An Introduction to the Science of Yogic Breathing/Pranayama

Yoga Alliance Webinar
April 27, 2022

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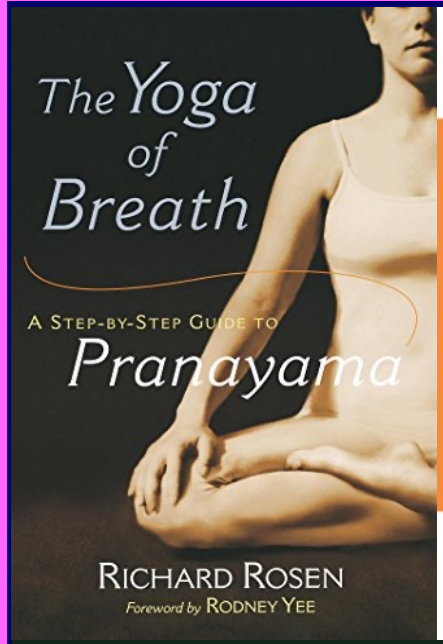
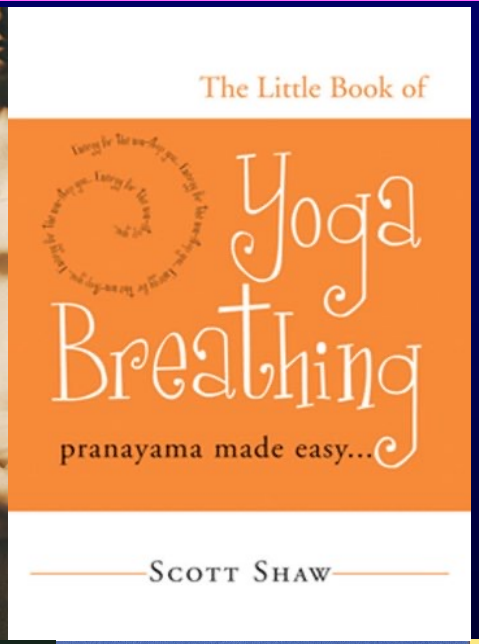
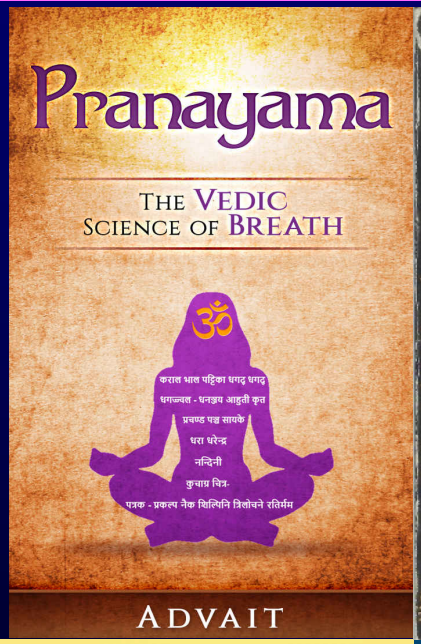
Pranayama in Patanjali's Yoga Sutras

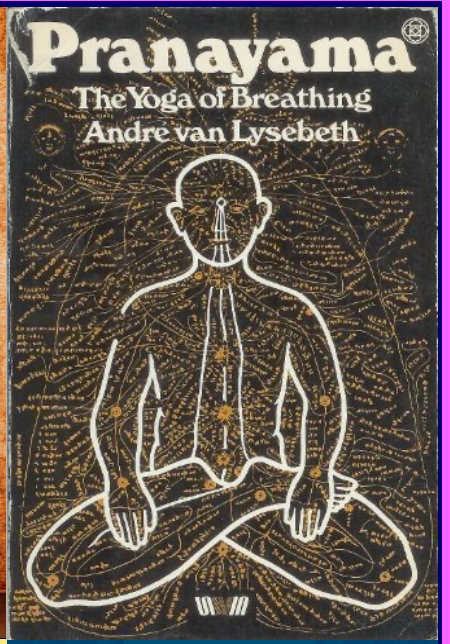
1.34
The mind is also calmed by regulating the breath, particularly attending to exhalation and the natural stilling of breath that comes from such practice.

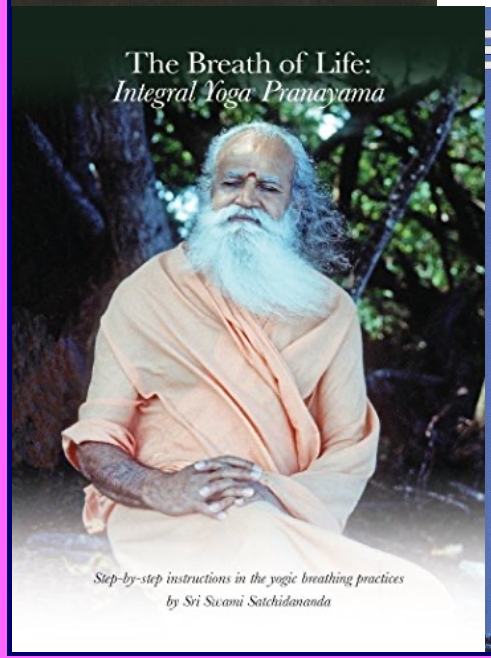
http://www.swamij.com/pdf/yogasutrasinterpretive.pdf

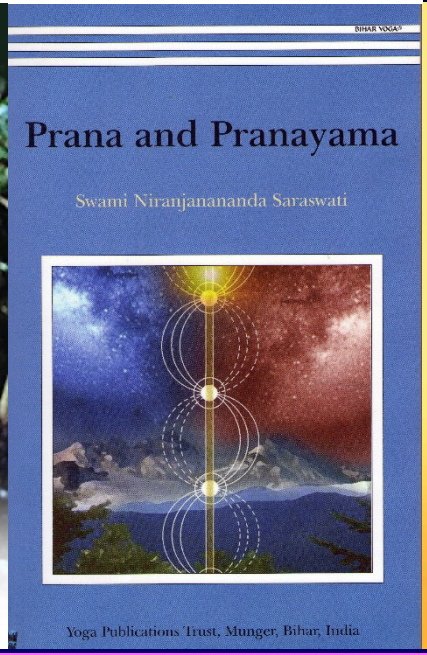

The Yoga of Breath
A Step-by-Step Guide to Pranayama
Richard Rosen
Foreword by Rodney Yee

