

Psychophysiological Effects of Yoga

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The contents of this bibliography do not provide medical advice and should not be so interpreted. Before beginning any exercise program, see your physician for clearance.

NOTE: Some basic psychological research is included in this bibliography, but see the extensive “Psychology and Psychotherapy” bibliography for a complete list of citations.

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Abstract: The thermic effect (TEF) of vegetarian meals was measured for breakfast and lunch in 6 lean healthy men (18-25 years) during normal feeding (NF) and with 20% overfeeding (OF) on 28 successive days. The energy contents of breakfast were 223 +/- 10 and 330 +/- 48 kcal, and those of lunch were 1,033 +/- 22 and 1,247 +/- 222 kcal in NF and OF, respectively. In NF, the TEF per 180 min was 32.7 +/- 8.6 and 54.8 +/- 6.3 kcal for breakfast and lunch, respectively. In OF, the TEF was 38.3 +/- 8.3 kcal for breakfast and 57.2 +/- 5.4 kcal for lunch. The increase in total TEF due to OF was nonsignificant ($p < 0.2$). In response to 20% OF, adaptive thermogenesis was manifested mainly through an increase in the resting metabolic rate of 4.9% ($p < 0.001$). In both feeding regimes, the percent TEF was higher for breakfast than for lunch ($p < 0.05$). Regression analysis of TEF versus calorie load indicated a stable component of 42 kcal with a 2% rate of increase. Yoga exercises were performed from 16.00 to 17.00 daily. The thermic effect of

yoga exercises observed from 17.10 to 18.30 was 21 kcal and persisted beyond 90 min, indicating the role of yoga in energy metabolism.

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The data obtained in this investigation indicate that further research in the application of Transcendental Meditation as an adjunct therapy with stutterers is warranted.

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_____, **G. S. Chhina, and B. Singh.** Studies on Shri Ramanand Yogi during his stay in an air tight box. *Indian Journal of Medical Research*, 1961, 49:82-89.

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Abstract: This study explores the physiological correlates of a highly practiced Kundalini Yoga meditator. Thoracic and abdominal breathing patterns, heart rate (HR), occipital parietal electroencephalograph (EEG), skin conductance level (SCL), and blood volume pulse (BVP) were monitored during prebaseline, meditation, and postbaseline periods. Visual analyses of the data showed a decrease in respiration rate during the meditation from a mean of 11 breaths/min for the pre- and 13 breaths/min for the postbaseline to a mean of 5 breaths/min during the meditation, with a predominance of abdominal/diaphragmatic breathing. There was also more alpha EEG activity during the meditation ($M = 1.71$ microV) compared to the pre- ($M = .47$ microV) and postbaseline ($M = .78$ microV) periods, and an increase in theta EEG activity immediately following the meditation ($M = .62$ microV) compared to the pre-baseline and meditative periods (each with $M = .26$ microV). These findings suggest that a shift in breathing patterns may contribute to the development of alpha EEG, and those patterns need to be investigated further.

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Abstract: Purpose: This clinical study was carried out with the aim of investigating whether Hatha Yoga (HY) training affects aerobic and anaerobic power in healthy young adults. Material and method: 33 sedentary, healthy, young adult subjects, aged 18 to 26 were divided into two groups according to age, sex and activity levels. 10 female and 7 male (mean 20.06 +/- 2.41 years, range 18-26 years) young adults were trained with Hatha Yoga (HYG). The aerobic exercise group (AEG) consisted of 9 female and 7 male (mean 19.75 +/- 1.81 years, range 18-26 years) young adults who performed aerobic type strength and stretch exercises of at least 60% maximal heart rate or higher. Both training programs were given by a supervisor, one hour per day, four days per week, for six weeks. Subjects in both groups were assessed by Cooper's 12 minutes running test for cardiovascular endurance and vertical jump test for anaerobic power before and after training. Results: Aerobic and anaerobic power increased by 9.8%, 5.5% following HY and by 6.6%, 2.3% following aerobic training respectively. A significant increase was found in aerobic power and anaerobic power ($p < 0.001$) in HYG. There was a significant increase in aerobic power ($p < 0.01$) in AEG, while anaerobic power of subjects in AEG were consistently higher compared to that of before training, statistically the difference was not significant ($p > 0.05$). Although there was no substantial differences between the groups concerning cardiovascular endurance ($p > 0.05$), anaerobic power was significantly higher ($p < 0.05$) in the HYG. Conclusion: The results of this study suggest that HY training has positive effects on cardiovascular aerobic and anaerobic power. Therefore HY could be an exercise option for enhancing aerobic and anaerobic power in young adults.

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Abstract: We need to clarify at least four aspects of selfhood if we are to reach a better understanding of consciousness in general, and of its alternate states.

First, how did we develop our self-centred psychophysiology? Second, can the four familiar lobes of the brain alone serve, if only as preliminary landmarks of convenience, to help understand the functions of our many self-referent networks? Third, what could cause one's former sense of self to vanish from the mental field during an extraordinary state of consciousness? Fourth, when a person's physical and psychic self do drop off briefly, how has conscious experience then been transformed? In particular, what happens to that subject's personal sense of time?

Our many-sided self arose in widely distributed brain networks. Since infancy, these self-oriented circuits have been over-conditioned by limbic biases. Selfhood then seems to have evolved along lines suggesting at least in shorthand the operations of a kind of 'I-Me-Mine' complex.

But what happens when this egocentric triad briefly dissolves? Novel states of consciousness emerge. Two personally-observed states are discussed: (1) insight-wisdom (kensho-satori); (2) internal absorption. How do these two states differ phenomenologically? The physiological processes briefly suggested here emphasize shifts in deeper systems, and pivotal roles for thalamo-cortical interactions in the front and back of the brain.

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approach that does not allow for a nonlocal reality. See:
<http://www.noetic.org/Ions/publications/r54zen.htm>.

Contents: Starting to point toward Zen, Meditating, Neurologizing, Exploring states of consciousness, Quickening, Turning in: The absorptions, Turning out: The awakenings, Being and beyond: To the stage of ongoing enlightenment

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Abstract: Asymmetrical shoulder, thoracic and buttock pressure affect ipsilateral nasal resistance, autonomic tone, and hemisphericity. This factor must be taken into consideration when conducting psychological experimentation, and, in fact, may have confounded much prior research.

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Some excerpts from the findings and discussion: “an extreme slowing of respiration rate 4 to 6 per minute . . . more than 70% increase of palmar electrical resistance but without change in basic waking EEG and EKG patterns . . . heart slowing (24 per minute) through particular maneuvers . . . physiologically Yogic meditation represents deep relaxation of the autonomic nervous system without drowsiness or sleep and a type of cerebral activity without highly accelerated electro-physiological manifestation but probably with more or less insensibility to some outside stimuli for a short or long time.”

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_____, **and Maurice Sailhan.** Quantified EEG spectral analysis of sleep and Transcendental Meditation. In D. W. Orme-Johnson and J. T. Farrow, eds., *Scientific*

Research on the Transcendental Meditation Program: Collected Papers, Vol. 1. New York: M.E.R.U. Press, 1977, pp. 182-186.

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Barnes, V. A., F. A. Treiber, and H. Davis. Impact of Transcendental Meditation on cardiovascular function at rest and during acute stress in adolescents with high normal blood pressure. *Journal of Psychosomatic Research*, Oct 2001, 51(4):597-60. Author email: vbarnes@mail.mcg.edu. PMID: 11595248.

OBJECTIVE: This study examined the impact of the Transcendental Meditation (TM) program on cardiovascular (CV) reactivity in adolescents with high normal BP. **METHOD:** Thirty-five adolescents [34 African Americans (AAs), 1 Caucasian American (CA); ages 15-18 years] with resting systolic blood pressure (SBP) between the 85th and 95th percentile for their age and gender on three consecutive occasions, were randomly assigned to either TM (n=17) or health education control (CTL, n=18) groups. The TM group engaged in 15-min meditation twice each day for 2 months including sessions during school lunch break. Primary CV outcome measures were changes in blood pressure (BP), heart rate (HR), and cardiac output (CO) at rest and in response to two laboratory stressors, a simulated car driving stressor and an interpersonal social stressor interview. **RESULTS:** The TM group exhibited greater decreases in resting SBP ($P < .03$) from pre- to postintervention, compared to the CTL group. The TM group exhibited greater decreases from pre- to postintervention in SBP, HR, and CO reactivity (P 's $< .03$) to the simulated car driving stressor, and in SBP reactivity ($P < .03$) to the social stressor interview. **CONCLUSION:** The TM program appears to have a beneficial impact upon CV functioning at rest and during acute laboratory stress in adolescents at-risk for hypertension.

_____, **Frank A. Treiber, J. Rick Turner, Harry Davis, and William B. Strong.** Acute effects of Transcendental Meditation on hemodynamic functioning in middle-aged adults. *Psychosomatic Medicine*, Jul/Aug 1999, 61(4):525-531. Abstract available online: <http://www.psychosomatic.org/v61n899.html#525>.

Objective: Increased peripheral vasoconstriction (ie, total peripheral resistance, or TPR) has been implicated as playing an important role in the early development of essential hypertension. Some studies have demonstrated that Transcendental Meditation (TM) reduces high blood pressure, but the hemodynamic adjustments behind these blood pressure reductions have not been elucidated. The aim of this study was to provide a preliminary investigation of the acute effects of TM on TPR.

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Bauman, Alisa. Is yoga enough to keep you fit? *Yoga Journal*, Sep/Oct 2002, pp. 84-91, 158.

“Many yogis wonder if they need to supplement their yoga practice with weight-training or aerobic exercise like running to stay in shape. To investigate, *Yoga Journal* headed to a university sports medicine lab [at the University of California at Davis] to test three yogis for strength, endurance, flexibility, and lung capacity.”

Flexibility: The yogis “compare favorably with top performers who train for maximum flexibility in fields like gymnastics and ballet.”

Body composition: “According to skinfold measurements taken with calipers, all three yogis had body fat ratios and body mass indices comparable to those of elite endurance athletes like top marathoners and bicyclists.”

Muscular strength, endurance, and balance: Based on Biodex tests of elbow and knee flexion and extension, measuring maximum force exerted, muscle endurance, and muscle balance—both between the right and left sides and between agonist and antagonist muscles, “the yogis scored mostly in or near the normal ranges.”

Lung capacity: Using a spirometer, two of the yogis performed within a few percentage points of the norm and one performed better than the norm.

Cardiorespiratory fitness: “All three yogis produced . . . VO₂max measurements in the same range as fairly active athletes.”

Beary, F., and H. Benson. A simple psychologic technique which elicits the hypometabolic changes of the relaxation response. *Psychosomatic Medicine*, 1974, 36(2):115-120. (A meditation technique based on Transcendental Meditation.)

Becker, D. E., and D. Shapiro. Physiological responses to clicks during zen, yoga, and TM meditation. *Psychophysiology*, 1981, 18(6):694-699.

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Benson, H., T. Dryer, and L. H. Hartley. Decreased oxygen consumption during exercise with elicitation of the relaxation response. *Journal of Human Stress*, 1978; 4:38-42.

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_____, **J. W. Lehman, M. S. Malhotra, R. F. Goldman, J. Hopkins, and M. D. Epstein.** Body temperature changes during the practice of g tum-mo (heat) yoga. *Nature*, 1982, 295:234-236.

A follow-up study is currently underway using sophisticated equipment to attempt to determine the mechanism for g tum-mo. Baseline data has been taken on the three Buddhist monks who are the study subjects, including oxygen consumption, carbon dioxide elimination, respiratory rate, immunologic measurements, and determination of nitric oxide. The monks will be observed for at least six months, and “the scientists will try to discover how the monks generate heat by measuring distribution of heat in the body and other metabolic changes, production of nitric oxide in the blood, and immunological changes.” For more information, see <http://www.mbmi.org/press/shownews.asp?id=38&type=NB>.

_____, **M. S. Malhotra, R. F. Goldman, G. D. Jacobs, and P. J. Hopkins.** Three case reports of the metabolic and electroencephalographic changes during advanced Buddhist meditation techniques. *Behavioral Medicine*, Summer 1990, 16(2):290-295. PMID: 2194593.

Abstract: To examine the extent to which advanced meditative practices might alter body metabolism and the electroencephalogram (EEG), we investigated three Tibetan Buddhist monks living in the Rumtek monastery in Sikkim, India. In a study carried out in February 1988, we found that during the practice of several different meditative practices, resting metabolism (VO₂) could be both raised (up to 61%) and lowered (down to 64%). The reduction from rest is the largest ever reported. On the EEG, marked asymmetry in alpha and beta activity between the hemispheres and increased beta activity were present. From these three case reports, we conclude that advanced meditative practices may yield different alterations in metabolism (there are also forms of meditation that increase metabolism) and that the decreases in metabolism can be striking.

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The following review of this study appears in an article by Ralph La Forge entitled “Spotlight on Yoga” in the May 2001 issue of *IDEA Health and Fitness Source* (http://www.findarticles.com/cf_0/m0BTW/5_19/74886169/p1/article.jhtml?term=yoga):

Study: Researchers at the Scientific Research Department at Kaivalyadhama S.M.Y.M. Samiti in Lonavla, India, compared the efficacy of Shavasana (a yogic relaxation posture) and two other postures (resting in a chair and resting in the supine position) as methods of recovery from induced physiological stress (treadmill running).

Twenty-one males and six females (age range = 21-30 years) were allowed to rest in one of the above postures after completing a treadmill workout. Recovery was assessed by measuring resting and exercise recovery heart rate and blood pressure. These factors were measured before and every two minutes after the treadmill running until they returned to their initial resting levels.

The results revealed that the effects of treadmill exercise stress were reversed in significantly ($p < 0.01$) shorter time with Shavasana than with either of the other two resting postures.

Comments: The Shavasana pose (sometimes spelled “Savasana” or called “corpse pose”) is often overlooked as an effective yoga pose. Seemingly easy, it is one of the most challenging poses in yoga. Shavasana is practiced in a relaxed supine position, feet apart, palms facing up to gently open the chest. The neck should be extended. (Placing a folded towel underneath the neck is recommended.) What primarily distinguishes Shavasana from the other two modes of relaxation used in this study is utilization of the breath. Abdominal yogic breathing is sequenced with normal breathing throughout Shavasana.

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Berger, B. G., and D. R. Owen. Mood alteration with yoga and swimming: Aerobic exercise may not be necessary. *Perceptual Motor Skills*, 1992, 75(3, Part 2):1331-1343.

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Abstract: Objective: To test whether rhythmic formulas such as the rosary and yoga mantras can synchronise and reinforce inherent cardiovascular rhythms and modify baroreflex sensitivity. Design: Comparison of effects of recitation of the Ave Maria (in Latin) or of a mantra, during spontaneous and metronome controlled breathing, on breathing rate and on spontaneous oscillations in RR interval, and on blood pressure and cerebral circulation. Setting: Florence and Pavia, Italy. Participants: 23 healthy adults. Main outcome measures: Breathing rate, regularity of breathing, baroreflex sensitivity, frequency of cardiovascular oscillations. Results: Both prayer and mantra caused striking, powerful, and synchronous increases in existing cardiovascular rhythms when recited six times a minute. Baroreflex sensitivity also increased significantly, from 9.5 (SD 4.6) to 11.5 (4.9) ms/mm Hg, $P < 0.05$. Conclusion: Rhythm formulas that involve breathing at six breaths per minute induce favourable psychological and possibly physiological effects.

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Abstract: Autonomic responses to breath holding were studied in twenty healthy young men. Breath was held at different phases of respiration and parameters recorded were Breath holding time, heart rate systolic and diastolic blood pressure and galvanic skin resistance (GSR). After taking initial recordings all the subjects practised Nadi-Shodhana Pranayama for a period of 4 weeks. At the end of 4 weeks same parameters were again recorded and the results compared. Baseline heart rate and blood pressure (systolic and diastolic) showed a tendency to decrease and both these autonomic parameters were significantly decreased at breaking point after pranayamic breathing. Although the GSR was recorded in all subjects the observations made were not conclusive. Thus pranayama breathing exercises appear to alter autonomic responses to breath holding probably by increasing vagal tone and decreasing sympathetic discharges.

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Bhavanani Ananda Balayogi, Madanmohan, and Kaviraja Udupa. Acute effect of *much bhastrika* (a yogic bellows type breathing) on reaction time. *Indian Journal of Physiology and Pharmacology*, 2003, 47(3):297-300.

Abstract: Reaction time (RT) is an index of the processing ability of [the] central nervous system and a simple means of determining sensory-motor performance. It has been reported that yoga training improves human performance including central neural processing. Earlier studies from our laboratories have shown that yoga training produces a significant decrease in visual reaction time (VRT) and auditory reaction time (ART). The present work was planned to determine if *mukh bhastrika* (a yogic technique in which breath is actively blasted out in “whooshes” following a deep inspiration) has any effect on central neural processing by studying its effect on RT. 22 healthy schoolboys who were practicing yoga for the past three months were recruited for the present study. VRT and ART were recorded before and after nine rounds of *mukh bhastrika*. *Mukh bhastrika* produced a significant ($P < 0.01$) decrease in VRT as well as ART. A decrease in RT indicates an improved sensory-motor performance and enhanced processing ability of central nervous system. This may be due to greater arousal, faster rate of information processing, improved concentration and/or an ability to ignore extraneous stimuli. This is of applied value in situations requiring faster reactivity such as sports, machine operation, race driving and specialized surgery. It may also be of value to train mentally retarded children and older sports persons who have prolonged RT.

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“Various exercises, games, sports and even physio-therapy, occupational therapy and various techniques based on biofeedback system mainly work through the motor cortex making person to ‘DO’ an action as per his decision. On the other hand, most of the yoga techniques seem to work through the sensory cortex and the neuro-vegetative system and the person is advised to ‘FEEL’ and ‘OBSERVE’ various happenings and how these happenings are taking place in the body. In games and sports most of the time the extremities are exercised while in yoga techniques the visceral organs and the vertebral column [are] worked upon at the periphery and subcortical levels at the centre.”

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Study: The vital capacity of the lungs (functional lung volume) is a critical component of good health. Vital capacity is an important concern for those with asthma, heart conditions or lung ailments; those who smoke; and those who have no known lung problems.

Researchers at Ball State University in Muncie, Indiana, studied the effects of yoga poses and breathing exercises on vital capacity. The investigators measured lung volume using the Spiropet spirometer (an instrument designed specifically for this purpose). Determinants were taken near the beginning and end of two 17-week semesters. No control group was used. A total of 287 college students (89 men and 198 women) enrolled in the yoga training program.

Subjects were taught yoga poses, breathing techniques and relaxation in 50-minute class meetings twice weekly for 15 weeks. Class adherence was very high (99.96%). The main outcome measure was vital capacity over time for asthmatics, smokers and subjects with no known lung disease. The large number of subjects--287--was a valid sample for a study of this type.

The study showed a statistically significant (p [less than] 0.001) improvement in vital capacity across all categories over time. It is not known whether this positive improvement was the result of yoga poses, breathing techniques, relaxation or other aspects of exercise in the subjects' life. However, these findings were consistent with those of other research studies.

Comments: Increases in lung capacity and function are among the trademark benefits of yoga exercise as long as it is of sufficient quality and duration and involves a distinct yogic breathing component. Earlier studies have demonstrated yoga-induced increases in forced expiratory volume in one second (FEV-1), the factor that is perhaps the most functional index of lung function. This is an important benefit for those who have diminished lung volume and function from emphysema or a sedentary lifestyle.

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“The fundamental secret of yoga is to create and maintain a process of resonance, in other words a process of initiating and amplifying a vibratory response (a link) in a receiving system that is attuned to an emitting system . . . In yoga, the process of resonance is created and maintained mainly by permanently focused attentiveness (effortless mental concentration) . . .”

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Abstract: Relative nostril efficiency (nasal cycle) is related to hemispheric EEG differences and performance on cognitive tasks. We investigated how unilateral forced nostril breathing influences spatial and verbal performance. Right-handed males and females performed both tasks under either left-nostril, right-nostril, or free-breathing conditions. Unilateral breathing affects performance differently in males and females. It influences male performance ipsilaterally on both tasks: Their spatial performance is better during right-nostril breathing, and their verbal performance is better during left-nostril breathing. Unilateral breathing influences female performance contralaterally, but only on the spatial task: Their spatial performance is better during left-nostril breathing. These differences within and between sexes may exist because unilateral nostril breathing differentially activates the two hemispheres and thereby facilitates performance, or because attempts of the brain to control the nasal cycle unilaterally interfere with performance.

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Blumenthal, J. A., C. F. Emery, D. J. Madden, L. K. George, R. E. Coleman, M. W. Riddle, D. C. McKee, J. Reasoner, and R. S. Williams. Cardiovascular and behavioral effects of aerobic exercise training in healthy older men and women. *Journal of Gerontology*, Sep 1989, 44(5):M147-157. PMID: 2768768.

Abstract: The cardiovascular and behavioral adaptations associated with a 4-month program of aerobic exercise training were examined in 101 older men and women (mean age = 67 years). Subjects were randomly assigned to an Aerobic Exercise group, a Yoga and Flexibility control group, or a Waiting List control group. Prior to and following the 4-month program, subjects underwent comprehensive physiological and psychological evaluations. Physiological measures included measurement of blood pressure, lipids, bone density, and cardiorespiratory fitness including direct measurements of peak oxygen consumption (VO₂) and anaerobic threshold. Psychological measures included measures of mood, psychiatric symptoms, and neuropsychological functioning. This study demonstrated that 4 months of aerobic exercise training produced an overall 11.6% improvement in peak VO₂ and a 13% increase in anaerobic threshold. In contrast, the

Yoga and Waiting List control groups experienced no change in cardiorespiratory fitness. Other favorable physiological changes observed among aerobic exercise participants included lower cholesterol levels, diastolic blood pressure levels, and for subjects at risk for bone fracture, a trend toward an increase in bone mineral content. Although few significant psychological changes could be attributed to aerobic exercise training, participants in the two active treatment groups perceived themselves as improving on a number of psychological and behavioral dimensions.

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Abstract: It is unclear whether the age-associated reduction in baroreflex sensitivity is modifiable by exercise training. The effects of aerobic exercise training and yoga, a non-aerobic control intervention, on the baroreflex of elderly persons was determined. Baroreflex sensitivity was quantified by the α -index, at high frequency (HF; 0.15–0.35 Hz, reflecting parasympathetic activity) and mid-frequency (MF; 0.05–0.15 Hz,

reflecting sympathetic activity as well), derived from spectral and cross-spectral analysis of spontaneous fluctuations in heart rate and blood pressure. Twenty-six (10 women) sedentary, healthy, normotensive elderly (mean 68 years, range 62–81 years) subjects were studied. Fourteen (4 women) of the sedentary elderly subjects completed 6 weeks of aerobic training, while the other 12 (6 women) subjects completed 6 weeks of yoga. Heart rate decreased following yoga (69 ± 8 vs. 61 ± 7 min^{-1} , $P < 0.05$) but not aerobic training (66 ± 8 vs. 63 ± 9 min^{-1} , $P = 0.29$). VO_2 max increased by 11% following yoga ($P < 0.01$) and by 24% following aerobic training. Following yoga, α_{HF} (8.0 ± 3.6 vs. 11.5 ± 5.2 ms mmHG^{-1} , $P < 0.01$) but not α_{MF} (6.5 ± 3.0 vs. 7.6 ± 2.8 ms mmHG^{-1} , $P = 0.29$) increased. Short-duration aerobic training does not modify the α -index at α_{MF} or α_{HF} in healthy normotensive elderly subjects. α_{HF} but not α_{MF} increased following yoga, suggesting that these parameters are measuring distinct aspects of the baroreflex that are separately modifiable.

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On the author’s cooperative endeavor with Mahayogi Pilot Baba to establish a Yoga research center in India. “A plan for studies of deep *samadhi* yoga meditation, in which the meditator is able to voluntarily reduce vital functions to a level of profound hypometabolism, [has been] sketched out. This research [will] take place in both India

and the U.S. The first installment of the program has . . . been scheduled to begin between April and June 2001 at the Autonomic Physiology Laboratory of the Columbia-Cornell Medical Center in New York City, specific dates to be set. This demonstration will be performed by Pilot Baba himself.”

Via interviews with several yogis at the Kumbha Mela, it was “found, as expected, that yoga practitioners, like so many others, were followers of what is formally called in western nutritional science a *dietary* or *caloric restriction* (DR or CR) regimen. This ancient practice of Indian yogic science has been recently discovered in Western science only in the past several decades, and especially in the last several years has become a subject of enormous importance in Western nutritional science, gerontology, and medicine and physiology in general. The reason for this intensive focus is the fact that CR can significantly retard aging and extend the maximum life-span, and delay or prevent the onset of many diseases associated with aging, including cancer, heart disease, stroke, Alzheimer’s Disease, Parkinson’s Disease, other major forms of neurodegenerative disease, diabetes, arthritis, and other debilitating conditions.

“The essential CR regimen involves a reduction of caloric intake, by between one- and two- thirds, while maintaining a comprehensive, balanced nutritional composition: ‘undernutrition without malnutrition.’ Achievement of this goal is generally facilitated by utilization of nutritionally rich, balanced foods such as legumes, milk, and other kinds of nutrient-dense foods. Such a regimen results in enhanced physiological functioning on a fundamental level, involving enhancement of the immune system, antioxidant defense systems, and, as most recently determined, enhancement of growth factor and stem cell activity.

“While in Western medical science the discovery of the benefits of the CR regimen are currently flourishing as never before - and bringing with them the very tangible, realistic notion of dramatic life-span and health-span extension into Western scientific consciousness - this knowledge has been a central part of Indian yogic science for centuries, and probably millenia. The association of this type of dietary regimen with enhanced longevity has continued into modern times, and the yogis I interviewed at the Kumbha Mela followed a classic Indian form of CR based on 1-2 small meals a day consisting of legumes, milk, and augmented with fresh vegetables and fruit . . .

“The spectacle of the underground (*bhugarbha*) *samadhi* that I was privileged to witness at the Kumbha Mela camp of Mahayogi Pilot Baba was truly impressive. Performed by his student, Yog Mata Keiko Aikawa, a Japanese woman, the *yogini* was buried in an underground pit for 72 hours. She emerged on the afternoon of January 23rd in apparently excellent condition after having entered the pit, which was covered over with earth, on the afternoon of January 20th.

