Chapter 12
Mind-Body Practices and the Neuro-psychology of Wellbeing

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Traditional Western cultures tend to subdivide wellbeing into three realms: physical, emotional, and spiritual. Consequently, people often seek physical wellbeing through exercise, emotional wellbeing through psychotherapy, and spiritual wellbeing through religion. In contrast, Eastern cultures envision more of a mind-body continuum. Classical yoga and other meditative traditions use highly developed physical and mental practices to increase positive states of mind and body. As Eastern practices adapted to Western cultures, physical practices, asanas (movements and postures), became predominant to enhance physical fitness. More recently, however, breathing and contemplative practices are regaining lost ground due to increased recognition of their potential benefits for dealing with stress and reducing distress. At the same time, modern research is showing that neuro-immuno-endocrine changes associated with stress and aging contribute to inflammation, dysregulation of energy utilization (for example, insulin resistance), oxidative damage by free radicals, and neuronal degeneration (Brown & Gerbarg, 2009; Desteno, Gross, & Kubzansky, 2013; Poitras & Pyke, 2013; Shalev et al., 2013; Stuart & Baune, 2012). Consequently, interest in aspects of yoga as a mind-body and psycho-spiritual practice is growing in tandem with the evidence that emotional states affect physical wellbeing and disease progression (Benson, 1996; Jacobs, 2001). Of course, prior to yoga and in many places outside of Asia, mind-body practices such as

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shaking, movement, breathing, dancing, and chanting have been used for health and spiritual wellbeing for millennia; thus, while this chapter focuses mainly on breath practices, examples from diverse religious mind-body traditions are included where relevant.

12.1 Breath Practices, the Foundation of Yoga and Other Mind-Body Techniques

Yoga began developing about 8,000 years ago as a method for emotional, physical, mental and spiritual wellbeing. Breath awareness and breath practices form the foundation of yoga and other healing traditions. Yoga philosophy considers the greatest stress to come from fluctuations of the mind as it moves toward the things it wants in the future or away from things it dislikes, such as future threats or past mistakes. When we focus our attention on present experiences, instead of focusing attention on past or future experiences, we tend to feel calmer and experience greater stress tolerance. According to yoga teachings, mental and physical illnesses are caused by fluctuations of the mind as it shifts between worries about the future and regrets or negative feelings about the past. Thus, yoga breathing heals by quieting the fluctuations of the mind and directing our attention to the present moment (Feuerstein, 1998).

The word yoga comes from the Sanskrit word 'yuj', which means 'unity'. It is said that the purpose of yoga is to unite with the highest, our 'true nature', which is thought to go beyond the limits of human mind, personality and our limited sense of self.

According to the Yoga Sutras written by Patanjali, who systematized yoga philosophy around 200 BCE, breathing exercises, called pranayamas, are crucial yoga practices intended to help cleanse the body and mind of the effects of daily and long-term stresses. With yogic breathing, the 'life force' (prana) is brought 'under control' (yama). Stress can cause rapid shallow breathing. In contrast, relaxation promotes deeper, slower respiration. Yogic scriptures teach that pranayamas also improve concentration, mental focus, and self-control.

Within yoga traditions, many breathing exercises are described: for example, breathing at different rates and depths, breathing against airway resistance, altering how the nose, mouth, and throat are used, and coordinating breathing with body movements and postures.

Breath practices are used in most spiritual traditions to enhance positive mental, emotional, and physical states. Classical Hindu and Buddhist texts focus on the breath as the *conditio sine qua non* of spiritual practice. In Traditional Chinese Medicine, *Qi*, the life force energy, is strengthened, collected and stored using breath techniques. The calming breath, called *Xi*, is gentle, smooth, "thread-like, continuous, similar to the silk-worm emitting silk," according to T. K. Shih (1999). He quotes an ancient song: "*The heart rules over the movement of the Qi. The Qi brings long life. When long and thread-like, smooth and continuous breath flows in its circle, disease can be removed and life prolonged.*" (Shih, 1999). Breath practices are central in meditative

and martial arts traditions. Chanting, a form of paced breathing in which vocal cord contraction increases airway resistance to create sound, is prominent in Judaism, Christianity, Buddhism, Islam, and in tribal practices worldwide. For example, in Nigeria, the ancient Ibo word for lungs "ngugu" is derived from the word "gugu" meaning to console or heal. Thus the lungs or "ngugu" constitute the healer (Dr. Uzoma Nwosu, personal written communication, June 21, 2012).

12.2 Effects on Stress Response, Emotion Regulation, Bonding, Compassion, and Spirituality

We will explore the impact of mind-body practices on the following aspects of wellbeing:

1. The sense of calmness and safety depends upon the health, flexibility, balance, and resiliency of the stress response systems.
2. The ability to manage stress well and to experience positive emotions emerges from early bonding experiences and adequate functioning of emotion regulatory systems.
3. The experience of positive emotions, particularly love of oneself and others, depends on the capacity for bonding, connectedness, compassion, and caregiving.
4. The experience of spirituality requires the ability to feel a meaningful connection to someone or something.

As described in the previous section, breath practices form the foundation of yoga and many mind-body practices. In the following discussion we will focus mainly on the effects of breath practices on wellbeing.

12.2.1 Stress Response Systems

People vary in their reaction to stressful experiences. Resiliency of the stress response systems affects how we deal with stress and how it impacts our health and wellbeing (Selye, 1979). In brief, the autonomic nervous system, which regulates the automatic body functions, is a major component of the stress response system. It consists of two counterbalancing divisions, the sympathetic and the parasympathetic systems, each with its own intricate network of neural pathways. In acute stress situations, the sympathetic nervous system (SNS) is activated to prepare the body for action. The parasympathetic nervous system (PNS) facilitates vegetative, and nonemergency activities and allows the body to relax, repair itself, and restore energy reserves after a stressful period. Balance between the SNS and PNS is essential for healthy functioning during and after stress (Brown & Gerbarg, 2009; Porges, 2009; Thayer & Brosschot, 2005).

Another part of the stress response system involved in long-term, prolonged stress involves the hypothalamus and the pituitary that regulate the secretion of cortisol by the adrenal glands. The functions of the autonomic and hypothalamic-pituitary-adrenal systems as well as the interactions between them can be influenced by breathing and other mind-body practices. Until the last 15 years, western science focused on the top-down effects of the PNS on body organs; for example, the cardiovascular, respiratory, digestive, and glandular systems. More recent research reveals profound effects of the PNS on perception, emotion, cognition, and social behavior. Clinical studies find that imbalances in the PNS and SNS stress response system are associated with psychological disorders, particularly anxiety, depression, post-traumatic stress disorder, attention deficit disorder, and autism (Beauchaine, 2001). Maintaining the balance between the SNS and PNS is critical to preventing over reactions and emotion dysregulation, as seen, for example, in anxiety disorders. SNS and PNS balance is also essential to prevent or repair cellular damage from prolonged excess levels of cortisol, adrenaline, and excitatory neurotransmitters, such as glutamate. Most anxiolytic, anti-depressant, and anti-psychotic medications dampen down the activity of the SNS. However, to date, there are no medications that have been shown to elevate the activity of the PNS. Research evidence has shown that mind-body practices and positive emotional experiences can activate and strengthen the PNS (Brown & Gerbarg, 2005a, 2005b, 2009; Telles & Desiraju, 1992).

