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Immediate effect of stimulation in comparison to relaxation in healthy volunteers

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In this self-control, cross over study carried out over two consecutive days, 43 healthy male volunteers aged 20-45 yrs practiced 20 minutes Kapalbhati and 20 minutes Breath Awareness. Subjects were assessed before and after both practices for State Anxiety, sustained attention (Six Letter Cancellation and Digit Letter Substitution tests), and verbal and spatial memory. After Kapalbhati, scores reduced significantly on State Anxiety, and increased on both sustained attention, and verbal and spatial memory; statistical significance was high on all variables ($p<0.001$). After Breath Awareness, changes were also significant ($p<0.001$) on all variables except State Anxiety ($p>0.05$).

Keywords: *Yoga, Kapalbhati*, Anxiety, Attention, Memory

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Modern business trends both reduce physical activity and increase mental strain, making for life-styles that are *tamasic,* yet hyperactive. Minimal physical activity results in lethargy, yet *rajasic* influences of ambition fueled by strong desire drive attached modes of action. This combination creates stress and fatigue. One solution is a two fold process of *sadhana* contained in *Mandukya Upanishad*: *laye sambodhayet chittam* (when the mind becomes lethargic, stimulate and awaken it); and *vikshiptam samyet punah* (when it speeds up and distractions set in, calm it). A *pranayama* process combining *Kapalbhati* (stimulating) and breath awareness (calming) can achieve this, removing stress of all kinds, and developing attention span and memory[1]. Studies suggest that *yoga* breathing increases spatial rather than verbal scores without a lateralized effect[2]. In one study, the *yoga* group showed significant increases in spatial memory test scores, while verbal memory test scores remained the same in all subjects[3]. Improvement in spatial memory scores following *yoga* can be related to reduced anxiety, which improves performance on memory tasks[4]. Practicing *yoga* may help in memory development by deepening perception, reducing distractibility/ increasing the attention span, activating dormant areas and sifting useful memories from useless ones for our overall development. *kapalbhati*, breathing practices and *pranayama* techniques are known to develop and to improve memory[5]. Study of a student group (mean age 20.7 yrs), showed that forced left nostril breathing increased spatial performance on a cognitive task[6].

Kapalbhati is a *pranayama* technique, which invigorates the entire brain and awakens dormant centers responsible for subtle perception[7]. The *Hath Ratnavali* defines it as fast rotation of the breath from left to right / right to left, or exhalation and inhalation through both nostrils together. *Kapalbhati* helps eliminate CO_2, cleans air passages, stimulates abdominal organs, and improves autonomic balance[8]. Increased blood circulation and O_2 levels revitalize and activate brain cells concerned with memory and other functions, increasing concentration, improving memory, and stimulating intellectual faculties[9]. Other studies found unilateral forced nostril breathing to improve spatial and verbal performance, and that 30-45 seconds *kapalbhati* increases breath holding time (important for *yoga sadhana*)[10,11]. For anxiety and depression, alternating fast and slow breathing practices for 20-30 minutes, starting with *kapalbhati* (fast breathing) before *pranayama* (slower breathing), stops persistent worry[12]. Relaxation with Guided Imagery (RGI) script yields short term reduction in State-Trait Anxiety Inventory (STAI) scores, as shown in each of three tests on nursing students[13]. A previous study has investigated the effect of stimulants on psycho-motor performance. Subjects

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were served either a hot drink without coffee or a hot drink with coffee before taking the digit letter substitution (DLS) or six letter cancellation (SLC) tests. Results indicated significant increases in scores on both tests following coffee administration, confirming coffee's stimulating effects on psycho-motor functions, and suggesting that that improved test performance[14]. No previous study has assessed *kapalbhati* on measures of anxiety, sustained attention, or verbal and spatial memory, nor has it been compared with breath awareness for its effects on these variables. Hence, the reasons for this study being carried out.