“The full scientific understanding of this phenomenon awaits an appropriate investigation, which has in fact been scheduled for the spring of this year at the Columbia-Cornell Medical Center. The practice has been observed and written about for centuries by Indians and Westerners, including physicians. An appropriate scientific

consideration of the practice must take into account the following: the practice has been done in the past under false pretenses, i.e., in some cases a secret tunnel was dug which allowed the performer to escape the underground enclosure. Instances of such deception have been recorded. In addition, the underground enclosure can be constructed so that, in actuality, no special respiratory, metabolic, or other putative yogic abilities are necessary, other than the ability to tolerate the tedium and physical discomfort imposed by the demonstration (although this may not be designed with the intent to deceive). In such a case, the dimensions of the pit, in conjunction with air seepage through the soil, allows for enough oxygen to make survival possible without such reputed yogic abilities. However, these considerations do not fully explain the *bhugarbha samadhi* practice, as several previous preliminary clinical investigations, including by members of our own research team, have shown that dramatic voluntary control over respiration and metabolism may in fact be involved. In these several studies, the yogis agreed to perform the samadhi under controlled conditions while being monitored. In these several cases, the yogis demonstrated an unprecedented voluntarily-induced state of profound hypometabolism, ranging from 40-64% below resting baseline. Such states are generally only encountered in profoundly hypothermic individuals close to death.

“Furthermore, Mahayogi Pilot Baba has purportedly demonstrated the more extreme variation of this practice, the *underwater* or *jala samadhi*, for four. If such a feat proves to be possible under controlled conditions - as is soon to be tested - this indeed would constitute a revolution in Western physiological science. Such a feat would require, among a number of critical adaptations, the survival of extended respiratory suspension and circulatory arrest. Although human survival of circulatory arrest for briefer durations has been conclusively documented - in, for example, cases of medically induced hypothermia for surgery and cold-water near-drownings - the voluntary induction and survival of such a phenomenon is scientifically unprecedented. (See Bushell, in preparation, for comprehensive review of this data and discussion of allegedly demonstrated heart-stopping by yoga practitioners. On the genetic relevance of hibernation for primates, including humans, see Andrews et al 1998, Srere et al 1992). The study of this phenomenon, as mentioned, is scheduled to be conducted at the Autonomic Physiology Laboratory of the Columbia-Cornell Medical Center within the next several months. With the present author as Principle Investigator, the study has been designed by him and the above-mentioned researchers. HC Heller, Chairman of the Biology Department and Dean of Students at Stanford University, is an authority on mammalian hibernation, and R Elsner, formerly of the prestigious Scripps Research Institute, is one of the world's leading experts on the physiology of diving mammals. The study of this phenomenon, far from merely representing an exotic, anomalous sideshow technique, actually represents part of the spectrum of enhanced physiological functioning that constitutes the true potential of human nature as understood empirically in the advanced yogic science of India.”

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Abstract: The purpose of this program of research was to explore the use of muscle stretching procedures in relaxation training with a clinical population. In the first controlled study, stretching exercises for four muscle groups (obicularis occuli, sternocleidomastoid/trapezius, triceps/pectoralis major, and forearm/wrist flexors) were prepared. A group of people using these procedures (SR, N = 8) was compared to a group using the Bernstein and Borkovec (1973) tense-release (TR; N = 8) techniques for those same muscle groups, as well as compared to an appropriate group of controls (WL; N = 8). Assessment of physiological (multi-site EMG) and subjective (emotions, muscle tension, and self-efficacy) responses showed that persons in the SR displayed less sadness, less self-reported muscle tension at four sites, and less EMG activity on the r.masseter than persons in the TR group. In the second study, 15 subjects were administered an expanded version of the SR relaxation procedures. Results showed that all subjects reported significant decreases in self-reported levels of muscle tension; muscle tension responders showed lowered trapezius EMG and respiration rates and cardiovascular responders showed lowered diastolic blood pressure. The results are discussed in terms of the utility of relaxation procedures based primarily on muscle stretching exercises for lowering subjective and objective states of arousal.

Carroll, J., A. Blansit, R. M. Otto, and J. W. Wygand. The metabolic requirements of Vinyasa Yoga. *Medicine & Science in Sports & Exercise*, May 2003, 35(5):S155.

Abstract: Purpose: To quantify the hemodynamic and metabolic demand of Ashtanga Vinyasa Yoga (aka power yoga), and compare the heart rate/oxygen consumption relationship of yoga to a maximal treadmill GXT, thirteen yoga practitioners (age 36.7 ± 6.5 yrs, body mass 62.1 ± 13.2 kg, height 166.1 ± 9.4 cm, max VO_2 46.6 ± 4.5 mL/kg-min) with yoga experience of 3-36 months, participated in the study. Methods: Open circuit spirometry was continuously employed during both a maximal Bruce protocol GXT and while subjects mimicked a fifteen-minute video displayed yoga sequence. The video included six yoga positions repeated in several sequences with verbal cueing. All participants were familiarized with the yoga sequence prior to testing. Results: The following mean data were obtained during the yoga trial: VO_2 : 23.4 ± 2.2 mL/kg-min (~50% max VO_2), HR: 143 ± 14 b/min (~77% max HR), Lactate: 4.16 ± 1.3 mMol/L, RER: $.89 \pm .04$, caloric expenditure 7.15 ± 1.3 kcal/min. The correlation of HR versus VO_2 was $r = .90$ and $r = .05$ for the Bruce protocol and yoga, respectively. Conclusion: Despite the lack of relationship between HR and VO_2 , and the mild blood lactate level, Ashtanga Vinyasa Yoga can provide a moderate cardiovascular stimulus through a combination of anaerobic and aerobic energy requirements. The anaerobic exercise and isometric muscle actions involved in Vinyasa Yoga, may in part be responsible for the disproportionate HR/ VO_2 response and thus preclude the use of HR to estimate exercise intensity. The 6.7

MET energy cost of Vinyasa Yoga is similar to the moderate exercise intensity required by aerobic dance and walking.

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Abstract: Autonomic and electroencephalographic (EEG) correlates of Tantric Yoga meditation were studied in three groups of subjects as they progressed from normal consciousness into meditation. Groups differed in their level of meditation proficiency. Measures of skin resistance, heart rate, respiration, autonomic orienting responses, resting EEG, EEG alpha and theta frequencies, sleep-scored EEG, averaged evoked responses, and subjective experience were employed. Unlike most previously reported meditation studies, proficient meditators demonstrated increased autonomic activation during meditation while unexperienced meditators demonstrated autonomic relaxation. During meditation, proficient meditators demonstrated increased alpha and theta power, minimal evidence of EEG-defined sleep, and decreased autonomic orienting to external stimulation. An episode of sudden autonomic activation was observed that was characterized by the meditator as an approach to the Yogic ecstatic state of intense concentration. These findings challenge the current "relaxation" model of meditative states.

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_____. *Anatomy of Hatha Yoga: A Manual for Students, Teachers, and Practitioners*. Honesdale, Pa.: Body and Breath, Inc., 2001. URL: www.bodyandbreath.com. (Excellent.)

From the publisher: “As the third millennium begins, *Anatomy of Hatha Yoga* is the only modern authoritative source that correlates the study of hatha yoga with anatomy and physiology. Yoga teachers, personal trainers, medical therapists of all kinds, or anyone who is at times curious or troubled about how the body responds to stretching and exercise will find in this book a cornucopia—partly new and partly old—of readable and reliable information. Chapter 1 summarizes general principles of anatomy and physiology as applied to hatha yoga. Breathing is next in chapter 2 because yogic breathing expedites movement and posture. Breathing is followed by pelvic and abdominal exercises in chapter 3 because the pelvis and abdomen form the foundation of the body. Standing postures will then be covered in chapter 4 because these poses are so important for beginning students, and because they provide a preview of backbending, forward bending, and twisting postures, which are covered in detail in chapters 5, 6, and 7. The headstand and shoulderstand, including an introduction to cardiovascular function, are presented in chapters 8 and 9. Postures for relaxation and meditation are treated last in chapter 10.”

About the author: “David Coulter received a Ph.D. in anatomy from the University of Tennessee Center for the Health Sciences in 1968. From 1968 to 1986 he taught various microscopic, neuroscience, and elementary gross anatomy courses in the Department of Anatomy of the University of Minnesota (Medical School) in Minneapolis, MN. During that period he also served as a principal investigator for neuroscience research funded by the National Institutes of Health and the National Science Foundation. He next taught in the Department of Anatomy and Cell Biology at Columbia University College of Physicians & Surgeons (1986 to 1988), and since then has practiced and taught a style of bodywork called Ohashiatsu® in New York City and elsewhere. Dr. Coulter has been

practicing yoga since 1974. He was initiated by Swami Veda (formerly Dr. Usharbudh Arya of Minneapolis, MN), trained under Swami Rama from 1975 to 1996, and studied under Pandit Rajmani Tigunait at the Himalayan Institute since 1988. From the inception of his interest in yoga, Dr. Coulter has been committed to correlating his understanding of the practices of that discipline with accepted principles of biomedical science.”

Criswell, Eleanor. *How Yoga Works: An Introduction to Somatic Yoga.* Novato, Calif.: Freeperson Press, 1989. (See especially the section: The Psychophysiology of Somatic Yoga.) Reviewed by Jim Dreaver in *The Journal of The International Association of Yoga Therapists*, 1995, no. 6, pp. 48-49.

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“In a monastery in northern India, thinly clad Tibetan monks sat quietly in a room where the temperature was a chilly 40 degrees Fahrenheit. Using a yoga technique known as g Tum-mo, they entered a state of deep meditation. Other monks soaked 3-by-6-foot sheets in cold water (49 degrees) and placed them over the meditators’ shoulders. For untrained people, such frigid wrappings would produce uncontrolled shivering.

“If body temperatures continue to drop under these conditions, death can result. But it was not long before steam began rising from the sheets. As a result of body heat produced by the monks during meditation, the sheets dried in about an hour.

“Attendants removed the sheets, then covered the meditators with a second chilled, wet wrapping. Each monk was required to dry three sheets over a period of several hours . . .

“During visits to remote monasteries in the 1980s, Benson and his team studied monks living in the Himalayan Mountains who could, by g Tum-mo meditation, raise the temperatures of their fingers and toes by as much as 17 degrees. It has yet to be determined how the monks are able to generate such heat.

“The researchers also made measurements on practitioners of other forms of advanced meditation in Sikkim, India. They were astonished to find that these monks could lower their metabolism by 64 percent. ‘It was an astounding, breathtaking [no pun intended] result,’ Benson exclaims.

“To put that decrease in perspective, metabolism, or oxygen consumption, drops only 10-15 percent in sleep and about 17 percent during simple meditation. Benson believes that such a capability could be useful for space travel. Travelers might use meditation to ease stress and oxygen consumption on long flights to other planets.

“In 1985, the meditation team made a video of monks drying cold, wet sheets with body heat. They also documented monks spending a winter night on a rocky ledge 15,000 feet high in the Himalayas. The sleep-out took place in February on the night of the winter full moon when temperatures reached zero degrees F. Wearing only woolen or cotton shawls, the monks promptly fell asleep on the rocky ledge. They did not huddle together

and the video shows no evidence of shivering. They slept until dawn then walked back to their monastery.”

Curtis, William D., And Harold W. Wessberg. A comparison of heart rate, respiration, and galvanic skin response among meditators, relaxers, and controls. *Journal of Altered States of Consciousness*, 1975-1976, 2:319-324.

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Abstract: This study explored the effects of hatha yoga and progressive relaxation on heart rate, blood pressure, physical self-efficacy, and self-esteem. Ninety-five female Japanese undergraduates participated in the three weekly treatment sessions. Results showed that both treatments were effective in lowering heart rate and blood pressure and increasing self-esteem; however, perceptions of physical self-efficacy declined over time. No significant differences were found between the treatments.

Cysarz,Dirk, Dietrich von Bonin, Helmut Lackner, Peter Heusser, Maximilian Moser, and Henrik Bettermann. Oscillations of heart rate and respiration synchronize during poetry recitation. *American Journal of Physiology: Hearth and Circulatory Physiology*, 2004, 287:H579-H587. Author email: d.cysarz@rhythmen.de. Abstract: <http://ajpheart.physiology.org/cgi/content/abstract/287/2/H579?ct>

Abstract: The objective of this study was to investigate the synchronization between low-frequency breathing patterns and respiratory sinus arrhythmia (RSA) of heart rate during guided recitation of poetry, i.e., recitation of hexameter verse from ancient Greek literature performed in a therapeutic setting. Twenty healthy volunteers performed three different types of exercises with respect to a cross-sectional comparison: 1) recitation of hexameter verse, 2) controlled breathing, and 3) spontaneous breathing. Each exercise was divided into three successive measurements: a 15-min baseline measurement (S1), 20 min of exercise, and a 15-min effect measurement (S2). Breathing patterns and RSA were derived from respiratory traces and electrocardiograms, respectively, which were recorded simultaneously using an ambulatory device. The synchronization was then quantified by the index γ , which has been adopted from the analysis of weakly coupled chaotic oscillators. During recitation of hexameter verse, γ was high, indicating prominent cardiorespiratory synchronization. The controlled breathing exercise showed cardiorespiratory synchronization to a lesser extent and all resting periods (S1 and S2) had even fewer cardiorespiratory synchronization. During spontaneous breathing, cardiorespiratory synchronization was minimal and hardly observable. The results were largely determined by the extent of a low-frequency component in the breathing oscillations that emerged from the design of hexameter recitation. In conclusion, recitation of hexameter verse exerts a strong influence on RSA by a prominent low-frequency component in the breathing pattern, generating a strong cardiorespiratory synchronization.

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Abstract: The purpose of this study was to determine whether a 10-week yoga practice of postures, breathing, and relaxation can increase a person's strength, balance, functional flexibility, and mental and physical quality of life. A sample of 16 volunteers was recruited from a community-based yoga center. A quasi-experimental, one-group within subject control, pre-post-test design was used for this study. Data were analyzed at the significance level of $p < .05$ for one group pre- and post-test of two data sets. The first set generating physical performance data of five tests. The second set, a survey measuring mental and physical health. The Mann-Whitney showed significance at the $p < .01$ for the sit-to-stand physical test. A West showed significance at the $p < .05$ for the mental component of the questionnaire. This study suggests that, even a relatively short (10-weeks) program of yoga will result in improvements of lower limb strength and self-perception of mental well-being of community-dwelling adults (mean age = 46.81) who are novice yoga practitioners.

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Abstract: A finger tapping task was used to assess motor speed (MS) of both hands in 53 adults and 152 children before and after yoga training and in 38 adults of a non-yoga (control) group. All subjects were right hand dominant. The 30-second tapping speed (TS) test was considered as three time intervals, i.e. 0-10 second (TS1), 10-20 seconds (TS2) and 20-30 seconds (TS3). There was a significant (Student's t-test) increase in all three TS values following 10 days of yoga in children and 30 days of yoga in adults. However for both groups at baseline and final assessments, TS2 and TS3 were significantly lower than TS1. Hence the TS was increased after yoga training during the first 10-seconds of the test but not during the next 20 seconds. These results suggest an increase in motor speed for repetitive finger movements following yoga training, but not in strength or endurance, as the increase was not sustained over 30 sec.

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Abstract: The present study aimed at assessing the effects of a set of yoga practices on normal adults (n = 37), children (n = 86), and patients with rheumatoid arthritis (n = 20). An equal number of normal adults, children, and patients with rheumatoid arthritis who did not practice yoga were studied under each category, forming respective control groups. Yoga and control group subjects were assessed at baseline and after varying intervals, as follows, adults after 30 days, children after 10 days and patients after 15 days, based on the duration of the yoga program, which they attended, which was already fixed. Hand grip strength of both hands, measured with a grip dynamometer, increased in normal adults and children, and in rheumatoid arthritis patients, following yoga, but not in the corresponding control groups, showing no re-test effect. Adult female volunteers and patients showed a greater percentage improvement than corresponding adult males. This gender-based difference was not observed in children. Hence yoga practice improves hand grip strength in normal persons and in patients with rheumatoid arthritis, though the magnitude of improvement varies with factors such as gender and age.

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Deepak K. K. Neurophysiological mechanisms of induction of meditation: a hypothetico-deductive approach. *Indian Journal of Physiology and Pharmacology*, Apr 2002, 46(2):136-158. PMID: 12500489.

Abstract: A detailed analysis of methods of induction of meditation and meditative experience encountered therein implicates involvement of several mechanisms in inducing “meditative effect.” “Efferent attenuation,” “sensory attenuation” and “cognitive restructuring” appear three possible mechanisms employed in varying degree of combinations to produce the “meditative effect” during different types of meditations. Using hypothetico-deductive approach, it is possible to generate a neural model for explaining the “meditative effect.” Primarily, the meditation is produced by disengaged association cortices driven by thalamus or other older group of reticular nuclei. Secondly, there may be involvement of some more phylogenetically older structures depending upon depth and types of meditation. This model explains induction, maintenance and long-term effects of meditation.

Defense Institute of Physiology and Allied Sciences, Lucknow Road, Timarpur, Delhi, India. Effect of yogic practices on the physiological and antioxidant systems in man. URL: <http://www.ccryn.org/Index1.html> (click on “Abstract of Research Works” in the left menu bar).

Summary: So far, under this study maximal oxygen consumption and anaerobic threshold were determined on forty Army subjects. They were divided into two groups, i.e., “Yoga” and “Control.” The Yoga group underwent one-hour of yogic practices, consisting of *asanas*, *pranayama*, and meditation, every day except Sunday for twelve months. During this period recordings were repeated at the seventh to eighth month and twelfth to fourteenth month.

During each exercise session on a bicycle ergometer, blood samples were taken before and after exhaustive exercise to assess the subject’s level of oxidative stress due to exercise by recording various markers of oxidative stress and antioxidant activity to observe if there is any effect of Yogic practices in the modulation of oxidative stress. Tests were conducted on 20 Yoga proficient participants (Yoga instructors) for recording of various physiological parameters during yogic practices. Among them 8 subjects showed better responses as compared to Yoga trainees.

We found significant reduction in perceived exertion after maximal exercise in the Yoga group after 4-5 months of Yogic training, which demonstrates the potential of yogic exercises in sports training and in different occupational situations both in the military and civil sectors. The data on oxidative stress recorded before and after exercise indicate that the subjects practicing yogic exercises could successfully cope with oxidative stress by changes in three systems: increased metabolism of glutathione, elevated production of antioxidant enzymes, and more efficient elimination of per-oxidation products.

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_____. Biochemical indices associated with meditation practice: A literature review. *Neuroscience and Biobehavioral Reviews*, Winter 1985, 9(4):557-561.

Abstract: Research findings on biochemical responsivity to meditation are reviewed. Although there are some contradictory and inconclusive outcomes, there is nevertheless sufficient evidence of interest to warrant further investigation of this area. However, in the meantime, there is no compelling basis to conclude that meditation practice is associated with special state or trait effects at the biochemical level.

Biochemical markers examined included: blood lactate and blood flow; cortisol, testosterone, growth hormone, thyroxine and triiodothyronine; plasma rennin, aldosterone and dopamine—betahydroxylase; catecholamines; serum cholesterol; plasma phenylalanine; neuro-transmitter metabolites; prolactin; salivary translucency, proteins, minerals and pH

_____. Electro cortical activity and related phenomena associated with meditation

practice: A literature review. *International Journal of Neurosciences*, 1984, 24:217-231.

Abstract: The state effects of meditation appear to include decreased electrocortical arousal. There is also evidence that meditators more readily demonstrate alpha and theta activity than nonmeditators, even when not meditating. It is not clear whether prospective meditators as a group already possessed this characteristic, or whether the state effects of meditation practice eventually generalize to become traits. However, certain individuals, namely the psychologically “healthy” and those with a capacity for relaxed absorbed attention, appear to be more favourably disposed to meditation. Meditators appear to show both stronger orienting and recovery responses to stressors while meditating than controls. Meditation may begin with left hemisphere type activity, which gives way to functioning more characteristic of the right hemisphere. However, it appears that during advanced meditation (“no thought”) both left and right hemisphere activity are largely inhibited or suspended. Depending on the individual, inexperienced meditators may report sleep, hypnagogic reverie, trance or abreaction during practice. The evidence to date does not support the notion of unique state effects associated with the practice of meditation.

_____. Physiological concomitants of meditation practice. *International Journal of Psychosomatics*, 1984, 31(4):23-36.

Abstract: Meditation has been extensively researched in terms of physiological responsiveness. Although practice is associated with both state and trait (long-term) decrements in arousal (especially in blood pressure, muscle tension and respiratory indices) there is, generally, no compelling evidence to suggest superiority to other established relaxation techniques (except, perhaps, in the case of blood pressures). At best, meditation appears to be somewhat more relaxing than eyes-closed rest. There is little to support the notion of unique state effects associated with practice. However, meditators appear to show stronger recovery responses to stressful stimuli than controls. This finding warrants further investigation.

Meditation is increasingly gaining prominence as a self-management and personal development technique as well as becoming more prevalent in the clinical setting as an adjunct to psychotherapy. This is particularly true in the case of Transcendental Meditation (TM) and its non-cultic or clinically adapted variants. However, there is no extensive up-to-date review of the research literature dealing with the psychophysiological effects of meditation practice. This article addresses that issue by reviewing the effects of meditation.

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Abstract: Electroencephalographic (EEG) recordings from 19 scalp recording sites were used to differentiate among two posited unique forms of mediation, concentration and mindfulness, and a normal relaxation control condition. Analyzes of all traditional frequency bandwidth data (i.e., delta 1-3 Hz; theta, 4-7 Hz; alpha, 8-12 Hz; beta 1, 13-25 Hz; beta 2, 26-32 Hz) showed strong mean amplitude frequency differences between the two meditation conditions and relaxation over numerous cortical sites. Furthermore, significant differences were obtained between concentration and mindfulness states at all bandwidths. Taken together, our results suggest that concentration and mindfulness “meditations” may be unique forms of consciousness and are not merely degrees of a state of relaxation.

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Abstract: How patients with coronary artery disease respond to stress can effect their cardiac health. This study examined whether patients with documented coronary artery disease would be able to learn a self-help skill which would reduce cardiac reactivity during mildly stressful and restful activities. Cardiac stress was determined measuring Heart Rate Variability (HRV), an indication of autonomic arousal. HRV has been shown to be a predictor of sudden cardiac death in patients with cardiac disease. 56 patients with documented coronary artery disease were randomized to receive either a cardiac stress management video or a meditation video which guided them through a standard a standard Zen breath awareness meditation. The technique involved becoming attentionally absorbed in the breath, but not manipulating it. Patients' HRV (SDNN) was measured during several conditions including rest, reading, paced breathing, Stroop color word conflict stressor, post stressor rest, post stressor reading, and post stressor paced breathing. Patients who received meditation instruction significantly increased heart rate variability post intervention compared to patients who received a stress management lecture ($p \leq .007$). In addition, patients who engaged in meditation practice handled stress better, as indicated by an increase in heart rate variability during the Stroop task ($p \leq .042$) and post-intervention pre-stressor paced breathing period ($p \leq .006$). Results suggest that engaging in even one brief period of Zen breath meditation awareness can be effective for improving the heart's response to stress for patients with coronary artery disease.

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Abstract: Seven converging lines of thought are synthesized in support of the perennial theory of spirit-mind-body unity and control, namely 1) ethology, 2) Freudian psychodynamics, 3) perception, 4) psychoneuroanatomy, 5) autogenic training, 6) yogic subtle-energy theory, and 7) Jungian psychology. Biofeedback training and visualization therapy are seen as simple and natural ways of becoming conscious of, and modulating, normally unconscious body/mind processes.

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Abstract: Energy Medicine and Subtle Energies will be defined operationally in increasingly precise ways as new techniques, as new tools, and new theories are developed and tested. *Personal ecology* is discussed in relation to the burgeoning consumption of non-organic drugs being produced and advertised by commercial drug companies under the umbrella of “the American health care system.” In contrast, a yogic self-regulation theory is outlined which, if it is tested, could provide strong guidance for the development of a Science of Human Potential and lead to a better understanding of psychophysiological self-regulation (mind-over-matter inside the skin, INS) and parapsychology, psychokinesis, and traditional “healing” (mind-over-matter outside the skin, OUTS). Basic *Patanjali yoga* and *volition*, and their relation to both INS and OUTS “coincidence control” are considered. On the other hand, it is argued that if we hope in ISSSEEM to build bridges, linking paradigms for clinicians and scientists, that, whenever possible, it is useful to use concepts and metaphors, instruments and techniques, that are understood in present-day science and clinical practice, and as much as possible avoid metaphysical explanations. It is useful to be open minded, but not “far out,” to conquer our fears of the anomalous, but not be reckless when talking with colleagues.

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Abstract: A Tibetan meditation system reported in 1882 suggested a way to facilitate self-awareness by isolating students from electrical ground while they sat beneath a bar magnet and looked at their image in a polished copper wall. The research question: Does an electrostatic charge build up on electrically-isolated meditators? This question was tested with 10 “regular” subjects (typical meditators) and 9 “exceptional” subjects (experienced Non-Contact Therapeutic Touch (NCTT) therapists) in a Copper Wall Lab designed to isolate the subject from ground and also isolate, individually, four surrounding copper walls, front, back, up, and down. For detection of electrostatic potential, the subject’s body and the four walls were individually “floated” on single-ended electrometer inputs. A pair of video cameras guarded against body-motion artifact. In 45-minute meditation sessions with the 10 regular meditators, *no body-potential surges reached 4 v*. In comparison, in comparable meditation sessions with the NCTT meditators, many body-potential surges greater than 4 v were found. Surges appearing in the records of NCTT meditators ranged from 4 v to 221 v (median = 8.3 v), with surge duration ranging from 0.5 s to 12.5 s (median = 3.6 s). During NCTT *therapy sessions*

with patients, NCTT therapists produced body-potential surges ranging from 4 v to 190 v. The majority of surges were of negative polarity. Though there is a long tradition of Non-Contact Therapeutic Touch in both folklore and in religion, there are as yet no known psychophysiological or biophysical explanations for such large-magnitude electrical phenomena, 103 times greater than large psychophysiological skin-potential (GSP) changes related to emotional responses, 105 larger than EKG voltages, and 106 larger than EEG voltages. Since focus-of-attention by NCTT therapists is often a correlate factor in this anomalous phenomenon, results suggest the presence of previously-unmeasured human potential, as well as body potential. Various schemes are discussed for analysis of body-potential surge data, with an eye to determining body mechanisms that might be capable of generating electrostatic charge.