The main pathways of the PNS are the right and left vagus nerves (10th cranial nerves) which exit from the brainstem and travel through the chest and abdomen. The vagus nerves send branches to all of the internal organs, glands, blood vessels, and other internal tissues. The vagus nerves are bidirectional. Approximately 30 % of vagal fibers carry messages from the brain down to the body, regulating the autonomic functions such as heart rate, respiratory rate, the dilation and contraction of blood vessels, and digestion, as well as inflammation, and insulin release. The remaining 70 % of vagal fibers convey information from the body up through the brainstem to critical structures inside the brain. From the brainstem, pathways ascend to the limbic system (emotion processing structures), hypothalamus, thalamus, and broad areas of the cerebral cortex (including the prefrontal cortex and the insular cortex), influencing how we experience our bodies, emotions, perceptions, and states of consciousness. The PNS also has a significant impact on how we express our feelings and on our capacities for social interactions, bonding, and love (Brown, Gerbarg, & Muench, 2013; Porges, 2009; Streeter, Gerbarg, Saper, Ciraulo, & Brown, 2012).

Breathing, the only autonomic function easily controlled through voluntary effort, can be used as a portal through which imbalances in the stress-response system can be corrected. In the last section of this chapter, we will elaborate on the potential effects of breathing on the PNS and SNS. To examine activity of the PNS, researchers studied the naturally occurring variations in heart rate. During inhalation the heart speeds up and during exhalation the heart slow down. Input from the SNS and from one of the vagal nerves regulates heart rate. Variations in heart rate can be used to calculate the level of activity in the PNS and SNS (Porges, 2001). Low heart rate variability (HRV) and respiratory sinus arrhythmia (RSA) are associated with depression, timidity or fear in infants and with anxiety, panic disorder,

depression, inflammatory bowel disease, cardiovascular disease, and obesity (Beauchaine, 2001; Carney et al., 1995; Friedman & Thayer, 1998; Jacob et al., 2013). Improvements in HRV can be used to assess positive effects of interventions on PNS activity and the balance between SNS and PNS.

12.2.2 Emotion Regulation

Western research confirms the Indo-Tibetan teaching that breathing and emotion have a reciprocal relationship (Ley, 1999). Emotional states affect respiratory rate, depth and pattern. Conversely, voluntarily changing the pattern of breath can account for at least 40 % of the variance in feelings of anger, fear, joy and sadness (Philippot, Chapelle, & Blairy, 2002). Breathing is controlled by both voluntary and involuntary mechanisms with complex feedback involving networks of the autonomic nervous system, brain stem nuclei, limbic system, cerebral cortex, and the neuroendocrine system. The voluntary control of breath can modulate autonomic nervous system functions, including vagal activity (as measured by HRV), vigilance and attention, chemoreceptor and baroreflex sensitivity, and the level of central nervous system excitation (Bernardi, Gabutti, Porta, & Spicuzza, 2001; Brown & Gerbarg, 2005b; Fokkema, 1999; Lehrer, Sasaki, & Saito, 1999; Sovik, 2000; Spicuzza, Gabutti, Porta, Montano, & Bernardi, 2000).

Polyvagal theory asserts that "physiological states characterized by increased vagal influence on HRV support social engagement and bonding." Moreover, "any stimulus that increases feelings of safety can recruit neural circuits that support social engagement and inhibit defensive limbic activity." (Porges, 2009). Simply slowing the respiratory rate increases parasympathetic activity. Furthermore, Resistance Breathing (eg. *Ujjayi*, also known as Ocean Breath, Noisy Breath, or Victorious Breathing) augments these effects through vagal inputs to the brain, further improving HRV (Brown & Gerbarg, 2005b, 2012; Telles & Desiraju, 1992). Many yoga practices stimulate vagal pathways. For example, chanting, another aspect of yoga and other religious traditions, induces internal vibrations in the body, which stimulate the vagal nerves. Similarly, *Bramhari* (Bubble Bee Breath, a calming yoga breathing practice, involves inserting the index fingers into the ear canals and vibrating the fingers while humming or buzzing like a bee). Stimulation of a small branch of the vagus nerve inside the ear canal probably accounts for the calming effect.

12.2.3 Gamma-Aminobutyric Acid (GABA)

Gamma-aminobutyric acid (GABA) is the brain's main inhibitory neurotransmitter. GABA interneurons and receptors are present in the main anatomic structures involved in emotion regulation. GABA-ergic transmission is postulated to be a

means by which mind-body practices may enhance the functioning of emotion regulatory systems. A small pilot study demonstrated that an Iyengar yoga intervention was associated with increased GABA levels in the thalamus and amygdala and that the change in GABA levels correlated with improvements in mood and reduction in back pain (Streeter et al., 2012). This promising line of research is being pursued in a larger study of the effects of a mind-body intervention on brain GABA levels, HRV, and depression.

12.2.4 Self-Regulation

Self-regulation or the ability to successfully handle our thoughts and emotions contributes greatly to wellbeing. Difficulties regulating emotional responses not only play an essential role in mood, anxiety and personality disorders, but also in non-clinical complaints in healthy individuals. In a nonrandomized comparison controlled pilot study, an intensive 6-day yogic breathing program (including Sudarshan Kriya, a cyclic breathing technique), was found to reduce non-clinical symptoms of anxiety, depression, and stress, and to increase the degree of optimism in the participants ($n=55$) when compared to a group instructed to relax in an arm chair ($n=48$) (Kjellgren, Bood, Axelsson, Norlander, & Saatcioglu, 2007). Although this study has methodological limitations, it suggests that by learning and applying a yogic breathing program, wellness may be improved.

To deal with unpleasant thoughts and emotions, individuals may use different coping strategies. Such individual differences in the use and efficiency of emotion and attention regulation strategies may play a role in healthy psychological functioning and in vulnerability to anxiety, neuroticism, depressive feelings and worry. Several studies indicate that the practice of yogic techniques and breathing is beneficial for emotion regulation. By examining brain activity with electroencephalography (EEG), the emotional value of a stimulus to an individual can be investigated. EEG measures the electrical activity of the brain using electrodes placed on the scalp. The electrical activity of the brain is maintained by millions of brain cells. By examining the electrical brain response to the repeated presentation of emotional or cognitive stimuli, it is possible to investigate covert processing of these stimuli in the brain. Stimuli with a strong negative emotional value induce stronger responses in the brain than neutral stimuli.

In a pilot study using EEG, one of the authors found that yoga practitioners showed sustained attenuation of emotional responses on their EEGs in an emotion regulation task (Gootjes, Franken, & Strien, 2011). This indicates that the practitioners were more successful in regulating their emotions over a longer time. Yogic practice, and more specifically the meditative component of yoga, was found to be associated with diverse aspects of attention control (Slagter et al., 2007; Tang et al., 2007). Other EEG studies also found evidence that yogic breathing has positive effects on emotion and attention. During Sudarshan Kriya (a cyclic breathing exercise), increased brain activity was found in the theta frequency range, which was interpreted as an indication of increased focused attention (Baijal & Srinivasan, 2010).

