

PRANAYAMA AND BRAIN CORRELATES

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ABSTRACT: *Many yogic methods emphasis control and suspension of breath as important components of the path to transcendence. However, the Pranayamas are varied and their role of both improve the physical aspects of breathing and for calming the mind, the latter being very important in the management of many psychosomatic disorders. Different types of Pranayama seem to influence the brain functioning in specific ways. Since the breath seems to link the body and the mind, it is possible to study this link by studying the effect of Pranayama on some brain functioning. This report document some of the recent observations of EEG changes during different types of Pranayama and their significance in health and diseases.*

Introduction

Pranayama is an important **anga** (limb) of the Yoga system of Patanjali, though only three aphorisms are dedicated to this in the **Yoga Sutras**. They may be roughly translated as follows: “**Pranayama** is the control of exhalation and inhalation”; “It is modified through external, internal and motionless ways, controlled in place, time, number, being either long or short”; and “The fourth is the complete cessation (of breathing) with reflection on external or internal objects” (**Yoga Sutras : II 49 – 51**). After this very terse exposition on the method of **Pranayama** practice, Maharishi Patanjali states that by this, the covering on the **citta** is removed and the **citta** becomes fit for **Dharana** (II 52, 53).

In this beautiful and expressive translation of the **Patanjala Yoga Sutras**, Swami Vivekananda writes as follows (1):

“The three sorts of motion of **Pranayama** are, one by which we draw the breath in, another by which we throw it out, and the third action in which the breath is held in the lungs, or stopped from entering the lungs. These, again, are varied by place and time. By place is meant that the **prana** is held to some particular part of the body. By time is meant how long the **prana** should be confined to a certain place, and so we are told how many seconds to keep one motion, and how many seconds to keep another. The results of this **Pranayama** is **Udgata**, awakening the **Kundalini**”.

While this passage clarifies the three types of **Pranayama** mentioned in the Sutras, the fourth type that is mentioned has come under much discussion. Several commentators have tried to interpret the fourth type of **Pranayama** in their own way. One certain message of the relevant **Sutra** is that the breath should be stopped and the

citta or the mind brings to focus an object for contemplation.

Hatapradipika of **Svatmarmma** is a text of importance when the actual practice of the Yoga **angas** are in discussion. In this work, it is said that the practice of **Pranayama** is necessary for removing all impurities in the **nadis** or the subtle channels through which the **pranic** energy flows in the body. Tranquility of the mind, avoiding disease and transcending the fear of death (note, not transcending death itself) are the outcomes of proper practice of **Pranayama** (2).

More recently, the famous yoga teacher from India, Sri. B. K. S. Iyengar has the following to say in his book 'Light on **Pranayama**' (3) :

“**Pranayama** is an art and has techniques to make the respiratory organs to move and expand internally, rhythmically and intensively. It consists of long, sustained flow of inhalation (**puraka**), exhalation (**rechaka**), and retention of breath (**kumbhaka**). **Puraka** stimulates the system; **rechaka** throws out vitiated air and toxins; **kumbhaka** distributes the energy throughout the body.... This disciplined breathing helps the mind to concentrate and enables the **sadhaka** to attain robust health and longevity”.

While writing commentary on the classical text **Satcakra Nirupana**, the exposition on the **Kundalini Sakthi** in the body, Sir John Woodroffe has the following to say (4):

“**Pranayama** is frequently translated “breath control”. Having regard to the processes employed, the term is not altogether inappropriate if it is understood that “breath” means not only the **Sthula**, but the **Suksma-vayu**. But the word does not come from **Prana** (breath) and **Yama**

(control), but from **Prana** and **Ayama**, while the latter term according to **Amarakosa** means length, rising, extensity, expansion, in other words, it is the process whereby the ordinary and comparatively slight manifestation of **Prana** in lengthened, strengthened and developed.