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“Over the past decade I have tried to determine what [it is] about yoga that makes it so good for so many people. Valerie [Kit Love, who teaches an ‘Anatomy of Movement’ workshop] provided me with a very sensible answer. She explained that as we move our muscles over a period of time, little adhesions form. Yoga acts as a self-Rolfing technique allowing the fibers of the muscles to slide pass each other ultimately improving the glide of tight fibers so that they become free and open allowing oxygen-carrying blood to penetrate and nourish the cells. This could be one of the most important therapeutic benefits of yoga that students can experience as they practice the postures.”

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between running and meditation, we predicted that mood change after these activities would be similar when associated with similar hormonal change. Compared to pre-test and control values, mood was elevated after both activities but not significantly different between the two groups at post-test. There were significant elevations of beta-EP and CRH after running and of CRH after meditation, but no significant differences in CRH increases between groups. CRH was correlated with positive mood changes after running and meditation. Cortisol levels were generally high but erratic in both groups. We conclude that positive affect is associated with plasma CRH immunoreactivity which itself is significantly associated with circulating beta-EP supporting a role for CRH in the release of beta-EP. Increased CRH immunoreactivity following meditation indicates, however, that physical exercise is not an essential requirement for CRH release.

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“Following the meditation, a significant rise of alpha and theta rhythms in the brain was observed in ten out of eleven subjects. For some, the alpha waves more than doubled. The increase of these rhythms was greatest in the rear part of the brain (parietal regions), where both alpha and theta rhythms rose by an average of 40%. There was a general tendency for these rhythms to spread from the rear part of the brain forwards. In ten of the eleven right handed people, the alpha increased more in the right than in the left side of the temporal regions.

“The considerable increase in alpha and theta activity in most regions of the brain after meditation indicates that the brain is deeply relaxed and focused following Kriya Yoga. It also shows that through the meditation the subjects have obtained a better contact with their subconscious and their emotions.

“The great increase of alpha in the right temporal lobe is an interesting finding. Recent research in the U.S. has shown that depressed, introvert people have more alpha in the left fronto-temporal region, while optimistic, extrovert people have more alpha in the right side. According to the American research, an increase of alpha in the right side, as found in this study of Kriya Yoga, counteracts stress and depression.

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Abstract: The experience of Pure Consciousness (PC) is met on the way to Samadhi—the goal of all yogic practices. Though the earlier seven steps of control of body and mind—discussed in Astanga Yoga—are fairly comprehensively described and understood in current scientific terminology, the state of Samadhi seems to defy all such simplistic and logical approaches. There is therefore an urgent need to understand the physical and the psychophysiological basis of PC and to relate it to the evolutionary process through

modern scientific idea. In this paper, we try to describe the state of PC using the thermodynamic principle of minimum entropy production.

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Abstract: With the aim of evaluating the sympathetic-adrenal medulla system in subjects practicing transcendental meditation (TM), their plasma catecholamine levels were determined at two different times of day. The study group consisted of 19 subjects who regularly practice either TM or Sidhi-TM technique, with a control group made up of 16 healthy subjects who had not previously used any relaxation technique. Catecholamine plasma levels were determined by high performance liquid chromatography, at 0900 and 2000 h. Morning and evening norepinephrine (NE) levels and morning epinephrine (E) levels were significantly lower in the TM group than in the control subjects (morning NE levels, pg/ml, mean \pm S.E.: TM group 136.6 \pm 13.0, control 236.8 \pm 21.0, P=.0001; evening NE levels: TM group 119.7 \pm 10.8, control 175.6 \pm 17.4, P=.009; morning E levels, pg/ml: TM group 140.2 \pm 10.6, control 196.7 \pm 23.8, P=.019). No differences were recorded for evening E levels and dopamine (DA) levels. No significant differences were found for catecholamine levels measured at different times of day in the TM group, demonstrating a lack of daily hormonal rhythm. Anxiety levels were similar in both groups. Based on the results obtained, it can be considered that the regular practice of TM has a significant effect on the sympathetic-adrenal medulla system. A low hormonal response to daily stress caused by sympathetic tone regulation through regular TM could explain our results, as well as the physiological and other effects related to the field of health described in those who practice meditation.

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Abstract: This study describes the effects of 30 minutes of unilateral forced nostril breathing on cognitive performance in 51 right-handed undergraduate psychology students (25 males and 26 females). A verbal analogies task modeled after the Miller Analogies and SAT Tests was used as a test of left-hemispheric performance and mental rotation tasks based on the Vandenburg and Kuse adaptation of Shepard and Metzler's tests were used as spatial tasks for testing right-hemispheric performance. Spatial task performance was significantly enhanced during left nostril breathing in both males and females, $p = .028$. Verbal task performance was greater during right nostril breathing, but not significantly $p = .14$. These results are discussed in comparison to other cognitive and physiological studies using unilateral forced nostril breathing. This yogic breathing technique may have useful application in treating psychophysiological disorders with hemispheric imbalances and disorders with autonomic abnormalities.

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_____, **H. C. Pirkle, and A. F. Wilson.** Behavioral alteration of plasma phenylalanine concentration. PMID: 343124.

Abstract: The concentration of 13 neutral and acidic plasma amino acids was measured before, during and after either 40 min of control relaxation or 40 min of the process known as transcendental meditation (TM). An electro-oculogram, electroencephalogram, and electromyogram were simultaneously monitored in these subjects. Increased phenylalanine concentration was noted during TM practice with no change during control relaxation; no difference between the groups of total time slept or sleep stage percent was observed. The stability of phenylalanine concentration in controls and lack of correlation of increased phenylalanine with sleep in the long-term practitioners seem to suggest a relationship of the phenylalanine increase to TM practice.

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Abstract: While for centuries a wakeful and tranquil state or experience variously called "samadhi," "pure awareness," or "enlightenment" had been said to be a normal experience and the goal of meditation in Vedic, Buddhist, and Taoist traditions, there was little known about this behavior until recently, when the practice of "transcendental meditation" (TM) became available for study in Western scientific laboratories. Derived from the Vedic tradition, TM is unique because it requires no special circumstances or effort for practice. Based upon a wide spectrum of physiological data on TM, we hypothesize that meditation is an integrated response with peripheral circulatory and metabolic changes subserving increased central nervous activity. Consistent with the subjective description of meditation as a very relaxed but, at the same time, a very alert state, it is likely that such findings during meditation as increased cardiac output, probable increased cerebral blood flow, and findings reminiscent of the "extraordinary" character of classical reports: apparent cessation of CO₂ generation by muscle, fivefold plasma AVP elevation, and EEG synchrony play critical roles in this putative response.

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_____, **A. F. Wilson, J. P. O'Halloran, and R. N. Walsh.** Forearm blood flow and metabolism during stylized and unstylized states of decreased activation. *American Journal of Physiology*, Jul 1983, 245(1):R110-116. PMID: 6869572.

Abstract: We have measured forearm oxygen consumption and blood flow changes during two wakeful rest behaviors. We have observed acute reduction of forearm respiration (28%) during an acute stylized rest state (TM) and a nonsignificant small decline (11%) during unstylized ordinary eyes-closed rest. These changes were not associated with significant change of forearm blood flow or glycolytic metabolism. Hence, forearm oxygen consumption decline was due almost solely to decreased rate of

oxygen extraction. Small variation of forearm blood flow implies that little of the previous findings of increased nonrenal, nonhepatic circulation during TM or increased nonrenal circulation during ordinary rest can be accounted for by altered muscle blood flow, which therefore is consistent with possible increased cerebral blood flow. However, reduced muscle metabolism was a likely contributor to the forearm metabolic decline. The lack of coupling between metabolic and blood flow changes during TM indicates limitation of obligatory coupling between cardiovascular and metabolic function in the rest state of TM.

_____, **A. F. Wilson, H. Pirkle, J. P. O'Halloran, and R. N. Walsh.** Metabolic control in a state of decreased activation: Modulation of red cell metabolism. *American Journal of Physiology*, 1983, 245:C457-C461. PMID: 6416079.

Abstract: Very little is known in depth of the biochemical and physiological changes induced at the cellular level by human behavioral states. For study of the physiology of behavior at this level, the erythrocyte may be useful, because it is readily available and its metabolism and metabolic control are comparatively well understood. In this report we describe a marked decline of red cell glycolytic rate induced by the transcendental meditation technique (TM). This decline was significantly correlated with decreased plasma lactate concentration and with relaxation as indicated by electrodermal response. The occurrence of sleep was not correlated with the metabolic changes. The observed lack of variation of blood pH, blood gases, glucose, and hematocrit in this behavior implies that the decrease of erythrocyte metabolism is not an epiphenomenon of respiratory change or substrate availability. Based upon further measurements indicating persisting alteration of the red blood cell, we suggest the possibility of attachment of a humoral agent(s) to the cell in the mechanism of this effect. This behavioral effect is unique, and the effector(s) responsible may increase our understanding of metabolic control of the erythrocyte and of TM.

_____, **A. F. Wilson, W. R. Smith, and M. E. Morton** Redistribution of blood flow in acute hypometabolic behavior. *American Journal of Physiology*, Jul 1978, 235(1):R89-92. PMID: 354414.

Abstract: Cardiac output, renal and hepatic blood flows, arterial lactate concentration, and minute volume were measured before, during, and after 40 min of rest induced either by the practice known as "transcendental meditation" (TM) or by an ordinary eyes-closed rest-relaxation period. Two groups of normal young adults were studied: one group consisted of regular practitioners of TM and the other of similar individuals studied prior to learning this technique. Marked declines of renal blood flow were noted in both groups. Decline of hepatic blood flow, increased cardiac output, decreased arterial lactate, and minute volume were also recorded in the TM-induced rest period. These changes imply a considerable increase of nonrenal, nonhepatic blood flow during TM (44%) and, to a lesser extent, during rest (12%). Increased cerebral and/or skin blood flow is hypothesized to account for part of the redistributed blood flow in the practitioner.

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Abstract: This thesis investigates the practice of meditation from these three distinct perspectives. Meditation practice as defined in this analysis includes both concentration meditation and mindfulness or awareness meditation as developed in Zen Buddhism.

Our examination of meditation begins with neuroscience. In the first chapter, we examine how neuroscience explains the construction of self and reality through processes of the brain. We follow the path of stimuli from the sense organs to the higher structures of the brain as this information is processed to form both our external reality as well as our internal sense of self. We then examine studies of the effect of the practice of meditation on these association processes of the brain, as researched by neuroscientists.

While neuroscience provides us with an objective understanding of how the brain functions during meditation, it is limited in providing us with an explanation of the subjective experience of meditation. In the second chapter, in order to gain an understanding of the subjective processes of the mind, we must turn to philosophy. Through phenomenology, we are provided with a similar sequential explanation of the construction of self and reality. We then examine how the practice of meditation affects these subjective experiences.

While phenomenology provides a more in-depth analysis of our subjective experience, it is limited to an abstract description of understanding self and reality. In the third chapter, we examine the experiential practice of meditation as outlined by practitioners of Zen. This explanation of meditative practice provides an understanding of the Buddhist non-dual view of reality as the ground out of which our objective and subjective understandings of self and reality arise.

Neuroscience, phenomenology, and Zen are three very different perspectives for examining reality. This thesis points to similarities in how each perspective understands

the construction of self and reality, thus providing a deeper understanding of the practice as a whole. Previously, attempts to understand meditation were limited to either objective or subjective approaches; however this thesis combines both objective and subjective approaches to meditation as well as a more complete understanding of the non-dual perspective of Zen.

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Abstract: Thirty three normal male and forty two normal female subjects, of average age of 18.5 years, underwent six weeks course in "Pranayam" and their ventilatory lung functions were studied before and after this practice. They had improved ventilatory functions in the form of lowered respiratory rate (RR), and increases in the forced vital capacity (FVC), forced expiratory volume at the end of 1st second (FEV1%), maximum voluntary ventilation (MVV), peak expiratory flow rate (PEFR-lit/sec), and prolongation of breath holding time.

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“A lot of research has been carried out to examine the effect of yoga on neuro-physiological, hormonal and metabolic parameters but while it is of interest that yogis can control their heartbeat or change their brain waves, the crucial question from the psychological point of view is whether they can control their mental fluctuations. Indian tradition claims that the only way to understand the impact of yoga on the subjective states is by experiencing it yourself.

“A few years ago, I took a year off from my work to do just that. I apprenticed myself to a guru and devoted myself to yoga, spending about five hours every day on yogic practices. Every evening, I would spend an hour or two recording my observations regarding what had happened to my own mental state. After the completion of one year, I once again stood outside my experiences and examined whether my daily observations revealed any consistent patterns. It is my understanding that if a few fellow professionals go through similar training and report their conclusions in a similar manner, some commonalities can be culled out to form a body of phenomenological knowledge around

the yoga technique. Walsh has done such an exercise for vipasana meditation but I am not aware of any with respect to yoga.

“This paper gives an account of my exploration.”

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Abstract: [The] stress and strain of modern life can be reduced either by relaxation or meditation. Complete mental and physical relaxation is possible by ancient procedures like Yogic Meditation (YM) and Transcendental Meditation. Earlier studies on EEG during meditation, have shown dominant alpha pattern which is recorded symmetrically all over the cerebral hemispheres.

The study was conducted and the results showed the alpha frequency and voltage were significantly higher in meditators. Beta waves were significantly higher in control group. In either of the groups theta waves were not found. On photic stimulation no difference was observed in meditators and control group in EEG. There was a significant decrease in respiratory rate in meditators.

In conclusion, we found that meditation enhances self-confidence, sense of well-being, and empathy; improves cognitive functions as evidenced by increased alpha wave activity and its synchronization. It also increase mental concentration and reduces susceptibility to stress and strain. Thus meditation promotes complete health and well-being in an individual.

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after practicing this asana. A tendency toward a mild regression of the left ventricular mass was noticed, though it was not statistically significant. The CV responses to acute 45 degrees head-down tilt (HDT) in a tilt table was not altered after practicing this asana. Also there was no orthostatic intolerance during the 3-5 min period of 70 degrees head-up tilt (HUT). These results strongly indicate that further studies of this asana performed for a longer period is most likely to yield very significant observations of applied value.

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Abstract: Nearly all authorities agree that exercise reduces tension and improves mental health; however, a specific cause-and-effect phenomenon has not been found. More than five decades of research have revealed numerous plausible mechanisms underlying exercise-related mood alterations. The purpose of this narrative review is briefly to review six of the more popular mechanisms and acquaint health promotion professionals with their affiliated nature. Nearly all of the mechanisms proposed overlap or share some common neuroanatomic pathway. It is probably that the best candidate for exercise-induced affective changes evolves from an integration of brain neurotransmission processes involving such principle neuroactive substances as endorphin, enkephalin, serotonin, dopamine, and norepinephrine, among many others. The alliance of these specialized brain systems responsible for mood changes also influences a constellation of “mind-body” functions such as state-dependent learning and memory, autogenic training, eating behavior, hypnosuggestion, psychoneuroimmunology, and stress-related disorders such as hypertension. The utilization of new brain imaging techniques to study acute exercise and collaborative efforts with researchers in cognitive neuroscience and neurobiology will help elucidate how these mechanisms are functionally coupled. Individual psychobiological responses to exercise and other stimuli are invariably related to one’s genetic code, the nature of the exercise, the exercise environment, and present health and fitness. By attempting to comprehend these extraordinary psychobiological features, fitness and health promotion professionals can better understand and respect individual differences in mood and performance.

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Abstract: In recent years health promotion programs have generated many worthwhile psychologic and physiologic benefits but frequently with less than optimal long-term adherence. Incorporating approaches such as mind-body exercise with existing health

promotion and cardiac rehabilitation services can improve self-efficacy and long-term adherence to healthy behaviors as well as improve personal stress management skills. Mind-body exercise couples muscular activity with an internally directed focus so that the participant produces a temporary self-contemplative mental state. This internal focus is in contrast to conventional body-centered aerobic and muscular fitness exercise in which there is little or no mindful component. Research on mind-body exercise programs such as yoga and tai chi reveal they have significant mental and physical value. There also are numerous primary and secondary preventive indications for cardiovascular disease in which mind-body exercise can play a primary or complementary role. Mind-body exercise programs will be a welcome and necessary addition to evolving disease management models that focus on self-care and decreased health care use.

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Meditation is a conscious mental process that induces a set of integrated physiologic changes termed the relaxation response. Functional magnetic resonance imaging (fMRI) was used to identify and characterize the brain regions that are active during a simple form of meditation. Significant ($p < 10^{-7}$) signal increases were observed in the group-averaged data in the dorsolateral prefrontal and parietal cortices, hippocampus/parahippocampus, temporal lobe, pregenual anterior cingulate cortex, striatum, and pre- and post-central gyri during meditation. Global fMRI signal decreases were also noted, although these were probably secondary to cardiorespiratory changes that often accompany meditation. The results indicate that the practice of meditation activates neural structures involved in attention and control of the autonomic nervous system.

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Abstract: Multichannel EEG of an advanced meditator was recorded during four different, repeated meditations. Locations of intracerebral source gravity centers as well as Low Resolution Electromagnetic Tomography (LORETA) functional images of the EEG “gamma” (35-44 Hz) frequency band activity differed significantly between meditations. Thus, during volitionally self-initiated, altered states of consciousness that were associated with different subjective meditation states, different brain neuronal populations were active. The brain areas predominantly involved during the self-induced meditation states aiming at visualization (right posterior) and verbalization (left central) agreed with known brain functional neuroanatomy. The brain areas involved in the self-induced, meditational dissolution and reconstitution of the experience of the self (right fronto-temporal) are discussed in the context of neural substrates implicated in normal self-representation and reality testing, as well as in depersonalization disorders and detachment from self after brain lesions.

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Abstract: OBJECTIVE: This study examined the effects of “tanden breathing” by Zen practitioners on cardiac variability. Tanden breathing involves slow breathing into the lower abdomen. METHODS: Eleven Zen practitioners, six Rinzai and five Soto, were each studied during 20 minutes of tanden breathing, preceded and followed by 5-minute periods of quiet sitting. During this time, we measured heart rate and respiration rate. RESULTS: For most subjects, respiration rates fell to within the frequency range of 0.05 to 0.15 Hz during tanden breathing. Heart rate variability significantly increased within this low-frequency range but decreased in the high-frequency range (0.14–0.4 Hz), reflecting a shift of respiratory sinus arrhythmia from high-frequency to slower waves. Rinzai practitioners breathed at a slower rate and showed a higher amplitude of low-frequency heart rate waves than observed among Soto Zen participants. One Rinzai master breathed approximately once per minute and showed an increase in very-low-frequency waves (<0.05 Hz). Total amplitude of heart rate oscillations (across frequency spectra) also increased. More experienced Zen practitioners had frequent heart rhythm irregularities during and after the nadir of heart rate oscillations (i.e., during inhalation). CONCLUSIONS: These data are consistent with the theory that increased oscillation amplitude during slow breathing is caused by resonance between cardiac variability caused by respiration and that produced by physiological processes underlying slower rhythms. The rhythm irregularities during inhalation may be related to inhibition of vagal modulation during the cardioacceleratory phase. It is not known whether they reflect cardiopathology.

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Abstract: Purpose: The purpose of this study was to determine if selected balance tests are sensitive and appropriate when determining if there is a significant difference in the balance abilities on selected balance test with a group of yoga and non-yoga trained older adults. Diminished balance abilities in the elderly often predispose the individual to a potentially serious fall. If yoga training can be shown to produce significant improvement in balance with older adults it might reduce the incidence of falls and prove an effective intervention. There are numerous balance tests incorporated with older adults, but some prove more sensitive and valid when determining the risk for falls in the elderly.

Subjects: 42 healthy and active community-dwelling older adults, 24 (mean age, 70.50, range 62 - 79) who have recently participated in yoga classes (Y), and 20 (mean age 72.05, range 63 - 80) who had not (NY). Methods: Three balance measurements, the Berg Balance Test (BBT), the Multidirectional Reach Test (MDRT), and the Timed Up and Go Test (TUG) were administered to the two groups. Analysis: Means were calculated for test scores from both groups. An independent t-test compared the difference in means. Results: Only the BBT showed statistical difference (54.67 (Y) VS 53.15 (NY), $p < .01$, although not clinically significant. Two of the items on the BBT, the Tandem Stand and the One Leg Stand, showed significant differences, 3.54 (Y) VS 3.00 (NY), and 3.54 (Y) VS 2.85 (NY) respectively, $p < .05$. Conclusions: When testing the effect of intervention on balance ability of healthy active older adults, the BBT, MDRT and TUG tests may not be sensitive to detect significant change and may not be the most appropriate indicators. Further studies utilizing either more challenging balance tests (e.g. timed single-leg stance), or tests on a less healthy population may be necessary to detect a significant effect of yoga training on balance.

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Abstract: QiGong is an ancient and widely practiced Chinese meditation exercise. We studied the effects of QiGong on brain function with modern neuromonitoring tools in two subjects. In a male QiGong master (extremely trained practitioner), the technique induced reproducible changes in transcranial Doppler sonography, EEG, stimulus-induced 40 Hz oscillations, and near-infrared spectroscopy findings. Similar effects were seen after the application of multimodal stimuli and when the master concentrated on intense imagined stimuli (e.g. 22.2% increase in mean blood flow velocity (vm) in the posterior cerebral artery, and a simultaneous 23.1% decrease of vm in the middle cerebral artery). Similar effects were seen in the female subject. Neuromonitoring during QiGong appears able to objectify accompanied cerebral modulations surrounding this old Chinese meditation exercise.

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Abstract: The aim of the present study was to examine whether the neural structures subserving meditation can be reproducibly measured, and, if so, whether they are different from those supporting the resting state of normal consciousness. Cerebral blood flow distribution was investigated with the 15O-H2O PET technique in nine young adults, who were highly experienced yoga teachers, during the relaxation meditation (Yoga Nidra), and during the resting state of normal consciousness. In addition, global CBF was measured in two of the subjects. Spectral EEG analysis was performed throughout the investigations. In meditation, differential activity was seen, with the noticeable exception of V1, in the posterior sensory and associative cortices known to participate in imagery tasks. In the resting state of normal consciousness (compared with meditation as a baseline), differential activity was found in dorso-lateral and orbital frontal cortex, anterior cingulate gyri, left temporal gyri, left inferior parietal lobule, striatal and thalamic regions, pons and cerebellar vermis and hemispheres, structures thought to support an executive attentional network. The mean global flow remained unchanged for both subjects throughout the investigation (39+/-5 and 38+/-4 ml/100 g/min, uncorrected for partial volume effects). It is concluded that the (H2)15O PET method may measure CBF distribution in the meditative state as well as during the resting state of normal consciousness, and that characteristic patterns of neural activity support each state. These findings enhance our understanding of the neural basis of different aspects of consciousness.

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Abstract: There is evidence that the practice of yoga improves physical and mental performance. The present investigation was undertaken to study the effect of yoga training on visual and auditory reaction times (RTs), maximum expiratory pressure (MEP), maximum inspiratory pressure (MIP), 40 mmHg test, breath holding time after expiration (BHTexp), breath holding time after inspiration (BHTinsp), and hand grip strength (HGS). Twenty seven student volunteers were given yoga training for 12 weeks. There was a significant ($P < 0.001$) decrease in visual RT (from 270.0 +/- 6.20 (SE) to 224.81 +/- 5.76 ms) as well as auditory RT (from 194.18 +/- 6.00 to 157.33 +/- 4.85 ms). MEP increased from 92.61 +/- 9.04 to 126.46 +/- 10.75 mmHg, while MIP increased from 72.23 +/- 6.45 to 90.92 +/- 6.03 mmHg, both these changes being statistically significant ($P < 0.05$). 40 mmHg test and HGS increased significantly ($P < 0.001$) from 36.57 +/- 2.04 to 53.36 +/- 3.95 s and 13.78 +/- 0.58 to 16.67 +/- 0.49 kg respectively. BHTexp increased from 32.15 +/- 1.41 to 44.53 +/- 3.78s ($P < 0.01$) and BHTinsp increased from 63.69 +/- 5.38 to 89.07 +/- 9.61 s ($P < 0.05$). Our results show that yoga practice for 12 weeks results in significant reduction in visual and auditory RTs and significant increase in respiratory pressures, breath holding times and HGS.

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Abstract: Indian culture stresses the importance of direction during performance of daily activities. Some yoga teachers prescribe that yogic relaxation and polarity practices must be done while lying with head towards north in order to align oneself with the earth's electromagnetic field. There is some evidence that earth's magnetic field influences physiological functions. Hence, the present study was undertaken to see whether head direction has any effect on heart rate (HR) and blood pressure during supine rest. 43 normal healthy school children were recruited and their recordings were taken after 5 minutes of supine rest. The subjects were randomly assigned to lie with their head towards north, east, south and west directions on four different days. HR and blood pressure were recorded at the end of 5 minutes of supine rest. HR was lowest in north and highest in south, the difference being statistically significant by students' paired "t" test. Systolic pressure was lowest in the north and significantly higher in the west. Lying supine with head towards north had the lowest rate-pressure-product as compared to the west. Our study demonstrates that lying supine with head in different directions has a definite effect on the HR and blood pressure. Further studies in different age groups and in hypertensive patients may help in understanding the mechanisms and implications of this phenomenon.

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Abstract: Shavasan is known to enhance one's ability to combat stressful situations. The present study was planned to determine if shavasan could modulate the physiological response to stress induced by cold pressor test (CPT) and the possible mechanisms involved. Ten normal adults were taught shavasan and practiced the same for a total duration of seven days. RR interval variation (RRIV), deep breathing difference (DBD), and heart rate, blood pressure and rate-pressure-product (RPP) response to CPT were measured before and immediately after shavasan. Shavasan produced a significant increase in DBD and an appreciable but statistically insignificant increase in RRIV suggesting an enhanced parasympathetic activity. Significant blunting of cold pressor-induced increase in heart rate, blood pressure and RPP by shavasan was seen during and even five minutes after CPT suggesting that shavasan reduces the load on the heart by blunting the sympathetic response. It is concluded that shavasan can enhance one's ability to withstand stress induced by CPT and this ability can be achieved even with seven days of shavasan training.

