Heart and Brain Regulation by Yoga – Global Trends

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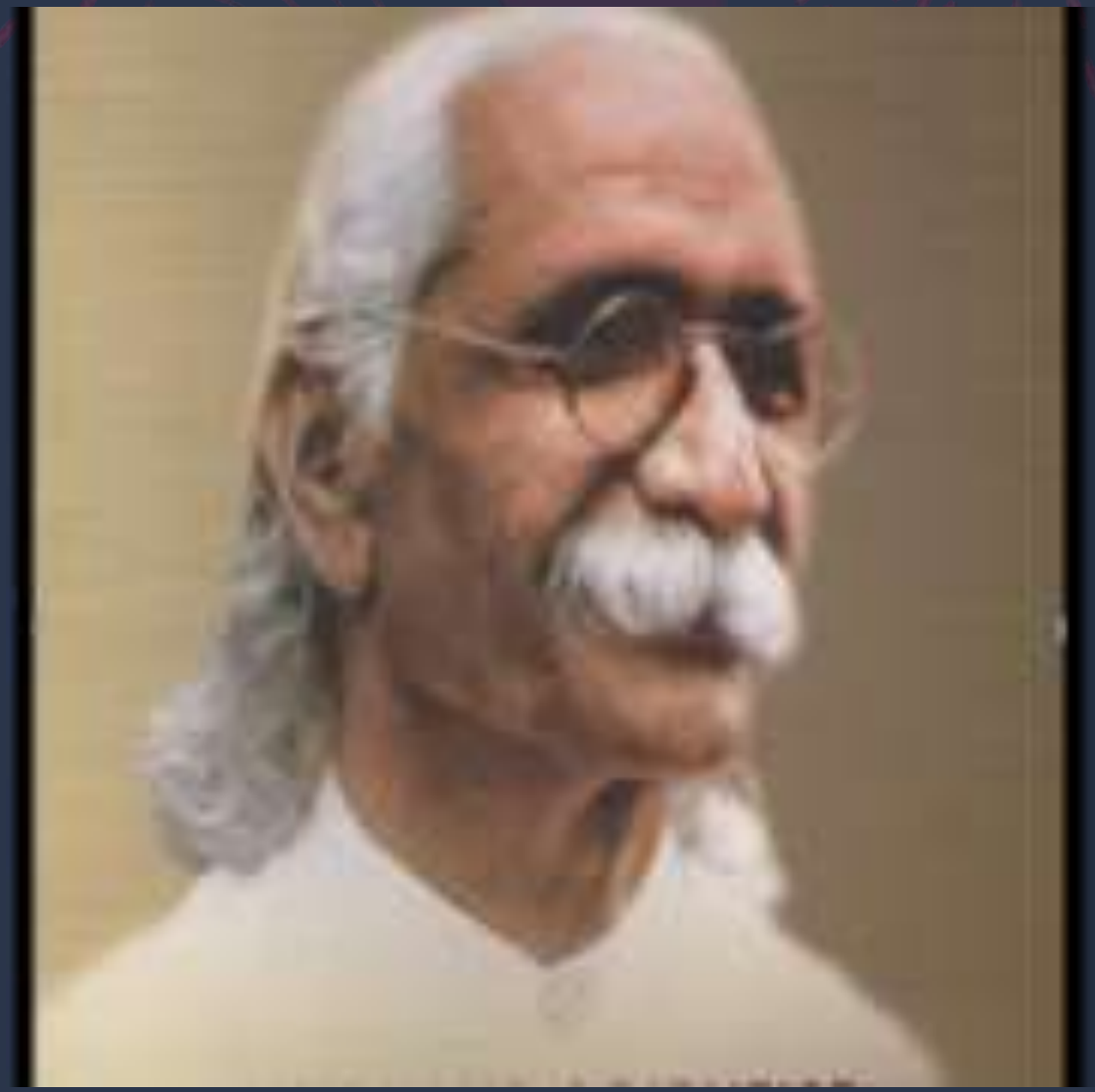
Exploring the science behind Yoga

- Science studies Yoga - A century old journey
- Exceptional feats – voluntary control over involuntary functions
- Electrical activity to Hemodynamic changes
- Plasticity redefined – Functional as well as Structural
- Evidence for its use in Health and Disease
- Global trends looking at translational value of Yoga research
- Deep diving into Consciousness based approach

Earliest experiments on Yoga

- Began with the works of N. C. Paul & Major D. Basu (late 19th century)
- Continued with Sri Yogendra (1897–1989) & Swami Kuvalayananda (20th century)
- Western medical researchers came to Kuvalayananda's Kaivalyadhama Health and Yoga Research Center to study Yoga as a science (1928).



Shri T. Krishnamacharya

In 1935 demonstrated to Dr. Brosse that he had stopped his heart.