Methodology

Subjects

Forty three healthy males aged 20-45 yrs (mean 28 yrs) volunteered from groups completing SVYASA one month residential *yoga* courses. They were divided into 2 groups labeled *kapalbhati* (KB) and Breath Awareness (BA).

Inclusion Criteria

Subject health was verified by routine clinical examination and general health questionnaire (GHQ) scores (<4). None was taking medication. Aims and methods of the study were explained to them; all gave written informed consent.

Designs

This was a crossover self-control study. The KB group did *kapalbhati* on the first day and breath awareness the second day; for the BA group, the order was reversed.

Assessments

Assessments were made before and after KB and BA practice at the same time on two consecutive days.

Instruments

STAI is a self-report instrument, for study of state and trait anxiety. State anxiety (STAI A-State) reflects transitory emotional states characterized by subjectively perceived feelings of tension, apprehension, and heightened ANS activity. Intensity may fluctuate over time[15]. The test consists of a worksheet with 4 statements describing different states of anxiety, said to be the most common in measuring present anxiety. Subjects select score numbers against each statement indicating frequency of occurrence of these states: *almost never*, *sometimes*, *often*, and *almost always*. STAI-A scores have a direct interpretation: high scores mean more state anxiety; low scores mean less. The six letter cancellation (SLC) test and digit letter substitution (DLS) test require visual selectivity and repetitive motor response. They assess selective, focused and sustained attention, visual scanning and activation and inhibition of rapid responses, helping isolate major components of performance like detection, perception, recognition, processing and integration. Both have been standardized for Indian populations[16]. They are valid for the study of immediate effects[14].

The SLC test consists of a worksheet containing 22 rows × 14 columns randomly arranged letters of the alphabet, and specifying 6 target letters to be canceled. Subjects strike out as many target letters as possible in the specified time (90 seconds). The DLS test consists of a worksheet containing 12 rows × 8 columns randomized digits, with a key specifying pairings between digits 1-9 and Roman letters. Subjects substitute as many target digits as possible in the specified time of 90 seconds[16]. These 2 tests are standard measures of attention span, hence their selection. The verbal memory test consists of 4 different sets of 10 nonsense syllables, e.g. ZOC enough to be presented both pre and post the KB and BA interventions. The spatial memory test consists of 10 line drawings of easily described geometrical or other shapes, that are simple and reproducible (not square or circle). As for verbal memory, 4 similar sets of drawings are used, one each, pre and post KB and BA interventions[3,17]. Each test is projected on a laptop for the subjects allowing 10 seconds for each slide. Immediately after the slides, subjects are shown a mathematical problem on the screen (e.g. 3+5-2+4-2-5+6-3). Subjects are then asked to recall and write down (or draw in the case of spatial memory) as many of the 10 test items as they can within 60 seconds.

Test Reliability and validity

Reliability refers to consistency of measurement, reflected in score reproducibility. Validity concerns how well a test measures what it purports to. The STAI and sustained attention tests have been evaluated for them based on standard criteria. A-State anxiety scores have high degrees of internal consistency[15]. Their point–biseral r (Pb) correlations are 0.60 and 0.73, respectively[15]. For the SLC test, reliability is ascertained based on temporal stability and internal consistency[18]. In the first, the correlation

coefficient was calculated using unpublished pilot data collected on 29 healthy male volunteers. Spearman's correlation coefficient was calculated between data collected before and after a 23 min non-specific intervention: subjects read a book of their choice, while remaining seated. The net score variable for which correlation was calculated remained stable (r=.781, p=.002). As the SLC test consists of one variable, internal consistency cannot be calculated. Content validity of this test is adequate for its intended purpose. Corresponding data on the DLS test are unfortunately not available. The tests of verbal and spatial memory developed at SVYASA clearly test the intended variable and are valid; their reliability is currently being more precisely evaluated.