“**Pranayama** is first with a view to control. The latter is then moved into **Susumna** by stirring of **Kundalini**, who blocks the entry (**Brahma-dvara**) thereto. With the disappearance of **Prana** there from, **Ida** and **Pingala** “die” (i.e, they are relaxed and devitalized, as every part of the body is from which the **Prana – Sakti** is with drawn), and the **Prana** in **Susumna** by means of the **Sakti-Kundalini**, pierces the six **Cakras** which block the passage in the **Brahmanadi**, and eventually becomes **laya** in the Great British which is the final end and aim of this process”.

While these important sources talk about the role of **Pranayama** in expanding consciousness and in maintaining health, we need to look for very specific changes that occur in the body – mind continuum in individuals practicing this ancient technique. The brain is a logical place for a search since yoga is for restraining **citta** or the mind. The workings of the mind, breathing and body functions are closely connected to each other, as most workers in the psychosomatic area will agree. Breathing is a link between body and mind, as much as brain is a link between the two. Thus, if both brain and breathing are individually linked to the psyche and the soma, the natural question is what connections are there between is what connections are there between brain and breathing themselves. We shall review the current literature in research aimed at understanding this link.

EEG correlates of Pranayama

While many studies report brain electrical activity or EEG (electroencephalogram) changes during meditation (a topic which will not be taken by here), only recently the effects of **Pranayama** along is being studied to understand the changes in brain activity during these procedures.

Agnisara is a unique **Pranayama** whose description is as follows (5) : “The student sits with crossed legs and inhales deeply. Then with a forced exhalation he empties the lungs as much as possible. After the exhalation, he keeps the breath out for a few moments without inhaling. In this condition, his diaphragm is raised naturally to the thoracic cavity and he can manipulate the abdominal muscles. Again, as long as his diaphragm is in the raised position, he pumps the abdominal muscles inward and outward in a quick succession. In each round, when he empties his lungs, he pumps fifteen to twenty times without inhaling. This is one round. A student can practice ten rounds daily”.

Two reports are available indicating certain unusual EEG patterns during **Agnisara** (6,7). During this practice, EEG pattern showed bursts of 50 – 100 microvolt amplitude waves in the frequency 12 – 13 Hz. These waves seemed to occur preferentially during the retraction of the abdominal wall and at the pre – Rolandic areas of the brain. The brain responds to the somato – visceral inputs arising from the abdominal wall activity. Further, exercises such as **Nauli**, **Bastrika** and **Suryabedana** seem to have characteristic frequencies between 12 and 17 Hz and between 26 and 33 Hz with specific cortical localizations. Hence, the conclusion is that these **Pranayamas** stimulate specific receptors in the body, each of which have, in their turn,

specific frequency of activity and localization in the brain.

The consequence of such specificity is difficult to understand at this time. With current research focus in many prominent laboratories, of relating specific frequencies in the brain to specific neurotransmitter release, it is likely that a particular neurotransmitter is released for each type of **Pranayama**. If found true, this could lead to therapeutic procedures for many neurologic disorders. For example, a calcium deficiency could be compensated through the practice of a particular **Pranayama**.

Ultradian Rhythm in the Body Functions

Before we take up the subject of EEG changes due to other Pranayamic breathing, let us review briefly the biorhythms associated with some body functions. There are several rhythms in the environment that the body follows cyclically, for example, the well-known circadian rhythm which follows the day-night cycle and the circannual one with a period of about a year which are seen in the seasonal variations. The ultradian rhythm, is a rhythm with a period less than 20 hours and here the examples include sleep-wake cycle and the hunger-satiation periods.

An important ultradian rhythm is the nasal cycle well known to the ancient yogis. This rhythm is an endogenous one, meaning that it is internally controlled and is characterized by dominance in nostril breathing. This means at any time, the breathing is predominantly through one nostril and after a time, a switch occurs to the other nostril. This switching occurs about 10 times in a 24 hour period. Thus, for a normal individual, there is a shift in nostril breathing once in every two to three hours.