Interestingly, long-term advanced yogic meditation practitioners have also been found to show increased levels of perceived thought regulation (Gootjes & Rassin, 2014). In a study in 104 practitioners, the amount of meditation experience was found to correlate with scores on the thought control ability questionnaire (TCAQ), a questionnaire that was developed specifically to examine individual differences in the perceived (subjective) ability to regulate thoughts. Rather than aiming for thought control, most yogic and meditative practices cultivate an accepting and open stance to any experience or thought. However, this does not mean that practitioners let their minds wander. On the contrary, in most body-mind practices, as soon as the practitioner becomes aware that the mind is wandering, the attention is directed back to, for example, the breath (in breath-based meditation), a mantra (in mantra meditation), a loving and kind thought (in loving-kindness meditation), or a 'meta-awareness' of ongoing mental or physical processes (in open-focus meditation). In other words, yoga and meditative practices are not about controlling which thoughts *arise*, but about whether thoughts are *attended to* or not. The latter may actually lead to an increased sense of control over cognitive processes, usually in the form of an overall quieting of mental activity or reducing of repetitive anxious thoughts. Experienced practitioners may find it easier not to attend to unwanted intrusive thoughts and may be less distressed when such thoughts arise. This would be consistent with recent studies on mindfulness meditation indicating that mindful breathing reduces reactivity to repetitive thoughts (Feldman, Greeson, & Senville, 2010) and that higher mindfulness scores are associated with less intense negative responses to unwanted thoughts (Berry, May, Andrade, & Kavanagh, 2010). (For an extended discussion on the effects of mindfulness on wellbeing see Chap. 11).

Self regulation includes the capacities to modulate emotional, cognitive, physical, and behavioral responses within an appropriate range. The importance of self regulation was highlighted in a study of 5,716 middle aged people. Those who had the best self regulatory abilities were 50 times more likely to be alive and without chronic disease 15 years later than those with low scores on measures of self regulation (Frentzel-Beyme & Grossarth-Maticek, 2001). Clinical studies demonstrating the benefit of using yoga to reduce symptoms of anxiety, Post-traumatic Stress Disorder (PTSD), insomnia, depression and fatigue have been reviewed (Brown & Gerbarg, 2009, 2012; Gerbarg, Wallace, & Brown, 2011). For example, a controlled study of 45 hospitalized patients with severe depression found that Sudarshan Kriya Yoga (SKY) was equivalent to treatment with 150 mg/day of imipramine (a tricyclic antidepressant). Electroconvulsive therapy (ECT) was only slightly more effective than SKY or imipramine (Janakiramaiah et al., 2000).

12.2.5 Attachment, Bonding, Love, Empathy and Compassion

Humans are born with the innate capacities to develop attachment, bonding, love, and ultimately empathy and compassion. A consistent, nurturing, loving environment fosters these positive emotions (Bowlby, 1969; Gilbert, 2010; Winnicott, 1965).

Neglect, trauma, abuse, and betrayal of trust can disrupt or, in extreme cases, irreparably damage these abilities (Lee et al., 2001; Lee and Robbins, 1998; Mcpherson et al., 2006; Rahn and Transue, 1998). The neurophysiological capacity for bonding, the formation of deeply meaningful connections, is the foundation of love, empathy, and compassion. A well-balance autonomic nervous system is conducive to social interactions and bonding. In addition, pro-social/anti-anxiety hormones such as oxytocin, prolactin, and vasopressin can facilitate bonding. On the other hand, states of emotion dysregulation, fear or rage impede social approach and affiliative behaviors and can disrupt bonding.

Disconnectedness and loss of meaning are symptoms of posttraumatic stress disorder (PTSD). It is proposed that interventions that improve the balance between the SNS and the PNS (as indicated by increased HRV), emotion regulation, and release of oxytocin and other pro-social hormones may facilitate restoration of the sense of connectedness, bonding, and meaning in life. The authors (PG and RPB) have observed many cases in which mind-body practices have restored the capacity for feeling meaningfully connected to the self, to other people, or to the universe. Whether the sense of connectedness is experienced as spirituality depends upon one's belief system. Disconnectedness, as a symptom of PTSD, is difficult to treat with verbal therapies alone. Several studies (e.g. Brown et al., 2013; Streeter et al., 2012) provide evidence that mind-body practices may help reverse disconnection and restore bonding through the convergence of several mechanisms:

- improving the balance between the PNS and the SNS
- reducing over activity within the limbic system, thus reducing anxiety
- enhancing feelings of safety
- and increasing release of pro-social/anti-anxiety hormones

Gilbert and colleagues point out that the attachment system evolved as a threat regulator and soothing system for the child (Liotti and Gilbert, 2011). The release of neurohormones, endorphin and oxytocin induce feelings of calmness and safety within the affiliative system. When infants are close to their parents they tend to be calmer and quieter. When children grow older and feel safe enough to leave their parents to engage in play, the moment a threat arises they return to the parent to restore their sense of safety and calmness. Increasing evidence suggests that affiliative systems may also be involved in social intelligence, empathy and mentalizing (Fonagy & Target, 2006). Mentalization is the imaginative mental activity that enables one to understand the mental state of oneself and others. It makes possible the perception and interpretation of behavior based upon needs, desires, feelings, beliefs, and goals. The PNS may be the link between breathing and the affiliative system (Porges, 2009; Thayer & Sternberg, 2006). A one-month randomized study of schizophrenic patients found significant elevations in endogenous plasma oxytocin levels among those who participated in a yoga program with breathing practices compared with controls (Jayaram et al., 2013). Stimulation of the vagal nerves (PNS) through breath practices may enable the sense of connectedness (bonding, affiliation, and love) by increasing the release of oxytocin and other pro-social hormones as well as by activating pathways involved in social affiliation. Some people are

uncomfortable with feeling compassion for themselves or receiving compassion from others (Gilbert, McEwan, Matos, & Rivis, 2011). A pilot study of 22 adults given a relaxation, compassion-focused imagery task found that those who were less self-critical with a secure attachment style responded with increased HRV and significantly decreased salivary cortisol (an indicator of reduced stress), while those who were more self-critical with an insecure attachment style did not. This suggests a relationship between HRV, sympatho-vagal balance, attachment and compassion response (Rockliff et al., 2011). In a pilot study, 17 women were instructed to imagine either being self-critical or self-reassuring. This study used functional Magnetic Resonance Imaging (fMRI), a neuroimaging technique that visualizes brain activity. Self-criticism was associated with increased activity in the lateral prefrontal cortex and dorsal anterior cingulate, which are brain areas related to error processing and behavioral inhibition. In contrast, self-reassurance was associated with increased activity in the left temporal pole and insula, areas involved in expressing compassion and empathy toward others (Longe et al., 2010).

Neural structures involved in attachment, self-criticism, compassion and empathy can be influenced by increased parasympathetic activity. This would be consistent with the authors' clinical observations that mind-body practices that include breathing techniques can help to reduce self-criticism, enhance attachment, and enable feelings of compassion and empathy.

When faced with threat or danger, the affiliative system has to be shut down. One does not want to feel empathy, compassion or love while fighting to the death with an enemy. Similarly, the anger, fear, fight, flight circuits must be turned down to experience love, bonding, empathy, compassion. However, for this to occur, one has to feel safe enough to become vulnerable. By activating the PNS, mind-body practices may provide methods that enable "bottom-up" interoceptive information to persuade 'the mind' that conditions are safe enough. When this succeeds, pro-social affiliative systems are enabled or recruited (Brown & Gerbarg, 2009, 2012; Gerbarg, 2008; Porges, 2009). Multiple mechanisms and pathways are involved in the effects of mind-body practices the authors have observed in patients with PTSD, including the stress response system, sympatho-vagal balance, the hypothalamic-pituitary-adrenal (HPA) axis, neurotransmitters, GABA, and pro-social/anti-anxiety neurohormones (Streeter et al., 2012).