Interventions

Instructions were delivered by audiotape for the 20 minutes performance of both practices; one minute practice was followed by one minute relaxation, repeated 10 times. Subjects sat with their spine straight. For *kapalbhati*, instructions were as follows: *Sit straight keeping your head, neck, spine erect. Take a deep inhalation, exhale forcibly, blast out the air using abdominal muscle, inhale passively relaxing the abdominal muscles, and repeat these movements as quickly as possible starting with 60 strokes per minutes and increasing gradually up to 80 strokes per minute. There is no holding of breath*. The rapid active exhalation with passive effortless inhalation is accomplished by flapping movement of the abdomen, continued at a uniform speed of 80 strokes per minute. It is continued for 1 minute, slowing down gently at the end. Following each minute's KB practice, relaxation instructions were given as follows: *Relax … relax …yourself. Allow your abdominal muscles to relax; relax your whole body and mind, enjoy the deep silence of the mind, relax… relax…*! Breath awareness practice was performed similarly: one minute practice was followed by one minute relaxation, repeated ten times. Instructions were as follows: *Sit comfortably, relax yourself, become aware of your breathing, just observe your breathing pattern, simply observe, do not manipulate, just go on observing, maintain your awareness towards breathing, just observe, now relax, relax yourself totally from toes to head, allow relaxation to continue all your body and mind..*! The same relaxation instructions were used as in the KB session.

Data analysis

Statistical analysis was done using SPSS (version 10.0). Data were assessed for normality using the Kolmogorov-Shapiro Test. Paired 't' tests and RM ANOVA tests were used to assess significance within and between groups, respectively.

Results

The Kolmogorov–Shapiro tests of normality showed pre data of SAS, SLC and DLS tests were normally distributed for both groups, while pre-data of the two memory tests were not normally distributed. The group means values, standard deviation values, p values and percentage change values of both groups, i.e. of *kapalbhati* and breath awareness are given below (Table 1). The STAI A-State (SAS) test of relatively labile *state anxiety*,

Table 1— Pre-post changes in measured variables

Test	N=43	*KB*				*BA*			
		Mean	± SD	P-value	Post-pre % change	Mean	± SD	P-value	Post-pre % change
SAS	Pre	8.16	2.44	0.001	11.32	7.79	2.05	0.142	3.04
	Post	7.33	2.01			7.56	2.11		
SLC	Pre	40.65	9.93	0.001	23.69	39.86	11.27	0.001	14.83
	Post	50.28	9.62			45.77	12.81		
DLS	Pre	56.53	11.15	0.001	14.89	54.67	9.64	0.001	6.73
	Post	64.95	12.1			58.35	9.77		
MMR- VBL	Pre	3.05	1.84	0.001	33.44	3.67	2.04	0.001	-36.51
	Post	4.07	2.27			2.33	1.71		
MMR- SP	Pre	4.56	1.14	0.001	34.20	4.81	1.72	0.001	-16.84
	Post	6.12	1.28			4.00	1.46		

SAS-Stai A State, SLC-Six Letter Cancellation, DLS-Digit Letter Substitution, MMR VBL-Verbal, & MMR SP-Spatial Memory

Legend: Table 1 presents Pre-Post Mean ± Standard Deviations, significance p values and percentage changes in value for all measured variables (state anxiety, sustained attention, and verbal and spatial memory) before and after *Kapalbhati* (KB) and Breath Awareness (BA). The contrasting increase and decrease in memory scores are of great significance.

Table 2 —Significance of p values between groups

Test	Significance
SAS	0.023
SLC	0.007
DLS	0.01
MMR-VBL	0.001
MMR-SPL	0.001

SAS-Stai A State, SLC-Six Letter Cancellation, DLS-Digit Letter Substitution, MMR VBL-Memory Verbal, MMR SP-Memory Spatial

was significantly reduced after *kapalbhati* practice ($p<0.001$), but the reduction after breath awareness practice did not reach significance ($p=0.142>0.05$) (Paired 't' test). Between groups results were significantly different ($p<0.02$), as given in Table 2 below. Scores on the SLC and DLS tests of sustained attention were significantly increased for both groups ($p<0.001$) (Paired 't' test). In contrast, scores on both the verbal (MMR VBL) and spatial memory (MMR SP) tests showed significant but *opposite* changes. For the *kapalbhati* group, both significantly increased ($p<0.001$), but for the breath awareness group, both significantly decreased ($p<0.001$) (Paired 't' test).

