

NEUROCOGNITIVE EFFECTS OF YOGA VOLUNTARILY REGULATED BREATHING

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ABSTRACT

[A] Background

(i) Literary Research

Pranayamas' (in Sanskrit) are voluntarily regulated specific yoga breathing practices which includes breathing with awareness and nostril manipulation. Yoga an ancient Indian science gives a lot of emphasis on breathing. Breathing has a very important role and *prāëa* is the subtlest and the most vital part of breathing. This subtle form of energy has been described in various *upaniçads* in e.g. In *Praçnopaniñat* '*prāëa*' is defined as the primordial energy which has come out of *hiryaëagarbha* as protector of three worlds, and in *Mudakopanisad* *prāëa* means life. The fundamental purpose of *prāëäyāma* is to expand the dimensions of *prāëa* and to gain mastery over *prāëa*. It is done essentially through breathing in *prāëäyāma*. *Prāëa* and mind are intricately linked (*Haöhayoga*). *Hatha Yoga Pradīpikā* practitioners say that by controlling *prāëa* automatically mind is controlled, while raja yoga practitioners say by controlling the mind *prāëa* is controlled. Concentration on the breath is the most powerful methods of introverting the restless mind (Taimani, 2001). The process of gaining mastery over mind has four phases of concentration: introversion (*pratyahara*), concentration (*dharana*), meditation (*dhyana*) and finally transcendence or absorption (*Samādhi*). For achieving this mastery over *prāëa*, *Hatha Yoga Pradīpikā* prescribes six cleansing techniques. *Kapalabhati* is one among them in which fast breathing is used to cleanse the breath and there by promote *prāëäyāma*.

(ii) Review of scientific literature

A previous study was conducted on middle latency auditory evoked potentials (MLAEPs) in right nostril yoga breathing compared to breath awareness in 14 healthy male volunteers (Raghuraj & Telles, 2004). There was a significant increase in the peak amplitudes of the Na wave (corresponding to the activity at the mesencephali-diencephalic level) and the Nb wave (corresponding to the activity at the primary auditory cortex) of MLAEP components on the right hemisphere showing an increase in the neural activity in the hemisphere ipsilateral to the nostril breathing. Previously no such study was conducted, it

was interesting to study immediate effects of yoga breathing practices, at secondary auditory cortices, on attention, and hemisphere-specific task, and as well as on hand grip strength. The variables are as follows: (i) various centres at secondary auditory cortices of auditory pathway using electrophysiological test i.e. long latency auditory evoked potentials (LLAEPs), (ii) the influence of nostril manipulation on attention abilities by using another electrophysiological test i.e. P300 auditory evoked potential (P300 ERPs), (iii) immediate effect on verbal and spatial memory, and (iv) its influence on hand grip strength.

Aims and Objectives

[A] Literary Research: To find references in ancient Indian texts related to how *pranayama* influences focussed and defocused attention.

[B] The present study was aimed to evaluate the effects of yoga voluntarily regulated breathing on (i) long latency auditory evoked potentials (LLAEPs), (ii) P300 auditory event related potentials (P300 ERPs), (iii) verbal and spatial memory, and (iv) grip strength. Another study was conducted to assess the effects of *kapalabhati* on P300 auditory event related potentials.

[B] Methods

Participants:

The subjects were twenty nine healthy male volunteers with ages ranging between 20 and 45 yrs (group average yrs 25.59 ± 5.0) with minimum experience of 3 months in yoga breathing practices. Thirty healthy male volunteers with ages range between 20 to 35 yrs, mean age \pm S.D. of the group who practiced *kapalabhati* was 26.0 ± 4.6 years, and for the breath awareness group it was 27.6 ± 3.7 years.

Design:

This was self-as-control design and each subject was assessed separately in each session. The five sessions were right nostril yoga breathing (RNYB), left nostril yoga breathing (LNYB), alternate nostril breathing (ANYB), breath awareness (BAW), and no-intervention (CTL). The assessments were done before, and after the intervention and in some cases even during the intervention. *Kapalabhati kriya* was assessed on a separate group of thirty subjects. The assessments were made before and after 70 seconds of practice using P300 auditory event-related potentials.