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Abstract: The present study was conducted in trained (n=7) and untrained (n=7) volunteers to determine the effect of savitri pranayam and shavasan on O₂ consumption, heart rate and blood pressure. In trained subjects we found a consistent and significant (p<0.01) reduction in O₂ consumption within a few minutes of starting savitri pranayam. During shavasan, there was significant reduction in O₂ consumption (p<0.05), heart rate (p<0.001) and diastolic blood pressure (p<0.05). In untrained subjects, the changes in above mentioned parameters were statistically insignificant.

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Abstract: Objectives: This exploratory study is the first systematic outcome evaluation to examine the effects of an 8-week meditation-based program in mindfulness in a German sample. Design: Twenty-one (21) participants with chronic physical, psychologic, or psychosomatic illnesses were examined in a longitudinal pretest and post-treatment design with a 3-month follow-up. Outcome Measures: Both quantitative and qualitative data were gathered. Emotional and general physical well-being, sense of coherence, overall psychologic distress, and satisfaction with life were measured with standardized instruments. Results: Overall, the interventions led to high levels of adherence to the meditation practice and satisfaction with the benefits of the course, as well as effective and lasting reductions of symptoms (especially in psychologic distress, well-being, and quality of life). Changes were of moderate-to-large effect sizes. Positive complementary effects with psychotherapy were also found. Conclusions: These findings warrant controlled studies to evaluate the efficacy and cost effectiveness of mindfulness-based stress reduction as an intervention for chronic physical and psychosomatic disorders in Germany.

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Abstract: Certain yoga asanas if practiced regularly are known to have beneficial effects on [the] human body. These yoga practices might be interacting with various somato-neuro-endocrine mechanisms to have therapeutic effects. The present study done in twenty four NIDDM patients . . . 30 to 60 year[s] old provides metabolic and clinical evidence of improvement in glycemic control and pulmonary functions. These middle-aged subjects were type II diabetics on antihyperglycemic and dietary regimen. Their baseline fasting and postprandial blood glucose and glycosylated Hb were monitored along with pulmonary function studies. The expert gave these patients training in yoga asanas [and they were practiced] 30-40 min/day for 40 days under guidance. These asanas consisted of 13 well-known postures, done in a sequence. After 40 days of yoga asanas regimen, [tests of] the parameters were repeated. The results indicate that there was significant decrease in fasting blood glucose levels (basal 190.08 +/- 90.8 in mg/dl to 141.5 +/- 79.8 in mg/dl). The postprandial blood glucose levels also decreased (276.54 +/- 101.0 in mg/dl to 201.75 +/- 104.1 in mg/dl), glycosylated hemoglobin showed a decrease (9.03 +/- 1.4% to 7.83 +/- 2.6%). The FEV1, FVC, PEFr, MVV increased significantly (1.81 +/- 0.4 lt to 2.08 +/- 0.4 lt, 2.20 +/- 0.6 lt to 2.37 +/- 0.5 lt, 3.30 +/- 1.0 lt/s to 4.43 +/- 1.4 lt/s and 64.59 +/- 25.7 lt min to 76.28 +/- 28.1 lt/min respectively). FEV1/FVC% improved (85 +/- 0.2% to 89 +/- 0.1%). These findings suggest that better glycemic control and pulmonary functions can be obtained in NIDDM cases with yoga asanas and pranayama. The exact mechanism as to how these postures and controlled

breathing interact with [the] somato-neuro-endocrine mechanism affecting metabolic and pulmonary functions remains to be worked out.

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Abstract: Twenty Type 2 diabetic subjects between the age . . . of 30-60 years were studied to see the effect of 40 days of Yoga asanas on the nerve conduction velocity. The duration of diabetes ranged from 0-10 years. Subjects suffering from cardiac, renal and proliferative retinal complications were excluded from the study. Yoga asanas included Suryanamskar, Tadasan, Konasan, Padmasan Pranayam, Paschimottansan, Ardhamatsyendrasan, Shavasana, Pavanmukthasan, Sarpasan and Shavasana. Subjects were called to the cardio-respiratory laboratory in the morning time and were given training by the Yoga expert. The Yoga exercises were performed for 30-40 minutes every day for 40 days in the above sequence. The subjects were prescribed certain medicines and diet. The basal blood glucose [and] nerve conduction velocity of the median nerve was measured and repeated after 40 days of [the] Yogic regimen. Another [control] group of 20 Type 2 diabetes subjects of comparable age and severity . . . were kept on prescribed medication and light physical exercises like walking. Their basal & post 40 days parameters were recorded for comparison. Right hand and left hand median nerve conduction velocity increased from 52.81 +/- 1.1 m/sec to 53.87 +/- 1.1 m/sec and 52.46 +/- 1.0 to 54.75 +/- 1/1 m/sec respectively. Control group nerve function parameters deteriorated over the period of study, indicating that diabetes is a slowly progressive disease involving the nerves. Yoga asanas have a beneficial effect on glycemic control and improve nerve function in mild to moderate Type 2 diabetes with sub-clinical neuropathy.

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Abstract: Twenty girls between 10 and 13 years of age, studying at a residential school were randomly assigned to two groups. One group practiced yoga for one hour fifteen minutes per day, 7 days a week, while the other group was given physical training for the same time. Time for planning and for execution and the number of moves required to complete the Tower of London task were assessed for both groups at the beginning and end of a month. These three assessments were separately tested in increasingly complex tasks requiring 2-moves, 4-moves and 5-moves. The pre-post data were compared using the Wilcoxon paired signed ranks test. The yoga group showed a significant reduction in planning time for both 2-moves and 4-moves tasks (53.9 and 59.1 percent respectively), execution time in both 4-moves and 5-moves tasks (63.7 and 60.3 percent respectively), and in the number of moves in the 4-moves tasks (20.9 percent). The physical training group showed no change. Hence yoga training for a month reduced the planning and execution time in simple (2-moves) as well as complex tasks (4, 5-moves) and facilitated reaching the target with a smaller number of moves in a complex task (4-moves).

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correlated with better overall mental health. Religiosity is correlated with higher levels of self-monitoring, empathy, and moral insight and other positive behaviors and negatively correlated with depression and impulsive and risky behaviors. Independent data show that self-monitoring, empathy, hope, and moral insight are all selectively associated with intact frontal function, whereas depression, impulsiveness, and drug and alcohol abuse are associated selectively with frontal dysfunction. If religious practices do indeed preferentially activate and stimulate development of the frontal lobes, (a) religious practices should be considered as possible adjuncts for some patients in treatment for mental health disorders, and (b) the frontal lobes (rather than the temporal lobes) should be considered the major brain site that supports the core components of religious experience.

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Abstract: This study measured changes in regional cerebral blood flow (rCBF) during the complex cognitive task of meditation using single photon emission computed tomography. Eight experienced Tibetan Buddhist meditators were injected at baseline with 7 mCi HMPAO and scanned 20 min later for 45 min. The subjects then meditated for 1 h at which time they were injected with 25 mCi HMPAO and scanned 20 min later for 30 min. Values were obtained for regions of interest in major brain structures and normalized to whole brain activity. The percentage change between meditation and baseline was compared. Correlations between structures were also determined. Significantly increased rCBF ($P < 0.05$) was observed in the cingulate gyrus, inferior and orbital frontal cortex, dorsolateral prefrontal cortex (DLPFC), and thalamus. The change in rCBF in the left DLPFC correlated negatively ($P < 0.05$) with that in the left superior parietal lobe. Increased frontal rCBF may reflect focused concentration and thalamic increases overall increased cortical activity during meditation. The correlation between the DLPFC and the superior parietal lobe may reflect an altered sense of space experienced during meditation. These results suggest a complex rCBF pattern during the task of meditation.

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Abstract: This paper considers the neuropsychology of religious and spiritual experiences. This requires a review of our current understanding of brain function as well as an integrated synthesis to derive a neuropsychological model of spiritual experiences. Religious and spiritual experiences are highly complex states that likely involve many brain structures including those involved in higher order processing of sensory and cognitive input as well as those involved in the elaboration of emotions and autonomic responses. Such an analysis can help elucidate the biological correlates of these experiences and provide new information regarding the function of the human brain.

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Using PET scans of regular practitioners of Kriya Yoga who were practicing Yoga Nidra from a tape or CD guided by Swami Janakananda, researchers found that subjects were "in a deeply relaxed state the whole time, similar to that of sleep. The theta activity rose significantly on all the twenty-one electrodes (11%p). The reduction of the alpha activity (2% NS) was not significant; this shows that this meditative state is altogether different

from that of the sleeping state and comprises conscious awareness . . . the state was constant and evenly distributed over the entire brain for the forty-five minutes the relaxation lasted . . . There was a surprisingly significant similarity between the pictures [of the brains] of the seven yoga teachers who were measured.

“Something that may seem paradoxical to those who have no experience of meditation is perhaps the fact that these clear results, which reveal a high degree of concentration, are brought about entirely without effort. While you are lying in Yoga Nidra, you are not trying to force the various things that you experience. On the contrary. The EEG shows that you are completely relaxed from start to finish. You just listen to the instructions and experience clearly what happens, as a child listening to a fairy tale—active and participating, but without effort.

“The results confirm the experience of the yogi: Concentration is a spontaneous state, which comes of its own accord when a method is used that removes whatever is hindering it.

“And as the doctors said, ‘It proves that the 1.5 kg (brain mass) with the unknown content can control its own activity in an astonishingly precise manner. From a holistic point of view, it indicates that the soul and body act in unity.’”

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Researchers at a university clinic in Cologne, Germany, in the early 1980s found that Yoga Nidra had a more thorough effect than the relaxations based on suggestion or hypnosis. During Yoga Nidra the alpha waves covered the whole brain, whereas they occurred only here and there during the other relaxations. Furthermore, the level of Alpha waves was constant throughout the entire Yoga Nidra, while they came and went during the other relaxations. The balance between the EEG in the two brain halves was better in Yoga Nidra, which means that the two brain halves communicated better. These results were confirmed in 1997 in the research described above under “Pictures of the brain’s activity during Yoga Nidra.”

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Reports on research Yoga teacher Jonathan Fields, founder of Sonic Yoga in New York, had done by Bob Otto, Ph.D., at the Human Performance Lab at Adelphi University in Garden City, New York, after noticing that many of his students lost significant amounts of weight from practicing Sonic Vinyasa Yoga (Ashtanga Vinyasa-style Yoga).

“To test Fields’s theory, Otto assembled a preliminary group of thirteen men and women to run through a sampling of traditional yoga poses and sun salutations found in a typical one-hour session of any form of the practice. During the sequences, the participants were wired so that everything from heart rate to calorie expenditure was recorded.” This is the first time objective data on the energy cost of Yoga has been collected.

“The results were surprising: The ‘active standing element (the poses that keep you on your feet) of Vinyasa yoga can burn up to 540 calories an hour—the equivalent of running an eleven-minute mile.” Fields’s students say they find Yoga much more motivating, however, than other activities that burn similar amounts of calories.

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Summarizes the physiological changes associated with yoga training, including decreased sympathetic tone, improved control of sympathetic function, decreased peripheral vascular resistance, improved cardiac stroke output, reduction in blood pressure, reduced heart rate, and improved cardiovascular endurance.

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Abstract: We report extremely prominent heart rate oscillations associated with slow breathing during specific traditional forms of Chinese Chi and Kundalini Yoga meditation techniques in healthy young adults. We applied both spectral analysis and a novel analytic technique based on the Hilbert transform to quantify these heart rate dynamics. The amplitude of these oscillations during meditation was significantly greater than in the pre-meditation control state and also in three non-meditation control groups: i) elite athletes during sleep, ii) healthy young adults during metronomic breathing, and iii) healthy young adults during spontaneous nocturnal breathing. This finding, along with the marked variability of the beat-to-beat heart rate dynamics during such profound meditative states, challenges the notion of meditation as only an autonomically quiescent state.

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Abstract: Pranayama is a Yogic breathing practice which is known experientially to produce a profound calming effect on the mind. In an experiment designed to determine whether the mental effects of this practice were accompanied by changes in the arterial blood gases, arterial blood was drawn from 10 trained individuals prior to and immediately after Pranayama practice. No significance changes in arterial blood gases were noted after Pranayama. A neural mechanism for the mental effects of this practice is proposed.

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Raghuraj, P., R. Nagarathna, H. R. Nagendra, and S. Telles. Pranayama practice increases grip strength without lateralized effects. *Indian Journal of Physiology and Pharmacology*, 1997, 41(2):129-133. PMID: 9142556.

Abstract: The present study was conducted to determine whether breathing through a particular nostril has a lateralized effect on hand grip strength. 130 right hand dominant, school children between 11 and 18 yrs of age were randomly assigned to 5 groups. Each

group had a specific yoga practice in addition to the regular program for a 10 day yoga camp. The practices were: (1) right-, (2) left-, (3) alternate- nostril breathing (4), breath awareness and (5) practice of mudras. Hand grip strength of both hands was assessed initially and at the end of 10 days for all 5 groups. The right-, left- and alternate-nostril breathing groups had a significant increase in grip strength of both hands, ranging from 4.1% to 6.5%, at the end of the camp though without any lateralization effect. The breath awareness and mudra groups showed no change. Hence the present results suggest that yoga breathing through a particular nostril, or through alternate nostrils increases hand grip strength of both hands without lateralization.

_____, **A. G. Ramakrishnan, H. R. Nagendra, and S. Telles.** Effect of two selected yogic breathing techniques on heart rate variability. *Indian Journal of Physiology and Pharmacology*, Oct 1998, 42(4):467-472. (Breathing techniques: kapalabhati and alternate nostril breathing.)

The following review of this study appears in an article by Ralph La Forge entitled "Spotlight on Yoga" in the May 2001 issue of *IDEA Health and Fitness Source* (http://www.findarticles.com/cf_0/m0BTW/5_19/74886169/p1/article.jhtml?term=yoga):

Study: Heart rate variability (HRV) is a functional measure of the proficiency of the parasympathetic nervous system. Greater variability is associated with relaxation and quiescence and a lower risk of major cardiovascular events, such as heart attack.

To measure HRV, two spectral components of an electrocardiogram are usually recorded: a high-frequency (0.15-0.50 hertz [Hz]) component, attributable to parasympathetic activity, and a low-frequency component (0.05-0.15 Hz), attributable to sympathetic activity.

Researchers at the Vivekananda Kendra Yoga Research Foundation in Bangalore, India, studied HRV during two yoga practices that had previously been found to have opposite effects: sympathetic stimulation (kapalabhati, or breathing at high frequency, i.e., 2 breaths per second for several seconds) and reduced sympathetic activity (nadi shodana, or alternate-nostril breathing). All 12 male volunteers (age range = 21-33 years) were assessed before and after each practice on separate days.

Following kapalabhati, low-frequency power and the ratio of low to high frequency increased significantly, whereas high-frequency power fell significantly. There were no significant changes following nadi shodana. According to Raghuraj and colleagues, these results suggest that (1) kapalabhati modifies cardiac autonomic control (nervous system regulation of heart function) by increasing sympathetic activity and reducing vagal (primary parasympathetic nerve) activity and (2) HRV is a more useful psychophysiological measure than heart rate alone.

Comments: HRV is an up-and-coming measure of cardiovascular function in clinical cardiology. HRV cannot be discerned by heart rate palpation or wrist-worn cardiometers; it must be measured using very expensive electrocardiographic

spectral analysis equipment, such as that found in university-based cardiovascular research institutions.

_____, **A. Sudha, N. K. Manjunath, S. Telles, and H. R. Nagendra.** Depth perception, Muller Lyer and critical flicker fusion measurements show beneficial effects of yoga in school students. Swami Vivekananda Yoga Research Foundation.

_____, **and S. Telles.** Muscle power, dexterity skill and visual perception in community home girls trained in yoga or sports and in regular school girls. *Indian Journal of Physiology and Pharmacology*, Oct 1997, 41(4):409-415.

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_____, **and S. Telles.** Physiological effects of yoga breathing. In H. R. Nagendra, R. Ragarathna, and S. Telles, *Yoga Research & Applications: Proceedings of the 5th International Conference on Frontiers in Yoga Research and Applications*. Bangalore, Vivekananda Kendra Yoga Research Foundation, 2000, pp. 91-93.

_____, **and S. Telles.** Effect of yoga-based and forced uninostril breathing on the autonomic nervous system. *Perceptual Motor Skills*, Feb 2003, 96(1):79-80. PMID: 12705513.

Abstract: Some reports have described the effects of forced uninostril breathing on autonomic activity as sex-specific, while other reports [have] described selective effects of breathing through a specific nostril on the two divisions of the autonomic nervous system, irrespective of sex. There are also yoga breathing techniques which involve voluntary uninostril breathing. These techniques also influence the autonomic activity based on the patent nostril rather than sex. These descriptions were in line with experiential observations of the ancient sages described in classical yoga texts. This paper summarizes these perspectives on uninostril breathing.

_____, **S. Telles, and H. R. Nagendra.** Autonomic changes in visually impaired children following yoga and physical training. Swami Vivekananda Yoga Research Foundation.

_____, **S. Telles, and H. R. Nagendra.** Mirror star training studies on the beneficial effects of yoga on school students. Swami Vivekananda Yoga Research Foundation.

_____, **S. Telles, and H. R. Nagendra.** Visuo-spatial judgment among students undergoing yoga intervention for total personality development. Swami Vivekananda Yoga Research Foundation.

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_____. *Yogasanas and Their Scientific Evaluation.* Haryana, India: Anubhav Rai Publications. Email: Irai@ndf.vsnl.net.in.

_____, **and K. Ram.** Energy expenditure and ventilatory responses during Matsyasana—a yogic backward bending posture. *Yoga-Mimamsa*, Jan 1992, 30(4):1-9.

_____, **and K. Ram.** Energy expenditure and ventilatory responses during Virasana—a yogic standing posture. *Indian Journal of Physiology and Pharmacology*, Jan 1993, 37(1):45-50. PMID: 8449544.

Abstract: Energy expenditure and ventilatory responses to yogic standing posture of Virasana were studied on 10 healthy men (25-37 years of age). The results of various responses respectively to the horizontal supine, Chair-sitting and Virasana were: Minute Ventilation (VE) 7.64, 8.61 and 18.67 L/min; Respiratory Frequency (FR) 15.71, 15.70 and 21.45 Breath/min; Tidal Volume (VT) 0.496, 0.544 and 0.827 L/min; Oxygen consumption (VO₂) 0.127, 0.234 and 0.573 L/min; Carbondioxide Elimination (VCO₂) 0.127, 0.134 and 0.420 L/min; Respiratory Exchange Ratio (RER) 0.58, 0.57 and 0.69; Heart Frequency (FH) 65.2, 74.5 and 104.4 beats/min; Oxygen Pulse (O₂P) 3.32, 3.17 and 5.45 ml/beat; Ventilatory Equivalent (VE-EQ) 36.78, 37.12 and 33.85; Multiple of Resting VO₂ (METS) 0.96, 1.05 and 2.53 and Metabolic Cost (MC) 1.04, 1.13 and 2.76 Cal/min. Virasana posture was characterised by higher VE, FR, VT, VO₂, VCO₂, FH and O₂P with lesser VE-EQ. The observations suggest that Virasana induces temporarily a hypermetabolic state characterised by enhanced sympathetic nervous system activity which gets inhibited during the adoption of resting supine shavasana posture.

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Abstract: Twelve normal healthy volunteers (6 males and 6 females) undergoing yoga training for 90 days were studied for the effect of yoga on exercise tolerance. Their ages ranged from 18 to 28 years. The volunteers were taught only Pranayama for the first 20 days and later on yogic asanas were added. Sub-maximal exercise tolerance test was done on a motorized treadmill by using Balke's modified protocol, initially, after 20 days (Phase-I) and after 90 days of yoga training (Phase-II). Pyruvate and lactate in venous

blood and blood gases in capillary blood were estimated immediately before and after the exercise. Minute ventilation and oxygen consumption were estimated before and during the test. Post exercise blood lactate was elevated significantly during initial and Phase-I, but not in Phase-II. There was significant reduction of minute ventilation and oxygen consumption only in males in Phase-I and II at the time when the volunteers reached their 80% of the predicted heart rate. Female volunteers were able to go to higher loads of exercise in Phase-I and II.

_____, **S. Madhavi, K. V. Prasad, M. V. Reddy, M. E. Reddy, B. K. Sahay, and K. J. Murthy.** Comparison of effects of yoga & physical exercise in athletes. *Indian Journal of Medical Research*, Aug 1994, 100:81-87. PMID: 7927562.

Abstract: The effect of pranayama a controlled breathing practice, on exercise tests was studied in athletes in two phases; sub-maximal and maximal exercise tests. At the end of phase I (one year) both the groups (control and experimental) achieved significantly higher work rate and reduction in oxygen consumption per unit work. There was a significant reduction in blood lactate and an increase in P/L ratio in the experimental group, at rest. At the end of phase II (two years), the oxygen consumption per unit work was found to be significantly reduced and the work rate significantly increased in the experimental group. Blood lactate decreased significantly at rest in the experimental group only. Pyruvate and pyruvate-lactate ratio increased significantly in both the groups after exercise and at rest in the experimental group. The results in both phases showed that the subjects who practised pranayama could achieve higher work rates with reduced oxygen consumption per unit work and without increase in blood lactate levels. The blood lactate levels were significantly low at rest.

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_____, **S. Telles, and H. R. Nagendra.** Tweezer manual dexterity studies on PDC students. Swami Vivekananda Yoga Research Foundation.

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From a review by Norman Weinstein in *Yoga Journal*: “. . . this text is absolutely the most lucid examination of the interface between Western medicine and yoga I have discovered . . . rarely in available literature have the physiological facts been presented in such accessible form . . .”

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_____. The fourth state of consciousness: the Thuriya Avastha. *Psychiatry and Clinical Neurosciences*, May 1995, 49(2):107-110. PMID: 8726124.

Abstract: Present day neurophysiology stops with attributing thinking processes as the highest level of function of the brain. It has been common knowledge to oriental thinkers for many centuries, that there are many further states of the human mind, culminating in the state of thoughtless awareness; the fourth state of consciousness. This state must have a physiological basis. The complicated structure of the brain, the extravagant abundance of neural and glial elements in the brain, the infinite possibilities of synaptic junctions and synaptic transmission, and the multitude of neurotransmitters and neuromodulators; all these point to the definite possibility of a much greater level of performance and achievement for the human brain than has been apparent so far. Not only the theories but also the experience of Eastern seers have shown that the brain can transcend the boundaries of logic and reason, and experience states of awareness, commonly unrecognized. In the past few decades, knowledge about the functioning of the human brain has been growing exponentially and scientists of diverse disciplines are concentrating on unraveling its mysteries. It is necessary for scientists to investigate this state with all available tools and find the neurophysiological basis of this state.

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Raman, Krishna, M.D. Bio-mechanics of Yoga. Article available online: <http://medicineau.net.au/columns/yoga/biomech.htm>.

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Abstract: Yoga has become increasingly popular in Western cultures as a means of exercise and fitness training; however, it is still depicted as trendy as evidenced by an April 2001 *Time* magazine cover story on "The Power of Yoga." There is a need to have yoga better recognized by the health care community as a complement to conventional medical care. Over the last 10 years, a growing number of research studies have shown that the practice of Hatha Yoga can improve strength and flexibility, and may help control such physiological variables as blood pressure, respiration and heart rate, and metabolic rate to improve overall exercise capacity. This review presents a summary of medically substantiated information about the health benefits of yoga for healthy people and for people compromised by musculoskeletal and cardiopulmonary disease.

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Abstract: A study was undertaken to observe any beneficial effect of yogic practices during training period on the young trainees. 54 trainees of 20-25 years age group were divided randomly in two groups i.e. yoga and control group. Yoga group (23 males and 5 females) was administered yogic practices for the first five months of the course while control group (21 males and 5 females) did not perform yogic exercises during this period. From the 6th to 10th month of training both the groups performed the yogic practices. Physiological parameters like heart rate, blood pressure, oral temperature, skin temperature in resting condition, responses to maximal and submaximal exercise, body flexibility were recorded. Psychological parameters like personality, learning, arithmetic and psychomotor ability, mental well being were also recorded. Various parameters were taken before and during the 5th and 10th month of training period. Initially there was relatively higher sympathetic activity in both the groups due to the new work/training environment but gradually it subsided. Later on at the 5th and 10th month, yoga group had relatively lower sympathetic activity than the control group. There was improvement in performance at submaximal level of exercise and in anaerobic threshold in the yoga group. Shoulder, hip, trunk and neck flexibility improved in the yoga group. There was improvement in various psychological parameters like reduction in anxiety and depression and a better mental function after yogic practices.

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extension values increased only in the yoga group after training. There was no significant change in trunk flexion-extension in either group.

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Abstract: BACKGROUND & OBJECTIVES: Reports on the effect of yogic exercises on aerobic capacity are few. There is also no literature available on the effect of yogic exercise on perceived exertion (PE) after maximal exercise. In this study the effect of training in Hatha yogic exercises on aerobic capacity and PE after maximal exercise was observed. METHODS: Forty men from the Indian army (aged 19-23 yr) were administered maximal exercise on a bicycle ergometer in a graded work load protocol. The oxygen consumption, carbon dioxide output, pulmonary ventilation, respiratory rate, heart rate (HR) etc., at maximal exercise and PE score immediately thereafter were recorded. The subjects were divided into two equal groups. Twelve subjects dropped out during the course of study. One group (yoga, n = 17) practiced Hatha yogic exercises for 1 h every morning (6 days in a week) for six months. The other group (PT, n = 11) underwent conventional physical exercise training during the same period. Both groups participated daily in different games for 1 h in the afternoon. In the 7th month, tests for maximal oxygen consumption (VO₂Max) and PE were repeated on both groups of subjects. RESULTS: Absolute value of VO₂Max increased significantly (P < 0.05) in the yoga group after 6 months of training. The PE score after maximal exercise decreased significantly (P < 0.001) in the yoga group after 6 months but the PT group showed no change. INTERPRETATION & CONCLUSION: The practice of Hatha yogic exercises along with games helps to improve aerobic capacity like the practice of conventional exercises (PT) along with games. The yoga group performed better than the PT group in terms of lower PE after exhaustive exercise.