Discussion

It has previously been established that *Kapalbhati* practice causes autonomic activation: increased heart rate and systolic blood pressure were observed as an immediate effect during 3 continuous *kapalbhati* sessions of 5 minutes each[19]. This suggests that practice of *kapalbhati* increases sympathetic activity[20]. The study found reduction in anxiety score after practice of *kapalbhati* (11.32%, $p<0.001$), but the 3.04% reduction following breath awareness did not reach significance ($p=0.142$). The difference in anxiety reduction between *kapalbhati* and breath awareness was significant ($p<0.023$). This result therefore suggests that, although it temporarily increases sympathetic activation, *kapalbhati* is more effective than breath awareness in reducing subjects' anxiety levels. This might be thought surprising, because previous work suggests that *yoga* practice reduces anxiety, because of its ability to reduce psycho-physiological arousal[21]. This is clearly not the reason in the study. However, a different study supports the idea that practices producing arousal may, in the end, be more beneficial: cyclic meditation, which combines stimulating *and* calming techniques, practiced with a background of relaxation and awareness, in the end reduces physiological arousal more effectively than supine rest in *shavasana*, which is only calming[22]. For the SLC and DLS tasks, the results suggest that *kapalbhati* augments attention, both enhancing performance, and reducing distraction. The study found increases in sustained attention scores after practice of both *kapalbhati* (23.69% & 14.89% for SLC & DLS tasks, respectively) (both $p<0.001$), and breath awareness (14.83% & 6.73% for SLC & DLS, respectively) (both $p<0.001$), but, again, significantly more after *kapalbhati* than breath awareness (both SLC & DLS $p<0.001$). These results support the idea that *kapalbhati* is more effective in increasing subjects' sustained attention span than breath awareness.

Since *Kapalbhati* increases psycho-physiological arousal, this finding is consistent with the study on effects of drinking coffee, which suggested that coffee's stimulating effects on psycho-motor function, improve test performance[14]. With regard to memory, one study of a group trained in *yoga* found significant increase in spatial memory test scores, while verbal memory test scores remained the same[3]. Another study reported effects on memory of 4 *pranayama* techniques: right nostril breathing, left nostril breathing, alternate nostril breathing and breath awareness without manipulation of nostrils[2]. All 4 groups showed a significant increase in spatial test scores (mean 84%), while the control group showed no change. It was suggested that *yoga* breathing increases spatial memory scores without a lateralized effect[2]. It has also been suggested that improvements in spatial memory scores may be due to anxiety reduction, which is known to improve performance on learning and memory tasks[4] e.g. a study of undergraduates (mean age 20.7 yrs) showed that forced left nostril breathing increased spatial performance on a cognitive test of mental rotation, manipulation and twisting of 2 and 3 dimensional objects[6]. In this light, the present study's findings that verbal and spatial memory scores both increased significantly after *kapalbhati* practice (33.44% & 34.20%, respectively, both $p < 0.001$), but decreased significantly after breath awareness practice (-36.51% & -16.84% respectively, $p<0.001$), is very important. It was found that *kapalbhati* does not produce a lateralized effect. Also, the opposite changes in *kapalbhati* and Breath Awareness demonstrate that the hypothesis that all mind-body techniques have similar effects is erroneous[23].

Conclusion

The study suggests that both *kapalbhati* and breath awareness reduce anxiety and improve sustained attention. However, *kapalbhati* was significantly more effective in doing so than breath awareness. In contrast, they act oppositely on verbal and spatial memory: whereas *kapalbhati* significantly increases both, scores on these variables significantly declined after breath awareness. This suggests that breath awareness is intrinsically dulling to the mind, though further experiment is needed determine whether verbal instructions yield better results than the repeated audio tape instructions used in the experiment. This would be a significant experiment, because breath awareness and related techniques are considered important components of many systems of psycho-spiritual development.