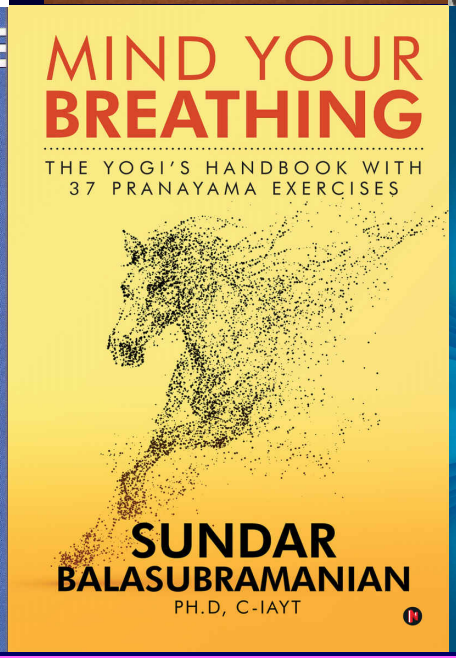

The Little Book of
Yoga Breathing
pranayama made easy...
Scott Shaw

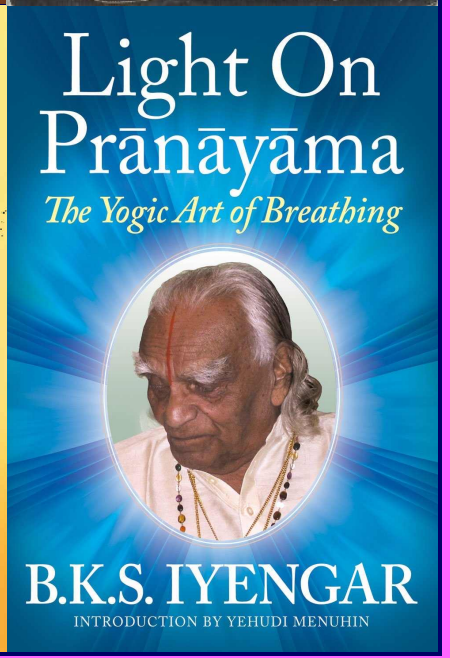

Pranayama
The Vedic Science of Breath
Advait

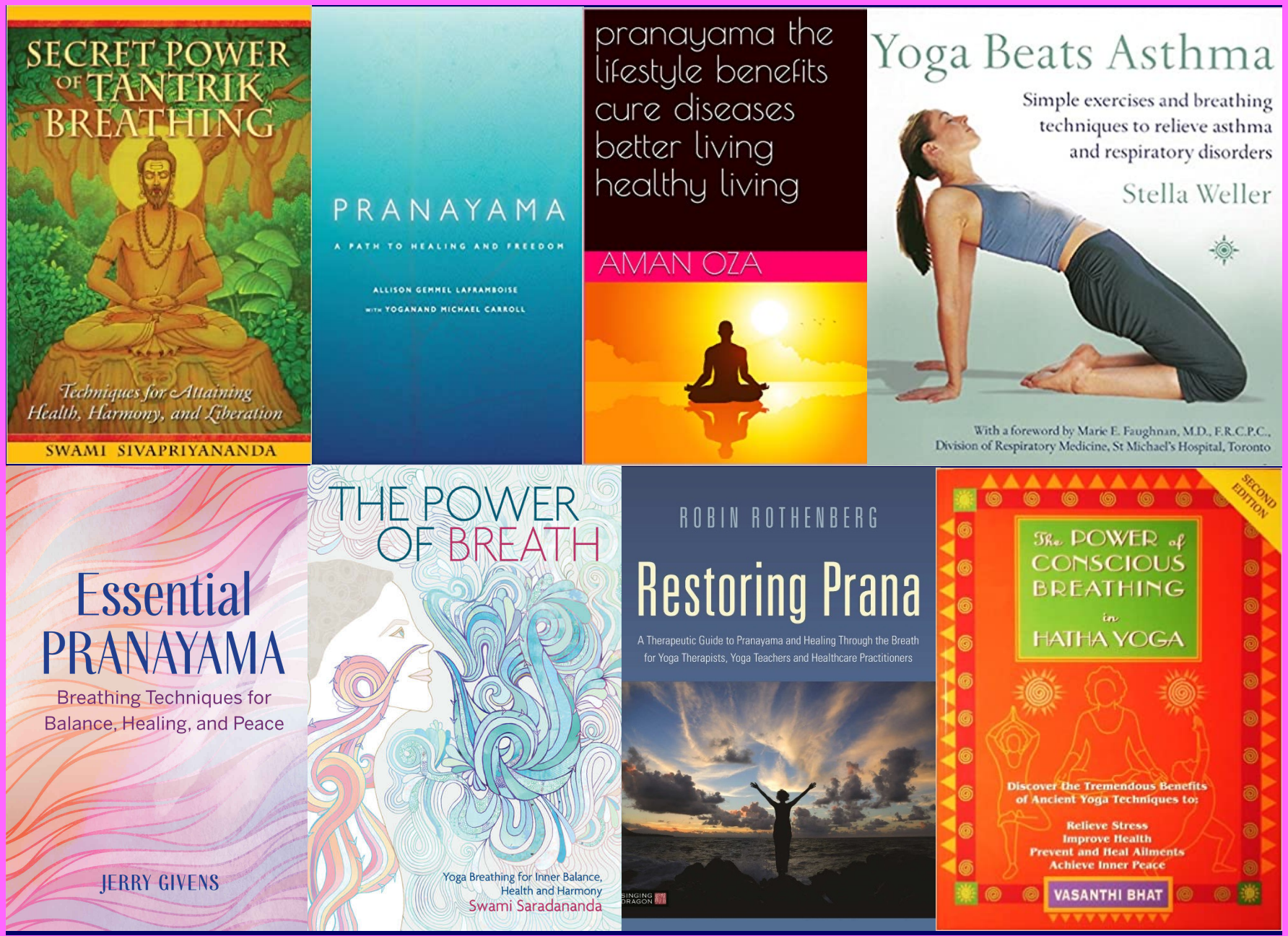

Pranayama
The Yoga of Breathing
Andre van Lysebeth


The Breath of Life:
Integral Yoga Pranayama
Step-by-step instructions in the yogic breathing practices
by Sri Swami Satchidananda


Prana and Pranayama
Swami Niranjanananda Saraswati
Yoga Publications Trust, Munger, Bihar, India


MIND YOUR BREATHING
THE YOGI'S HANDBOOK WITH 37 PRANAYAMA EXERCISES
SUNDAR BALASUBRAMANIAN
PH.D, C-IAYT


Light On Prānāyāma
The Yogic Art of Breathing
B.K.S. IYENGAR
INTRODUCTION BY YEHUDI MENUHIN


SECRET POWER OF TANTRIK BREATHING
Techniques for Attaining Health, Harmony, and Liberation
SWAMI SIVAPRIYANANDA
PRANAYAMA
A PATH TO HEALING AND FREEDOM
ALLISON GEMMEL LAFRAMBOISE
WITH YOGANAND MICHAEL CARROLL
pranayama the lifestyle benefits cure diseases better living healthy living
AMAN OZA
Yoga Beats Asthma
Simple exercises and breathing techniques to relieve asthma and respiratory disorders
Stella Weller
With a foreword by Marie E. Faughnan, M.D., F.R.C.P.C., Division of Respiratory Medicine, St Michael's Hospital, Toronto
Essential PRANAYAMA
Breathing Techniques for Balance, Healing, and Peace
JERRY GIVENS
THE POWER OF BREATH
Yoga Breathing for Inner Balance, Health and Harmony
Swami Saradananda
ROBIN ROTHENBERG
Restoring Prana
A Therapeutic Guide to Pranayama and Healing Through the Breath for Yoga Therapists, Yoga Teachers and Healthcare Practitioners
SECOND EDITION
The POWER of CONSCIOUS BREATHING in HATHA YOGA
Discover the Tremendous Benefits of Ancient Yoga Techniques to:
Relieve Stress
Improve Health
Prevent and Heal Ailments
Achieve Inner Peace
VASANTHI BHAT

Yogic Breath Practices - Pranayama

Long Slow Deep Breathing
- 3-Part Breath, Ocean Breath, Abdominal / Belly Breathing