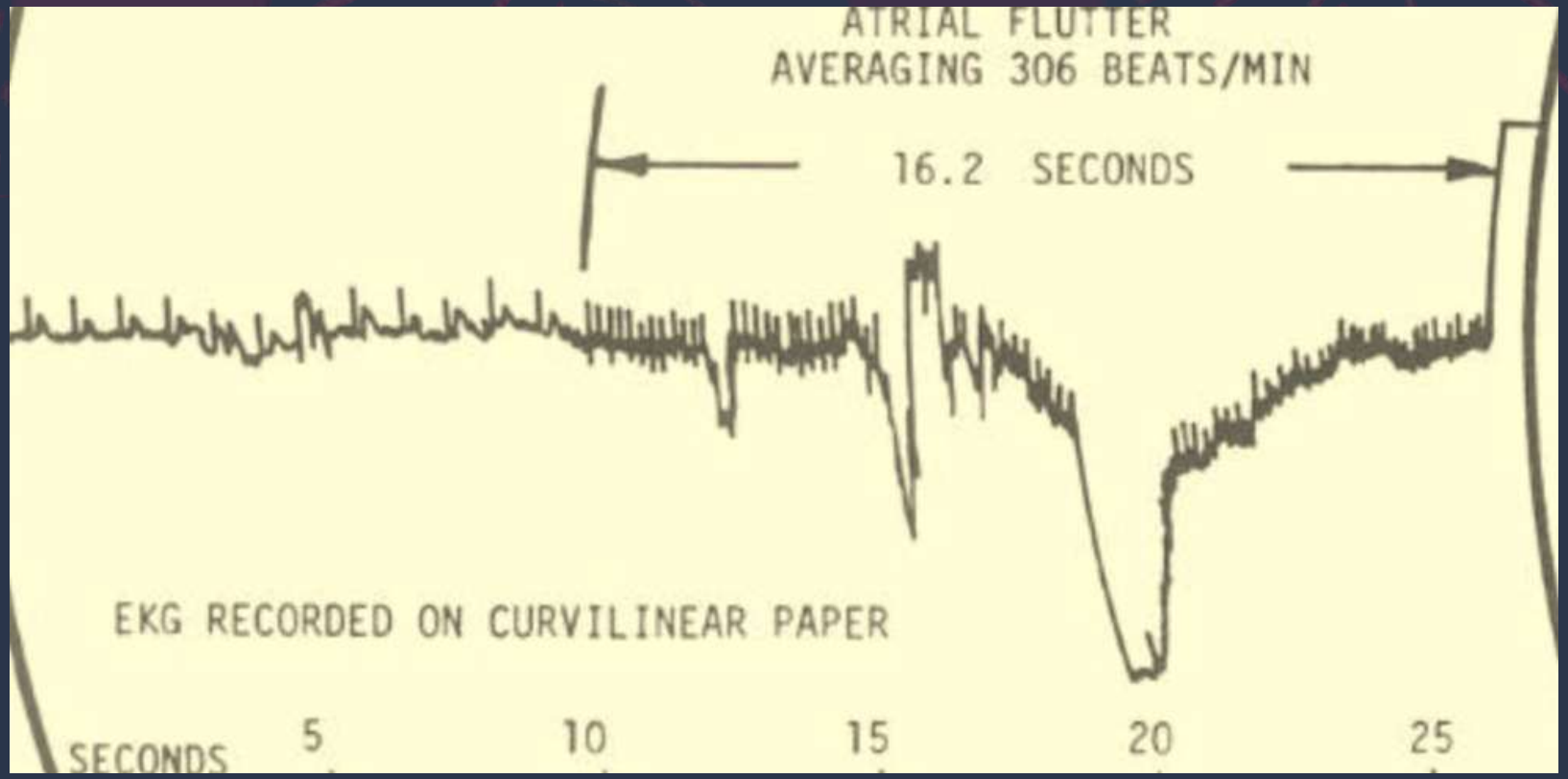
Ramananda Yogi Demonstrating an exceptional feat of reducing oxygen during a meditation and demonstrated the ability of slowing down the electrical activity of the heart

With scientific instruments attached to his head and chest, India's Yogi Ramanand is about to be locked in an air-tight box as doctors test his claim that he can use his conscious mind to control his body's need for oxygen. The Yogi's experiment and the surprising results are part of NET's forthcoming science special "The Mind of Man."

Swami Paramahansa Yogananda

- !950s participated in various demonstrations of exceptional feats including suspended animation
- Physiological hibernation
- Reduced electrical activity of the heart

Swami Rama's experiments



- voluntarily speeding up his heart rate to over 300 beats per minute, causing atrial flutter. This demonstration and others were performed at the Menninger Foundation, in Topeka, Kansas in 1970.

STUDY OF *SIDDHIS*

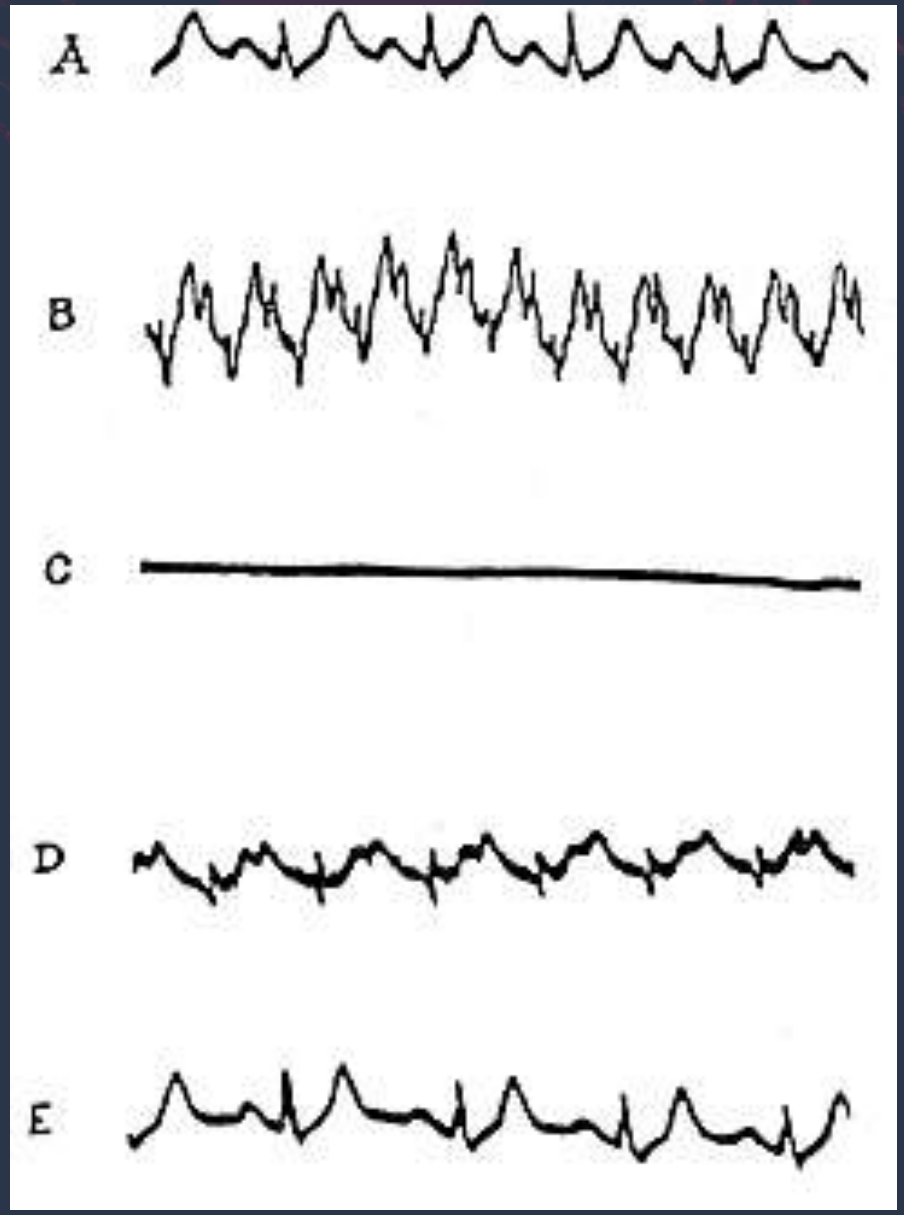
Yogi Satyamurthy Demonstrating an exceptional feat

- **An Unusual Demonstration: The yogic claim of voluntary control over the heart beat:**