12.3 Yoga Therapy in Relation to Wellbeing

Every aspect of wellbeing is impacted by mass disasters because they entail physical and emotional traumas followed by an aftermath of losses of loved ones, homes, jobs, economic opportunity, and health. Current treatment approaches fall far short of restoring wellbeing. Mind-body practices can play an important role in the recovery of individuals and communities following mass disasters, including war, floods, earthquakes, oil or chemical spills, or radioactive contamination.

Many studies have shown that mind-body practices can reduce anxiety, depression, and symptoms of PTSD (Brown & Gerbarg, 2005a, 2009; Brown et al., 2013;

Brown, Gerbarg, & Muskin, 2009; Gerbarg, 2008; Hutcherson et al., 2008; Janakiramaiah et al., 2000; Kabat-Zinn et al., 1992; Katzman, Vermani, Gerbarg, Brown, Iorio, et al., 2012; Katzman, Vermani, Gerbarg, Brown, Tsirgielis, et al., 2012; Shapiro et al., 2007; van der Kolk, 2006). Only a few have been conducted in disaster zones. Nevertheless, it is worthwhile to review studies of mind-body treatments as they offer a practical, safe, inexpensive modality to alleviate suffering and support the recovery of wellbeing. Further research is needed to identify effective post-disaster interventions that can be administered quickly and inexpensively to large numbers of survivors by small mobile groups of providers.

Traumatic experiences often lead to emotion dysregulation. Core features of PTSD, persistent re-experiencing, avoidance, and increased arousal associated with intense psychological distress, physiological over reactivity, feeling detachment or estrangement from others, difficulty falling asleep, irritability or outbursts of anger, hypervigilance, and exaggerated startle response as described by the DSM-IV (American Psychiatric Association, 1994). PTSD is characterized by significant dysfunction in stress response systems and emotion dysregulation. Therefore, by studying PTSD, we can learn a great deal about how mind-body practices affect autonomic and emotion regulatory systems, enabling us to identify mind-body practices that can effectively treat PTSD and many other less severe psychological conditions. Studies of the effects of mind-body approaches on symptoms of PTSD illustrate the power of these practices, particularly breathing techniques, on the stress response system.

In a wait-list controlled study of 183 survivors of the 2004 Asian Tsunami who had been living for nine months in refugee camps in India, an 8-h program of yogic breath techniques (Ujjayi, Bhastrika, and Sudarshan Kriya) reduced symptoms of PTSD by about 60 % and depression by about 90 % on standardized measures within one week. Scores for the control group showed no significant change. Furthermore, these benefits were maintained over a long period of time as became clear at 6-week, 3-month, and 6-month follow-ups (Descilo et al., 2010).

A randomized wait-list controlled study evaluated a 22-h Sudarshan Kriya Yoga (SKY) course adapted for veterans. Among 30 Australian Vietnam veterans who were disabled due to PTSD, those given the modified SKY intervention had significantly reduced symptoms of PTSD on standardized measures (Carter et al., 2013).

A randomized wait-list controlled study of the effects of a 6-week multi-component mind-body skills training program on 82 adolescents with PTSD in post-war Kosovo included meditation, biofeedback, drawings, autogenic training, guided imagery, genograms, movement, and breathing techniques. Classroom school teachers were trained to teach the 12-session mind-body skills program. Psychiatrists and psychologists provided supervision. Compared with those in the wait-list control group, students given this mind-body skills training showed significantly lower PTSD symptom scores following the intervention and scores were maintained at 3-month follow-up (Gordon, Staples, Blyta, Bytyqi, & Wilson, 2008).

An open study of the effects of a one-week Vivekananda Yoga program in 47 survivors of the 2004 tsunami in the Andaman Islands showed that self-rated fear, anxiety, sadness and disturbed sleep were significantly less after the yoga program

compared to before (Telles, Naveen, & Dash, 2007). Vivekananda Yoga, based on Ashtanga Yoga, includes loosening exercises (*sithilikarana vyayama*), specific postures (*asanas*), cleansing practices (*kriyas*), regulated breathing (*pranayamas*), guided relaxation and meditation (*dhyana*). In a randomized study of 22 survivors one month after a flood in Bihar, India, a similar yoga program (Telles, Singh, Joshi, & Balkrishna, 2010) that placed more emphasis on breath practices showed that those given yoga practice one hour a day for one week had significant decrease in sadness. Subjects in the control group had an increase in anxiety but those in the yoga group did not. These findings suggest that the yoga intervention may have reduced sadness while preventing an increase in anxiety, implying a possible role for mind-body practices in preventing the development of anxiety disorders following disasters.

Case reports and the authors' (PG and RPB) clinical experience suggest that patients with PTSD benefit when Coherent and Resistance Breathing are combined with traditional psychiatric and psychological therapies (Gerbarg, 2008; Sageman, 2004). Authors Brown and Gerbarg developed Breath~Body~Mind (BBM), a 2-day program of breath practices, Qigong movements and Open Focus meditation (Fehmi & Robbins, 2007). BBM includes slow gentle breathing at 4–6 breaths per minute with equal lengths of inspiration and expiration (Coherent or resonant breathing). Coherent Breathing has been shown to maximize HRV and is therefore thought to optimally balance the sympatho-vagal and stress response systems (Bernardi et al., 2001; Brown & Gerbarg, 2005b, 2009; Karavidas et al., 2007). The BBM program augments Coherent Breathing with Resistance Breathing (*Ujjayi* or Ocean Breath) to further stimulate the PNS (Brown & Gerbarg, 2005b, 2009; Gerbarg, 2008), and Breath Moving, a meditative process whereby one imagines moving the breath in circuits between various parts of the body. Breath Moving, found in Qigong and other ancient practices, was developed to a high degree by Russian Orthodox Christian monks in the eleventh century (Vasiliev, 2006). Twenty adults with treatment resistant generalized anxiety disorder (GAD) with or without comorbidities were enrolled in a 2-day (16 h), open-label trial of the BBM Workshop as an adjunct to standard treatment of GAD. Statistically significant reductions in symptoms of anxiety, depression, and worry were found after the BBM workshop (Katzman, Vermani, Gerbarg, Brown, Iorio, et al., 2012; Katzman, Vermani, Gerbarg, Brown, Tsirgielis, et al., 2012).

The authors, Brown and Gerbarg, completed several pilot studies on the effects of Breath~Body~Mind (BBM) in disaster survivors. Working with Serving Those Who Serve (www.stws.org), a non-profit that offers holistic treatments for people affected by the September 11th World Trade Center Attacks, Brown and Gerbarg found that the BBM program helped relieve symptoms of PTSD, anxiety, and depression after two days, based on standardized measures (Brown, Gerbarg, Vermani, & Katzman, 2010). The BBM program has been further simplified such that the basic practices can be taught effectively in a few hours in disaster areas.