Altered Ratio Slow Breathing
- 1:2 Inhale:Exhale

Specific Nostril Breathing
- Alternate Nostril Breathing, Uninostril Breathing

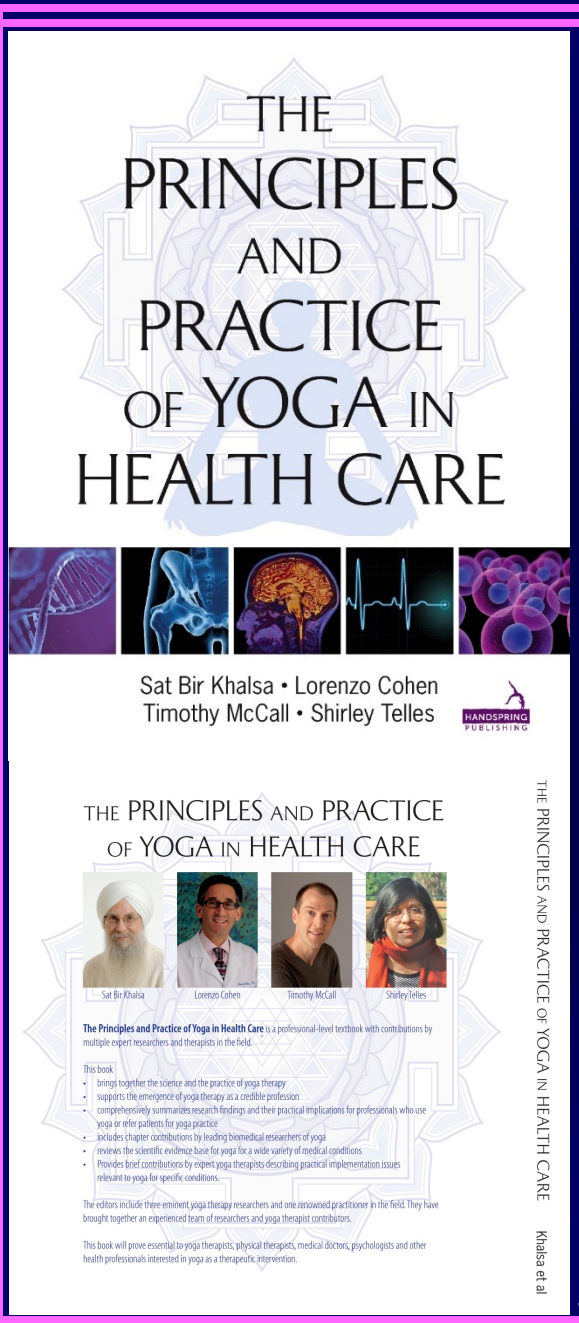
Cooling Breath
- Beak Breath, Curled Tongue

Segmented Breathing

Lion's Breath

Fast/Forceful Breathing
- Kapalabhati, Bhastrika, Breath of Fire

Slow Breathing with Sound
- Humming, OM Chanting



CHAPTER FOUR

RESEARCH ON THE PSYCHOPHYSIOLOGY OF YOGA

L SCHMALZL • CC STREETER • SBS KHALSA

Introduction

Yoga as a multicomponent practice

Yoga-based practices are inherently multifaceted in nature. In modern contexts, they typically involve a combination of specific postures or movement sequences, breath regulation, deep relaxation, and meditative techniques (Gard et al., 2014b). There are numerous "styles" of yoga-based practices representing various schools and lineages of yoga. Most of them differ in terms of the relative emphasis that is put on each of the main components as well as how these components are taught, which in turn impacts their psychophysiological effects. This chapter will outline what is currently known about the psychophysiology of the main components of yoga-based practices, and how they work in concert, primarily based on basic research studies (i.e., psychophysiology research on healthy populations).

History of basic psychophysiological research on yoga

Basic research on yoga-based practices began in the early twentieth century with the work of Swami Kuvalyananda, founder of the Kaivalyadhama Research Institute and the first yoga research journal, *Yoga Mimamsa*, which was launched in 1924. Kuvalyananda and colleagues conducted dozens of studies on individual yoga practices, which were published in their journal over the next four decades. Many of the early studies focused on investigating the effects of individual physical or respiratory practices with the use of X-rays and measures of air pressure, O_2 and CO_2 levels, acid/base balance, and blood pressure. For Western scientists, interest in the psychophysiology of yoga was likely inspired by the reports of remarkable feats of expert yoga practitioners, such as the ability to slow/stop heart rate and to reduce metabolism sufficiently to survive in airtight enclosures. These led to observational studies and subsequently published reports in the 1950s and 1960s, which affirmed the ability of these practitioners to self-regulate internal psychophysiological processes including heart rate, respiration, metabolism, and autonomic nervous system functioning (Wenger & Bagchi, 1961).

Psychophysiology of yoga postures and movement sequences

Characteristics of yoga postures and movement sequences

Modern yoga-based practices typically have a strong emphasis on postures and movement sequences (Singleton, 2010). In fact, particularly in the West, there are yoga practice styles consisting solely of posture or movement sequences that exist alongside more traditional multicomponent contemplative yoga practice styles. Yoga postures and movements can range from large and overt to small and subtle and may even include purely internal or imagined motion (Schmalzl, Crane-Godreau, & Payne, 2014). Some types of practices involve dynamic and continuous physical movement with a focus on creating a "flow" by linking one posture to the next (Jois, 1999), some are more static with individual postures being held for a longer period of time (Iyengar, 1966), and some employ a combination of flowing movement sequences and static postures.

There are innumerable individual yoga postures and variations thereof, which are typically aimed at increasing range of motion, strength, endurance, flexibility, and balance, as well as promoting relaxation and well-being. In broad terms, yoga postures can be divided into categories including standing postures, seated postures, supine postures, forward bends, backbends, lateral bends of the spine, twists, hip-openers, and inversions. Postures are

https://www.handspringpublishing.com/product/principles-practice-yoga-health-care/

Review Article

Effects of Various *Prāṇāyāma* on Cardiovascular and Autonomic Variables

Abstract

Cardiovascular functions are controlled by neural factors, temperature, hormones, etc., Of these, neural factors primarily concern the autonomic nervous system, which plays a major role in maintaining and regulating cardiac functions, e.g., blood pressure and heart rate. *Prāṇāyāma* is one of the most important yogic practices. There are various review articles on Yoga and its effects but, though *Prāṇāyāma* is a part of yoga, there is lack of review articles. To the best of our knowledge there is no known review article on effect of various *Prāṇāyāma* on cardiovascular and autonomic variables. To provide a general overview about the effect of various *prāṇāyāma* (breathing techniques) on cardiovascular and autonomic variables. A narrative review was performed based on the available scientific literature. An electronic data search was performed in Medline/PubMed database to review relevant articles, using keywords such as "*Prāṇāyāma*, Yogic breathing techniques, Unilateral nostril breathing, Alternate nostril breathing, *Kapalbhati*, *Bhastrika* and *Bhramari Pranayama*". All the relevant articles published from 1988 to 06-04-2016 were included in this review. Slow type of yogic breathing technique was reported to produce beneficial effect on cardiovascular and autonomic variables while fast breathing techniques do not produce such effects. There is lack of consistency in the results of specific nostril yogic breathing techniques and the mechanisms behind the effects of various *prāṇāyāma*. This review suggests that different types of *Prāṇāyāma* techniques produce different effects and the mechanisms behind these effects are not fully understood.

Keywords: *Autonomic nervous system, cardiovascular, prāṇāyāma*

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Received: September, 2016. **Accepted:** March, 2017.

"Pranayama is known since ancient times to relieve stress and stabilize autonomic function of the body. It is easy to learn, practice and follow in our daily life."

"Different types of pranayama techniques were shown to produce different effects…"

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5382821/?report=printable

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journal homepage: http://elsevier.com/locate/jaim

Review Article

Effects of yogic breath regulation: A narrative review of scientific evidence

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Table 1
Procedures of various yogic breathing practices.

