaction time and cardiorespiratory variables. *Indian J Physiol Pharmacol* 2005; 49: 313-318.
15. Etnyre B, Kinugasa T. Postcontraction influences on reaction time (motor control and learning). *Research Quarterly for Exercise and Sport* 2002; 73: 271-282.
16. Collardeau M, Brisswalter J, Audiffren M. Effects of a prolonged run on simple reaction time of well-trained runners. *Perceptual and Motor Skills* 2001; 93: 679-689.
17. Roldan E, Dostalek C. EEG patterns suggestive of shifted levels of excitation effected by hathayogic exercises. *Act Nerv Super (Praha)* 1985; 27: 81-88.