It is too early to talk about the consequences of this rhythm in health and diseases; however, a few reports have emerged to indicate its importance in maintaining a balance in the autonomic nervous system activity. We shall briefly report some recent findings of correlations between unilateral nostrils breathing and brain functioning.

Unilateral nostril breathing and brain functions

The most interesting work in this area is related to changes in the electrical activity of the brain hemispheres due to both natural alterations in nostril breathing and during forced unilateral nostril breathing, this latter being similar to Pranayamic breathing. It has been observed that the total EEG amplitude is higher in the contra lateral hemisphere than the ipsilateral hemisphere. In other words, if a person is breathing predominately with the left nostril, that person's right hemisphere of the brain will be more active, putting out a greater electrical signal than the left hemisphere (8).

Even during forced nostril breathing, such hemispheric responses have been found. Figure 1 shows a typical frequency response plot of an individual during forced nostril breathing conditions taken with Lexicor 23 channel brain mapping system at our

laboratory. Both the top and bottom panels of the figure show one epoch each, representing two seconds of EEG data. The panels show the frequency spectra at 19 locations on the scalp. The frequency band covered in this plot is between 0 and 32 Hz. The plots have the front of the head represented on the top of each panel and the back at the bottom. The top panel is with the subject breathing with the dominant (left) nostril with the right nostril closed, while the bottom panel is taken when the right or the non dominant nostril is utilized for breathing with the left nostril closed. In each case, the breathing is achieved by closing one nostril with a nasal plug.

It is seen clearly that in the top panel, the right brain hemisphere is more active than the left, while in the bottom panel the opposite seems to be the case. This is seen consistently in some subjects. In other subjects, the contra lateral dominance is not as clear as in the above case; however, one could still see a shift in activity in the EEG. There is a third category of subjects for whom it is observed that they are unable to make any shift at all, even in relative magnitudes (9). Both physiologic (such as polyp in one nostril) and psychologic (stress and anxiety) reasons could be assigned in such cases, though we have not investigated these possibilities at this time.