Name of the practice	Method of practice
Kapalabhati	Sitting with back and neck erect, one should inhale through both nostrils and exhale rapidly by flapping the abdomen during each exhalation at a pace of 60–120 breaths/min.
Bastrika (Bellow's breath)	One should inhale and exhale quickly and forcefully without straining by flapping the abdomen. This should be practiced for up to 100 breaths.
Nadishodhana/Nadishuddhi (Alternate nostril breathing)	With the right thumb, close the right nostril and inhale through left nostril. Closing the left nostril, exhale through right, following which inhalation should be done through right nostril. Closing the right nostril, breath out through left nostril. This is one round. The procedure is repeated for desired number of rounds.
Suryanuloma Viloma (Right uninostril breathing)	Closing the left nostril, both inhalation and exhalation should be done through right nostril, without altering the normal pace of breathing.
Chandranuloma Viloma (Left uninostril breathing)	Procedure similar to *Suryanuloma Viloma*, breathing is done through left nostril alone, by closing the right nostril.
Suryabhedana (Right nostril initiated breathing)	Closing the left nostril, inhalation should be done through right nostril. At the end of inhalation, close the right nostril and exhale through the left nostril. This is one round. The procedure is repeated for desired number of rounds.
Ujjayi (Psychic Breath)	Inhalation and exhalation are done through the nose at normal pace, with partial contraction of glottis, which produce light snoring sound. One should be aware of the passage of breath through the throat during the practice.
Bhramari (Female honeybee humming breath)	After a full inhalation, closing the ears using the index fingers, one should exhale making a soft humming sound similar to that of a female honeybee.

https://www.sciencedirect.com/science/article/pii/S0975947617303224

frontiers in Human Neuroscience

SYSTEMATIC REVIEW
published: 07 September 2018
doi: 10.3389/fnhum.2018.00353

How Breath-Control Can Change Your Life: A Systematic Review on Psycho-Physiological Correlates of Slow Breathing

*Andrea Zaccaro[1], Andrea Piarulli[1,2], Marco Laurino[3], Erika Garbella[4], Danilo Menicucci[1], Bruno Neri[5] and Angelo Gemignani[1,3,6]**

[1] Department of Surgical, Medical, Molecular and Critical Area Pathology, University of Pisa, Pisa, Italy, [2] Coma Science Group, GIGA Consciousness, University of Liège, Liège, Belgium, [3] National Research Council, Institute of Clinical Physiology, Pisa, Italy, [4] Nuovo Ospedale degli Infermi, Biella, Italy, [5] Department of Information Engineering, University of Pisa, Pisa, Italy, [6] Azienda Ospedaliero-Universitaria Pisana, Pisa, Italy

"The main effects of slow breathing techniques cover autonomic and central nervous systems activities as well as the psychological status."

https://www.frontiersin.org/articles/10.3389/fnhum.2018.00353/pdf

Conditioning of Slow Yogic Breathing

"…[yoga respiration training] induced long-lasting modifications of the ventilatory pattern with a significant lengthening of expiratory duration and a modest tidal volume increase."

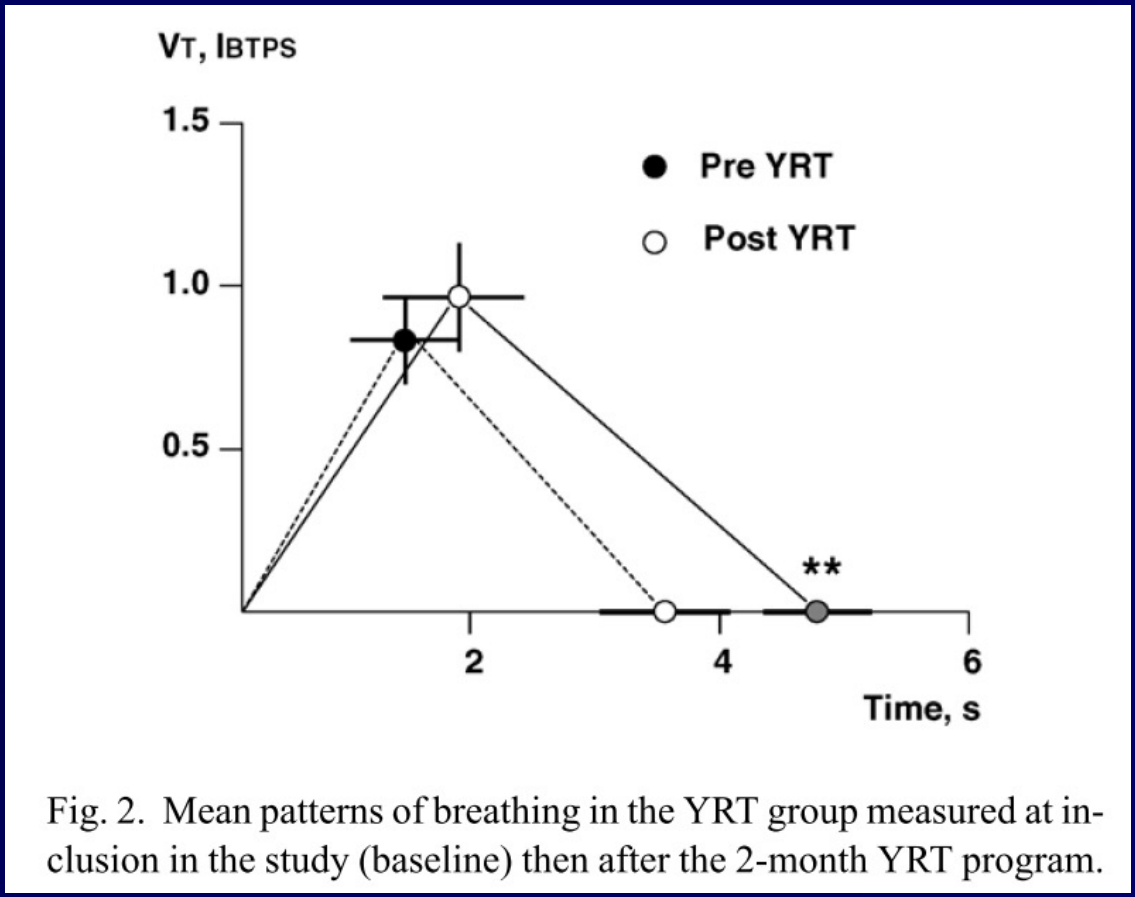


Fig. 2. Mean patterns of breathing in the YRT group measured at inclusion in the study (baseline) then after the 2-month YRT program.

From: *Training to yoga respiration selectively increases respiratory sensation in healthy man. Villien F, Yu M, Barthélémy P, Jammes Y, Respiratory Physiology and Neurobiology, 146:85-96, 2005.*