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From the publisher: “Western doctors make quantitative, objective observations on the bodies and the minds of others, and from such experiments are able to construct a general model of the body/mind. On the other hand, Eastern yogis make qualitative, subjective observations of their own bodies and minds, yielding a model of the body/mind with little or no apparent relevance to that of the Western Doctor. This Handbook attempts to reconcile these two points of view, discussing many basic aspects of physiology and then applying these ideas to the practice of the *yogasanas*, as well as pointing out many phenomena well known to yogis, for which Western medicine has only a feeble explanation.

“In the course of this study, many interesting questions are raised, and answers are put forth using modern concepts. We discuss questions such as, How can inversions lower blood pressure? Why are backbends energizing? If one has a heart condition, what is the best time of day to practice *yogasana*? How does *yogasana* practice blur the line between the conscious and the subconscious? Can practicing in colored lights intensify the physiological effects of various *yogasanas*? How can one balance in *yogasanas* without leaning against the wall? Why must one turn the femur of the forward leg outward in *trikonasana* but inward in *parsvottanasana*? Answers to these and many other questions can be found in this Handbook.”

About the author: “On graduating from the University of Washington in 1960 with a Ph.D. degree in chemical physics, Dr. Robin took a position at Bell Telephone Laboratories, Murray Hill, New Jersey, in the Molecular Spectroscopy research area. Though he published 4 books and over 100 technical papers during the next 28 years, in hindsight, the most fortunate event of that exciting time was having wandered into Judy Freedman’s noontime yoga class at the Labs, which proved to be a turning point in his life. On retiring in 1988, he spent time between studying and teaching yoga, and working as Director of Student Research at Science High School in Newark, New Jersey. During the 8 years spent at Science High, he was the recipient of the Science Mentor of the Year award from President W. J. Clinton, the first such award ever given to a high-school teacher.

“Enchanted with the idea of writing a book exploring the possible connections between yoga and science, he retired from high-school science, and entered into the full-time practice and teaching of Iyengar Yoga, interspersed with more and more research into

how yoga and medicine might be related. This Handbook is the culmination of that effort. Nothing could make him happier than to think that there might be something in this Handbook that would advance some teacher's interest in and understanding of the subject."

Contents: Eastern Yoga and Western medicine; Nervous systems of the body; The brain; The spine and its appendages; The nerves; The autonomic nervous system; The skeletal muscles; The bones; Connective and supporting tissues; The skin; The heart and the vascular system; Respiration; The immune system; External secretions; The hormones; The eyes and vision; Sound, hearing, and balance; The gastrointestinal organs and digestion; Sexual function, gynecology, and pregnancy; The emotions; Time and body rhythms; Aging and longevity; *Yogasana* illustrations; Injuries incurred during improper *yogasana* practice; Body symmetry; Balancing; Gravity; Glossary; References; Index

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Abstract: Power yoga is a modernized form of Ashtanga Vinyasa yoga [and] has been suggested as a form of aerobic conditioning. Purpose: The purpose of this study was to determine whether participants in a beginning power yoga class could attain a level of intensity to achieve ACSM recommended target heart rate (THR) levels (55-90% HRmax) for aerobic training. Methods: Thirteen active college aged individuals with no prior yoga experience participated in the study. Participants met for three consecutive 45-minute testing sessions with a 48-hour rest interval between sessions. Each session consisted of six segments: 10 min rest, 5 min deep breathing, 5 min warm-up, 20 min work, 10 min deep-breathing, and 5 min final relaxation. Heart rate and rating of perceived exertion (RPE) was obtained every 5 minutes. Variables of interest included time to achievement of THR level, consistency of heart rates over the initial 3 power yoga sessions, ability to sustain THR levels, and correlation of perceived exertion (Borg 6-20 scale) to heart rate levels. Results: Time to achievement of THR levels varied among participants but there was no significant difference ($p = .05$) within a participant

across sessions (power = .145). The amount of time participants were in the target heart rate zone during the 20 minute work segment varied but there was no significant difference ($p = .05$) within a participant across sessions (power = .48). Heart rate and perceived exertion during the work segment showed poor correlation ($r < 0.58$) in each of the three sessions. Conclusion: The results indicate that power yoga does not consistently provide heart rate intensities that meet ACSM recommendations for aerobic training in beginning power yoga participants. In addition the use of perceived exertion during power yoga does not appear to be an accurate correlation with heart rate.

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Abstract: Santhi Kriya is a mixture of combined yogic practices of breathing and relaxation. Preliminary attempts were made to determine the effect of Santhi Kriya on certain psychophysiological parameters. Eight healthy male volunteers of the age group 25.9 +/- 3 (SD) years were subjected to Santhi Kriya practice daily for 50 minutes for 30 days. The volunteer's body weight, blood pressure, oral temperature, pulse rate, respiration, ECG and EEG were recorded before and after the practice on the 1st day and subsequently on 10th, 20th and 30th day of their practice. They were also given a perceptual acuity test to know their cognitive level on the 1st day and also at the end of the study i.e., on the 30th day. Results indicate a gradual and significant decrease in the body weight from 1st to 30th day (P less than 0.001) and an increase in alpha activity of the brain (P less than 0.001) during the course of 30 days of Santhi Kriya practice. Increase of alpha activity both in occipital and pre-frontal areas of both the hemispheres of the brain denotes an increase of calmness. This study also revealed that Santhi Kriya practice increases oral temperature by 3 degrees F and decreases respiratory rate significantly (P less than 0.05) on all practice days. Other parameters were not found to be altered significantly. It is concluded that the Santhi Kriya practice for 30 days reduces body weight and increases calmness.

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Abstract: Hatha Yoga's effects on the posture of 15 ten year-old children and also its effects on the psychophysical condition of 15 grown-ups was studied. As symptoms, during the first examination, 12 of the 15 children had head protrusion, 14 had shortened back extensors, all 15 had bent shoulders, relaxation of the frontal abdominal wall and shortened flexors of both the calf and thigh. The condition of all the children was remarkably better after six months of practice, some of the symptoms having completely disappeared (head protrusion, asymmetry of the shoulders, mamillas and hips, shortening of the pectoralis and back extensors), 9 children still had slight to medium relaxation of the frontal abdominal wall, 8 children still had bent shoulders, and 1 child still had shortened calf and thigh extensors. The adults were in a weak or very weak psychophysical condition, they tired easily, they complained of sleep disturbances, fluctuation of emotional state and irritability. After 3 months of practice, the vital capacity of 8 of the adults tested (53.3%) had increased by 435 ml. The time duration of apnoea had lengthened for all of the practicing adults, but with a truly large variation among them (a median of 14%). The deep waist-bend length of all the practicing adults had lengthened by an average of 9.5 cm, and the average length increase for the 3-minute running test was 42 m. All those who practiced had experienced an alleviation of psychic difficulties.

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Abstract: Hatha-Yoga has become increasingly popular in western countries as a method for coping with stress. However, little is known about the physiological and psychological effects of yoga practice. We measured heart rate, blood pressure, the hormones cortisol, prolactin and growth hormone and certain psychological parameters in a yoga practicing group and a control group of young female volunteers reading in a comfortable position during the experimental period. There were no substantial differences between the groups concerning endocrine parameters and blood pressure. The course of heart rate was significantly different; the yoga group had a decrease during the yoga practice. Significant differences between both groups were found in psychological parameters. In the personality inventory the yoga group showed markedly higher scores in life satisfaction and lower scores in excitability, aggressiveness, openness, emotionality and somatic complaints. Significant differences could also be observed concerning coping with stress and the mood at the end of the experiment. The yoga group had significant[ly] higher scores in high spirits and extravertedness.

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The following review of this study appears in an article by Ralph La Forge entitled "Spotlight on Yoga" in the May 2001 issue of *IDEA Health and Fitness Source* (http://www.findarticles.com/cf_0/m0BTW/5_19/74886169/p1/article.jhtml?term=yoga):

Study: Researchers at Hannover Medical University in Hannover, Germany, investigated some of the effects of a comprehensive, residential three-month kriya yoga training program on cardiovascular risk factors in 106 healthy adults (58 men and 48 women ages 18-64 years, mean age = 29.6 years). Kriya yoga is an advanced tantric meditation process combining physical and mental techniques; sessions last four hours or longer.

The yoga program, which took place at the Scandinavian Yoga and Meditation School in Ha, Sweden, consisted of three parts: During the first month, subjects practiced traditional yoga (daily hatha yoga exercises, breathing techniques, deep relaxation and meditation). In the second month, they learned kriya yoga. In the final month, they practiced kriya yoga daily, along with other yoga techniques and advanced meditations. Practical work in the school's kitchen, garden, fields and woods constituted an essential part of the training. Throughout the program, participants adhered to a low-fat (23% fat) vegetarian diet with no alcohol or caffeine. Pre- and postlaboratory assessments included blood lipids and lipoproteins, complete blood counts, fibrinogen (a plasma protein that contributes to the formation of blood clots), urinary and serum hormone levels, stress reactivity and blood pressure. The subjects were compared to control groups living their normal lives in Hannover; subjects and controls were matched for age, gender and respective initial risk factor levels.

The subjects lost an average of 5.7 kilograms and reduced their body mass index (BMI) by 1.88. Men experienced significant reductions in total serum cholesterol (from 181 to 166 milligrams per deciliter [mg/dl]), LDL cholesterol (from 117 to 102 mg/dl) and LDL-to-HDL ratio (from 2.7 to 2.2) (p [less than] 0.001 in each category). Reductions in these categories were not significant for women, whose initial levels were lower than the men's. HDL cholesterol did not change significantly in men or women. In the 15 participants whose HDL was initially [less than] 35 mg/dl, however, HDL did increase significantly (from 30 to 40 mg/dl, p [less than] 0.001).

Compared to the matched controls, male and female yoga participants had, after three months, significantly reduced their fibrinogen levels (decreasing the risk of blood clots) ($p = 0.04$). Blood pressure and heart rate dropped significantly during the course, with blood pressure improvements being more pronounced (decreasing from 150/82 to 123/69) in those with initial systolic blood pressure levels [greater than or equal to] 140 millimeters of mercury (both p [less than] 0.000 1). Serum testosterone levels and urinary excretions of adrenaline, noradrenaline, dopamine and aldosterone all fell significantly in the study group compared to the control group. Schmidt and his fellow

researchers concluded that commitment to intensive yoga therapy can significantly reduce cardiovascular risk factors, especially in individuals with increased risk factor levels, such as elevated BMI, cholesterol, blood pressure and fibrinogen.

Comments: The results of this study were not entirely unexpected considering the intensive and residential nature of the intervention. Nonetheless, reductions in total cholesterol, LDL cholesterol and blood pressure were substantial. Such clinical results rival those attained by many drugs prescribed for lowering lipid and blood pressure levels. The challenge for fitness and health promotion professionals as lifestyle-change agents is knowing how to implement effective strategies to foster lifelong behavior change. Finally, it is noteworthy that, as was the case in this program, yoga therapy is often far more comprehensive than mere exercise poses.

Schneider, R. H., S. I. Nidich, J. W. Salerno, H. M. Sharma, C. E. Robinson, R. J. Nidich, and C. N. Alexander. Lower lipid peroxide levels in practitioners of the Transcendental Meditation program. *Psychosomatic Medicine*, Jan-Feb 1998, 60(1):38-41.

From a review by Bella Neparstek, Health Journeys: Eighteen subjects were long-term practitioners of the TM program (average 16.5 years). Twenty-three controls were not practicing a formal stress management technique. Venous blood samples were analyzed for lipid peroxides by the TBARS assay. A dietary questionnaire was also used to assess fat intake, red meat consumption, antioxidant vitamin supplementation, and smoking. Differences between groups and subgroups were analyzed by T-test, and correlations.

The study found significantly lower serum levels of lipid peroxides in the TM practitioners, as compared with the controls (-15%, $p = .026$). No significant differences were found between groups on smoking, fat intake, or vitamin supplementation. TM practitioners also had lower red meat consumption but matched subgroup analysis. Partial correlations did not confirm a relationship between red meat intake and lipid peroxide levels.

These preliminary findings suggest that lower serum lipid peroxide levels are associated with a reduction of psychosocial stress from using the Transcendental Meditation technique. [Oxidative stress and free radical activity are increased by psychosocial stress, and are known to contribute to the pathophysiology of atherosclerosis and other chronic diseases associated with aging.]

Prospective controlled trials are needed to confirm that this effect is because of TM practice rather than other lifestyle factors, such as diet.

Schulte, H. J., and V. V. Abhyanker. Yogic breathing and psychologic states. *Arizona Medicine*, Sep 1979, 36(9):681-683.

Overview: "One of the authors (VVA) recently traveled to India and had the opportunity to interview several well-known yogic masters regarding their use of yogic breathing for

selected emotional disorders. The goal of this paper is to discuss the psychologic changes associated with respiration controlled by the Yogic method. Two case examples will be presented with discussion.”

Sedlak, W. Joga v swietle wspólczesnej biofizyki [Yoga in the light of modern biophysics]. *Zeszyty Naukowe, KUL*, 1972, 15(2):43-52. [In Polish.]

Selvamurthy, W. Yoga for everyone: A physiologists' view. *Journal of Oriental Research*, 1996, 63:7-32.

_____, **H. S. Nayar, N. T. Joseph, and S. Joseph.** Physiological effects of yogic practices. *NIMHANS (National Institute of Mental Health and Neuro Sciences of India) Journal*, Jan1983, 1(1):71-79.

Abstract: A comprehensive study was conducted on 30 healthy men [soldiers] (20-30 years of age) to evaluate the effects of six months of regular yogic practice on autonomic balance, thermoregulatory efficiency, orthostatic tolerance, energy metabolism and biochemical profile. The subjects were randomly divided into two groups (A & B) of 15 each. Group-A served as control, while in group-B yogic training was administered daily in the morning hours for one hour under the supervision of qualified Yoga instructor from Vishwaytan Yogashram for six months. Various physiological tests and biochemical estimations were done before, and after, every month of yogic training, in both the groups. Yogic practice for six months resulted in a trend of shift in the autonomic equilibrium towards relative parasympathodominance, improvement in thermoregulatory efficiency and orthostatic tolerance. It has also brought about improvement in physical performance by minimizing the energy expenditure during submaximal exercise. The changes in the biochemical profile indicated a relative hypometabolic state after six months of yogic practice. Physiological significance of these finds is discussed in this paper.

_____, **and U. S. Ray.** Yoga and physiology. In H. R. Nagendra, R. Ragarathna, and S. Telles, *Yoga Research & Applications: Proceedings of the 5th International Conference on Frontiers in Yoga Research and Applications*. Bangalore, Vivekananda Kendra Yoga Research Foundation, 2000, pp. 257-259.

_____, **U. S. Ray, K. S. Hedge, and R. P. Sharma.** Physiological responses to cold (100C) in men after six months' practice of yoga exercises. *International Journal of Biometeorology*, 1983, 32:188-193.

Shachoy, Cator. The chakra system and human physiology: The healing potential of integrating ancient yogic wisdom and modern medical understanding. *Common Ground*, Fall 2001, pp. 14, 126-128. Author contact: 415-235-9380

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Shannahoff-Khalsa, D., M. R. Boyle, and M. E. Buebel. The effects of unilateral forced nostril breathing on cognition. *International Journal of Neuroscience*, 1991, 57:239-249.

Abstract: Ultradian rhythms of alternating cerebral dominance have been demonstrated in humans and other mammals during waking and sleep. Human studies have used the methods of psychological testing and electroencephalography (EEG) as measurements to identify the phase of this \natural endogenous rhythm. The periodicity of this rhythm approximates 1.5 – 3 hours in awake humans. This cerebral rhythm is tightly coupled to another ultradian rhythm known as the nasal cycle, which is regulated by the autonomic nervous system, and is exhibited by greater airflow in one nostril, later switching to the other side. This paper correlates uninostril airflow with varying ratios of verbal/spatial performance in 23 right-handed males. Relatively greater cognitive ability in one hemisphere corresponds to unilateral forced nostril breathing in the contralateral nostril. Cognitive performance ratios can be influenced by forcibly altering the breathing pattern.

_____, **and B. Kennedy.** The effects of unilateral forced nostril breathing on the heart. *International Journal of Neuroscience*, Nov 1993, 73(1-2):47-60. PMID: 8132418.

Abstract: Three experiments are described that employ impedance cardiography to monitor the effects of unilateral forced nostril breathing (UFNB) on the heart. Experiment 1 includes 7 subjects (4 males, 3 females) with a respiratory rate of 6 breaths/min (BPM). Experiment 2 includes 16 trials using one subject to examine the intraindividual variability, at 6 BPM. Experiment 3 includes 10 trials with the same subject in experiment 2, but with a respiratory rate of 2-3 breaths/s. This rapid rate of respiration is a yogic breathing technique called "breath of fire" or "kapalabhatti" and employs a very shallow but rapid breath in which the abdominal region acts like a bellows. All 3 experiments demonstrated that right UFNB increases heart rate (HR) compared to left. Experiment 1 gave 7 negative slopes, or lowering in HR with left nostril breathing and 7 positive slopes, or increases in HR with right nostril breathing, $p = .001$. The second and third experiments showed differences in HR means in which right UFNB increases HR more than left, $p = .013$, $p = .001$, respectively. In experiment 2 stroke volume was higher with left UFNB, $p = .045$, compensating for lower HR. Left UFNB increased end diastolic volume as measured in both experiments 1 and 2, $p = .006$, $p = .001$, respectively. These results demonstrate a unique unilateral effect on sympathetic stimulation of the heart that may have therapeutic value.

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“Newfound interest in meditation is sparked by the discovery of its physiological effects . . .”

Singh, B. S. Ventilatory response to CO₂. II. Studies in neurotic psychiatric patients and practitioners of Transcendental Meditation. *Psychosomatic Medicine*, 1984, 46:347-362.

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Findings: Lower erythrocyte sedimentation rate levels indicating less serious illness and slower aging.

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Section headings: Introduction; Yoga and breathing; Stress, arousal, and self-regulation; The respiratory rhythm; Non-volitional influences on breathing; Voluntary control of breathing; A yogic view of breathing; The challenge of sustained awareness; Optimal breathing; Integration of voluntary and automatic control; Studies of voluntary respiratory control; Research hypotheses; Conclusion

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Abstract: We tested whether chemoreflex sensitivity could be affected by the practice of yoga, and whether this is specifically because of a slow breathing rate obtained during yoga or as a general consequence of yoga. We found that slow breathing rate per se substantially reduced chemoreflex sensitivity, but long-term yoga practice was responsible for a generalised reduction in chemoreflex.

Srinivasan, T. M. Electrophysiological correlates during yogic practices. *The Yoga Review*, Winter 1981, 1(4):165-173.

Srivastava, Niraj. Effect of hypoxia inducing yogic exercises on cardiovascular parameters. Thesis for Doctor of Medicine (Physiology), BRD Medical College, Gorakhpur, India, 2003. Author email: niraj1000@rediffmail.com.

Keeping in view the frequency of hypertension-induced cardiovascular incapacitation in a wide range of the population, the present study evaluated some of the beneficial effects of yogic practices on cardiovascular/respiratory parameters, viz., blood pressure, heart rate, electrocardiogram, and various pulmonary functions. Since in some earlier studies yogic practices have been shown to reduce not only blood pressure levels but also mitigate “electrocardiographic heterogeneity,” the present study assessed the overall influence of yogic practices on cardiovascular and respiratory parameters in normal human subjects.

Stachenfeld, N. S., G. W. Mack, L. DiPietro, T. S. Morocco, A. C. Jozsi, and E. R. Nadel. Regulation of blood volume during training in post-menopausal women. *Med. Sci. Sports Exerc.*, Jan 1998, 30(1):92-98. PMID: 9475649. (Compares aerobic exercise and Yoga.)

Abstract: In younger people the increase in aerobic capacity following training is related, in part, to blood volume (BV) expansion and the consequent improvements in maximal cardiac output. This training-induced hypervolemia is associated with a decrease in cardiopulmonary baroreflex (CPBR) control of peripheral vascular tone. PURPOSE: To test the hypothesis that improvement in peak oxygen consumption (VO₂peak) during

training in older women is associated with specific central adaptations, such as BV expansion and a reduction in CPBR control of vascular tone. **METHODS:** Seventeen healthy older women were randomized into training (N = 9, 71 +/- 2 yr) and control (N = 8, 73 +/- 3 yr) groups. The training group exercised three to four times per wk for 30 min at 60% peak heart rate for 12 wk and then 40-50 min at 75% peak heart rate for 12 wk. The control group participated in yoga exercises over the same time period. We measured resting BV (Evans blue dye), VO₂peak, and the forearm vascular resistance response to unloading low pressure mechanoreceptors during low levels of lower body negative pressure (through -20 mm Hg) before and after aerobic training. The slope of the increase in forearm vascular resistance (response) per unit decrease in central venous pressure (stimulus) was used to assess CPBR responsiveness. **RESULTS:** Aerobic training increased VO₂peak 14.2% from 24.2 mL x kg⁻¹ x min⁻¹ to 27.7 mL x kg⁻¹ x min⁻¹ (P < 0.05), a smaller improvement than typically seen in younger subjects. Blood volume (59.9 +/- 1.9 and 60.9 +/- 1.9 mL x kg⁻¹) and CPBR function (-3.98 +/- 0.92 and -3.46 +/- 0.94 units x mm⁻¹ Hg) were similar before and after training. **CONCLUSIONS:** These data indicate that the inability to induce adaptations in CPBR function may limit BV expansion during training in older women. In addition, the absence of these specific adaptations may contribute to the relatively poor improvements in VO₂peak in older women during short (10-12 wk) periods of training.

Stancák, A., Jr., M. Kuna, P. Novák, M. A. Srinivasan, C. Dostálek, and S. Vishnudevananda. Observations on respiratory and cardiovascular rhythmicities during yogic high-frequency respiration. *Physiol Res.*, 1991, 40(3):345-354. PMID: 1751482.

Yogic high-frequency respiration—kapalabhati (KB)—was studied in 24 subjects from a point of rhythmicity. Respiratory movements, blood pressure and R-R intervals of ECG were recorded in parallel and evaluated by spectral analysis of time series. Respiratory signals during KB were modulated by 0.1 Hz rhythm in 82% of experiments. This component was also present in R-R intervals and blood pressure during KB. Frequency (0.2-0.3 Hz) was observed in 67% of respiratory records. The presence of the component 0.2-0.3 Hz in respiration was dependent on resting respiratory frequency. This frequency component was reduced in R-R intervals but increased in blood pressure during kapalabhati as compared to that at rest. The occurrence of both frequency components in respiration during KB supports the hypothesis about the integrative role of cardiovascular and respiratory rhythms in physiological states characterized by altered respiratory frequency.

_____, **M. Kuna, Srinivasan, C. Dostálek, and S. Vishnudevananda.** Kapalabhati: Yogic cleansing exercise. II. EEG topography analysis. *Homeostasis*, 1991, 33:182-189. PMID: 1818698.

Abstract: Topography of brain electrical activity was studied in 11 advanced yoga practitioners during yogic high-frequency breathing kapalabhati (KB). Alpha activity was increased during the initial five min of KB. Theta activity mostly in the occipital region was increased during later stages of 15 min KB compared to the pre-exercise period. Beta 1 activity increased during the first 10 min of KB in occipital and to a lesser degree in

parietal regions. Alpha and beta 1 activity decreased and theta activity was maintained on the level of the initial resting period after KB. The score of General Deactivation factor from Activation Deactivation Adjective Checklist was higher after KB exercise than before the exercise. The results suggest a relative increase of slower EEG frequencies and relaxation on a subjective level as the after effect of KB exercise.

_____, **M. Kuna, Srinivasan, S. Vishnudevananda, and C. Dostálek.**

Kapalabhati: Yogic cleansing exercise. I. Cardiovascular and respiratory changes. *Homeost Health Dis*, Oct 1991, 33(3):126-34. PMID: 1818666.

Abstract: We studied cardiovascular and respiratory changes during yogic breathing exercise kapalabhati (KB) in 17 advanced yoga practitioners. The exercise consisted in fast shallow abdominal respiratory movements at about 2 Hz frequency. Blood pressure, ECG and respiration were recorded continuously during three 5 min periods of KB and during pre- and post-KB resting periods. The beat-to-beat series of systolic blood pressure (SBP) and diastolic blood pressure (DBP), R-R intervals and respiration were analysed by spectral analysis of time series. The mean absolute power was calculated in three frequency bands--band of spontaneous respiration, band of 0.1 Hz rhythm and the low-frequency band greater than 15 s in all spectra. The mean modulus calculated between SBP and R-R intervals was used as a parameter of baroreceptor-cardiac reflex sensitivity (BRS). Heart rate increased by 9 beats per min during KB. SBP and DBP increased during KB by 15 and 6 mmHg respectively. All frequency bands of R-R interval variability were reduced in KB. Also the BRS parameter was reduced in KB. The amplitude of the high-frequency oscillations in SBP and DBP increased during KB. The low-frequency blood pressure oscillations were increased after KB. The results point to decreased cardiac vagal tone during KB which was due to changes in respiratory pattern and due to decreased sensitivity of arterial baroreflex. Decreased respiratory rate and increased SBP and low-frequency blood pressure oscillations after KB suggest a differentiated pattern of vegetative activation and inhibition associated with KB exercise.

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Abstract: Systems for promoting self-realization have come from both the West and the East. Two basically eastern systems of "therapy," in the Zen tradition and the Hindu Yoga meditative tradition, are now attracting substantial interest in the West. There is now substantial Western concern to evaluate their effectiveness in the way that many other psychotherapeutic traditions have been examined. In particular a technique in the

Hindu Yoga meditative tradition, Transcendental Meditation (TM) is beginning to attract strong scientific attention in the West. This paper looks at some of the physiological, psychological and social research on this practice, and also looks at some of the rather arresting work done in the training of people to produce states of mind found subjectively to be pleasant. This paper then is concerned to look at some of the correlates of states of "human realization."