A letter to the American Heart Journal - 1973

LK Kothari MSc MAMS, Arum Bordia MD, VP Gupta MD

Rabindinath Tagore Medical College & Hospital; Udaipur India



Scientific Studies of Exceptional Feats of Yogis

- **Ability to stay in an air tight box**

(*Anand et al.,* 1961; Indian Journal of Medical Research)

- **Ability to stop the heart beating**

(*Wenger et al.,* 1961; Circulation)

- **Absence of cardiac electrical activity**

(*Kothari et al.,* 1973; American Heart Journal)

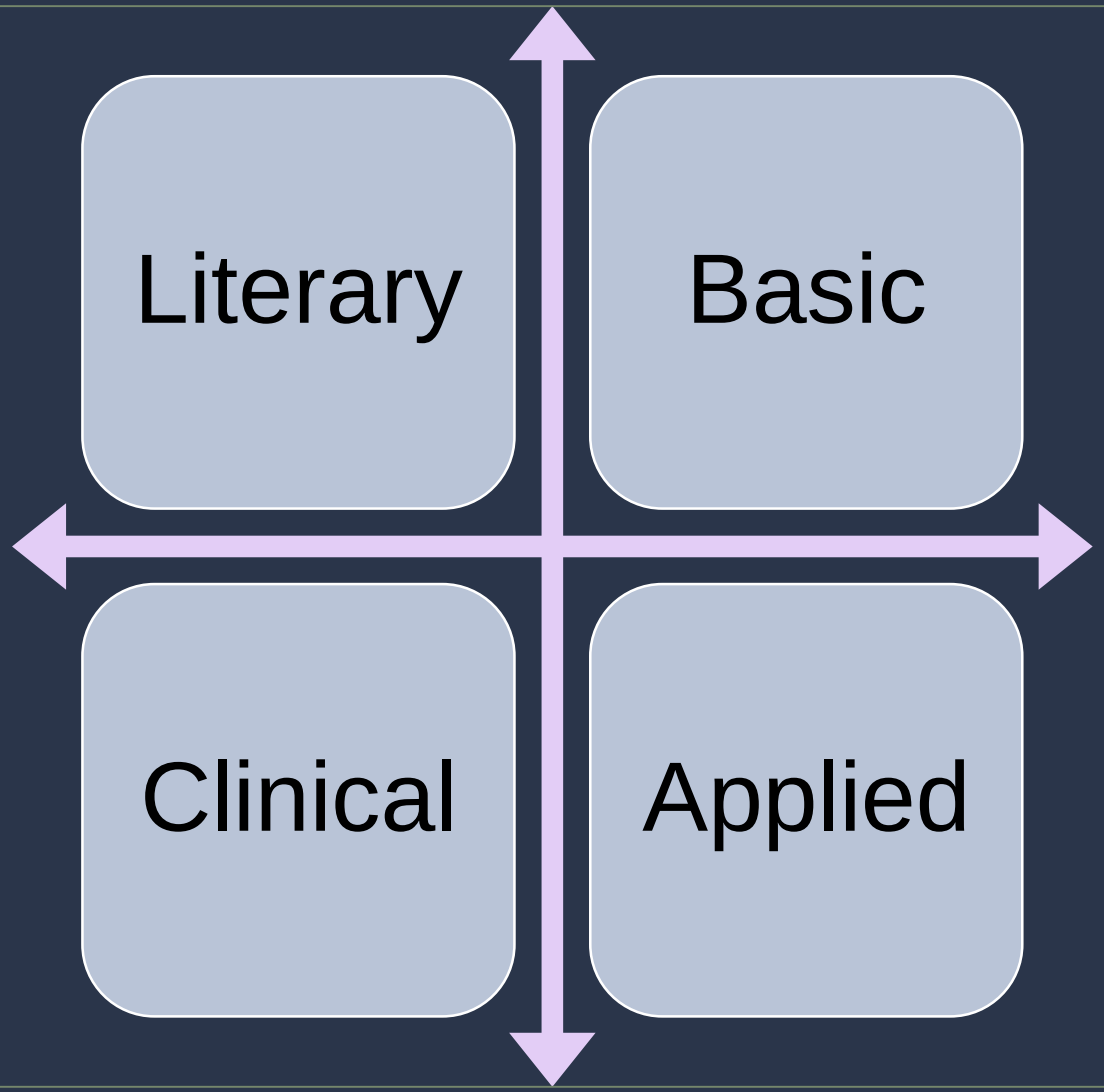
- **Changes in body temperature**

(*Benson et al.,* 1982; Nature)