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References

1 Nagendra HR & Nagarathna R, *New perspectives in stress management*, (Vivekananda Kendra Yoga Prakashna Bangalore), 1998.

2 Naveen KV, Nagarathna R, Nagendra HR & Telles S, Yoga breathing through a particular nostril increases spatial memory scores without lateralized effects, *Psychol Rep*, 81 (1997) 555-561.

3 Manjunath NK & Telles S, Spatial and verbal memory task scores following *yoga* and fine art camps for school children, *Indian J Physiol Pharmacol,* 48 (2004) 353-356.

4 Saltz E, Manifest anxiety: Have we missed the data?, *Psychol Rev,* 77 (1970) 568 – 573.

5 Nagendra HR & Telles S, *Yoga & Memory*, (Vivekananda Kendra Yoga Prakashna, Bangalore), 1999, 27.

6 Jella SA & Shannahoff – Khalsa DS, The effects of unilateral forced nostril breathing on cognitive performance, *Int J Neurosci,* 73 (1993) 61-68.

7 Muktibodhananda, *Hath yoga pradipika*, (Yoga Publication Trust, Munger, Bihar), 2001 187, 220-222.

8 Nagendra HR & Mohan T, *Yoga in Education,* (Vivekananda Kendra Yoga Anusandhana Samsthana, Bangalore), 2003.

9 Lysenbeth & Andrevan, *Pranayama*-The yoga of breathing, (Unwin Paperbacks, London), 1985.

10 Block RA, Arnott DP, Quigley B & Guch WC, Unilateral nostril breathing influences lateralized cognitive performance*, Brain Cogn,* 9 (1989) 181-90.

11 Bhole MV, Effect of *kapalbhati* on breath holding time, *Yoga Mimansa,* 18 (3&4) (1956) 21-26.

12 Nagarathna R & Nagendra HR, *Yoga practices for anxiety and depression*, (Swami Vivekananda Yoga Prakashna, Bangalore), 2004.

13 King Jane Valerie, A holistic technique to lower anxiety: Relaxation with guided imagery*, J Holistic Nursing,* 6 (1988) 16-20.

14 Natu MV & Agarawal AK, Testing of stimulant effects of coffee on the psychomotor performance, *Indian J Pharmacol*, 29 (1997) 11-14.

15 Spielberger CD, Gorsuch RL & Lushene RE, *State –Trait Anxiety Inventory,* (*Preliminary Test Manual, for Form B & X*), (Florida State University, Tallahassee, Florida), 1968.

16 Lezak MD, *Neuropsychological assessment,* 3rd edn, (Oxford University Press, New York), 1995.

17 Baddelay AD, *Your Memory* – A user's guide, (Avery, New York), 1993.

18 Singh AK, *Tests measurements and research methods in behavioral science*, (Bharati Bhavan, Patna), 2002.

19 Stancak AJV, Kuna MS, Vishnudevananda S & Dostalek, E, *Kapalbhati– Yogic* cleansing exercise and cardiovascular and respiratory changes, *Homeost Health*, 33 (3) (1991) 126-134.

20 Raghuraj P, Ramakrishnan AG, Nagendra HR & Telles S, Effect of two selected yogic breathing techniques on heart rate variability, *Indian J Physiol Pharmacol*, 42 (4) (1998) 467-472.

21 21 Telles S, Rajesh B & Srinivas, Automatic and respiratory measures in children with impaired vision following yoga and physical activity programs, *Int J Rehabilitation Health,* 4 (2) (1999) 117-122.

22 Telles S, Reddy SK & Nagendra HR, Oxygen Consumption and respiration following two *yoga* relaxation techniques, *Appl Psychophysiol Biofeed,* 25 (4) (2000) 221- 227.

23 Herbert B & Miriam ZK, *The Relaxation Response,* (Avon Books), 2000.