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Sudarsan, B., N. Janakiramiah, K. T. T. Shetty, B. N. Gangadhar, Vedamuthachar, and D. K. Subbakrishna. Effect of Sudarshan Kriya Yoga (SKY) on plasma cortisol. *Indian Journal of Psychiatry*, Apr 2001, 43.

Abstract: Sudarshan Kriya Yoga has been tried as an alternative treatment in depression. Studies on patients with dysthymia and major depression showed significant antidepressant effect. The biological basis of the therapeutic efficacy of SKY has not been investigated. In the present study we examined the effect of SKY on plasma cortisol. Plasma cortisol levels were measured before and after a SKY treatment in 20 major depressive patients who received no psychotropic medication. There was significant reduction in plasma cortisol levels. The relevance of this finding to the biological correlates of SKY will be presented.

Sudharani, A., and S. Telles. Effect of yoga on memory. In H. R. Nagendra, R. Ragarathna, and S. Telles, *Yoga Research & Applications: Proceedings of the 5th International Conference on Frontiers in Yoga Research and Applications*. Bangalore, Vivekananda Kendra Yoga Research Foundation, 2000, pp. 307-310.

Sudsuang, R., V. Chentanez, and K. Veluvan. Effect of Buddhist meditation on serum cortisol and total protein levels, blood pressure, pulse rate, lung volume and reaction time. *Physiology and Behavior*, Sep 1991, 50(3):543-548. PMID: 1801007.

Abstract: Serum cortisol and total protein levels, blood pressure, heart rate, lung volume, and reaction time were studied in 52 males 20-25 years of age practicing Dhammakaya Buddhist meditation, and in 30 males of the same age group not practicing meditation. It was found that after meditation, serum cortisol levels were significantly reduced, serum total protein level significantly increased, and systolic pressure, diastolic pressure and pulse rate significantly reduced. Vital capacity, tidal volume and maximal voluntary ventilation were significantly lower after meditation than before. There were also significant decreases in reaction time after meditation practice. The percentage decrease in reaction time during meditation was 22%, while in subjects untrained in meditation, the percentage decrease was only 7%. Results from these studies indicate that practising Dhammakaya Buddhist meditation produces biochemical and physiological changes and reduces the reaction time.

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Sukumaran, M., B. G. Nagaraja, B. V. Suresh, B. H. Hanumanthiah, G. Narasimhalu, and T. Desiraju. Changes in concentrations of urinary, HVA, MHPG, VMA, 5-HIAA, 17-keto steroid and of blood cortisol and lactate following meditation sessions. *Indian Journal of Physiology and Pharmacology*, 1987, 31(5).

Sundararajan, G. S. Passive adaptation through Yoga. *The Yoga Review*, Summer & Autumn 1983, 3(2&3):81-86.

Abstract: Optimal inputs fed into the system, in an organised planned schedule, over a period of time, produce progressive permanent improvements in the functional capacities of the body—the process of adaptation.

In the case of hypodynamic and static work-outs as in Yoga, a new concept of *passive adaptation* is evolved. Certain specialized sensory regulatory receptors have been identified, which exclusively operate during isometric, low-dynamic muscular contractions, as in Yoga.

The passive adaptation through Yoga of the cardiovascular system and the metabolic rearrangements are explained.

The Renshaw cybernetic channels and their special significance in the stretch-oriented Yoga are analysed. Yoga and hormonal balance, as controlled catecholamine release, is outlined.

The need for the evolution of a yogic battery of tests to assess functional fitness through parameters of passive adaptation is sought.

Tabogi, S. Effetti indotti dal programma di Meditazione Trascendentale sulla tolleranza glicidica. Unpublished doctoral dissertation (abbr.), Faculty of Medicine and Surgery, University of Trieste, Trieste, Italy, 1983. *Collected Papers* v4.299. [In Italian.]

Findings: Improved blood sugar homeostasis as measured by oral glucose tolerance test.

Talukdar, B., S. Verma, S. C. Jain, and Mazumdar. Effect of yoga training on plasma lipid profile, lipid peroxidation and Na K ATPase activity in essential hypertension. *Indian Journal of Clinical Biochemistry*, 1996, 11(2):129-133.

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_____, **and T. Desiraju.** Oxygen consumption during pranayamic type of very slow-rate breathing. *Indian Journal of Medical Research*, Oct 1991, 94:357-363. PMID: 1794892.

Abstract: To determine whether the yogic Ujjayi pranayamic type of breathing that involves sensory awareness and consciously controlled, extremely slow-rate breathing including at least a period of end-inspiration breath holding in each respiratory cycle would alter oxygen consumption or not, ten males with long standing experience in pranayama, and volunteering to participate in the laboratory study were assessed. These subjects aged 28-59 yr, had normal health appropriate to their age. Since kumbhak (timed breath holding) is considered as an important phase of the respiratory cycle in the pranayama, they were categorised into two groups of five each, one group practising the short kumbhak varieties of pranayama, and the other the long kumbhak varieties of pranayama. The duration of kumbhak phase was on an average 22.2 percent of the respiratory cycle in the short kumbhak group, and 50.4 per cent in the long kumbhak group. The oxygen consumption was measured in test sessions using the closed circuit method of breathing oxygen through the Benedict-Roth spirometer. Each subject was tested in several repeat sessions. Values of oxygen consumption of the period of pranayamic breathing, and of post-pranayamic breathing period, were compared to control value of oxygen consumption of the prepranayamic breathing period of each test

session. The results revealed that the short kumbhak pranayamic breathing caused a statistically significant increase (52%) in the oxygen consumption (and metabolic rate) compared to the pre-pranayamic base-line period of breathing. In contrast to the above, the long kumbhak pranayamic breathing caused a statistically significant lowering (19% of the oxygen consumption (and metabolic rate).

_____, **and T. Desiraju.** Heart rate and respiratory changes accompanying yogic conditions of single thought and thoughtless states. *Indian Journal of Physiology and Pharmacology*, 1992, 36(4):293-294.

_____, **and T. Desiraju.** Heart rate alterations in different types of pranayamas. *Indian Journal of Physiology and Pharmacology*, 1992, 36(4):287-288.

_____, **and T. Desiraju.** Autonomic changes in Brahmakumaris Raja Yoga meditation. *International Journal of Psychophysiology*, 1993, 15:147-152.

_____, **and T. Desiraju.** Recording of auditory middle latency evoked potentials during the practice of meditation with the syllable "OM." *Indian Journal of Medical Research*, 1993, 98[B]:237-239. PMID: 8119759.

Abstract: Middle latency auditory evoked potentials were examined in 7 proficient subjects during the practice of meditation on the syllable 'OM', to determine whether these potentials would differ significantly from those recorded during the baseline state without practicing mediation. Similar records were also obtained in 7 'naive' subjects, matched for age, before and during a control period which involved sitting with eyes closed, and with no special instructions for focusing their thoughts. There was considerable inter-subject variability in the different components. However, during meditation there was a small but significant reduction in the peak latency of the Nb wave (the maximum negativity occurring between 35 and 65 msec). This reduction was observed consistently during the 3 repeat sessions of each subject, while the 'naive' subjects did not show this change. These results suggest that the inter-subject variability of middle latency auditory evoked potentials precludes using them as the method of choice for assessing the effects of meditation. The small but consistent decrease in the Nb wave peak latency, indicates that the middle latency auditory evoked potentials do change with meditation. However, the variability of the potentials may mask subtle changes.

_____, **B. Hanumanthaiah, R. Nagarathna, and H. R. Nagendra.** Improvement in static motor performance following yogic training of school children. *Perceptual & Motor Skills*, Jun 1993, 76(3 Pt 2):1264-1266. PMID: 8337075.

Abstract: Two groups of 45 children each, whose ages ranged from 9 to 13 years, were assessed on a steadiness test, at the beginning and again at the end of a 10-day period during which one group received training in yoga, while the other group did not. The steadiness test required insertion of and holding for 15 sec. a metal stylus without touching the sides of holes of decreasing sizes in a metal plate. The contacts were

counted as “errors.” During the 10-day period, one group (the “Yoga” group) received training in special physical postures (asanas), voluntary regulation of breathing (Pranayama), maintenance of silence, as well as visual focussing exercises (tratakas) and games to improve the attention span and memory. The other group (control) carried out their usual routine. After 10 days, the “Yoga” group showed a significant (Wilcoxon's paired signed-ranks test) decrease in errors, whereas the “control” group showed no change.

_____, **B. Hanumanthaiah, R. Nagarathna, and H. R. Nagendra.** Duration of yoga practice and motivation influence static motor performance. *Journal of Clinical Psychology*, 1994.

_____, **B. Hanumanthaiah, R. Nagarathna, and H. R. Nagendra.** Plasticity of motor control systems demonstrated by yoga training. *Indian Journal of Physiology and Pharmacology*, 1994, 38(2):143-144. PMID: 8063362.

Abstract: The static motor performance was tested in two groups with 20 subjects in each (age range 17 to 22 years, and 5 females in each group). Tests were carried out at the beginning and end of a 10 day period. The test required being able to insert and hold a metal stylus within holes of varying sizes for 15 sec. Accidental contacts between the stylus and the sides of the holes, were registered on a counter as errors. During the 10 days one group (the yoga group) practised asanas (physical postures), pranayama (voluntary regulation of breathing), meditation, devotional sessions, and tratakas (visual focussing exercises). The control group followed their usual routine. At the end of 10 days the yoga group showed a significant reduction in number of errors (Wilcoxon paired signed ranks test), while the control group did not change. Our earlier study showed a similar improvement in children (9-13 years). It was interesting to note the same degree of plasticity in motor control systems in young adults. The implications for rehabilitation programmes have been discussed.

_____, **C. Joseph, S. Venkatesh, and T. Desiraju.** Alteration of auditory middle latency evoked potentials during yogic consciously regulated breathing and attentive state of mind. *International Journal of Psychophysiology*, 1992, 14:189-198. PMID: 8340237.

Abstract: Middle latency auditory-evoked potentials (AEP-MLRs) of 10 healthy male subjects in the age range of 21-33 years, were assessed to determine whether yogic pranayamic practice would cause changes in them. The pranayama type assessed here is an exercise of consciously-controlled rhythmic breathing involving timed breath-holding in each cycle of breathing, while the subject holds utmost attention and experiences the touch of inhaled air in the nasal passage. The results revealed that the Na-wave amplitude increased and latency decreased during the period of pranayamic practice, whereas the Pa-wave was not significantly altered. The change is interpreted as an indication of a generalized alteration cause in information processing at the primary thalamo-cortical level during the concentrated mental exercise of inducing modifications in neural mechanisms regulating a different functional system (respiratory). Further researches are

required to understand the operational significances of such changes.

_____, **R. Nagarathna, and H. R. Nagendra.** Breathing through a particular nostril can alter metabolism and autonomic activities. *Indian Journal of Physiology and Pharmacology*, 1994, 38(2):133-137. PMID: 8063359

Abstract: There is increasing interest in the fact that breathing exclusively through one nostril may alter the autonomic functions. The present study aimed at checking whether such changes actually do occur, and whether breathing is consciously regulated. 48 male subjects, with ages ranging from 25 to 48 years were randomly assigned to different groups. Each group was asked to practice one out of three pranayamas (viz. right nostril breathing, left nostril breathing or alternate nostril breathing). These practices were carried out as 27 respiratory cycles, repeated 4 times a day for one month. Parameters were assessed at the beginning and end of the month, but not during the practice. The 'right nostril pranayama' group showed a significant increase, of 37% in baseline oxygen consumption. The 'alternate nostril' pranayama group showed an 18% increase, and the left nostril pranayama group also showed an increase, of 24%. This increase in metabolism could be due to increased sympathetic discharge to the adrenal medulla. The 'left nostril Pranayama' group showed an increase in volar galvanic skin resistance, interpreted as a reduction in sympathetic nervous system activity supplying the sweat glands. These results suggest that breathing selectively through either nostril could have a marked activating effect or a relaxing effect on the sympathetic nervous system. The therapeutic implications of being able to alter metabolism by changing the breathing pattern have been mentioned.

_____, **R. Nagarathna, and H. R. Nagendra.** Improvement in visual perception following yoga training. *Journal of Indian Psychology*, 1995, 13(1):30-32.

_____, **R. Nagarathna, and H. R. Nagendra.** Physiological measures of right nostril breathing. *Journal of Alternative & Complementary Medicine*, 1996, 2(4):479-484. PMID: 9395677.

Abstract: This study was conducted to assess the physiological effects of a yoga breathing practice that involves breathing exclusively through the right nostril. This practice is called surya anuloma viloma pranayama (SAV). Twelve volunteers (average age 27.2 years +/- 3.3 years, four males) were assessed before and after test sessions conducted on two consecutive days. On one day the test session involved practicing SAV pranayama for 45 minutes (SAV session). During the test period of the other day, subjects were asked to breathe normally for 45 minutes (NB session). For half the patients (randomly chosen) the SAV session was on the first day and the NB session on the next day. For the remaining six patients, the order of the two sessions was reversed. After the SAV session (but not after the NB) there was a significant ($P < .05$, paired t test) increase in oxygen consumption (17%) and in systolic blood pressure (mean increase 9.4 mm Hg) and a significant decrease in digit pulse volume (45.7%). The latter two changes are interpreted to be the result of increased cutaneous vasoconstriction. After both SAV and NB sessions, there was a significant decrease in skin resistance (two factor

ANOVA, Tukey test). These findings show that SAV has a sympathetic stimulating effect. This technique and other variations of unilateral forced nostril breathing deserve further study regarding therapeutic merits in a wide range of disorders.

_____, **R. Nagarathna, and H. R. Nagendra.** Autonomic changes during “OM” meditation. *Indian Journal of Physiology and Pharmacology*, 1998, 39(4):418-420.

_____, **R. Nagarathna, and H. R. Nagendra.** Autonomic changes while mentally repeating two syllables, one meaningful and the other neutral. *Indian Journal of Physiology and Pharmacology*, 1998, 42(1):57-63.

_____, **R. Nagarathna, H. R. Nagendra, and T. Desiraju.** Physiological changes in sports teachers following 3 months of training in yoga. *Indian Journal of Medical Sciences*, Oct 1993, 47(10):235-238. PMID: 8112782.

Abstract: 1. This report shows that in a group of 40 physical education teachers who already had an average of 8.9 years physical training, 3 months of yogic training produced significant improvement in general health (in terms of body weight and BP reduction and improved lung functions). 2. There was also evidence of decreased autonomic arousal and more of psychophysiological relaxation (heart rate and respiratory rate reduction), and improved somatic steadiness (decreased errors in the steadiness test). 3. The changes at the end of 3 months in volar GSR in different directions (increase/decrease/no change), depending on the initial values, suggests that practising yoga may help to bring about a balance in different autonomic functions, so that functioning is optimised.

_____, **R. Nagarathna, H. R. Nagendra, and T. Desiraju.** Alterations in auditory middle latency evoked potentials during meditation on a meaningful syllabus “OM.” *International Journal of Neurosciences*, 1994, 76:87-93. PMID: 7960473.

Abstract: Middle latency auditory evoked potentials were recorded in 18 male volunteers with ages between 25 and 45 years, 9 of whom had more than 10 years of experience in "Om" meditation (senior subjects), whereas the other 9 had no meditation experience (naive subjects). Both groups were studied in two types of sessions. (1) Before, during, and after 20 minutes of mentally repeating "one" (control session), and (2) a similar session, though with 20 minutes of mentally chanting "Om" (meditation session). The senior subjects showed a statistically significant (paired t-test) increase in the peak amplitude of Na wave (the maximum negative peak between 14 and 18 ms) during meditation, while the same subjects showed a statistically significant reduction in the Na wave peak amplitude during control sessions. In contrast, the naive subjects had a significant decrease in the Na wave peak amplitude during meditation sessions and a nonsignificant trend of reduction during control sessions, as well. This difference between senior and naive subjects was significant (two-way ANOVA). There were no significant changes in short latency wave V or Pa wave (the positive peak between the Na wave and 35 ms). The changes in the Na wave suggest that both mediation on a meaningful symbol, and mental repetition of a neutral word cause neural changes at the

same level (possibly diencephalic). However, the change could be in opposite directions, and this difference could be correlated with differences in the duration of experience in meditation between senior and naive subjects.

_____, **R. Nagarathna, V. Ramana, and H. R. Nagendra.** A combination of focusing and defocusing through yoga reduces optical illusion more than alone. *Indian Journal of Physiology and Pharmacology*, 1997, 41(2):129-133.

_____, **H. R. Nagendra, and R. Nagarathna.** Effect of uninostril yoga breathing on tweezer dexterity. Submitted by Swami Vivekananda Yoga Research Foundation to *Indian Journal of Physiology and Allied Sciences*, Feb 1998.

_____, **S. Narendran, P. Raghuraj, R. Nagarathna, and H. R. Nagendra.** Comparison of changes in autonomic and respiratory parameters of girls after yoga and games at a community home. *Perceptual Motor Skills*, Feb 1997, 84(1):251-257.

_____, **V. Ramaprabhu, and S. K. Reddy.** Effect of yoga training on maze learning. *Indian Journal of Physiology and Pharmacology*, Apr 2000, 44(2):197-201.

_____, **S. K. Reddy, and H. R. Nagendra.** Oxygen consumption and respiration following two yoga relaxation techniques. *Applied Psychophysiology And Biofeedback*, Dec 2000, 25(4):221-227. MEDLINE® PMID: 11218923.

Abstract: The present study was conducted to evaluate a statement in ancient yoga texts that suggests that a combination of both “calming” and “stimulating” measures may be especially helpful in reaching a state of mental equilibrium. Two yoga practices, one combining “calming and stimulating” measures (cyclic meditation) and the other, a “calming” technique (shavasan), were compared. The oxygen consumption, breath rate, and breath volume of 40 male volunteers (group mean +/- SD, 27.0 +/- 5.7 years) were assessed before and after sessions of cyclic meditation (CM) and before and after sessions of shavasan (SH). The 2 sessions (CM, SH) were 1 day apart. Cyclic meditation includes the practice of yoga postures interspersed with periods of supine relaxation. During SH the subject lies in a supine position throughout the practice. There was a significant decrease in the amount of oxygen consumed and in breath rate and an increase in breath volume after both types of sessions (2-factor ANOVA, paired t test). However, the magnitude of change on all 3 measures was greater after CM: (1) Oxygen consumption decreased 32.1% after CM compared with 10.1% after SH; (2) breath rate decreased 18.0% after CM and 15.2% after SH; and (3) breath volume increased 28.8% after CM and 15.9% after SH. These results support the idea that a combination of yoga postures interspersed with relaxation reduces arousal more than relaxation alone does.

_____, **P. R. Vani, R. Nagarathna, and H. R. Nagendra.** A combination of focusing and defocusing through yoga reduces optical illusion more than focusing alone. *Indian Journal of Physiology and Pharmacology*, 1997, 41(2):71-74.

_____, **R. P. Vempati, and S. K. Reddy.** Effect of yoga training on maze learning. Unpublished date, Swami Vivekananda Yoga Research Foundation.

Thomas, Andrew. Yoga and fascia. *The Journal of The International Association of Yoga Therapists*, 1992, no. 3, pp. 39-42.

_____. Yoga and cardiovascular function. *The Journal of The International Association of Yoga Therapists*, 1993, no. 4, pp. 39-41.

Thomas, Tommijean, Christopher D. Tori, and Benjamin A. Thomas. Assessing the [psychological] benefits of practicing Iyengar Yoga. *Yoga Rahasya*, 1998, 5(2):30-33. Contact: Dr. Tommijean Thomas, tommijt@yahoo.com.

Abstract:

Objectives:

- a. To determine the physical, physiological and psychological effects of practicing Iyengar Yoga
- b. To determine the reason and motivation for practitioners to continue yoga practice.
- c. To evaluate perception of ‘stress’ and coping mechanisms amongst Iyengar Yoga practitioners
- d. To compare the personality characteristics of Iyengar Yoga Practitioners with the “normal” adults who did not practice Iyengar Yoga.

Participants and Methodology:

367 Iyengar Yoga practitioners, from North and South America, Asia, South Africa, New Zealand and Australia, who attended the “Iyengar Yoga Festival”, Pune in 1998 participated in this study. All these participants answered three questionnaires pertaining to their yoga practice, the perception and coping of stress and their personality traits. It took each participant at least one hour to answer all the questions listed. Their replies were then assessed using specific statistical tests.

Results:

Yoga Practice: 97% of the participants practiced asanas for an average of 8 hours per week while 71% practiced pranayama for an average of 2.3 hours a week.

Life Style: Yoga practice was a strong motivating factor amongst all the practitioners to improve health habits. 94% balanced work with recreation while 85% followed a vegetarian diet. It is pertinent to note that “Iyengar Yoga” does not compel the practitioner to any specific dietary or life style regiment.

Improvement in the Physical and Physiological Disorders following Yoga Practice: 65% of the participants had a medical problem when they started their yoga practice. Most people indicated that, on the average, they improved, with some proclaiming cures and others remission. There was a significant improvement in the physical health of all the

participants. Significant benefits were seen with reference to the respiratory, genitourinary, circulatory and digestive systems.

There was a very significant improvement with relation to emotional disorders especially those pertaining to mood disorders and substance abuse.

Reasons and Motivation to Continue Yoga Practice: Although, majority of practitioners started their yoga practice to seek physical benefit – it is the psychological benefits especially mental control and stress/ tension control which now motivates them to continue their practices.

Perception of Stress and Coping Mechanisms: The awareness of stress among yoga practitioners was similar to that of a normal population. Coping methods, however, were more active and varied than for the typical person. The management of stress by those practicing yoga was characterized by heightened self-control, using difficulties as a means to enhance personal growth and the ability to detach oneself from tension and anxiety. The results of the study also revealed that those who adopted a planful and optimistic approach to problem solving significantly reduced perceived stress. Interestingly, those primarily involved in the teaching of yoga had the lowest perceived stress.

Personality Characteristics: A comparative study of the personality differences between yoga practitioners and normal “non-practicing” individuals shows that the yoga practitioners had a higher than average values when assessed for their sensitivity, flexibility and self reliance. However, they were less conforming and “submissive” as compared with “normal” non practitioners.

Conclusion:

The results of this study clearly documents that practice of Iyengar Yoga improves the physical, physiological and psychological well being of the practitioner; a heightened self control; an enhancement of personal growth, a low perception of stress. The personality of the practitioners indicated that they were more sensitive, flexible and self-reliant but at the same time exhibited a “mind of their own” by being non-conforming and submissive.

_____, **Christopher D. Tori, Benjamin A. Thomas, and Rajvi H. Mehta.** Medical, psychological, and spiritual benefits of longterm Iyengar Yoga practice. *Yoga Rahasya*, 2000, 7(1):77-86.

_____, **Christopher D. Tori, and Benjamin A. Thomas.** Psychological and physical gains from Iyengar Yoga practice. 2002. Manuscript in progress.

“Data collection and entry (pre/post repeated measures and two follow ups) of the psychological and physical health benefits of meditation and yoga is completed. Individual coping resources, psychological adjustments, life style habits, mood states, and personality characteristics were measured in 190 college beginning yoga students. Preliminary results are revealing significant findings.”

Madnmohan., D. P. Thombre, and B. Balakumar. Effect of yoga training on reaction time, respiratory endurance and muscle strength. *Indian Journal of Physiology and Pharmacology*, Oct 1992, 36(4):229ff.

Throll, D. A. Transcendental Meditation and progressive relaxation: Their physiological effects. *Journal of Clinical Psychology*, 1982, 38(3):522-530.

Tloczynski, T., A. Santucci, and E. Astor. Perception of visual illusions by novice and longer-term meditators. *Perceptual and Motor Skills*, Dec 2000, 91(3 Pt 1):1021-1026. PMID: 11153836.

Undergraduate volunteers were divided into Control (n= 18) and Novice Meditators (n = 8). Residents of an American Zen monastery who volunteered as subjects, having 1 year or more experience in meditation, formed a Longer-term Meditation group. All subjects were tested over five trials on the Poggendorff and M?ller-Lyer illusions and completed the Taylor Manifest Anxiety Scale and the Beck Depression Inventory. Significant mean differences were found only for algebraic errors on the Poggendorff illusion, and significant decrement in illusion was noted for all subjects. A significant interaction was also found as the Longer-term Meditators showed less initial illusion and less dramatic decrement over five trials than the other groups. Finally, Longer-term Meditators exhibited significantly less anxiety and depression than the other two groups.

Tooley, G. A., S. M. Armstrong, T. R. Norman, and A. Sali. Acute increases in night-time plasma melatonin levels following a period of meditation. *Biological Psychology*, May 2000, 53(1):69-78. Author email: greggo@deakin.edu.au. PMID: 0010876066.

Abstract: To determine whether a period of meditation could influence melatonin levels, two groups of meditators were tested in a repeated measures design for changes in plasma melatonin levels at midnight. Experienced meditators practicing either TM-Sidhi or another internationally well known form of yoga showed significantly higher plasma melatonin levels in the period immediately following meditation compared with the same period at the same time on a control night. It is concluded that meditation, at least in the two forms studied here, can affect plasma melatonin levels. It remains to be determined whether this is achieved through decreased hepatic metabolism of the hormone or via a direct effect on pineal physiology. Either way, facilitation of higher physiological melatonin levels at appropriate times of day might be one avenue through which the claimed health promoting effects of meditation occur.

Tran, M. D., R. G. Holly, J. Lashbrook, and E. A. Amsterdam. Effects of Hatha Yoga practice on the health-related aspects of physical fitness. *Preventive Cardiology*, Autumn 2001, 4(4):165-170. PMID: 11832673.