Assessments:

1. Long latency auditory evoked potentials (LLAEPs) were recorded before, during, and after the intervention
2. P300 Auditory Event-Related Potential

3. Hand grip strength
4. Performance in verbal and spatial memory tasks, were all recorded before and after each session.

Intervention

Participants were assessed in five sessions and in *kaplabhati* (which was taken up as separate study) and they are as follows:

1. Right nostril yoga breathing or (RNYB) or *suryanuloma viloma pranayama*
2. Left nostril yoga breathing or (LNYB) or *chandra anuloma viloma pranayama*
3. Alternate nostril yoga breathing or (AYNB) or *nadisuddhi pranayama*
4. Breath awareness
5. No-intervention session as control session

Data analysis

The raw data table for each subject for five different types of sessions (SAV, CAV, NDS, BAW and CTL) during all the phases (pre, during and, post) was obtained and tabulated. The analysis was done using statistical package of social sciences (SPSS, Version 16.0). The group average and standard deviation were calculated for each variable and the data was verified for its normality by using F-test and Shapiro-Wilks test respectively.

First, repeated measures ANOVA were performed using SPSS (Version 16.0) with three within-subjects factors. For each variable (e.g., P300) repeated measure ANOVAs were performed: Within subjects Factor 1 (Sessions: SAV, CAV, NDS, BAW and CTL; 5 levels), Factor 2 (States: pre, during 1, during 2, during 3, during 4, and post, 6 levels) and Factor 3 (Sites: C3, C4 and Cz, 3 levels).

Repeated measures analysis of variance (RMANOVA) values were compared to pre values using *post-hoc* analysis with Bonferroni correction. Data were analyzed using SPSS (Version 16.0). For grip strength an analysis of covariate (ANCOVA) was also conducted. For verbal and spatial memory paired t- tests were used to compare pre values and post values.

[C] Results and Discussion

1. Long latency auditory evoked potentials- There was a significant increase in the P1 wave peak amplitude during ANYB on the right side ($p < 0.05$) and there was also a significant decrease in the N2 peak latency on the

left side compared to the right side during ANYB ($p < 0.05$). During left nostril yoga breathing there was a significant reduction in N2 wave peak latency on the left side compared to the right side ($p < 0.01$). Hence, following the earlier study similar changes have been seen in LLAEPs during yoga breathing, suggestive of facilitated auditory transmission ipsilaterally during LNYB at N2 peak. ANYB showed enhanced auditory transmission and increase in neuron allocation at secondary auditory cortical from both bilateral symmetrical scalp sites.

2. P300 auditory event related potentials –

Following *kapalabhati kriya*:

(a) There was a significant decrease in peak latency at Cz ($p < 0.05$) and no there was no change in peak amplitude between pre-post comparison. Hence, the present results suggest that *kapalabhati* facilitates performance in P300 by reduction in time required to complete the task which requires selective attention. Following BAW there was significant increase in amplitude ($p < 0.05$) and there was no change in peak latency between pre-post comparison.

Following voluntarily regulated yoga breathing:

(b) There was a significant decrease in the P300 peak latency on the left side ($p < 0.05$) compared to the right side after 20 minutes of RNYB. Hence the present results suggest that RNYB facilitates the performance in the P300 task, possibly requiring less time to complete the task.

1. Verbal and spatial memory – There was significant increase in spatial memory scores after 45 minutes of LNYB ($p < 0.05$). Left nostril yoga breathing influences cerebral hemisphere contralaterally.
2. Grip strength- There was a significant decrease in the left hand grip strength after LNYB compared to before ($p < 0.01$; paired t-test, one tailed; as ANOVA, ANCOVA showed no significance).

[D] Conclusions

Long latency auditory evoked potentials (LLAEPs) during alternate nostril yoga breathing, with changes on both side and all changes being suggestive of improvement in auditory cortical function, and during left nostril yoga breathing there is ipsilateral enhanced neural transmission. The P300 changes showed a contralateral decrease in latency during Right nostril yoga breathing suggestive of improvement in the ability to show selective and focused attention to target stimuli. Effect of *kapalabhati kriya* on P300 is suggestive of

improvement in performance task. Verbal and spatial memory scores showed enhanced performance in a hemisphere-specific cognitive task contralateral to the dominant nostril, with increased spatial scores after left nostril yoga breathing.

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