Process of converting tradition into Science

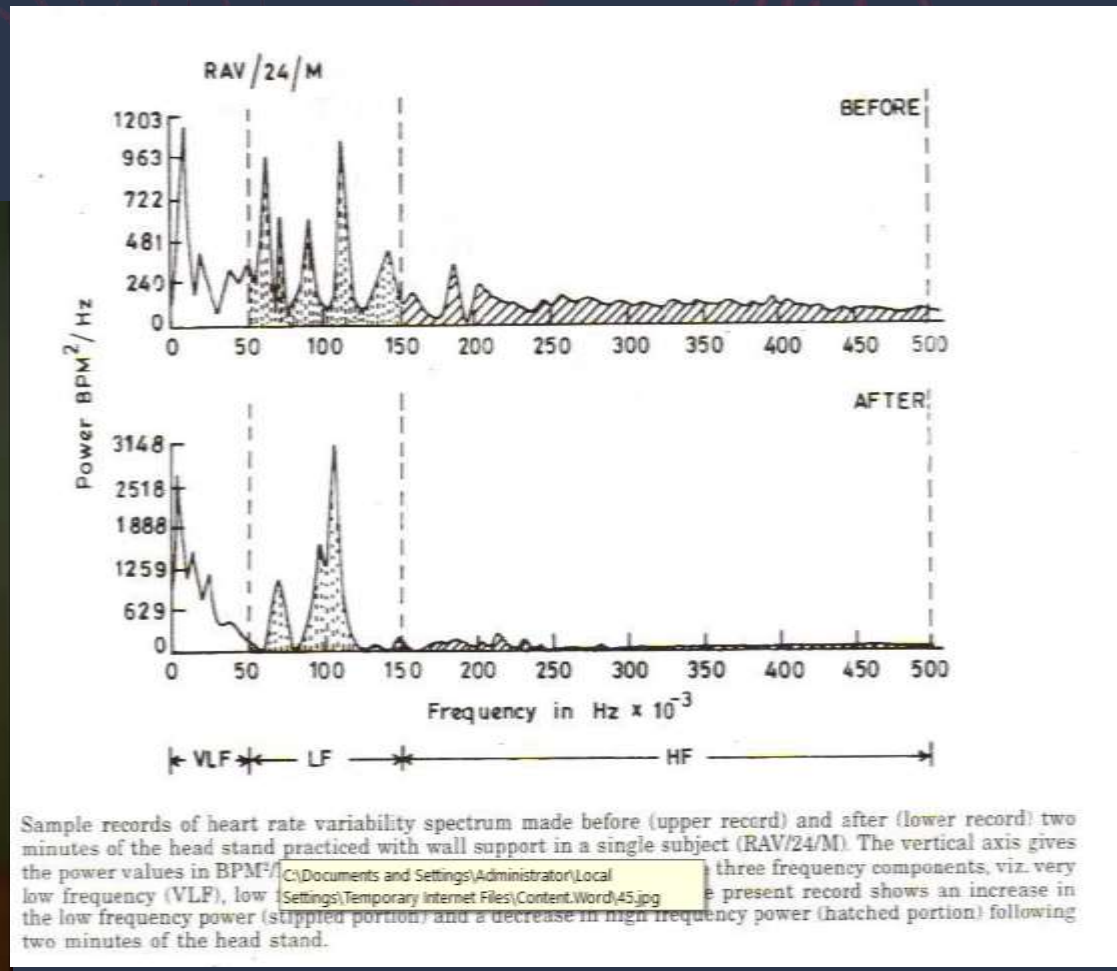
Experiential or Experimental

Research



Differential Autonomic changes

Autonomic changes following the headstand (*Sirsasana*)



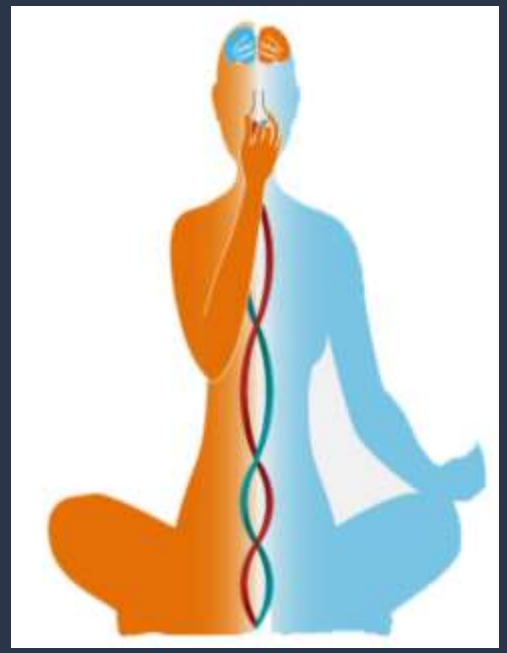
Sample records of heart rate variability spectrum made before (upper record) and after (lower record) two minutes of the head stand practiced with wall support in a single subject (RAV/24/M). The vertical axis gives the power values in BPM²/ three frequency components, viz. very low frequency (VLF), low e present record shows an increase in the low frequency power (stippled portion) and a decrease in high frequency power (hatched portion) following two minutes of the head stand.

C:\Documents and Settings\Administrator\Local Settings\Temporary Internet Files\Content.Word\45.jpg

Indian J Physiol Pharmacol, 2003 Jan;47(1):34-42.

Right nostril breathing (*Surya anuloma viloma*)

- Oxygen consumption
- Blood pressure
- Blood flow to the skin
- Memory
- Grip strength



Left nostril breathing (*Chandra anuloma viloma*)

- Blood pressure
- Imperceptible sweating (Galvanic Skin Resistance)
- Memory
- Grip strength

Applications:

1. Obesity, Depression, Attention Deficit disorders
2. Anxiety neurosis, Hypertension,

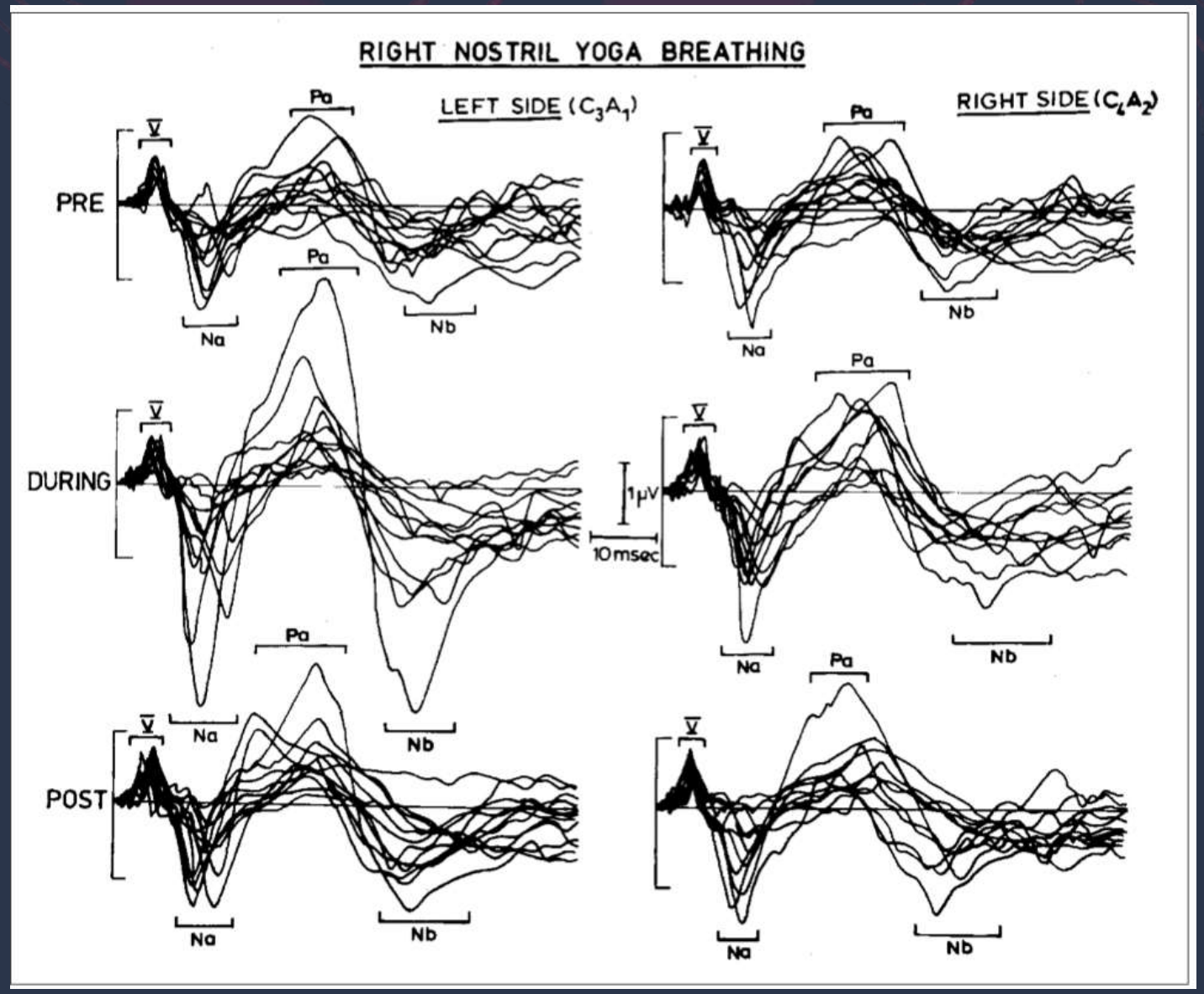
J Alt Comp Med 1996; 2(4):479-484

Appl Psychophysiol Biofeedback, 2008; 33(2):65-75
Psychol Reports 1997; 81(2):555-561

Cognitive Neuroscience Laboratory

Electrophysiology

Cerebral Hemodynamics



Neurol Sci. 2004 Dec;25(5):274-80.