Abstract: Ten healthy, untrained volunteers (nine females and one male), ranging in age from 18-27 years, were studied to determine the effects of hatha yoga practice on the health-related aspects of physical fitness, including muscular strength and endurance,

flexibility, cardiorespiratory fitness, body composition, and pulmonary function. Subjects were required to attend a minimum of two yoga classes per week for a total of 8 weeks. Each yoga session consisted of 10 minutes of pranayamas (breath-control exercises), 15 minutes of dynamic warm-up exercises, 50 minutes of asanas (yoga postures), and 10 minutes of supine relaxation in savasana (corpse pose). The subjects were evaluated before and after the 8-week training program. Isokinetic muscular strength for elbow extension, elbow flexion, and knee extension increased by 31%, 19%, and 28% ($p < 0.05$), respectively, whereas isometric muscular endurance for knee flexion increased 57% ($p < 0.01$). Ankle flexibility, shoulder elevation, trunk extension, and trunk flexion increased by 13% ($p < 0.01$), 155% ($p < 0.001$), 188% ($p < 0.001$), and 14% ($p < 0.05$), respectively. Absolute and relative maximal oxygen uptake increased by 7% and 6%, respectively ($p < 0.01$). These findings indicate that regular hatha yoga practice can elicit improvements in the health-related aspects of physical fitness. Copyright © 2001 CHF, Inc.

Travis, Frederick. Autonomic and EEG patterns distinguish transcending from other experiences during Transcendental Meditation practice. *International Journal of Psychophysiology*, Aug 2001, 42(1):1-9. PMID: 11451476.

Abstract: This study compared EEG and autonomic patterns during transcending to “other” experiences during Transcendental Meditation (TM) practice. To correlate specific meditation experiences with physiological measures, the experimenter rang a bell three times during the TM session. Subjects categorized their experiences around each bell ring. Transcending, in comparison to “other” experiences during TM practice, was marked by: (1) significantly lower breath rates; (2) higher respiratory sinus arrhythmia amplitudes; (3) higher EEG alpha amplitude; and (4) higher alpha coherence. In addition, skin conductance responses to the experimenter-initiated bell rings were larger during transcending. These findings suggest that monitoring patterns of physiological variables may index dynamically changing inner experiences during meditation practice. This could allow a more precise investigation into the nature of meditation experiences and a more accurate comparison of meditation states with other eyes-closed conditions.

_____, **T. Olson, T. Egenes, and H. K. Gupta.** Physiological patterns during practice of the Transcendental Meditation technique compared with patterns while reading Sanskrit and a modern language. *International Journal of Neuroscience*, Jul. 2001, 109(1-2):71-80. PMID: 11699342.

Abstract: This study tested the prediction that reading Vedic Sanskrit texts, without knowledge of their meaning, produces a distinct physiological state. We measured EEG, breath rate, heart rate, and skin conductance during: (1) 15-min Transcendental Meditation (TM) practice; (2) 15-min reading verses of the Bhagavad Gita in Sanskrit; and (3) 15-min reading the same verses translated in German, Spanish, or French. The two reading conditions were randomly counterbalanced, and subjects filled out experience forms between each block to reduce carryover effects. Skin conductance levels significantly decreased during both reading Sanskrit and TM practice, and increased slightly during reading a modern language. Alpha power and coherence were

significantly higher when reading Sanskrit and during TM practice, compared to reading modern languages. Similar physiological patterns when reading Sanskrit and during practice of the TM technique suggests that the state gained during TM practice may be integrated with active mental processes by reading Sanskrit.

_____, **and C. Pearson.** Pure consciousness: Distinct phenomenological and physiological correlates of “consciousness itself.” *International Journal of Neuroscience*, Jan 1999, 100(1-4):77-89. PMID: 10938552.

Abstract: This paper explores subjective reports and physiological correlates of the experience of “consciousness itself”—self awareness isolated from the processes and objects of experience during Transcendental Meditation practice. Subjectively, this state is characterized by the absence of the very framework (time, space, and body sense) and content (qualities of inner and outer perception) that define waking experiences. Physiologically, this state is distinguished by the presence of apneustic breathing, autonomic orienting at the onset of breath changes, and increases in the frequency of peak EEG power. A model, called the junction point model, is presented that integrates pure consciousness with waking, dreaming, or sleeping. It could provide a structure to generate a coherent program of research to test the full range of consciousness and so enable us to understand what it means to be fully human.

_____, **J. Tecce, A. Arenander, and R. K. Wallace.** Patterns of EEG coherence, power, and contingent negative variation characterize the integration of transcendental and waking states. *Biological Psychology*, Nov 2002, 61(3):293-319. PMID: 12406612. Author email: ftravis@mum.edu.

Abstract: Long-term meditating subjects report that transcendental experiences (TE), which first occurred during their Transcendental Meditation (TM) practice, now subjectively co-exist with waking and sleeping states. To investigate neurophysiological correlates of this integrated state, we recorded EEG in these subjects and in two comparison groups during simple and choice contingent negative variation (CNV) tasks. In individuals reporting the integration of the transcendent with waking and sleeping, CNV was higher in simple but lower in choice trials, and 6-12 Hz EEG amplitude and broadband frontal EEG coherence were higher during choice trials. Increased EEG amplitude and coherence, characteristic of TM practice, appeared to become a stable EEG trait during CNV tasks in these subjects. These significant EEG differences may underlie the inverse patterns in CNV amplitude seen between groups. An 'Integration Scale,' constructed from these cortical measures, may characterize the transformation in brain dynamics corresponding to increasing integration of the transcendent with waking and sleeping.

_____, **J. J. Tecci, and J. Guttman.** Cortical plasticity, contingent negative variation, and transcendent experiences during practice of the Transcendental Meditation technique. *Biological Psychology*, Nov 2000, 55(1):41-55. Author email: ftravis@mum.edu. PMID: 11099807.

Abstract: This study investigated effects of transcendent experiences on contingent negative variation (CNV) amplitude, CNV rebound, and distraction effects. Three groups of age-matched subjects with few (<1 per year), more frequent (10-20 per year), or daily self-reported transcendent experiences received 31 simple RT trials (flash (S(1))/tone (S(2))/button press) followed by 31 divided-attention trials - randomly intermixed trials with or without a three-letter memory task in the S(1)-S(2) interval). Late CNV amplitudes in the simple trials were smallest in the group with fewest, and largest in the group with most frequent transcendent experiences. Conversely, CNV distraction effects were largest in the group with fewest and smallest in the group with most frequent transcendent experiences (the second group's values were in the middle in each case). These data suggest cumulative effects of transcendent experiences on cortical preparatory response (heightened late CNV amplitude in simple trials) and executive functioning (diminished distraction effects in letter trials).

_____, **and R. Keith Wallace.** Autonomic patterns during respiratory suspensions: Possible markers of Transcendental Consciousness. *Psychophysiology*, 1997, 34:39-46.

Abstract: In two experiments, we investigated physiological correlates of Transcendental Consciousness during Transcendental Meditation sessions. In the first, experimenter-initiated bells, based on observed physiological patterns, marked three phases during a Transcendental meditation session in 16 individuals. Interrater reliability between participant and experimenter classification of experiences at each bell was quite good. During phases including Transcendental Consciousness experiences, skin conductance responses and heart rate deceleration occurred at the onset of respiratory suspensions or reductions in breath volume. In the second experiment, this autonomic pattern was compared with that during forced breath holding. Phasic autonomic activity was significantly higher at respiratory suspension onset than at breath holding onset. These easily measured markers could help focus research on the existence and characteristics of Transcendental Consciousness.

_____, **and R. Keith Wallace.** Autonomic and EEG patterns during eyes-closed rest and transcendental meditation (TM) practice: The basis for a neural model of TM practice. *Consciousness and Cognition*, Sep 1999, 8(3):302-318. PMID: 0010487785.

Abstract: In this single-blind within-subject study, autonomic and EEG variables were compared during 10-min, order-balanced eyes-closed rest and Transcendental Meditation (TM) sessions. TM sessions were distinguished by (1) lower breath rates, (2) lower skin conductance levels, (3) higher respiratory sinus arrhythmia levels, and (4) higher alpha anterior-posterior and frontal EEG coherence. Alpha power was not significantly different between conditions. These results were seen in the first minute and were maintained throughout the 10-min sessions. TM practice appears to (1) lead to a state fundamentally different than eyes-closed rest; (2) result in a cascade of events in the central and autonomic nervous systems, leading to a rapid change in state (within a minute) that was maintained throughout the TM session; and (3) be best distinguished from other conditions through autonomic and EEG alpha coherence patterns rather than

alpha power. Two neural networks that may mediate these effects are suggested. The rapid shift in physiological functioning within the first minute might be mediated by a “neural switch” in prefrontal areas inhibiting activity in specific and nonspecific thalamocortical circuits. The resulting “restfully alert” state might be sustained by a basal ganglia-corticothalamic threshold regulation mechanism automatically maintaining lower levels of cortical excitability. Copyright 1999 Academic Press.

Travis, T., C. Kondo, and J. Knott. Heart rate, muscle tension, and alpha production of Transcendental Meditation and relaxation controls. *Biofeedback and Self-Regulation*, 1976, I(4):387-394.

Trynham, R. The effects of experimental meditation, feedback and relaxation training on electromyograph and self-report measures of relaxation and altered states of consciousness. *Biofeedback & Self Regulation*, 1978, 3(2):187ff.

Tulpule, T. H. Cardio-respiratory, metabolic and hormonal changes in middle aged men following yogic exercise. *Maharashtra Med J*, 1978, 25(8):303-308.

Udupa, Kaviraja, Madanmohan, Ananda Balayogi Bhavanani, P. Vijyalakshmi, and N. Krishnamurthy. Effect of *pranayam* training on cardiac function in normal young volunteers. *Indian Journal of Physiology and Pharmacology*, Jan 2003, 47 (1):27-33. Article available online: http://www.ijpp.com/vol47_no1_orgn_artcl_1.htm.

Abstract: Systolic tire intervals (STI) are non-invasive and sensitive tests for measuring the ventricular performance. It has been reported that practice of *pranayam* modulates cardiac autonomic status and improves cardio-respiratory functions. Keeping this in view, the present study was designed to determine whether *pranayam* training has any effect on ventricular performance as measured by STI and cardiac autonomic function tests (AFT). Twenty-four school children were randomly divided into two groups of twelve each. Group I (*pranayam* group) subjects were given training in *nadishuddhi*, *mukh-bhastrika*, *pranav* and *savitri pranayams* and practised the same for 20 minutes daily for a duration of 3 months. Group II (control group) subjects were not given any *pranayam* training. STI (QS₂, LVET and PEP) and AFT (RRIV and QT/QS₂) were measured in both the groups at the beginning and again at the end of three months study period. *Pranayam* training produced an increase in RRIV and a decrease in QT/QS₂ suggesting an enhanced parasympathetic and blunted sympathetic activity respectively. QS₂, PEP and PEP/LVET increased significantly, whereas LVET was reduced significantly in *pranayam* group. In contrast, the changes in STI and AFT were much less marked in the control group. Our study shows that three months of *pranayam* training modulates ventricular performance by increasing parasympathetic activity and decreasing sympathetic activity. Further studies on a larger sample size may illustrate the underlying mechanism(s) involved in this alteration.

Udupa, K. N. Studies on physiological aspects of yoga. In K. N. Udupa, *Stress and Its Management by Yoga*. 2d ed. Delhi: Motilal Banarsidass, 1985.

_____, **and R. H. Singh.** The scientific basis of yoga (letter). *Journal of the American Medical Association*, 1972, 220:1365ff.

_____, **and R. H. Singh.** Biochemical studies on meditation. *Quarterly Journal of Surg. Sc.*, 1977, 13:294ff.

_____, **and R. H. Singh, K. N. Dwivedi, H. Pandey, and V. Rai.** Comparative biochemical studies on meditation. *Indian Journal of Medical Research*, 1975, 63(12):1676-1679.

_____, **R. H. Singh, and R. M. Shettiwar.** Studies on physiological and metabolic response to the practice of yoga in young normal volunteers. *Journal of Research in Indian Medicine*, 1971, 6(3):345-353.

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“In Philadelphia, a researcher discovers areas of the brain that are activated during meditation. At two other universities in San Diego and North Carolina, doctors study how epilepsy and certain hallucinogenic drugs can produce religious epiphanies. And in Canada, a neuroscientist fits people with magnetized helmets that produce ‘spiritual’ experiences for the secular.

“The work is part of a broad new effort by scientists around the world to better understand religious experiences, measure them, and even reproduce them. Using powerful brain imaging technology, researchers are exploring what mystics call nirvana, and what Christians describe as a state of grace. Scientists are asking whether spirituality can be explained in terms of neural networks, neurotransmitters and brain chemistry.

“What creates that transcendental feeling of being one with the universe? It could be the decreased activity in the brain’s parietal lobe, which helps regulate the sense of self and physical orientation, research suggests. How does religion prompt divine feelings of love and compassion? Possibly because of changes in the frontal lobe, caused by heightened concentration during meditation. Why do many people have a profound sense that religion has changed their lives? Perhaps because spiritual practices activate the temporal lobe, which weights experiences with personal significance . . .”

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Abstract: 35 male volunteers whose ages ranged from 20 to 46 years were studied in two sessions of yoga-based guided relaxation and supine rest. Assessments of autonomic variables were made for 15 subjects, before, during, and after the practices, whereas oxygen consumption and breath volume were recorded for 25 subjects before and after both types of relaxation. A significant decrease in oxygen consumption and increase in breath volume were recorded after guided relaxation (paired t test). There were comparable reductions in heart rate and skin conductance during both types of relaxation. During guided relaxation the power of the low frequency component of the heart-rate variability spectrum reduced, whereas the power of the high frequency component increased, suggesting reduced sympathetic activity. Also, subjects with a baseline ratio of LF/HF > 0.5 showed a significant decrease in the ratio after guided relaxation, while subjects with a ratio < or = 0.5 at baseline showed no such change. The results suggest that sympathetic activity decreased after guided relaxation based on yoga, depending on the baseline levels.

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- 1) Passive stretching of muscle
- 2) Activation of certain muscles, particularly on [the] trunk and proximal parts of [the] extremities
- 3) General relaxation after asana
- 4) Partial relaxation during asana
- 5) Improvement of proprioception

“Contrary to traditional Western exercises, active muscle contraction has only limited importance in yogic postures. To omit the criticism that yogic exercises are “static,” we prefer to call them . . . practices or procedures [rather] than exercises.”

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Abstract: Alternating dominance of cerebral hemispheric activity was demonstrated in humans by use of the electroencephalogram (EEG). Relative changes of electrocortical activity have a direct correlation with changes in the relative nostril dominance, the so-called nasal cycle. The nasal cycle is a phenomenon where efficiency of breathing alternates predominantly through right or left nostril with a periodicity ranging from 25 to greater than 200 minutes. Relatively greater integrated EEG value in one hemisphere correlates with predominant airflow in the contralateral nostril, defining a new interrelationship between cerebral dominance and peripheral autonomic nervous function.

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Abstract: The effects of three different procedures, relaxation, visualization and yogic breathing (pranayama) and stretch on perceptions of physical and mental energy and on positive and negative mood states have been assessed in a group of normal volunteers (N = 71, age range 21-76). Pranayama produced a significantly greater increase in perceptions of mental and physical energy and feelings of alertness and enthusiasm than the other two procedures (P < 0.05). Relaxation made subjects significantly more sleepy and sluggish immediately after the session than pranayama (P < 0.05). Visualization made them more sluggish but less content than pranayama (P < 0.05) and more upset than relaxation after the second session (P < 0.05). Thus, a 30 min programme of yogic stretch and breathing exercises which is simple to learn and which can be practised even by the elderly had a markedly "invigorating" effect on perceptions of both mental and physical energy and increased high positive mood. A more extensive investigation is planned to establish whether such a programme can readily be incorporated into everyday life, and with what long-term results.

Woolfolk, Robert L. Psychophysiological correlates of meditation: A review. *Archives of General Psychiatry*, Oct 1975, 32(10):1326-1333. Also in Deane H. Shapiro, Jr., and Roger N. Walsh, *Meditation: Classic and Contemporary Perspectives*. Hawthorne, N.Y.: Aldine Publishing, 1984, pp. 369-375. PMID: 1180661.

Abstract: The scientific research that has investigated the physiological changes associated with meditation as it is practiced by adherents of Indian Yoga, Transcendental Meditation, and Zen Buddhism has not yielded a thoroughly consistent, easily replicable pattern of responses. The majority of studies show meditation to be a wakeful state accompanied by a lowering of cortical and autonomic arousal. The investigations of Zen and Transcendental Meditation have thus far produced the most consistent findings. Additional research into the mechanisms underlying the phenomena of meditation will require a shifting from old to new methodological perspectives that allow for adequate experimental control and the testing of theoretically relevant hypotheses.

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Abstract: Although meditation has been employed successfully as a treatment for various stress-related disorders, there is still little evidence clarifying just which aspects of meditation training are responsible for these therapeutic effects. This experiment sought to test the hypothesis that creating two opposite expectations about an initial meditation experience would result in differing physiological and phenomenological responses, even though the same technique was practiced by all subjects. The results of the experiment failed to support this hypothesis.

Yadav, R. K., and S. Das. Effect of yogic practice on pulmonary functions in young

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Abstract: During recent years, a lot of research work has been done to show the beneficial effects of yoga training. The present study was undertaken to assess the effects of yogic practice on some pulmonary functions. Sixty healthy young female subjects (age group 17-28 yrs.) were selected. They had to do the yogic practices daily for about one hour. The observations were recorded by MEDSPIROR, in the form of FVC, FEV-1 and PEFR on day-1, after 6 weeks and 12 weeks of their yogic practice. There was significant increase in FVC, FEV-1 and PEFR at the end of 12 weeks.

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Young, J. D., and E. Taylor. Meditation as a voluntary hypometabolic state of biological estivation. *News in Physiological Sciences*, Jun 1998, 13:149-153. PMID: 11390779.

Abstract: Meditation, a wakeful hypometabolic state of parasympathetic dominance, is compared with other hypometabolic conditions, such as sleep, hypnosis, and the torpor of hibernation. We conclude that there are many analogies between the physiology of long-term meditators and hibernators across the phylogenetic scale. These analogies further reinforce the idea that plasticity of consciousness remains a key factor in successful biological adaptation.

Zaichkowsky, L. D., and R. Kamen. Biofeedback and meditation: Effects on muscle tension and locus of control. *Perceptual and Motor Skills*, 1978, 46:955-958.

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Zusne, Leonard, and Warren H. Jones. The psychophysiology of hypo- and hyperarousal. In Leonard Zusne and Warren H. Jones, *Anomalistic Psychology: A Study of Extraordinary Phenomena of Behavior and Experience*. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1982, pp. 65-91.

Of Related Interest

Ades, P. A., P. D. Savage, M. E. Cress, M. Brochu, N. M. Lee, and E. T. Poehlman. Resistance training on physical performance in disabled older female cardiac patients. *Medicine & Science in Sports & Exercise*, 23 Aug 2003, 35(8):1265-1270.

Abstract: Purpose: We evaluated the value of resistance training on measures of physical performance in disabled older women with coronary heart disease (CHD). Methods: The study intervention consisted of a 6-month program of resistance training in a randomized controlled trial format. Training intensity was at 80% of the single-repetition maximal lift. Control patients performed light yoga and breathing exercises. Study participants included 42 women with CHD, all ≥ 65 yr of age and community dwelling. Subjects were screened by questionnaire to have low self-reported physical function. The primary study measurements related to the performance of 16 household activities of the Continuous Scale Physical Functional Performance test (CSPFP). These ranged from dressing, to kitchen and cleaning activities, to carrying groceries and walking onto a bus with luggage, and a 6-min walk. Activities were measured in time to complete a task, weight carried during a task, or distance walked. Other measures included body composition, measures of aerobic fitness and strength, and questionnaire-based measures of physical function and depression score. Results: Study groups were similar at baseline by age, aerobic capacity, strength, body composition, and in performing the CSPFP. After conditioning, 13 of 16 measured activities were performed more rapidly, or with increased weight carried, compared with the control group (all $P < 0.05$). Maximal power for activities that involved weight-bearing over a distance, increased by 40% ($P < 0.05$). Conclusions: Disabled older women with CHD who participate in an intense resistance-training program improve physical capacity over a wide range of household physical activities. Benefits extend beyond strength-related activities, as endurance, balance, coordination, and flexibility all improved. Strength training should be considered an important component in the rehabilitation of older women with CHD.

Ainsworth, B. E., W. L. Haskell, A. S. Leon, D. R. Jacobs, Jr., H. J. Montoye, J. F. Sallis, and R. S. Paffenbarger, Jr. Compendium of physical activities: classification of energy costs of human physical activities. *Medicine and Science in Sports and Exercise*, Jan 1993, 25(1):71-80. PMID: 8292105.

A coding scheme is presented for classifying physical activity by rate of energy expenditure, i.e., by intensity. Energy cost was established by a review of published and unpublished data. This coding scheme employs five digits that classify activity by purpose (i.e., sports, occupation, self-care), the specific type of activity, and its intensity as the ratio of work metabolic rate to resting metabolic rate (METs). Energy expenditure in kilocalories or kilocalories per kilogram body weight can be estimated for all activities, specific activities, or activity types. General use of this coding system would enhance the comparability of results across studies using self reports of physical activity.

Ainsworth, B. E., W. L. Haskell, M. C. Whitt, M. L. Irwin, A. M. Swartz, S. J. Strath, W. L. O'Brien, D. R. Bassett, Jr., K. H. Schmitz, P. O. Emplaincourt, D. R.

Jacobs, Jr., and A. S. Leon. Compendium of physical activities: an update of activity codes and MET intensities. *Medicine and Science in Sports and Exercise*, Sep 2000, 32(9 Suppl):S498-504. Author email: bainsworth@sph.sc.edu. PMID: 10993420.

We provide an updated version of the Compendium of Physical Activities, a coding scheme that classifies specific physical activity (PA) by rate of energy expenditure. It was developed to enhance the comparability of results across studies using self-reports of PA. The Compendium coding scheme links a five-digit code that describes physical activities by major headings (e.g., occupation, transportation, etc.) and specific activities within each major heading with its intensity, defined as the ratio of work metabolic rate to a standard resting metabolic rate (MET). Energy expenditure in MET-minutes, MET-hours, kcal, or kcal per kilogram body weight can be estimated for specific activities by type or MET intensity. Additions to the Compendium were obtained from studies describing daily PA patterns of adults and studies measuring the energy cost of specific physical activities in field settings. The updated version includes two new major headings of volunteer and religious activities, extends the number of specific activities from 477 to 605, and provides updated MET intensity levels for selected activities.

Anderson, P., and S. A. Andersson. *Physiological Basis of the Alpha Rhythm*. New York: Appleton-Century-Crofts, 1968.

Bell, Harold J., and James Duffin. The respiratory response to passive limb movement is suppressed by a cognitive task. *Journal of Applied Physiology*, 2004. Author email: j.duffin@utoronto.ca.

Abstract: Feedback from muscles stimulates ventilation at the onset of passive movement. We hypothesized that central neural activity via a cognitive task source would interact with afferent feedback, and we tested this hypothesis by examining the fast changes in ventilation at the transition from rest to passive leg movement, under two conditions: (A) no task, and (B) solving a computer-based puzzle. Resting breathing was greater in condition (B) than in condition (A); evidenced by an increase in mean \pm SEM breathing frequency (18.2 ± 1.1 br min⁻¹ versus 15.0 ± 1.2 br min⁻¹, $p = 0.004$) and ventilation (10.93 ± 1.16 l min⁻¹ versus 9.11 ± 1.17 l min⁻¹ $p < 0.001$). In condition (A) the onset of passive movement produced a fast increase in mean \pm SEM breathing frequency ($= 2.9 \pm 0.4$ br min⁻¹, $p < 0.001$), tidal volume ($= 233 \pm 95$ ml, $p < 0.001$) and ventilation ($= 6.00 \pm 1.76$ l min⁻¹, $p < 0.001$). However, in condition (B) the onset of passive movement only produced a fast increase in mean \pm SEM breathing frequency ($= 1.3 \pm 0.4$ br min⁻¹, $p = 0.045$), significantly smaller than in condition (A) ($p = 0.007$). These findings provide evidence for an interaction between central neural cognitive activity and the afferent feedback mechanism, and we conclude that the performance of a cognitive task suppresses the respiratory response to passive movement.

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Bogen, J. E. On the neurophysiology of consciousness. I. An overview. *Consciousness and Cognition*, 1995, 4:137–158.

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Brooks, Vernon R. *The Neural Basis of Motor Control*. London: Oxford University Press.

“An extremely comprehensive and systematic textbook on motor control, this authoritative study synthesizes physiology, neuroanatomy, kinesiology, and psychology to provide a thorough introduction to the subject. The book deals with posture and movement, adaptation, motor learning, and guidance by the limbic system. Superbly illustrated and highlighted with many clinical examples.”

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Cuthbert, Bruce N., Peter J. Lang, Cyd Strauss, David Drobos, Christopher Patrick J., and Margaret M. Bradley. The psychophysiology of anxiety disorder: Fear memory imagery. *Psychophysiology*, May 2003, 40(3):407-422. Peter Lang email: langlab@nersp.nerdc.ufl.edu.

Abstract: Psychophysiological response to fear memory imagery was assessed in specific phobia, social anxiety disorder, panic disorder with agoraphobia, post-traumatic stress disorder (PTSD), and healthy controls. Heart rate, skin conductance, and corrugator muscle were recorded as participants responded to tone cues signaling previously memorized descriptor sentences. Image contents included personal fears, social fears, fears of physical danger, and neutral (low arousal) scenes. Reactions to acoustic startle probes (eyeblick) were assessed during recall imagery and nonsignal periods. Participants were significantly more reactive (in physiology and report of affect) to fear than neutral cues. Panic and PTSD patients were, however, less physiologically responsive than specific phobics and the socially anxious. Panic and PTSD patients also reported the most

anxiety and mood symptoms, and were most frequently comorbidly depressed. Overall, physiological reactivity to sentence memory cues was greatest in patients with focal fear of specific objects or events, and reduced in patients characterized by generalized, high negative affect.

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Abstract; The object of this article is to present a novel physiological classification of Limbic-Autonomic (LA) arousal on the basis of human physiological data, specifically the oro-nasal breathing patterns in man. It is proposed that the multidimensional LA arousal can be classified into five grades: Grade I: Non-nasal (NN) or oral breathing with bilateral nasal congestion, and nonactive behavior, Grade II: Left Nasal (LN) breathing and quiet behavior, Grade III: Right Nasal (RN) breathing and active behavior, Grade IV: Bilateral Nasal (BN) breathing and very active behavior, and Grade V: Oral and Bilateral Nasal (ON) breathing with maximal behavioral activation. The data from polygraphic electroencephalographic recordings from five healthy volunteers, before, during and after exercise are presented in support of this physiological classification of LA arousal. On the basis of Limbic-Autonomic asymmetry a novel concept of ‘Visceral Dominance’ is also proposed.