Respiratory Sinus Arrhythmia

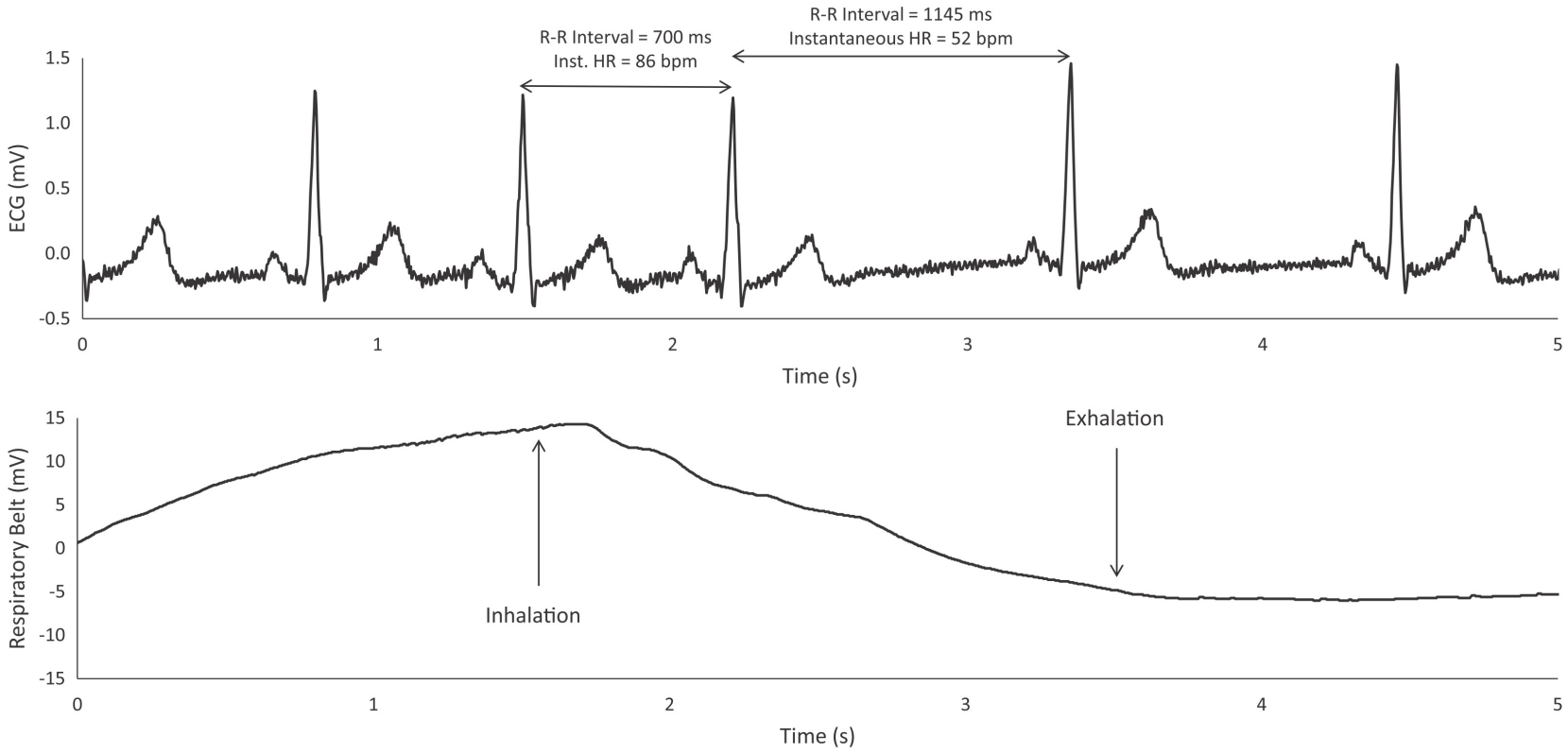
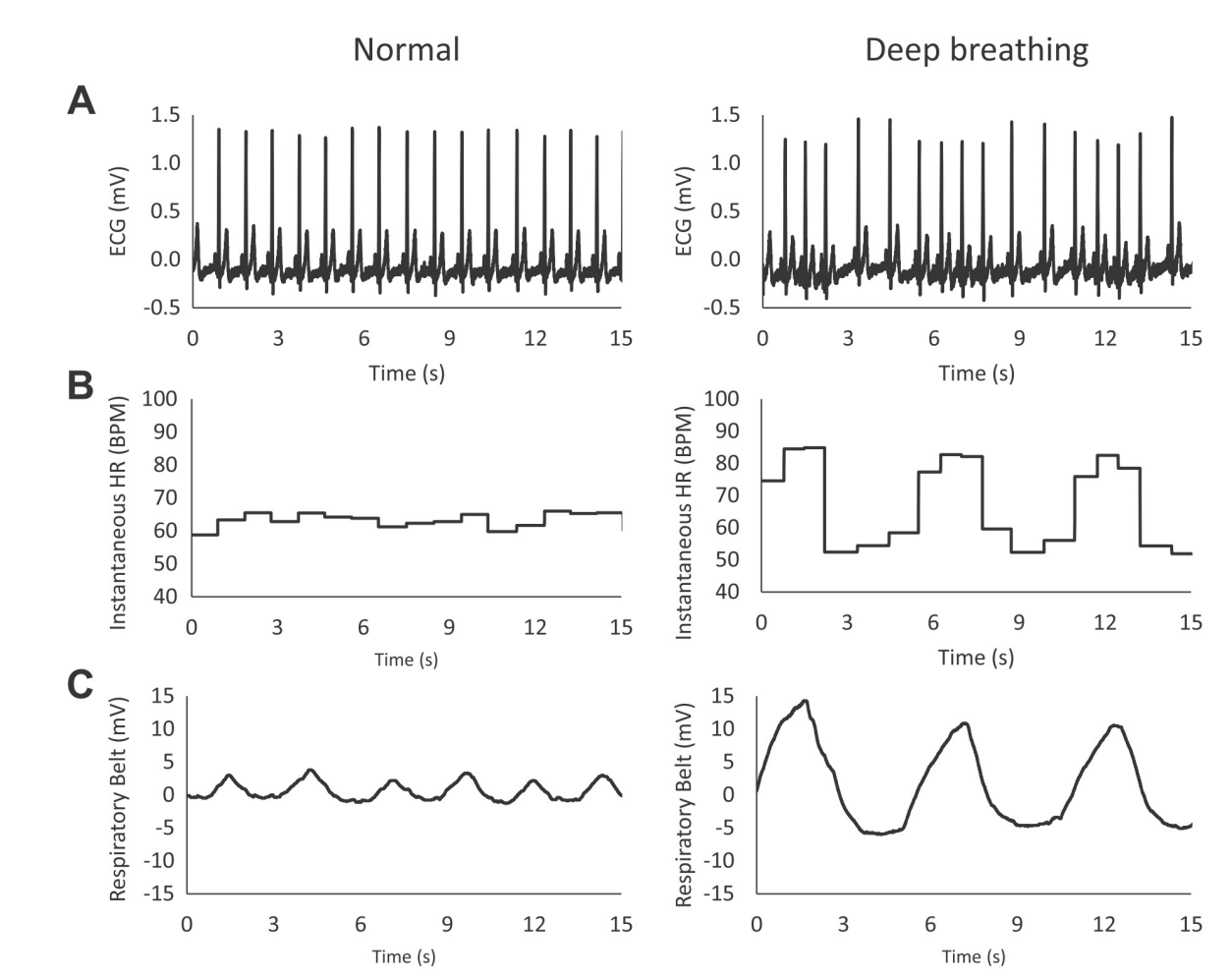


Fig. 1. An ECG and respiratory tracing for an individual deep breath. These tracings from the ECG setup and respiratory belt illustrate the shorter R-R interval, and our own calculated instantaneous heart rate (HR) during inhalation and the protracted R-R interval and slower instantaneous HR during exhalation. bpm, Beats/min.

From: *The impact of deep breathing and alternate nostril breathing on heart rate variability: a human physiology laboratory. Levin CJ, Swoap SJ. Advances in Physiology Education 43:270-276, 2019.*