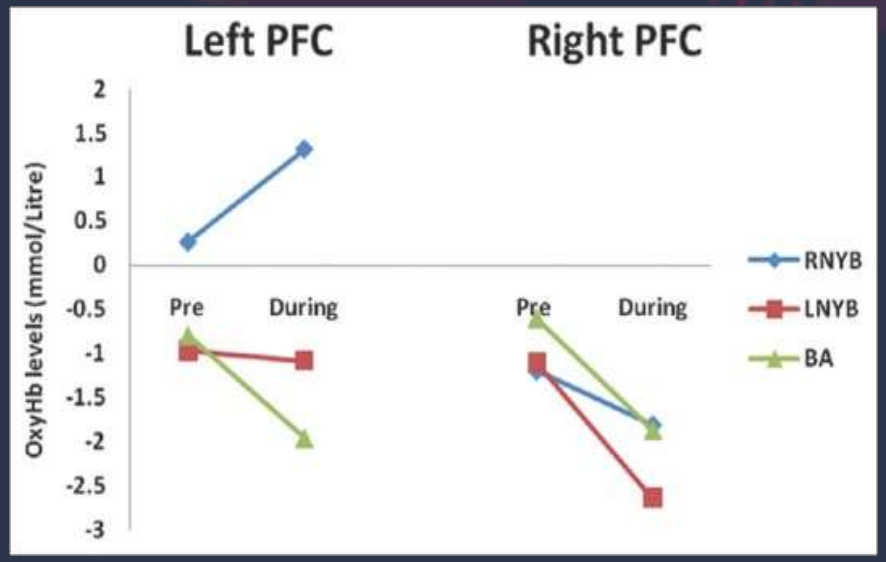
Right nostril breathing (RNB) Ipsilateral hemispheric changes in AEP-MLRs

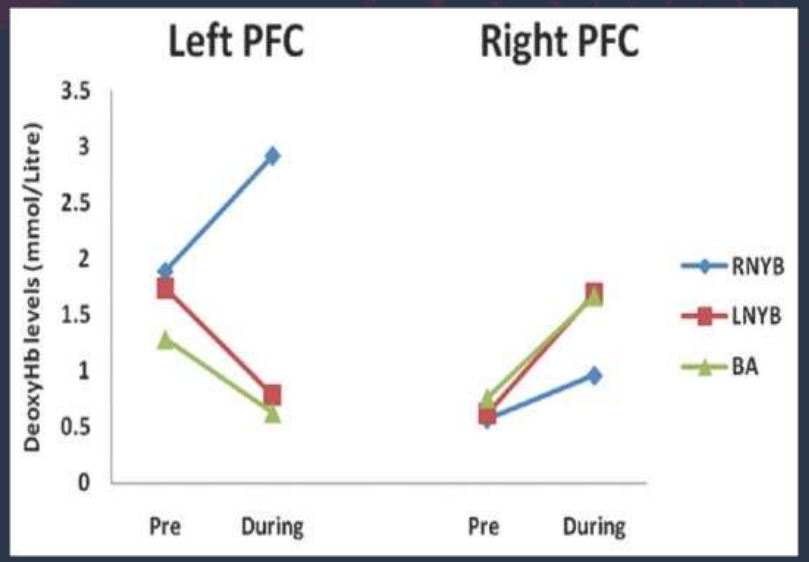
Significantly higher peak amplitude of the Na & Nb wave of the Middle Latency Auditory Evoked Potentials on the right side.

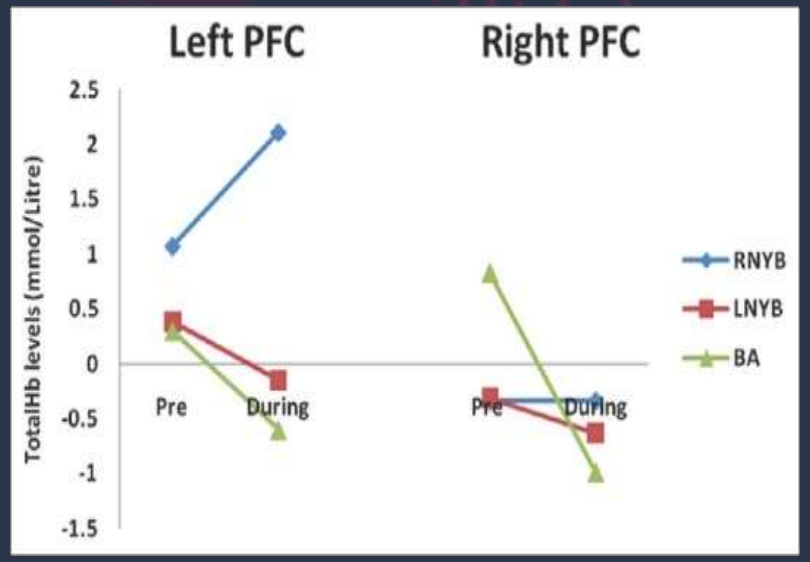
Applications:

1. Optimizing creativity
2. Psychiatric illnesses such as OCD

Uni-nostril breathing & Frontal lobe Oxygenation



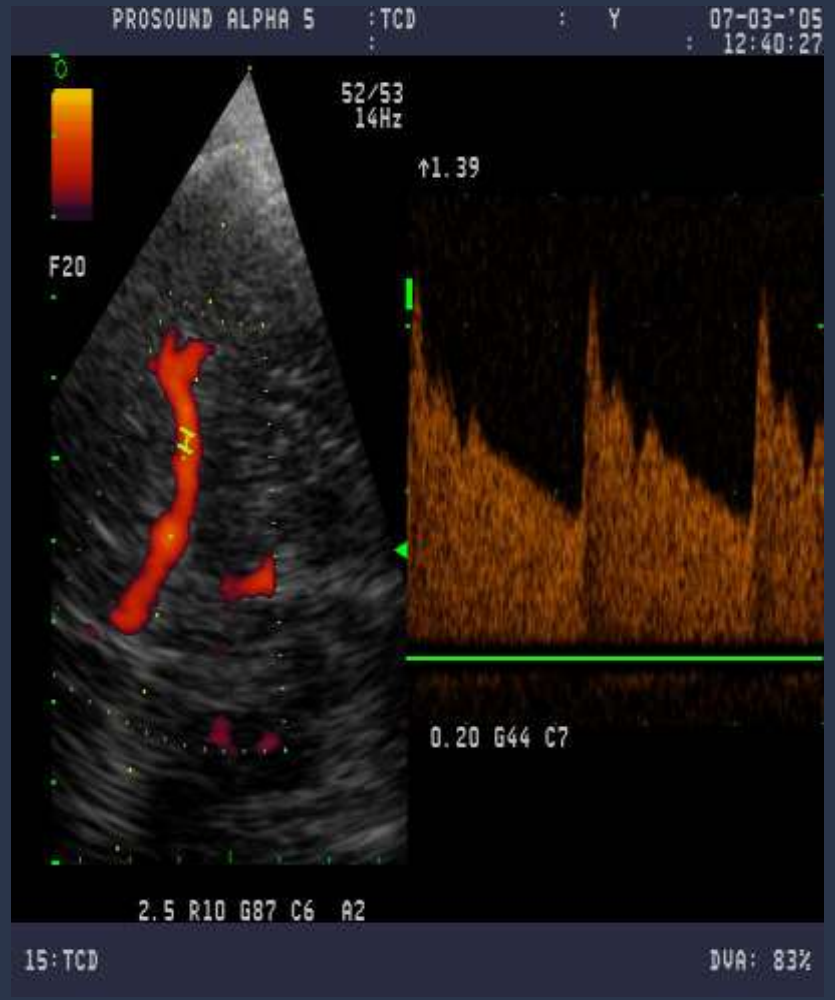




↑ ΔHbO level on both side but higher on contralateral side of the prefrontal cortex while practicing RNB.

Int J Yoga. 2016 Jan-Jun; 9(1): 12–19.

Influence of breathing on the cerebral blood flow measures



- Reduction in EDV and MFV increase in PI during Bhastrika.
- Increase in PSV, EDV and MFV with a reduction in PI during Kumbhaka.

Autonomic changes following two Meditations

Meditation on OM

- Decreased heart rate
- Decreased breath rate
- Increased Cutaneous Vascular Resistance
- Decreased Skin Resistance

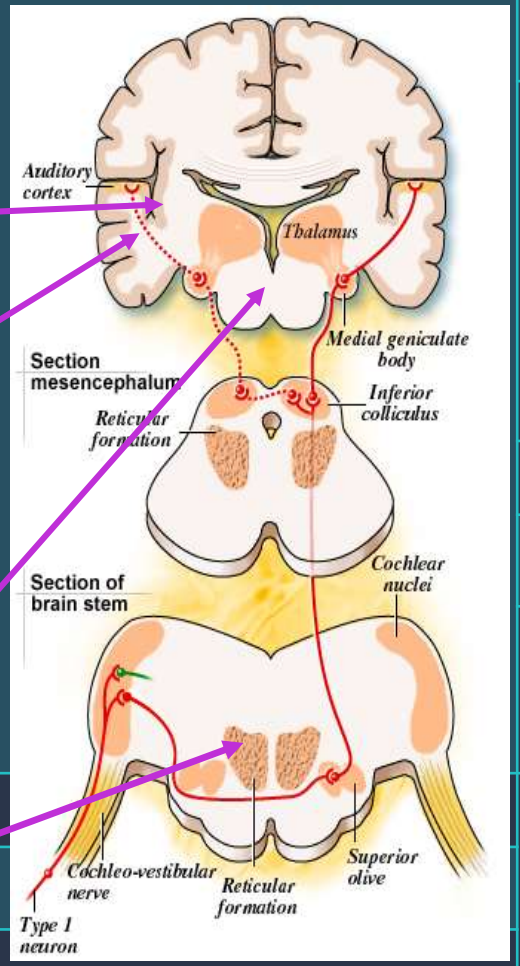
Indian J Physiol Pharmacol. 1995 Oct; 39(4):418-20.
Indian J Physiol Pharmacol. 1998 Jan;42(1):57-

'Cyclic' meditation

- Reduced oxygen consumption by 32%
- Increased breath volume and decreased breath rate
- Improved attention (cancellation task)
- Increased Vagal tone (HF power in HRV)
- Heightened cognitive functioning

Appl Psychophysiol Biofeedback. 2000 Dec;25(4):221-7.
Appl Psychophysiol Biofeedback. 2006

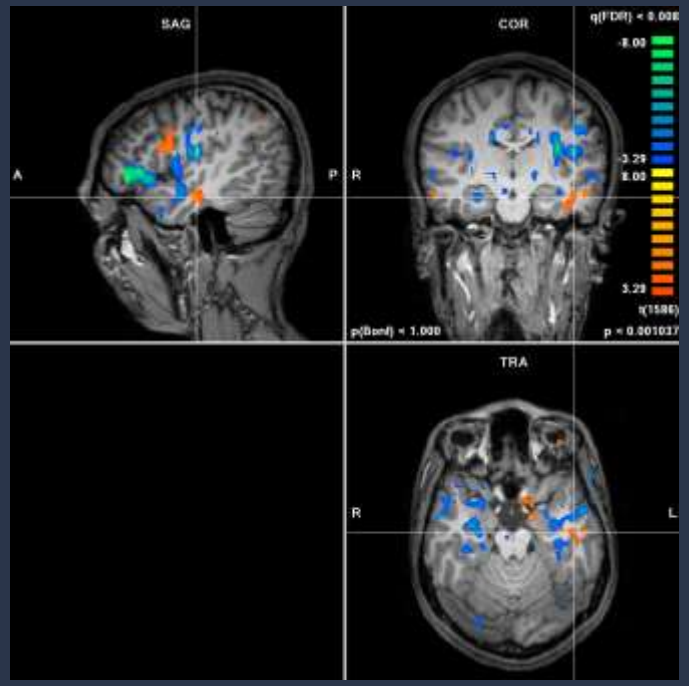
EP studies in Meditation practices

Evoked Potential	Waveform	Sessions	Neuronal Axis	Brain Areas	Changes in latency	Changes in Amplitude
Long Latency (100-250 ms)	P2 wave (120-180 ms)	Om Meditation	Secondary Auditory & Association Cortex		↓	↑
Mid Latency (10-100 ms)	Nb wave (35-65 ms)	Cyclic Meditation	Primary Auditory Cortex		↑	↑
		Non meditative focused thinking				
	Pa wave (25-32 ms)	Cyclic Meditation	Superior Temporal Gyrus			
		Defocused Meditation				
	Na wave (14-19 ms)	Om Meditation	Mesencephalic-diencephalic		↑	↑
		Brahmkumari Raja Yoga Meditation	Thalamic region		↓	↑
		Defocused Meditation	Medial Geniculate		↑	↑
		Supine Rest				
Brain Stem (0 - 10 ms)	Wave V (5-8 ms)	Random Thinking	Inferior Collicular level		↑	↑
		Nonmeditative focused thinking				
		Meditative Focused thinking				