Survivors of genocide or war in countries like Sudan and Rwanda have been victims or witnesses of murder, rape, torture, starvation, HIV infection, and severe deprivation. People with prolonged exposure to extreme trauma may develop

Complex PTSD with somatization (physical expression of PTSD) as well as dysfunctions in the regulation of affect (emotion), impulses, attention, consciousness, self-perception, relationships with others, and systems of meanings (Grodin, Piwowarczyk, Fulker, Bazazi, & Saper, 2008). Such individuals often rely on suppression of feelings and memories. If these are triggered, they may lose control of their minds and reactions. For these survivors, gentle mind-body practices that are less likely to trigger re-experiencing are recommended. The risk of re-traumatization can be minimized by creating a secure environment or "container" for the mind-body practice, ensuring survivor safety during sessions, training practitioners to assist a survivor who may re-experience a traumatic memory, minimizing silent, unguided meditation and avoiding practices, such as rapid breathing, which can alter states of consciousness or exacerbate anxiety (by over activating the SNS). For example, Brown and Gerbarg developed a program of 3 simple Qigong movements, 20 min of Coherent Breathing, and a few minutes of rest that proved to be easy to teach and highly effective in relieving trauma-related symptoms in survivors of war and slavery in South Sudan (Gerbarg et al., 2011). In the textbox below, a report of how the BBM program was performed in Sudan, can be read. The next textbox (see page 239) describes a program given to graduate students who are survivors of the Rwanda genocide. Suzanne Levy, LMT, CPT, Somatic Movement therapist, found that incorporating Breath~Body~Mind techniques into her work helped the students relieve stress, tension, anger, and physical pain.

Sudan Program Evaluation

During the many invasions by North Sudan, hundreds of thousands of South Sudanese have been captured and thousands are estimated to still be held in slavery, some for decades. Christian Solidarity International has been freeing these slaves by purchasing their freedom. Once liberated, the Sudanese, mostly women and children, walk for seven days through desert and jungle to cross the border into South Sudan. There they are met by a team headed by Dr. Luka Deng from the Pamela Lipkin, MD clinic in South Sudan, about 30 miles from the border with Darfur. They are also met by tribal leaders who facilitate return to their home villages. Ellen Ratner, EdM, who supports Dr. Deng's work, began teaching some of the women a 20-min set of Breath-Body-Mind practices to relieve their stress and trauma from years of war, abuse, and deprivation (www.goatsfortheoldgoat.com). In order to evaluate the effects of the program, Dr. Luka's clinic tested a group of 19 South Sudanese women who had been living in their home villages for about 6 months after being liberated from slavery. The participants came to the clinic 5 days a week for 18 weeks. Visual analogue scales (VAS) based on the Post-traumatic Stress Disorders Checklist-17 (PCL-17) and a 6-item mood scale were administered. Compared to baseline, scores on the PTSD VAS

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improved 65 % by week 6 and 71 % by week 18. Scores on the VAS for mood improved 48 % at week 6 and 66 % at week 18 (Gerbarg et al., 2011).

Subsequently, Dr. Brown travelled to Sudan to work with large groups of former slaves who were to cross the border in August 2011, the week before South Sudan declared independence. Six hundred former slaves crossed the border and sat down beneath a large tree, exhausted, their faces blank. Dr. Brown had 30 min to work with them. With the aid of a Dinka translator, he encouraged the refugees to stand up and begin the first movement, "shaking off the bonds of slavery." Frozen faces came alive with smiles as their movements became freer. They quickly learned "Ha" breath and Coherent Breath, which both energized and calmed them. The children joined in smiling and laughing. It was as though the movements and the breathing had broken the spell of slavery such that they could finally feel their freedom.

The experience in Sudan demonstrated that large groups of severely traumatized survivors of war and slavery could benefit immediately from Breath~Body~Mind practices. Nineteen Sudanese women who had been doing BBM practices for 2 years received additional training that included healing with sounds. They described profound benefits and they are sustaining the program by teaching the practices in surrounding villages. In addition, they are relieving symptoms of trauma and depression in children liberated from slavery who are living in a nearby orphanage.

Letters from Rwanda

Suzanne Levy, LMT, CPT, a Somatic Movement therapist who works with a non-profit, Jewish Helping Hands, teaches mind-body practices to survivors of the 1994 mass genocide in Rwanda (www.createequilibrium.com). She began incorporating Breath~Body~Mind techniques into her work with students at the University of Rwanda. A group of 28 graduate students wanted to learn how to teach BBM to help others recover from the trauma of genocide. Brown and Gerbarg provided a 3-day Breath~Body~Mind teacher training program for her to teach the students. All of the students had been traumatized, many having witnessed the murder of their neighbors and members of their family when they were children. At the beginning of the training, some were so tense that they could not take a single breath with ease. Ms. Levy started her program with mindfulness followed by movement and breathing practices. She integrated some somatic experiencing techniques into the program (Levine, 2008). On the last day, the students practiced teaching one another to prepare to help other Rwandans. They gave permission for the authors to quote excerpts from their course evaluations.

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Student 1: *In this exercise I feel very well in my head and very happy for it. I am happy for the exercise of breathe in and breathe out because when I did it I feel well in the parts of my body where I felt bad.*

Student 2: *I now know how I can breathe in order to teach others how they can breathe. I learned about mind: how I can control my mind to think about good things in order to get my life beautiful. And for the body I learned how to stimulate all my organs…using simple gestures; how to create energy in our body in order to connect all systems in our body. I learned the relationship between parasympathetic nervous system and sympathetic nervous system. Now I know how to use yoga to relieve stress, trauma, and pain in our body. I really appreciate your work because I add to my knowledge the true connections between Body, Breath, and Mind in order to have good life.*

Student 3: *This program came when I really needed it because I have been too stressed by certain activities and felt headache…In the last 4 days my friend died abruptly. I felt pissed with everything on planet earth. But due to this program, it's like my mind has been washed and now I can joke and engage in conversations with others. This is important today and in our future life, and even the entire population that we are going to teach.*

Student 4: *As I am a social worker, to have knowledge about all things which can help people to enhance their wellbeing is my purpose. So this was very helpful for me and society in general. Also talking about things that help people prevent, reduce stress like meditation, breathing, etc. helps me to accomplish my research and obtain bachelor's degree.*

12.4 Neurophysiologic Model for the Effects of Yoga Breathing

In the previous sections, we reviewed research and provided program examples that demonstrate the effects of mind-body practices on aspects of wellbeing. Drawing upon studies of neuroanatomy, neurophysiology, and brain imaging, a set of hypotheses will be offered that may explain these observed effects. The neurophysiologic model for the effects of yoga breathing described by authors Brown and Gerbarg is based on Polyvagal Theory (Porges, 2001, 2009), Neurovisceral Integration (Thayer & Lane, 2000), and Bud Craig's (Craig, 2008) mapping of interoceptive pathways from the body to the insular (interoceptive) cortex in the Sylvian fissure. Brown and Gerbarg (2005b, 2009; Brown et al., 2013) postulate that stretch receptors in alveoli, baroreceptors, chemoreceptors, and other interoceptive sensors throughout the respiratory structures send information about the respiratory system primarily via vagal afferents to brainstem nuclei (the nucleus tractus solitarius and parabrachial nucleus). Messages ascending from there to the

brain influence perception, cognition, emotion regulation, somatic expression, and behavior. In part this is possible because breathing is the only autonomic function that can be voluntarily controlled; therefore, specific breathing patterns can be utilized to send messages through PNS and interoceptive systems that swiftly affect how the brain perceives and responds to stress or threat. Because it is vital to survival, information about the respiratory system commands an immediate response and has widespread rapid effects on critical brain functions. If a problem occurs in breathing, the brain must put aside all other concerns and direct all resources towards correcting the problem and maintaining oxygenation or the organism will die within minutes (Brown et al., 2013). This may explain in part why changing the pattern of breathing can change the way a person thinks and feels so quickly. Brown and Gerbarg reviewed the evidence that yoga-breathing, particularly at 5–6 breaths per minute (bpm), increases heart rate variability (HRV) and parasympathetic nervous system (PNS) activity, improves sympatho-vagal balance, and promotes stress resilience (Brown & Gerbarg, 2005b, 2009).