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Abstract: A comparative analysis was conducted on a series of three experimental studies that examined the effect of various local and nonlocal (distant) complementary healing methods on multisite surface electromyographic (sEMG) and autonomic measures. The series concentrated sEMG electrode placement on specific neuromuscular paraspinal centers (cervical [C4], thoracic [T6], and lumbar [L3]), along with the frontalis region, due to the fact that these sites corresponded to the location of individual chakra centers as delineated in ancient Eastern medical and philosophical texts. It was hypothesized that

the sEMG assessment procedure had the potential to provide objective, quantifiable correlates for complementary healing treatment effects, as well as assess the energy flow through the chakras during a healing treatment. The studies were the first of their kind to incorporate randomized, double-blind, placebo-controlled protocols in order to evaluate correlative neuromuscular multisite sEMG paraspinal measures with different complementary healing treatment interventions. Although the measurement protocols were similar between experiments, the results, demonstrated by the individual studies, varied. Whereas the overall findings of the series are encouraging because they indicate a potential objective scientific correlate to complementary healing treatment intervention, the results are considered preliminary in nature and appear to be linked to either the meditational experience of the subjects or dependent on the particular healer(s) used. Additional research is needed in order to establish the multisite sEMG assessment procedure as a reliable correlative measure for complementary healing treatment effects and to determine whether a consistent replicative treatment effect can be demonstrated independent of the specific subject population or practitioner(s) used.

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Respiratory sinus arrhythmia is associated with efficiency of pulmonary gas exchange in healthy humans. *American Journal of Physiology—Heart and Circulation Physiology*, May 2003, 284(5):H1585-H1591

Abstract: Respiratory sinus arrhythmia (RSA) may be associated with improved efficiency of pulmonary gas exchange by matching ventilation to perfusion within each respiratory cycle. Respiration rate, tidal volume, minute ventilation (E), exhaled carbon dioxide (CO₂), oxygen consumption (O₂), and heart rate were measured in 10 healthy human volunteers during paced breathing to test the hypothesis that RSA contributes to pulmonary gas exchange efficiency. Cross-spectral analysis of heart rate and respiration was computed to calculate RSA and the coherence and phase between these variables. Pulmonary gas exchange efficiency was measured as the average ventilatory equivalent of CO₂ (E/CO₂) and O₂ (E/O₂). Across subjects and paced breathing periods, RSA was significantly associated with CO₂ (partial r = 0.53, P = 0.002) and O₂ (partial r = 0.49, P = 0.005) exchange efficiency after controlling for the effects of age, respiration rate, tidal volume, and average heart rate. Phase between heart rate and respiration was significantly associated with CO₂ exchange efficiency (partial r = 0.40, P = 0.03). These results are consistent with previous studies and further support the theory that RSA may improve the efficiency of pulmonary gas exchange.

Green, Judith, and Robert Shellenberger. The subtle energy of love. *Subtle Energies and Energy Medicine Journal*, 1993, 4(1).

Abstract: That love promotes health surprises few people and yet from the perspective of poets, philosophers and healers who for millennia have understood the powers of love, the scientific study of love and physical health is in its infancy. Because love has many facets and is manifested in many ways as described here, it was banned from Western Science that insisted upon observable and simple independent variables. In this article we present data indicating the salutary effects of love on physical health; these data are from several areas--psychology, sociology, medicine, epidemiology and healing--and together form a foundation for understanding and enhancing love and its effects. Three processes are formulated to explain the health promoting effects of love--psychophysiologic, psychophysical and psychosocial/behavioral. Love is described as an energy by virtue of its capacity to produce effects; it is subtle, not because its effects are subtle, but because it has been ineffable to science.

Halámek, Josef, Tomáš Kára, Pavel Jurák, Miroslav Souček, Darrel P. Francis, L. Ceri Davies, Win K. Shen, Andrew J. S. Coats, Miroslav Novák, Zuzana Nováková, Roman Panovský, Jiří Toman, Josef Šumbera, and Virend K. Somers. Variability of phase shift between blood pressure and heart rate fluctuations: A marker of short-term circulation control. *Circulation*, 2003, 108:292. Author email: josef@isibrno.cz.

Abstract: Background: We postulated that the variability of the phase shift between blood pressure and heart rate fluctuation near the frequency of 0.10 Hz might be useful in assessing autonomic circulatory control. Methods and Results: We tested this hypothesis in 4 groups of subjects: 28 young, healthy individuals; 13 elderly healthy individuals; 25 patients with coronary heart disease; and 19 patients with a planned or implanted cardioverter-defibrillator (ICD recipients). Data from 5 minutes of free breathing and at 2 different, controlled breathing frequencies (0.10 and 0.33 Hz) were used. Clear differences ($P < 0.001$) in variability of phase were evident between the ICD recipients and all other groups. Furthermore, at a breathing frequency of 0.10 Hz, differences in baroreflex sensitivity ($P < 0.01$) also became evident, even though these differences were not apparent at the 0.33-Hz breathing frequency. Conclusions: The frequency of 0.10 Hz represents a useful and potentially important one for controlled breathing, at which differences in blood pressure-RR interactions become evident. These interactions, whether computed as a variability of phase to define stability of the blood pressure-heart rate interaction or defined as the baroreflex sensitivity to define the gain in heart rate response to blood pressure changes, are significantly different in patients at risk for sudden arrhythmic death. In young versus older healthy individuals, only baroreflex gain is different, with the variability of phase being similar in both groups. These measurements of short-term circulatory control might help in risk stratification for sudden cardiac death.

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“How do we integrate consciousness into scientific research? And how does science account for subjective experience?”

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Abstract: Nearly all authorities agree that exercise reduces tension and improves mental health; however, a specific cause-and-effect phenomenon has not been found. More than five decades of research have revealed numerous plausible mechanisms underlying exercise-related mood alterations. The purpose of this narrative review is briefly to review six of the more popular mechanisms and acquaint health promotion professionals with their affiliated nature. Nearly all of the mechanisms proposed overlap or share some common neuroanatomic pathway. It is probably that the best candidate for exercise-induced affective changes evolves from an integration of brain neurotransmission processes involving such principle neuroactive substances as endorphin, enkephalin, serotonin, dopamine, and norepinephrine, among many others. The alliance of these

specialized brain systems responsible for mood changes also influences a constellation of “mind-body” functions such as state-dependent learning and memory, autogenic training, eating behavior, hypnosuggestion, psychoneuroimmunology, and stress-related disorders such as hypertension. The utilization of new brain imaging techniques to study acute exercise and collaborative efforts with researchers in cognitive neuroscience and neurobiology will help elucidate how these mechanisms are functionally coupled. Individual psychobiological responses to exercise and other stimuli are invariably related to one’s genetic code, the nature of the exercise, the exercise environment, and present health and fitness. By attempting to comprehend these extraordinary psychobiological features, fitness and health promotion professionals can better understand and respect individual differences in mood and performance.

Lee, Myeong Soo, Byung Gi Kim, Hwa Jeong Huh, Hoon Ryu, Ho-Sub Lee, and Hun-Taeg Chung. Effect of Qi-training on blood pressure, heart rate and respiration rate. *Clinical Physiology*, May 2000, 20(3):173-6. PMID: 10792409.

Abstract: To examine the physiological effects of Korean traditional Qi-training, we investigated the changes in blood pressure, heart and respiratory rates before, during and after ChunDoSunBup (CDSB) Qi-training. Twelve normal healthy CDSB Qi-trainees (19-37 years old; trained for 1.3 +/- 0.2 years; 9 men and 3 women) volunteered to participate in this study. Heart rate, respiratory rate, systolic blood pressure and rate-pressure product were significantly decreased during Qi-training. From these results, we suggest that CDSB Qi-training has physiological effects that indicate stabilization of cardiovascular system.

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Litscher, G., G. Wenzel, G. Niederwieser, and G. Schwarz. Effects of QiGong on brain function. *Neurological Research*, Jul 2001, 23(5):501-505. Author email: gerhard.litscher@kfunigraz.ac.at. PMID: 11474806.

Abstract: QiGong is an ancient and widely practiced Chinese meditation exercise. We studied the effects of QiGong on brain function with modern neuromonitoring tools in two subjects. In a male QiGong master (extremely trained practitioner), the technique induced reproducible changes in transcranial Doppler sonography, EEG, stimulus-induced 40 Hz oscillations, and near-infrared spectroscopy findings. Similar effects were seen after the application of multimodal stimuli and when the master concentrated on intense imagined stimuli (e.g. 22.2% increase in mean blood flow velocity (vm) in the posterior cerebral artery, and a simultaneous 23.1% decrease of vm in the middle cerebral artery). Similar effects were seen in the female subject. Neuromonitoring during QiGong appears able to objectify accompanied cerebral modulations surrounding this old Chinese meditation exercise.

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Mayer, David J. Biological mechanisms of acupuncture. In E. A. Mayer and C. B. Saper, eds. *Progress in Brain Research, Vol. 122: The Biological Basis for Mind Body Interactions*. Amsterdam: Elsevier, 2000, pp. 458-477.

McCraty, Rollin, Mike Atkinson, and William A. Tiller. *Subtle Energies and Energy Medicine Journal*, 1993, 4(3).

Abstract: This work utilizes the measurement of heart rate variability (HRV) as a vehicle to show that continued practice of certain specific techniques involving an intentional shift of focus to the area of the heart, and invoking specific feeling states such as “love” and “appreciation,” automatically manifests in increased autonomic nervous system balance. In particular, (1) enhanced balance between the parasympathetic and sympathetic nervous system, (2) a shift of the high frequency and low frequency portions of the HRV power spectra to around 0.1 Hz range, (3) entrainment and frequency portions of the HRV power spectra to around 0.1 Hz frequency, associated with a change in focus of the subject to a different heart feeling state, and (5) the intentional generation of a newly defined internal coherence state (near zero HRV), have all been achieved. These are electrophysiological correlates of certain mental and emotional states occupied by the individual. Three individual subjects plus a group study of twenty subjects are reported on and discussed. From these results, one sees that individuals can intentionally affect their autonomic nervous system balance, and thus, their HRV.

Muehsam, David J., M. S. Markham, Patricia A. Muehsam, Arthur A. Pilla, Ronger Shen, and Yi Wu. Effects of Qigong on cell-free myosin phosphorylation: Preliminary experiments. *Subtle Energies and Energy Medicine Journal*, 1994, 5(1).

Abstract: This work examines the effect of Qigong from two experienced practitioners on *in vitro* cell-free myosin phosphorylation. This system has a demonstrated sensitivity to variations in static magnetic fields above and below ambient values. The results show that both Qigong practitioners were able to consistently yield results similar to those observed for variations in applied magnetic fields near the ambient level. Qigong treatment with the myosin reaction mixture in the ambient magnetic field reduced phosphorylation in each experiment by an average of approximately 15% ($p < .05$). For trials with the myosin samples in a magnetic shield, two of four (one for each practitioner) Qi treatments yielded significant reductions in phosphorylation (average approximately 10%, $p < .05$). These effects were somewhat lower and not as consistent as those obtained under ambient field conditions. The results obtained in this study demonstrate that Qigong practice can consistently affect a biologically relevant enzyme system, requiring no physical contact between the practitioner and the sample. The mechanisms of the Qigong effects observed in this study are as yet unclear.

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Abstract: The constancy of the internal environment, internal homeostasis, and its stability are necessary conditions for the survival of a biological system within its environment. These have never been clearly defined. For this purpose nonequilibrium thermodynamics is taken as a reference, and the essential principles of equilibrium, reversibility, stationary steady state and stability (Lyapounov, asymptotic, local and global), are briefly illustrated. On this basis, internal homeostasis describes a stationary state of nonequilibrium, the actual state of rest, $X(t)$, resulting from the relation $X(t) = X_S + x(t)$, between a time-independent steady state of reference (X_S), and time-dependent fluctuations of the state variables, $x(t)$. In humans, two resting spontaneous homeostatic states are: (1) the conscious state of quiet wakefulness, during which time-dependent variables display bounded oscillations around the mean time-independent steady state level, this conscious state being thus stable in the sense of Lyapounov, and (2) the unconscious stable state of non-rapid eye movement sleep, in which the time-dependent variables would approach the lowest spontaneously attainable time-independent state asymptotically, sleep becoming a globally stable and attractive state. Exercise may be described as a non-resting, unstable active state far away from equilibrium and hibernation is a resting, time-independent steady state very near equilibrium. The range between sleep and exercise is neurohumorally regulated. For spontaneously stable states to occur, slowing of the metabolic rate, withdrawal of the sympathetic drive and reinforcement of the vagal tone to the heart and circulation are required, thus confirming that the parasympathetic division of the autonomic nervous system is the main controller of homeostasis.

Roitbak, A. I. [Variation of reaction time as a function of respiration phase: Possible causes of this phenomenon.] *Studii si Certari de Neurologie*, 1960, 5:549-556. [In Russian.]

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Abstract: To examine the hypothesis that the relaxation response is associated with an increase in cardiac parasympathetic tone, the frequency components of heart rate variability during relaxation training were investigated in 16 college students. Electrocardiograms and pneumograms were recorded during a 5-min baseline period followed by three successive 5-min sessions of the autogenic training (relaxation) or by the same periods of quiet rest (control), while subjects breathed synchronously with a visual pacemaker (0.25 Hz). Although neither the magnitude nor the frequency of respiration showed a significant difference between relaxation and control, the amplitude of the high-frequency component of heart rate variability increased only during relaxation ($p = .008$). There was no significant difference in the ratio of the low-frequency (0.04-0.15 Hz) to the high-frequency amplitudes. The increased high-frequency amplitude without changes in the respiratory parameters indicates enhanced cardiac parasympathetic tone. Thus, our results support the initial hypothesis of this study. Enhanced cardiac parasympathetic tone may explain an important mechanism underlying the beneficial effect of the relaxation response.

Salmon, P. Effects of physical exercise on anxiety, depression, and sensitivity to stress: A unifying theory. *Clinical Psychological Review*, Feb 2001, 21(1):33-61. PMID: 11148895. Author email: psalmon@liv.ac.uk.

Abstract: Until recently, claims for the psychological benefits of physical exercise have tended to precede supportive evidence. Acutely, emotional effects of exercise remain confusing, both positive and negative effects being reported. Results of cross-sectional and longitudinal studies are more consistent in indicating that aerobic exercise training has antidepressant and anxiolytic effects and protects against harmful consequences of stress. Details of each of these effects remain unclear. Antidepressant and anxiolytic effects have been demonstrated most clearly in subclinical disorder, and clinical applications remain to be exploited. Cross-sectional studies link exercise habits to protection from harmful effects of stress on physical and mental health, but causality is not clear. Nevertheless, the pattern of evidence suggests the theory that exercise training recruits a process which confers enduring resilience to stress. This view allows the effects of exercise to be understood in terms of existing psychobiological knowledge, and it can thereby provide the theoretical base that is needed to guide future research in this area. Clinically, exercise training continues to offer clinical psychologists a vehicle for nonspecific therapeutic social and psychological processes. It also offers a specific psychological treatment that may be particularly effective for patients for whom more conventional psychological interventions are less acceptable.

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Shang, C. Emerging paradigms in mind-body medicine. *Journal of Alternative and Complementary Medicine*, Feb 2001, 7(1):83-91. Email: cshang9@yahoo.com. PMID: 11246939.

Abstract: The emerging paradigms in medicine can be seen through mind-body interactions. Observations in many meditative traditions suggest a series of objective indicators of health beyond absence of disease. Several of the physical signs have been confirmed by research or are consistent with modern science. Further correlation with long term health outcome is needed. Integration of meditation with conventional therapy has enriched psychotherapy with parallels drawn between the Nine Step Qigong and Freudian developmental psychology. A unified theory of the chakra system and the meridian system widely used in traditional mind-body interventions and acupuncture is presented in terms of modern science based on the morphogenetic singularity theory. Acupuncture points originate from the organizing centers in morphogenesis. Meridians and chakras are related to the underdifferentiated, interconnected cellular network that regulates growth and physiology. This theory explains the distribution and nonspecific activation of organizing centers and acupuncture points; the high electric conductance of the meridian system; the polarity effect of electroacupuncture; the side-effect profile of acupuncture; and the ontogeny, phylogeny, and physiologic function of the meridian system and chakra system. It also successfully predicted several findings in conventional biomedical science. These advances have implications in many disciplines of medicine.

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Abstract: Maximum nasal flow rate in the right and left nostrils was simultaneously determined during expiration with the help of two flowmeters in 10 healthy subjects in different postures and in two patients, one with Horner's syndrome and the other with facial palsy. It was found that pressure on the hemithorax from any surface (i.e., lateral, anterior, posterior, or superior) leads to reduced patency of the ipsilateral nostril but increased patency of the nostril on the opposite site. In the patient with Horner's syndrome, the nostril on the affected side remained blocked even on compression of the opposite hemithorax, and in the one with facial nerve palsy, the nostril on the affected side remained patent despite compression of the hemithorax on that side. The findings suggest that compression of hemithorax leads to changes in the congestion of the nasal mucosa that may be mediated through autonomic nerves.

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Abstract: The purpose of this article is to describe one understanding of structures involved in energetic healing, which is defined as healing occurring at the quantum and electromagnetic levels of a person, plant, or animal. Characteristics of electromagnets, direct electric currents, Fourier analyzers, and L-C circuits are discussed and applied to the human being. Human electromagnetic characteristics are compared to descriptions of auras, meridians, and chakras. Quantum and chaos theories are presented and applied to the question of the mechanism of energetic healing.

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Abstract: Scalp surface field potential changes (EEG) have long been associated with activities of neuronal processes in the brain. In spite of much knowledge, success in identifying EEG signatures which represent specific brain activation states has been limited. Using on line fast-fourier transforms of brainwave signals and computer displays with one-second updates of 5, 7, 10, 12, 14, 16, 20 and 28 Hz with 1 Hz bandwidth specific brainwave signatures were identified for attentional, cognitive, imaginal, and somatosensory states. The data bring into question the functional utility ascribed to the commonly used brainwave frequency bands designated as Delta, Theta, Alpha, and Beta. The quest for the neuroanatomic substrate of conscious intention is addressed within the context of brain based parking spots and how they pertain to the invisible and quantifyingly problematic thing called "mind."

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Abstract: Objective: To conduct a systematic review of reports on the physical and psychological effects of Tai Chi on various chronic medical conditions. Data Sources: Search of 11 computerized English and Chinese databases. Study Selection: Randomized controlled trials, nonrandomized controlled studies, and observational studies published in English or Chinese. Data Extraction: Data were extracted for the study objective, population characteristics, study setting, type of Tai Chi intervention, study design, outcome assessment, duration of follow-up, and key results. Data Synthesis: There were 9 randomized controlled trials, 23 nonrandomized controlled studies, and 15 observational studies in this review. Benefits were reported in balance and strength, cardiovascular and respiratory function, flexibility, immune system, symptoms of arthritis, muscular strength, and psychological effects. Conclusions: Tai Chi appears to have physiological and psychosocial benefits and also appears to be safe and effective in promoting balance control, flexibility, and cardiovascular fitness in older patients with chronic conditions. However, limitations or biases exist in most studies, and it is difficult to draw firm conclusions about the benefits reported. Most indications in which Tai Chi was applied lack a theoretical foundation concerning the mechanism of benefit. Well-designed studies are needed.

Winkelman, Michael. Physiological and therapeutic aspects of shamanistic healing. *Subtle Energies and Energy Medicine Journal*, 1990, 1(2).

Abstract: This paper addresses the psychophysiological and therapeutic bases of some universal aspects of shamanistic healing practices. Shamanistic healing is universal because of the interrelated physiological, experiential and therapeutic bases in the use of altered states of consciousness (ASC). Case studies of cross-cultural therapeutic use of ASC illustrate cultural effectiveness. The scientific bases of therapeutic effectiveness are addressed through an examination of the psychophysiology of ASC. Clinical and physiological evidence for the therapeutic effectiveness of ASC in general and hallucinogens in particular is reviewed. Possession and the temporal lobe syndrome are briefly examined in the context of the psychophysiology of ASC.

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Xu, S. H. Psychophysiological reactions associated with qigong therapy. *Chinese Medical Journal (English)*, Mar 1994, 107(3):230-233. PMID: 8088187.

Abstract: Qigong as a part of the traditional Chinese medicine is similar to western “meditation,” Indian “Yoga” or Japanese “Zen,” which can all be included in the category of traditional psychotherapy. A series of physiological and psychological effects occur in the course of Qigong training, but inappropriate training can lead to physical and mental disturbances. Physiological effects include changes in EEG, EMG, respiratory movement, heart rate, skin potential, skin temperature and finger tip volume, sympathetic nerve function, function in stomach and intestine, metabolism, endocrine and immunity systems. Psychological effects are motor phenomena and perceptual changes: patients experienced warmth, chilliness, itching sensation in the skin, numbness, soreness, bloatedness, relaxation, tenseness, floating, dropping, enlargement or constriction of the body image, a sensation of rising to the sky, falling off, standing upside down, playing on the swing following respiration, circulation of the intrinsic Qi, electric shock, formication, during Qigong exercise. Some patients experienced dreamland illusions, unreality and pseudohallucination. These phenomena were transient and vanished as the exercise terminated. Qigong deviation syndrome has become a diagnostic term and is now used widely in China.

Zhang, J. Z., J. Zhao, and Q. N. He. EEG findings during special psychical state (Qi Gong state) by means of compressed spectral array and topographic mapping. *Computers in Biology and Medicine*, 1988, 18(6):455-463. PMID: 3060312

Abstract: Wallace first reported the changes in EEG during transcendental mediation [6]. Banquet [1] observed, on the basis of spectral analysis of the EEG, that the mediation state was a unique state of consciousness, and separate from wakefulness, drowsiness or sleep. The Qi Gong of China is not the same as either transcendental mediation or the Yoga Gong. The EEG during Qi Gong state is clearly different from those recorded during the resting state. The changes in the EEG during the Qi Gong have not been reported previously. The EEG alpha activity during the Qi Gong state occurs predominantly in the anterior regions. The peak frequency of EEG alpha rhythm is slower than the resting state. The change of EEG during Qi Gong between anterior and posterior half is negative correlation. These changes are statistically significant.

Ongoing Research

Mark Malay

San Diego, CA

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Conducting research for his Ph.D. on: Do measurable physiological changes occur for Hatha-Yoga asanas, and are those changes correlated to hypnotic ability? Contacted YREC 4/1/02.

Steve Ragsdale, Ph.D.

Professor, Department of Biochemistry

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Is exploring the relationship between biochemistry, the anatomy of the nervous system, and the *cakras*. Contacted YREC in 2000.

Philip Stevens, BSc (Psych, Physiol), BSc (hons) (Physiol)

Ph.D. candidate in collaboration with the department of Complementary Medicine in the School of Health Sciences and the School of Electrical and Computer Engineering RMIT University

Email: research@yogalinks.net

Conducting the following research project:

Electrophysiological Correlates of Yoga Breathing Techniques

Various styles of breathing are promoted as beneficial. Inhalation and exhalation methods often differ widely, however, with various combinations of abdominal &/or thoracic dominance being favored. Different rhythms of breathing, from hyperventilation to very-slow-rate, are used, often with various esoteric and/or medical claims. Validation studies are few, particularly comparative studies of more than one technique. While certain, specific breathing practices have been studied so far that show differential effects on brain laterality and cardiac autonomic variations, no study to-date has described and cross-correlated the effects of the all the main, breathing techniques commonly promoted in yoga classes today.

This project seeks to:

1. catalogue and describe the various breathing techniques available today using standard, anatomical, physiological, psychological and medical-terminologies.
 2. explore the relationship between certain breathing techniques by measuring abdominal and thoracic inputs and their concomitant-effects on the brain, heart and autonomic-nervous-system using electrophysiological recordings (EEG and ECG) on human subjects over time.
 3. uncover functional brain and cardiac autonomic-nervous-system interactions using conscious, controlled, yoga-based, breathing techniques that may have relevance in preventing and/or dealing with certain cardiac problems prevalent today.
- As certain types of breathing can profoundly impact on human physiology and psychology, this study will help better understand the neurophysiological implications underpinning various yoga, meditation and relaxation techniques. It may even have relevance in non-pharmacological management of stress, hypertension, depression, stroke, cardiac problems, sleep disordered breathing and asthma.

Equipment required to complete this study will include:

EEG to give measures of localised, hemispherical brain-activity, which can be correlated with other ancillary measures of autonomic nervous activity such as lateralised nasal-airflow and lateral peripheral-temperature.

ECG to provide relative changes in heart rate variability. Cardiac parasympathetic and sympathetic activity can then be assessed using respiratory sinus arrhythmia (RSA) and pre-ejection period (PEP). The cardiac system allows both parasympathetic and sympathetic activity to be reliably and concurrently estimated, with strong consensus in the literature identifying RSA and PEP as the most validated, non-invasive measures of cardiac parasympathetic and sympathetic activity, respectively.

Your participation would initially involve completing an online yoga and health-questionnaire that takes around 15 minutes. Various volunteers in certain locations around Australia will be required for the experimental trials that involve simple breathing practices for about 1-hour while measurements are taken and recorded on a laptop.

The experimental part of the project involves 15 minutes preparation time to attach medical recording equipment to your abdomen, chest and scalp and then approximately ½ -1 hour to complete the breathing tests. These will measure breathing muscle movements, heart-rate and brain-wave activity in conjunction with your breathing. Your total time commitment should only take 1½ - 2 hours.

Data collection will involve standard, non-invasive medical-recording equipment to test normal breathing using specific respiratory muscles. All electrical equipment is full shielded from the electricity grid as it runs on batteries and all equipment is medically approved for clinical and human research use in Universities, Hospitals and Clinics around Australia and overseas. All information collected will be coded so you will not be personally identifiable and kept secure at RMIT University for academic research purposes only. Non-identifying results will be reported in a manner that protects your anonymity.

If you have any queries regarding this project, want more information, or wish to be considered for the experimental trials, please contact me on 0419 806 066 or research@yogalinks.net