Clinical EEG and Neuroscience,46(4):299-309; *Clinical EEG and Neuroscience*, 43(2):154-60; *International Journal of Yoga*, 3(2): 37-41; *Clinical EEG and Neuroscience*, 40(3): 190-195; *Psychological Reports*, 94(2): 398-400

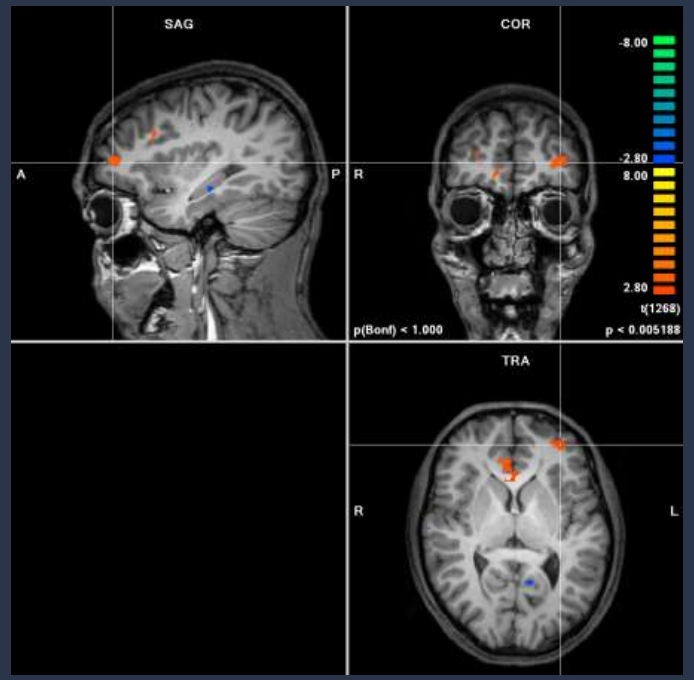
Changes in different meditative states

fMRI changes in *Ekagrata*



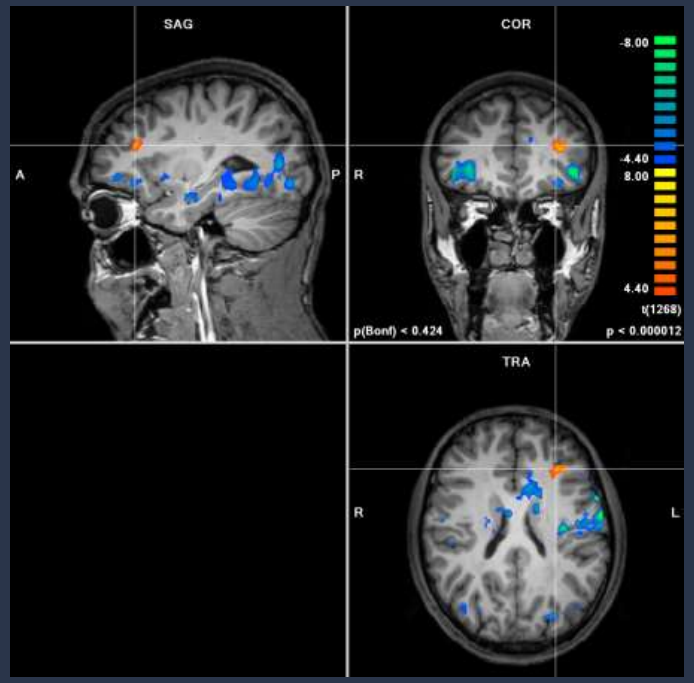
Increased activation in the Middle temporal gyrus