https://journals.physiology.org/doi/full/10.1152/advan.00019.2019

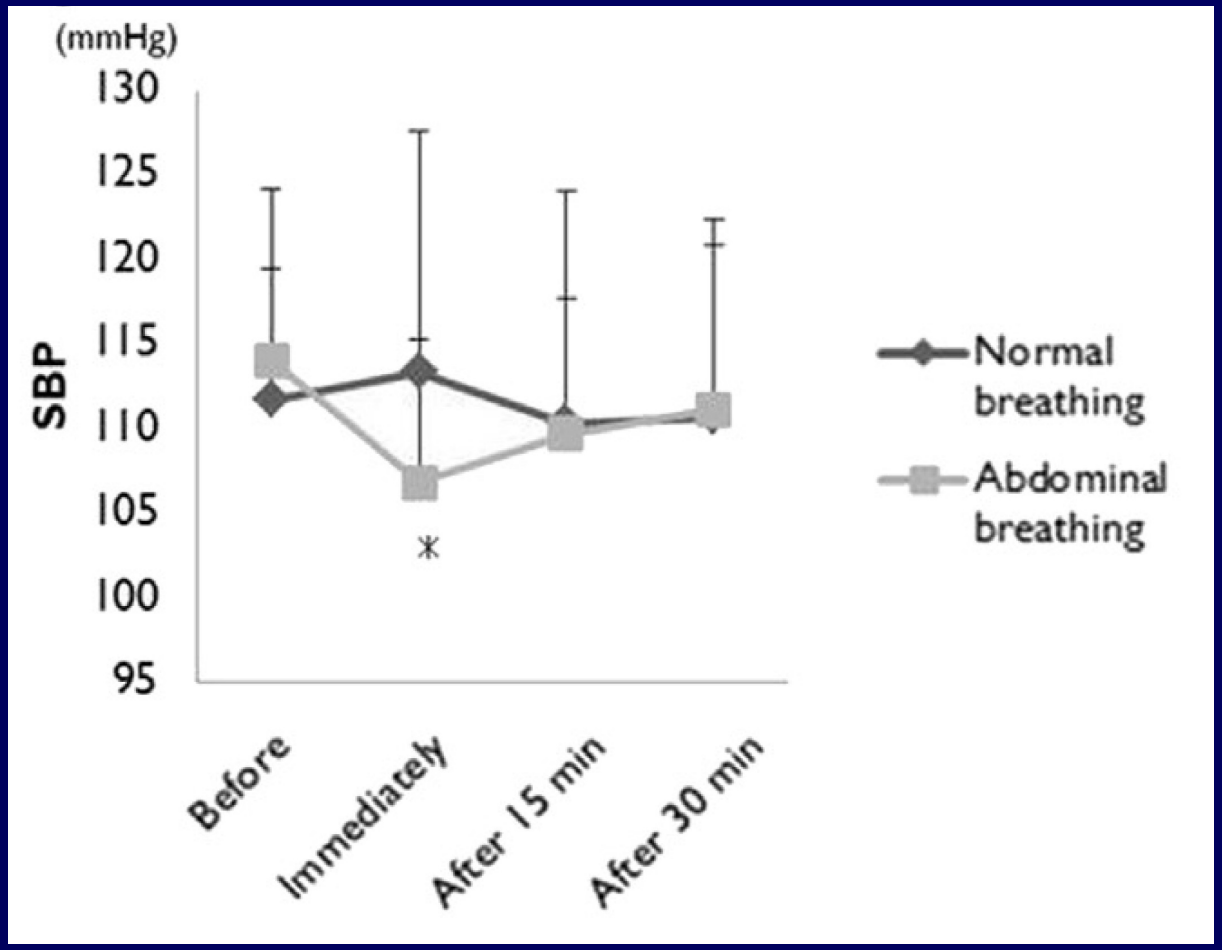
Heart Rate Variability and Respiratory Rate



From: *The impact of deep breathing and alternate nostril breathing on heart rate variability: a human physiology laboratory. Levin CJ, Swoap SJ. Advances in Physiology Education 43:270-276, 2019.*

https://journals.physiology.org/doi/full/10.1152/advan.00019.2019

Pranayama and Autonomic Deactivation



From: *Abdominal breathing increases tear secretion in healthy women, Sano K, Kawashima M, Ikeura K, Arita R, Tsubota K, Ocular Surface, 13:82-7, 2015.*

Slow Breathing on Stress

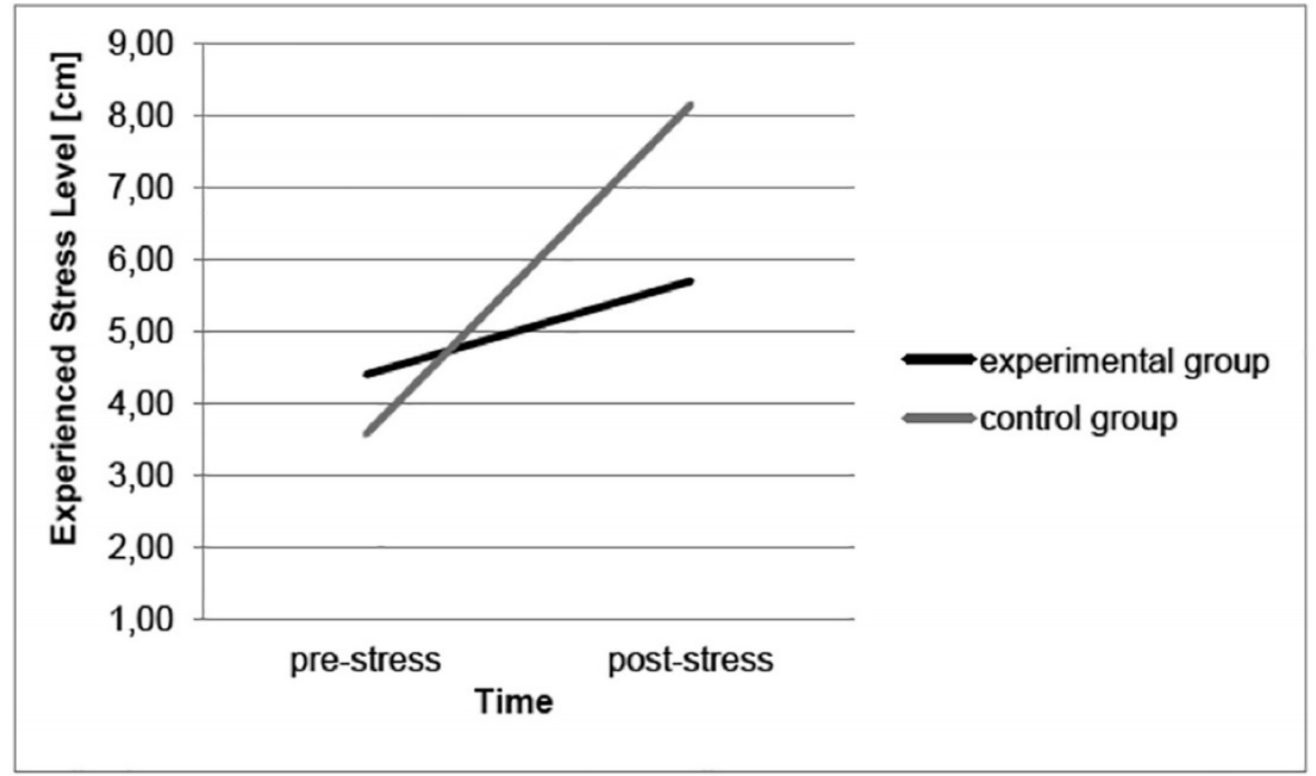
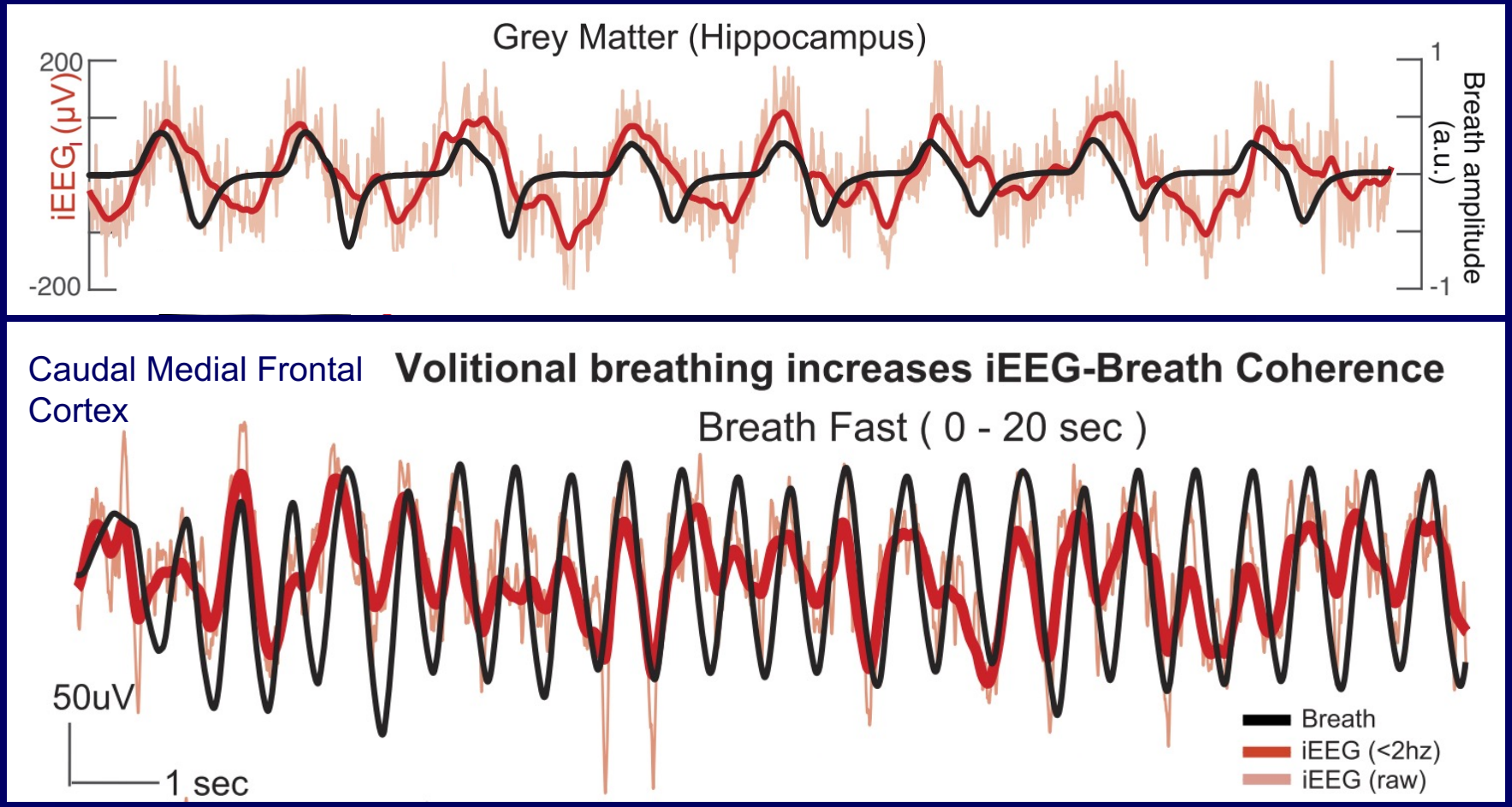