Ocean Breath (*ujjayi*), a form of Resistance Breathing, employs laryngeal contracture and partial closure of the glottis to impede the flow of air. Resistance Breathing techniques also increase intrathoracic pressure, baroreceptor stimulation, respiratory sinus arrhythmia (RSA), and HRV (Brown & Gerbarg, 2005b). Chanting and singing can be considered forms of Resistance Breathing because the sounds are created by the partial obstruction to air flow caused by contractions of the vocal cords. The pattern of slow Resistance Breathing with longer periods of exhalation compared to inhalation occurs during chanting, singing, and other breathing practices in many traditions. Bernardi suggests that a respiratory rate of 6 bpm augments 10-s (6/min) Mayer waves and increases RSA, a corollary of HRV. He showed that recitation of the rosary prayer in Latin at 6 bpm increased HRV and baroreflex sensitivity (Bernardi et al., 2001). The vibrational effects of chanting and singing also stimulate vagal activity. The ancient 'Om' chant involves slow breathing, airway resistance (contracting the vocal cords to generate sound), and vibrational effects which increase vagal tone and physiologic relaxation. Using fMRI, Kalyani, Gangadhar, and colleagues showed significant limbic system deactivation with 'OM' chanting (Kalyani et al., 2011). Overactivity in the limbic system which processes intense emotions such as fear and rage underlies PTSD symptoms. This study demonstrated that chanting 'OM' can reduce activity in the limbic system, meaning that the emotion processing centers, such as the amygdala, became quieter, less reactive.

Slow yoga breathing tends to normalize SNS activity and increase PNS tone. The Central Autonomic Network includes higher centers such as the medial prefrontal cortex (mPFC) that inhibit lower centers such as the amygdala (Thayer & Brosschot, 2005). When the mPFC is hypoactive and the amygdala is hyperactive, as occurs in depression and PTSD, the inhibitory mechanisms fail to modulate emotions such as fear and anger, leading to dysregulation of emotional responses and behaviors. Dysfunction in the circuits between the prefrontal cortex (PFC), amygdala and thalamus may contribute to symptoms in PTSD (LeDoux, 2000). Poor processing of affective (emotion) information, working memory deficits and executive function impairment have been associated with reduced activity of the

PNS (low HRV) and underactivity in the prefrontal cortex. In addition to the mPFC, the insular (interoceptive) cortex also sends inhibitory projections to the amygdala, suggesting that information about the moment-to-moment state of the body received by the insular cortex plays a role in emotion regulation (Brown et al., 2013; Streeter et al., 2012).

12.5 Conclusions

Growing evidence from scientific studies is indicating positive effects of yoga and related mind-body techniques on various aspects of wellbeing. Research shows that breath practices can exert powerful restorative effects following emotionally traumatic experiences. Mind-body practices that improve emotion regulation can enhance wellbeing by reducing the impact of disturbing thoughts, negative emotions, and recurring stressors. In addition, the inborn capacity for prosocial, affiliative behavior may be enhanced by mind-body practices, contributing to better self-regulation, connectedness, and compassion. In conclusion, mind-body practices such as breathing can offer a practical, safe, inexpensive modality to alleviate suffering and support the recovery of wellbeing for individuals and communities experiencing everyday stressors as well as following mass disasters.

References

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders (DSM)* (4th ed.). Washington, DC: American Psychiatric Association.

Baijal, S., & Srinivasan, N. (2010). Theta activity and meditative states: Spectral changes during concentrative meditation. *Cognitive Processing, 11*(1), 31–38. doi:10.1007/s10339-009-0272-0.

Beauchaine, T. (2001). Vagal tone, development, and Gray's motivational theory: Toward an integrated model of autonomic nervous system functioning in psychopathology. *Development and Psychopathology, 13*(2), 183–214.

Benson, H. (1996). *Timeless healing: The power and biology of belief* (pp. 222–234). New York: Scribner.

Bernardi, L., Gabutti, A., Porta, C., & Spicuzza, L. (2001). Slow breathing reduces chemoreflex response to hypoxia and hypercapnia, and increases baroreflex sensitivity. *Journal of Hypertension, 19*(12), 2221–2229.

Bernardi, L., Sleight, P., Bandinelli, G., Cencetti, S., Fattorini, L., Wdowczyc-Szulc, J., et al. (2001). Effect of rosary prayer and yoga mantras on autonomic cardiovascular rhythms: Comparative study. *BMJ, 323*(7327), 1446–1449.

Berry, L. M., May, J., Andrade, J., & Kavanagh, D. (2010). Emotional and behavioral reaction to intrusive thoughts. *Assessment, 17*(1), 126–137.

Bowlby, J. (1969). *Attachment: Attachment and loss* (Vol. 1). London: Hogarth Press.

Brown, R. P., & Gerbarg, P. L. (2005a). Sudarshan kriya yogic breathing in the treatment of stress, anxiety, and depression: Part II-clinical applications and guidelines. *Journal of Alternative and Complementary Medicine, 11*(4), 711–717. doi:10.1089/acm.2005.11.711.

Brown, R. P., & Gerbarg, P. L. (2005b). Sudarshan kriya yogic breathing in the treatment of stress, anxiety, and depression: Part I-neurophysiologic model. *Journal of Alternative and Complementary Medicine, 11*(1), 189–201. doi:10.1089/acm.2005.11.189.

Brown, R. P., & Gerbarg, P. L. (2009). Yoga breathing, meditation, and longevity. *Annals of the New York Academy of Sciences, 1172*, 54–62. doi:10.1111/j.1749-6632.2009.04394.x.

Brown, R. P., & Gerbarg, P. L. (2012). *The healing power of the breath: Simple techniques to reduce stress and anxiety, enhance concentration, and balance your emotions*. Boston: Shambhala Publications.

Brown, R. P., Gerbarg, P. L., & Muench, F. (2013). Breathing practices for treatment of psychiatric and stress-related medical conditions. *The Psychiatric Clinics of North America, 36*(1), 121–140. doi:10.1016/j.psc.2013.01.001.

Brown, R. P., Gerbarg, P. L., & Muskin, P. R. (2009). *How to use herbs, nutrients, and yoga in mental health care*. New York: W. W. Norton & Company.

Brown, R. P., Gerbarg, P. L., Vermani, M., & Katzman, M. A. (2010, May 22). *1st and 2nd trials of breathing, movement, and meditation for relief of PTSD, depression, and anxiety related to September 11th New York City World Trade Centre attacks*. 143rd Annual meeting course co28 yoga of the east and west: Integrating breath work and meditation into clinical practice, American Psychiatric Association, New Orleans, LA.

Carney, R. M., Saunders, R. D., Freedland, K. E., Stein, P., Rich, M. W., & Jaffe, A. S. (1995). Association of depression with reduced heart rate variability in coronary artery disease. *The American Journal of Cardiology, 76*(8), 562–564.

Carter, J., Gerbarg, P. L., Brown, R. P., Ware, R., D'Ambrosio, C., Dirlea, M., et al. (2013). Multi-component yoga breath program for Vietnam veteran post traumatic stress disorder: Randomized controlled trial. *Journal of Traumatic Stress Disorders & Treatment, 2*(3), 1–10.