fMRI changes in *Dharana*

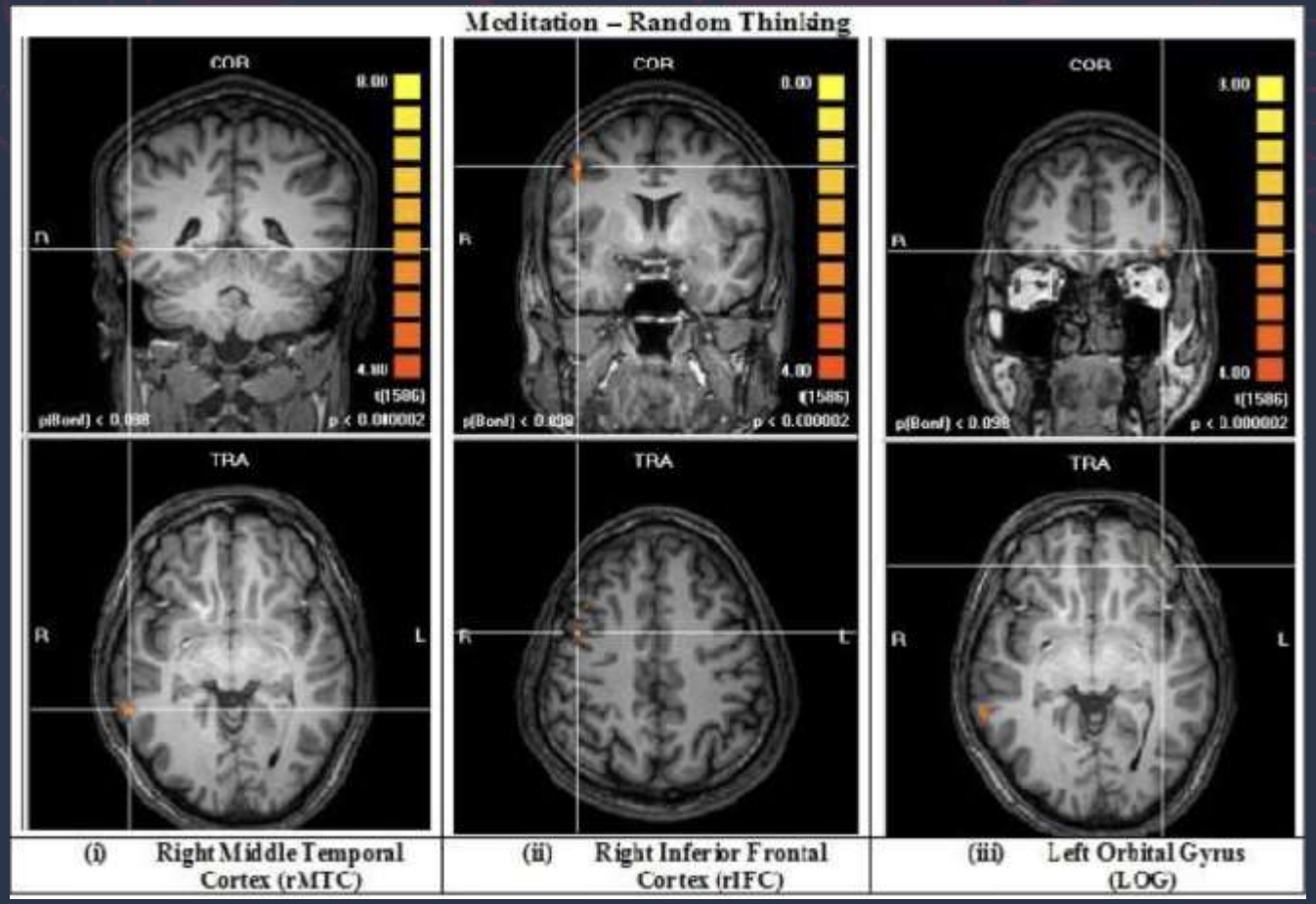


Increased activation in the **dorsolateral prefrontal cortex centralized**

fMRI changes in *Dhyana*



Increased activation in the **left middle frontal subcortical white matter centralized**



Significant activation in the right medial temporal cortex (rMTG), right inferior frontal cortex (rIFG), and left orbital gyrus (LOG)

Suggestive involvement of areas involved in semantic cognition, memory, sustained attention, creativity and the ability to detach mentally.

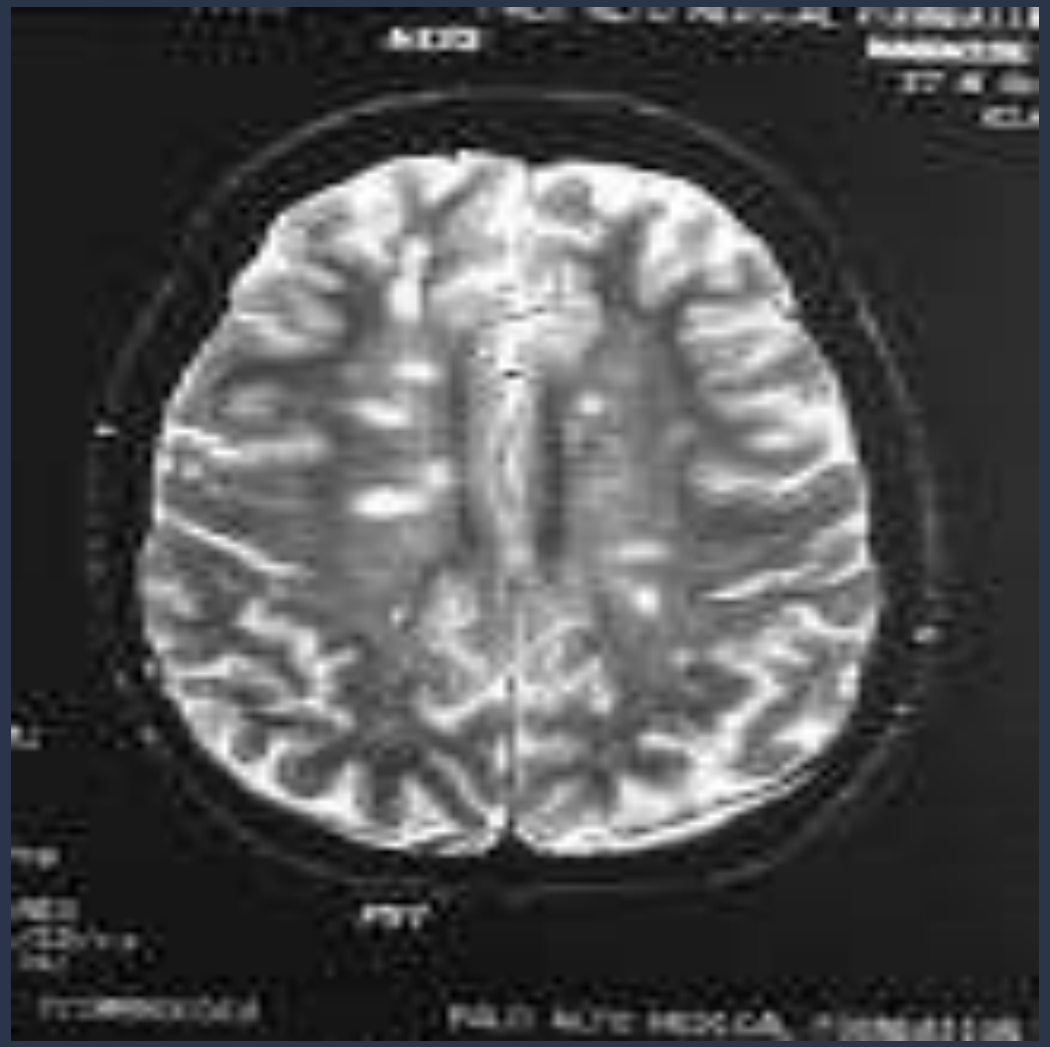
Sl. No.	Activation Area	Brodmann Area	L/R[a]	Talaraich Coordinates[b] (mm)			t-test	
				X	Y	Z	p - value[b] (uncorrected)	Bonferroni corrected
	Right middle temporal cortex (rMTC)	37	R	66	-54	0	$p < 0.000002$	$p < 0.049$
	Right inferior frontal cortex (rIFC)	44, 45 and 47	R	-48	14	18	$p < 0.000002$	$p < 0.049$
	Left lateral orbital gyrus (LOG)	11	L	6	42	-21	$p < 0.000002$	$p < 0.049$

[a]Left or Right Hemisphere
[b]From the atlas of Talairach and Tournoux (1988)

Table 2: Areas of Activation and Talairach Coordinates in the Comparison Between Random Thinking and Pure Meditation

Structural changes in the brain

- Increased thickness in cortical areas related to attention as well as increased subcortical gray matter in right insula and hippocampus in long-term Vipasana meditators



Neuroreport. 2005 Nov 28;16(17):1893-7.

Global trends

- Review and Meta analysis Vs Original research
- Self as Control Vs Matched Controlled Trials
- Single Case Experimental Design (SCED) Vs RCTs
- Components analysis Vs Integrated Approach in Yoga
- Alternative Medicine to Complementary and Integrative Medicine