Fig. 4. Comparison of pre- and post-stress levels per group.

From: *How breathing can help you make better decisions: Two studies on the effects of breathing patterns on heart rate variability and decision-making in business cases. De Couck M, Caers R, Musch L, Fliegauf J, Giangreco A, Gidron Y, International Journal of Psychophysiology, 139:1-9, 2019.*

Breathing and Control of Attention



From: *Breathing above the brain stem: volitional control and attentional modulation in humans, Herrero JL, Khuvis S, Yeagle E, Cerf M, Mehta AD, Journal of Neurophysiology, 119:145–159, 2018*

Effects of Pranayama

- Increases in physiological pulmonary function
- Improvement in respiratory efficiency
- Increase in heart rate variability
- Changes in chemoreflex characteristics
- Reduction in oxygen consumption
- Reduction in oxidative stress levels
- Regulation of psychophysiological arousal
- Regulation of blood pressure
- Regulation of psychological state
- Pain regulation

Alternate Nostril Breathing in Hatha Yoga Pradipika

Chapter 2

7. Sitting in the Padmasana posture the Yogi should fill in the air through the left nostril (closing the right one); and, keeping it confined according to one's ability, it should be expelled slowly through the [right nostril].
8. Then, drawing in the air through the [right nostril] slowly, the belly should be filled, and after performing [breath retention] as before, it should be expelled slowly through the [left nostril].
9. Inhaling thus through the one, through which it was expelled, and having restrained it there, till possible, it should be exhaled through the other, slowly and not forcibly.

http://www.swamij.com/hatha-yoga-pradipika.htm

Nasal Cycle

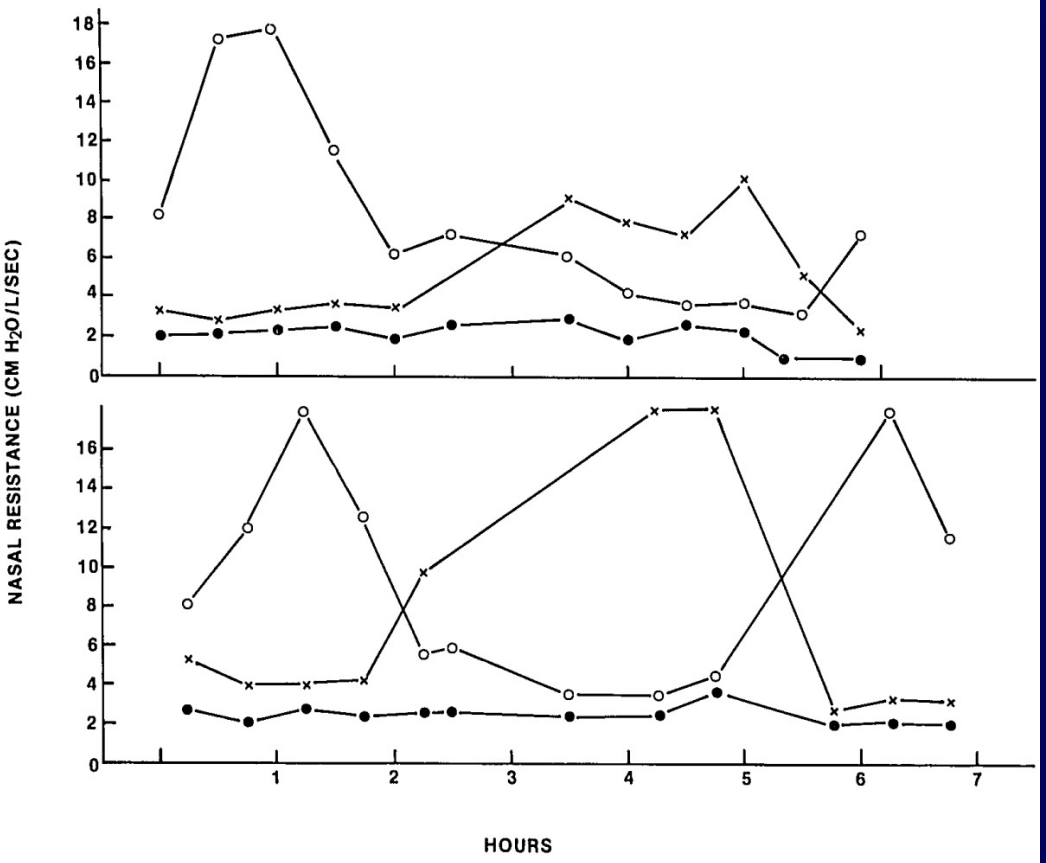


Fig. 1. Spontaneous phase reversals in the seated subject on two separate days.

From: *Is the nasal cycle an artifact? The role of asymmetrical postures, Haight JS, Cole P, Laryngoscope, 99:538-41, 1989.*

Ultradian Rhythmicity and Laterality

TABLE I-A

Proposed organization of ultradian rhythms

Table 1A lists the relationship of various ultradian phenomena and related correlates to two polar and separate states of lateralized autonomic balance, described as: (1) right sympathethic dominance with simultaneous left parasympathetic dominance; and (2), left parasympathetic dominance with simultaneous left sympathetic dominance.