Craig, A. D. (2008). Interception and emotion (2008). In M. Lewis, J. M. J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 272–288). NY: The Guilford Press.

Descilo, T., Vedamurtachar, A., Gerbarg, P. L., Nagaraja, D., Gangadhar, B. N., Damodaran, B., et al. (2010). Effects of a yoga breath intervention alone and in combination with an exposure therapy for post-traumatic stress disorder and depression in survivors of the 2004 South-East Asia Tsunami. *Acta Psychiatrica Scandinavica, 121*(4), 289–300. doi:10.1111/j.1600-0447.2009.01466.x.

Desteno, D., Gross, J. J., & Kubzansky, L. (2013). Affective science and health: The importance of emotion and emotion regulation. *Health Psychology: Official Journal of the Division of Health Psychology, American Psychological Association, 32*(5), 474–486. doi:10.1037/a0030259.

Fehmi, L., & Robbins, C. (2007). *The open focus brain: Harnessing the power of attention to heal mind and body*. Boston: Trumpeter Press.

Feldman, G., Greeson, J., & Senville, J. (2010). Differential effects of mindful breathing, progressive muscle relaxation, and loving-kindness meditation on decentering and negative reactions to repetitive thoughts. *Behaviour Research and Therapy, 48*(10), 1002–1011. doi:10.1016/j.brat.2010.06.006.

Feuerstein, G. (1998). *The yoga tradition: It's history, literature, philosophy, and practice*. Prescott, AZ: Hohm Press.

Fokkema, D. S. (1999). The psychobiology of strained breathing and its cardiovascular implications: A functional system review. *Psychophysiology, 36*(2), 164–175.

Fonagy, P., & Target, M. (2006). The mentalization-focused approach to self pathology. *Journal of Personality Disorders, 20*(6), 544–576. doi:10.1521/pedi.2006.20.6.544.

Frentzel-Beyme, R., & Grossarth-Maticek, R. (2001). The interaction between risk factors and self-regulation in the development of chronic diseases. *International Journal of Hygiene and Environmental Health, 204*(1), 81–88.

Friedman, B. H., & Thayer, J. F. (1998). Autonomic balance revisited: Panic anxiety and heart rate variability. *Journal of Psychosomatic Research, 44*(1), 133–151.

Gerbarg, P. L. (2008). Yoga and neuro-psychoanalysis. In F. S. Anderson (Ed.), *Bodies in treatment: The unspoken dimension* (pp. 127–150). Hillsdale, NJ: The Analytic Press.

Gerbarg, P. L., Wallace, G., & Brown, R. P. (2011). Mass disasters and mind-body solutions: Evidence and field insights. *International Journal of Yoga Therapy, 2*(21), 23–34.

Gilbert, P. (2010). *The compassionate mind. A new approach to life's challenges*. Oakland, CA: New Harbinger Publications.

Gilbert, P., McEwan, K., Matos, M., & Rivis, A. (2011). Fears of compassion: Development of three self-report measures. *Psychology and Psychotherapy, 84*(3), 239–255. doi:10.1348/147608310X526511.

Gootjes, L., Franken, I. H. A., & Strien, J. W. (2011). Cognitive emotion regulation in yogic meditative practitioners: Sustained modulation of electrical brain potentials. *Journal of Psychophysiology, 25*, 87–94.

Gootjes, L., & Rassin, E. (2014). Perceived thought control mediates positive effects of meditation experience on affective functioning. *Mindfulness, 5*(1), 1–9. doi:10.1007/s12671-012-0140-3.

Gordon, J. S., Staples, J. K., Blyta, A., Bytyqi, M., & Wilson, A. T. (2008). Treatment of posttraumatic stress disorder in postwar Kosovar adolescents using mind-body skills groups: A randomized controlled trial. *The Journal of Clinical Psychiatry, 69*(9), 1469–1476.

Grodin, M. A., Piwowarczyk, L., Fulker, D., Bazazi, A. R., & Saper, R. B. (2008). Treating survivors of torture and refugee trauma: A preliminary case series using qigong and t′ai chi. *Journal of Alternative and Complementary Medicine, 14*(7), 801–806. doi:10.1089/acm.2007.0736.

Hutcherson, C. A., Seppala, E. M., & Gross, J. J. (2008). Loving-kindness meditation increases social connectedness. *Emotion, 8*(5), 720–724. doi:10.1037/a0013237.

Jacob, V., Brown, R. P., Stevens, L., Gerbarg, P. L., Scherl, E., Bosworth, B., et al. (2013, October 14). *Impact of breathing and education programs on inflammatory bowel disease (IBD) quality of life (QOL) and inflammatory biomarkers*. Poster Number P1064. In 78th annual meeting American College of Gastroenterology, San Diego, CA.

Jacobs, G. D. (2001). Clinical applications of the relaxation response and mind-body interventions. *Journal of Alternative and Complementary Medicine, 7*(Suppl 1), S93–S101.

Janakiramaiah, N., Gangadhar, B. N., Naga Venkatesha Murthy, P. J., Harish, M. G., Subbakrishna, D. K., & Vedamurthachar, A. (2000). Antidepressant efficacy of sudarshan kriya yoga (SKY) in melancholia: A randomized comparison with electroconvulsive therapy (ECT) and imipramine. *Journal of Affective Disorders, 57*(1–3), 255–259.

Jayaram, N., Varambally, S., Behere, R. V., Venkatasubramanian, G., Arasappa, R., Christopher, R., et al. (2013). Effect of yoga therapy on plasma oxytocin and facial emotion recognition deficits in patients of schizophrenia. *Indian Journal of Psychiatry, 55*(Suppl 3), S409–S413.

Kabat-Zinn, J., Massion, A. O., Kristeller, J., Peterson, L. G., Fletcher, K. E., Pbert, L., et al. (1992). Effectiveness of a meditation-based stress reduction program in the treatment of anxiety disorders. *The American Journal of Psychiatry, 149*(7), 936–943.

Kalyani, B. G., Venkatasubramanian, G., Arasappa, R., Rao, N. P., Kalmady, S. V., Behere, R. V., et al. (2011). Neurohemodynamic correlates of 'OM' chanting: A pilot functional magnetic resonance imaging study. *International Journal of Yoga, 4*(1), 3–6. doi:10.4103/0973-6131.78171.

Karavidas, M. K., Lehrer, P. M., Vaschillo, E., Vaschillo, B., Marin, H., Buyske, S., et al. (2007). Preliminary results of an open label study of heart rate variability biofeedback for the treatment of major depression. *Applied Psychophysiology and Biofeedback, 32*(1), 19–30. doi:10.1007/s10484-006-9029-z.

Katzman, M. A., Vermani, M., Gerbarg, P. L., Brown, R. P., Iorio, C., Davis, M., et al. (2012). A multicomponent yoga-based, breath intervention program as an adjunctive treatment in patients suffering from generalized anxiety disorder with or without comorbidities. *International Journal of Yoga, 5*(1), 57–65. doi:10.4103/0973-6131.91716.

Katzman, M. A., Vermani, M., Gerbarg, P. L., Brown, R. P., Tsirgielis, D., & D'Ambrosio, C. (2012, May 5–9). *Breath- body-mind workshop as adjunctive treatment in patients suffering from generalized anxiety disorder (GAD) with or without comorbidity*. American Psychiatric Association, 165th annual meeting, Philadelphia, PA.