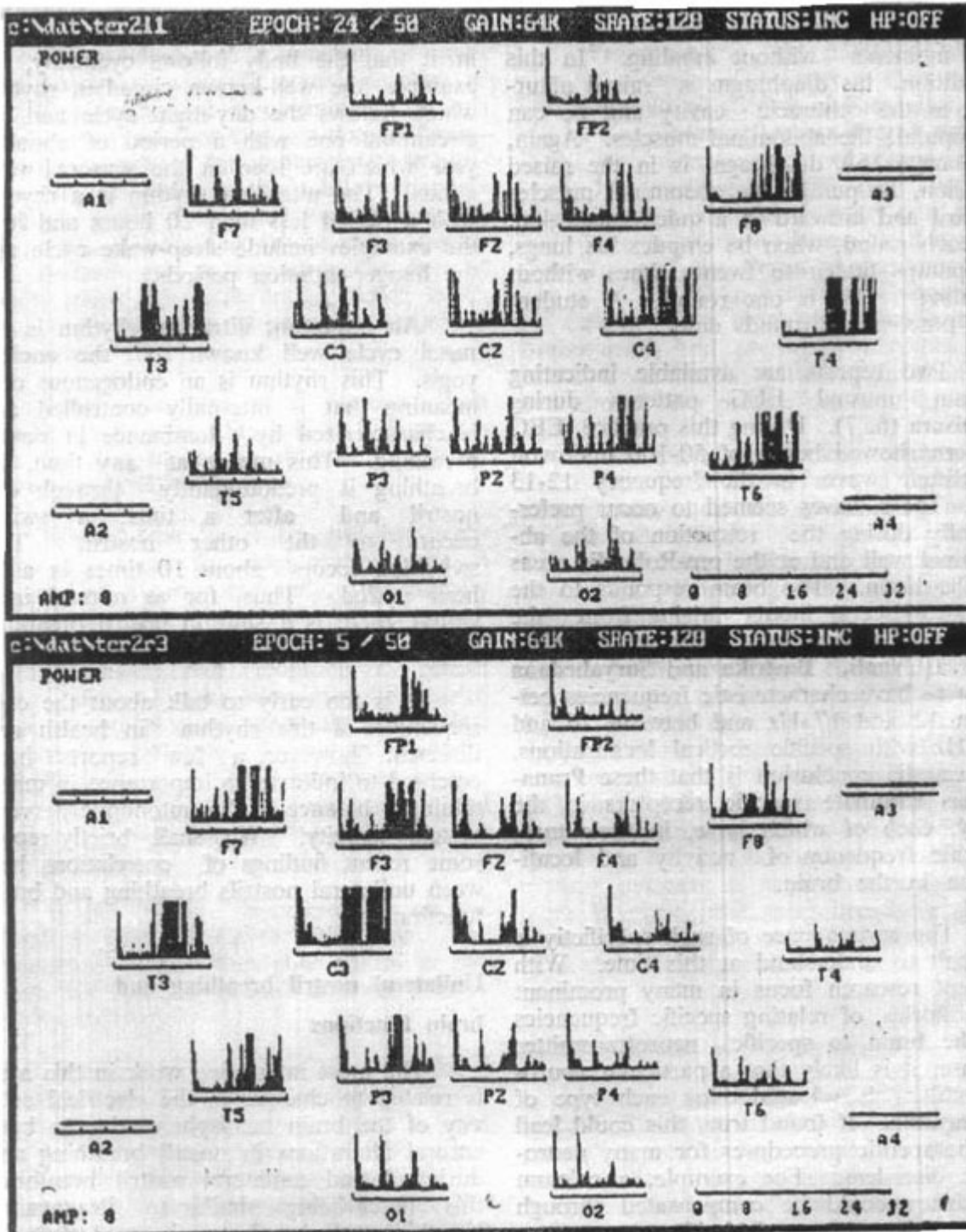


Figure 1. EEG power spectra at different electrode sites during left (dominant) nostril breathing (upper panel) and during right (nondominant) nostril breathing in one subject.

Clinical applications of unilateral nostril breathing.

The control mechanisms in the nostril dominance due to the ultradian rhythm is not understood. This relates to the question if the brain is driving the nostril switching for dominance in breathing or is it the nostril that is somehow initiating the brain switching to take place through other pathways. What is known is the fact that the left nostril dominance is associated with parasympathetic response and the right nostril dominance is associated with sympathetic response. If, due to some reason the nostril switching is not proper, then the balance in sympathetic – Para sympathetic inputs to body functions seems to be disturbed resulting in some somatic problems.

It has been reported that ipsilateral nasal occlusion is able to relieve symptoms during cluster headache episodes (10). For a left side headache, for example, blocking the left nostril either during the episode or prior to it as prevention improves the outcome. Another study reports increased intraocular pressure (which results in a large number of preventable blindness in India) in glaucoma patients could be due to polyp in one nostril.

Right unilateral nostril breathing has been observed to decrease intraocular pressure by 5mm Hg in 68 normal and 51 patients with glaucoma, the latter being aided therapeutically (11).

Conclusions

The ultradian rhythm associated with nostril breathing is well known to the Yogic tradition. Pressure applied to some parts of the body is known to result in unilateral breathing and thus aid in achieving higher states of consciousness. The results related to nostril breathing and the autonomic balance is very important and very recent to be applied effectively in therapy. Brain, cardiac and respiratory functions are coupled strongly through the autonomic nervous system and manipulation of breath could change the activity in these organs. Thus the role of **Prana**, if it may be called, in maintaining health is at last being investigated. **Pranayama** is a simple technique and could turn out to be a profound method for the management of psychosomatic disorders.

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