Autonomic physiology	
R Sympath. / L Parasympath. Dominance	*L Sympath. / R Parasympath. Dominance*
Right nostril dominance	Left nostril dominance
Right lung dominant	Left lung dominant
Right adrenal more active	Left adrenal more active
Right side increased perspiration	Left side increased perspiration
Right side increased catecholamines	Left side increased catecholamines
Ergotrophic state	Trophotropic state
Active phase-BRAC-blood glucose up	Resting phase-BRAC-blood glucose lower
Generalized sympathetic tonus	Generalized parasympathetic tonus
Locomotor activity increased	Locomotor activity reduced
Right pupil more dilated than left	Left pupil more dilated than right
Heart rate, stroke volume increased	Heart rate, stroke volume reduced
Blood pressure increased	Blood pressure reduced
Respiration rate increased	Respiration rate reduced
Oxygen consumption increased	Oxygen consumption reduced
Body temperature increased	Body temperature reduced
Involuntary eyeblink rate reduced	Involuntary eyeblink rate increased
Intraocular pressure reduced	Intraocular pressure increased

From: *Lateralized rhythms of the central and autonomic nervous systems, Shannahoff-Khalsa D, International Journal of Psychophysiology, 11:225-51, 1991.*

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EEG signatures change during unilateral Yogi nasal breathing

Imran Khan Niazi[1,2,3,6]✉, Muhammad Samran Navid[2,6], Jim Bartley[1], Daniel Shepherd[4], Mangor Pedersen[4], Georgina Burns[5], Denise Taylor[5] & David E. White[1]

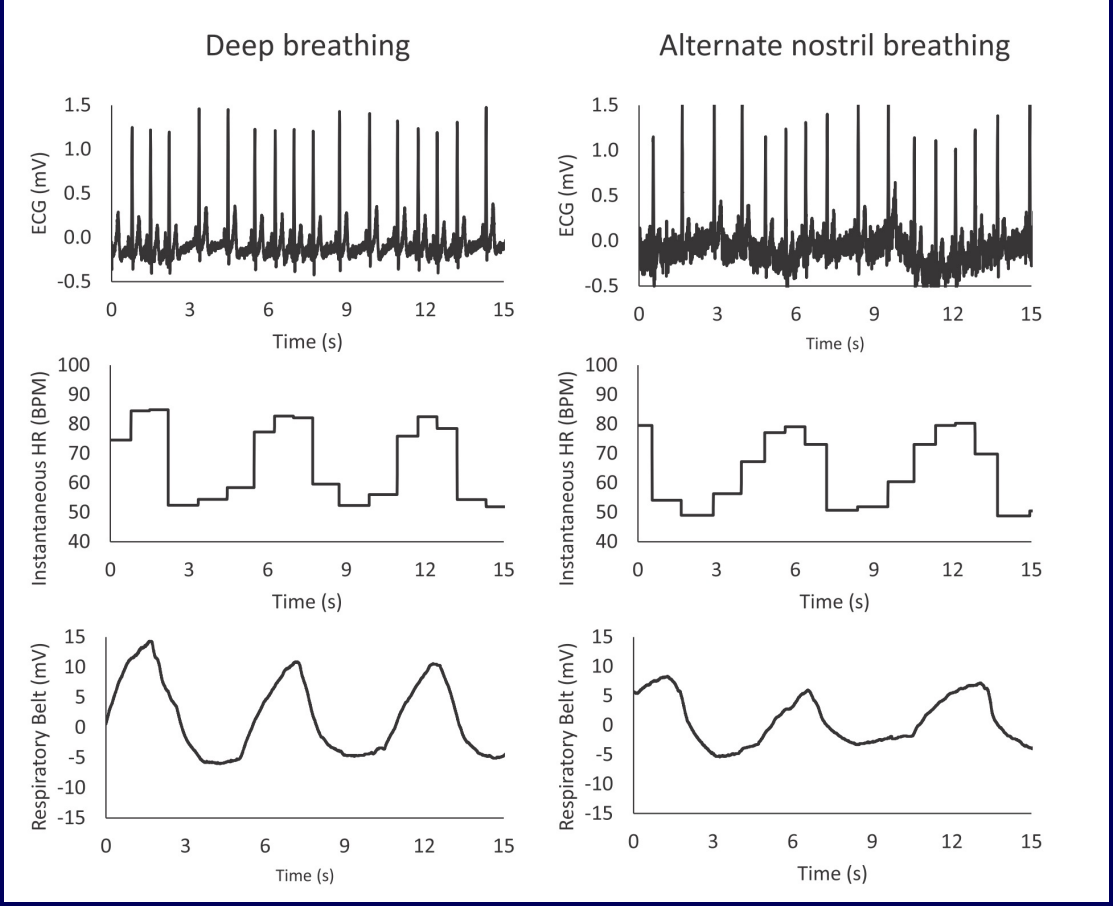
Scientific Reports | (2022) 12:520 | https://doi.org/10.1038/s41598-021-04461-8 nature portfolio

"Airflow through the left-and-right nostrils is said to be entrained by an endogenous nasal cycle paced by both poles of the hypothalamus. Yogic practices suggest, and scientific evidence demonstrates, that right-nostril breathing is involved with relatively higher sympathetic activity (arousal states), while left-nostril breathing is associated with a relatively more parasympathetic activity (stress alleviating state)."

"These preliminary findings may stimulate further research in the area…"

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8752782/pdf/41598_2021_Article_4461.pdf

Controlling for Respiratory Rate



From: *The impact of deep breathing and alternate nostril breathing on heart rate variability: a human physiology laboratory. Levin CJ, Swoap SJ. Advances in Physiology Education 43:270-276, 2019.*

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Scientific Research on Yoga

Substantial research has been done on many of the populations and parts of the body that COVID-19 preys on most. Use this section of Yoga Alliance's website to learn more about scientific research on the effects of yoga on the elderly, respiratory function, anxiety, and depression, to name a few.

Perhaps more than ever, yoga is being widely studied and evaluated for its positive effects and benefits. At Yoga Alliance, we curate the latest and most relevant research on yoga's applications in health, wellness, and disease. We have filtered it in a digestible manner for our Registered Yoga Schools and Registered Yoga Teachers as well as for the broader yoga community.

This evidence-based research not only reveals the science of yoga, it also explains its therapeutic efficacy when used in conjunction with conventional medicine. Our goal is that this impactful content will be utilized in a way that highlights even more of yoga's ancient, multi-faceted ability to improve lives.

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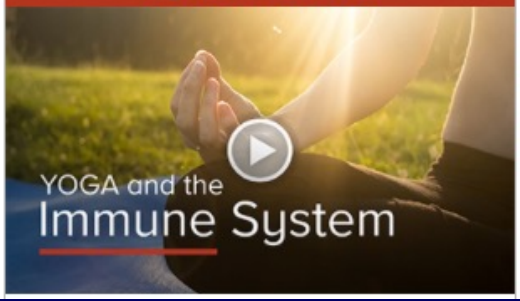

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Physical Health and Performance

Musculoskeletal Functioning, Neuromuscular Functioning, Cardiovascular Functioning, Neuroendocrine Functioning, Respiratory Functioning, Balance and Coordination, Sleep, Sports Performance

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Our hope is for yoga schools and yoga teachers to utilize this impactful content in their teachings to promote and highlight yoga's evident multi-faceted ability to improve lives. Let us know how research on yoga is important or valuable to you on social media (@YogaAlliance) or by emailing us at research@yogaalliance.org. We honor and value your personal experiences and look forward to featuring your stories.

These citations were curated by Yoga Alliance's Director of Yoga Research, Dr. Sat Bir Singh Khalsa.

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Saoji AA, Raghavendra BR, Manjunath NK.
J Ayurveda Integr Med. 2019 Jan - Mar;10(1):50-58.
[full text]

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