Kjellgren, A., Bood, S. A., Axelsson, K., Norlander, T., & Saatcioglu, F. (2007). Wellness through a comprehensive yogic breathing program – A controlled pilot trial. *BMC Complementary and Alternative Medicine, 7*, 43. doi:10.1186/1472-6882-7-43.

LeDoux, J. E. (2000). Emotion circuits in the brain. *Annual Review of Neuroscience, 23*, 155–184. doi:10.1146/annurev.neuro.23.1.155.

Lee, R. M., Draper, M., & Lee, S. (2001). Social connectedness, dysfunctional interpersonal behaviors, and psychological distress. *Journal of Counseling Psychology, 48*(3), 310–318.

Lee, R. M., & Robbins, S. B. (1998). The relationship between social connectedness and anxiety, self-esteem, and social identity. *Journal of Counseling Psychology, 45*(3), 338–345.
Lehrer, P., Sasaki, Y., & Saito, Y. (1999). Zazen and cardiac variability. *Psychosomatic Medicine, 61*(6), 812–821.
Levine, P. A. (2008). *Healing trauma: A pioneering program for restoring the wisdom of your body*. Boulder, CO: Sounds True.
Ley, R. (1999). The modification of breathing behavior. Pavlovian and operant control in emotion and cognition. *Behavior Modification, 23*(3), 441–479.
Liotti, G., & Gilbert, P. (2011). Mentalizing, motivation, and social mentalities: Theoretical considerations and implications for psychotherapy. *Psychology and Psychotherapy, 84*(1), 9–25. doi:10.1348/147608310X520094.
Longe, O., Maratos, F. A., Gilbert, P., Evans, G., Volker, F., Rockliff, H., et al. (2010). Having a word with yourself: Neural correlates of self-criticism and self-reassurance. *NeuroImage, 49*(2), 1849–1856. doi:10.1016/j.neuroimage.2009.09.019.
McPherson, M., Smith-Lovin, L., & Brashears, M. E. (2006). Social isolation in America: Changes in core discussion networks over two decades. *American Sociological Review, 71*, 353–375.
Philippot, P., Chapelle, G., & Blairy, S. (2002). Respiratory feedback in the generation of emotion. *Cognition & Emotion, 16*, 605–607. doi:10.1080/02699930143000392.
Poitras, V. J., & Pyke, K. E. (2013). The impact of acute mental stress on vascular endothelial function: Evidence, mechanisms and importance. *International Journal of Psychophysiology: Official Journal of the International Organization of Psychophysiology, 88*(2), 124–135. doi:10.1016/j.ijpsycho.2013.03.019.
Porges, S. W. (2001). The polyvagal theory: Phylogenetic substrates of a social nervous system. *International Journal of Psychophysiology, 42*(2), 123–146.
Porges, S. W. (2009). The polyvagal theory: New insights into adaptive reactions of the autonomic nervous system. *Cleveland Clinic Journal of Medicine, 76*(Suppl 2), S86–S90. doi:10.3949/ccjm.76.s2.17.
Rahn, W. M., & Transue, J. E. (1998). Social trust and value change: The decline of social capital in American youth, 1976–1995. *Political Psychology, 19*, 545–565.
Rockliff, H., Karl, A., McEwan, K., Gilbert, J., Matos, M., & Gilbert, P. (2011). Effects of intranasal oxytocin on 'compassion focused imagery'. *Emotion, 11*(6), 1388–1396. doi:10.1037/a0023861.
Sageman, S. (2004). Breaking through the despair: Spiritually oriented group therapy as a means of healing women with severe mental illness. *The Journal of the American Academy of Psychoanalysis and Dynamic Psychiatry, 32*(1), 125–141.
Selye, H. (1979). Stress and the reduction of distress. *Journal of the South Carolina Medical Association (1975), 75*(11), 562–566.
Shalev, I., Entringer, S., Wadhwa, P. D., Wolkowitz, O. M., Puterman, E., Lin, J., et al. (2013). Stress and telomere biology: A lifespan perspective. *Psychoneuroendocrinology, 38*(9), 1835–1842. doi:10.1016/j.psyneuen.2013.03.010.
Shapiro, D., Cook, I. A., Davydov, D. M., Ottaviani, C., Leuchter, A. F., & Abrams, M. (2007). Yoga as a complementary treatment of depression: Effects of traits and moods on treatment outcome. *Evidence-based Complementary and Alternative Medicine, 4*(4), 493–502.
Shih, T. K. (1999). *Swimming dragon: A Chinese way to fitness, beautiful skin, weight loss, and high energy* (p. 51). Barrytown, NY: Station Hill Press.
Slagter, H. A., Lutz, A., Greischar, L. L., Francis, A. D., Nieuwenhuis, S., Davis, J. M., et al. (2007). Mental training affects distribution of limited brain resources. *PLoS Biology, 5*(6), e138. doi:10.1371/journal.pbio.0050138.
Sovik, R. (2000). The science of breathing–the yogic view. *Progress in Brain Research, 122*, 491–505.
Spicuzza, L., Gabutti, A., Porta, C., Montano, N., & Bernardi, L. (2000). Yoga and chemoreflex response to hypoxia and hypercapnia. *Lancet, 356*(9240), 1495–1496. doi:10.1016/S0140-6736(00)02881-6.
Streeter, C. C., Gerbarg, P. L., Saper, R. B., Ciraulo, D. A., & Brown, R. P. (2012). Effects of yoga on the autonomic nervous system, gamma-aminobutyric-acid, and allostasis in epilepsy,

depression, and post-traumatic stress disorder. *Medical Hypotheses, 78*(5), 571–579. doi:10.1016/j.mehy.2012.01.021.

Stuart, M. J., & Baune, B. T. (2012). Depression and type 2 diabetes: Inflammatory mechanisms of a psychoneuroendocrine co-morbidity. *Neuroscience and Biobehavioral Reviews, 36*(1), 658–676. doi:10.1016/j.neubiorev.2011.10.001.

Tang, Y. Y., Ma, Y., Wang, J., Fan, Y., Feng, S., Lu, Q., et al. (2007). Short-term meditation training improves attention and self-regulation. *Proceedings of the National Academy of Sciences of the United States of America, 104*(43), 17152–17156. doi:10.1073/pnas.0707678104.

Telles, S., & Desiraju, T. (1992). Heart rate alterations in different types of pranayamas. *Indian Journal of Physiology and Pharmacology, 36*(4), 287–288.

Telles, S., Naveen, K. V., & Dash, M. (2007). Yoga reduces symptoms of distress in tsunami survivors in the Andaman islands. *Evidence-Based Complementary and Alternative Medicine: eCAM, 4*(4), 503–509. doi:10.1093/ecam/nem069.

Telles, S., Singh, N., Joshi, M., & Balkrishna, A. (2010). Post traumatic stress symptoms and heart rate variability in Bihar flood survivors following yoga: A randomized controlled study. *BMC Psychiatry, 10*, 18. doi:10.1186/1471-244X-10-18.

Thayer, J. F., & Brosschot, J. F. (2005). Psychosomatics and psychopathology: Looking up and down from the brain. *Psychoneuroendocrinology, 30*(10), 1050–1058. doi:10.1016/j.psyneuen.2005.04.014.

Thayer, J. F., & Lane, R. D. (2000). A model of neurovisceral integration in emotion regulation and dysregulation. *Journal of Affective Disorders, 61*(3), 201–216.

Thayer, J. F., & Sternberg, E. (2006). Beyond heart rate variability: Vagal regulation of allostatic systems. *Annals of the New York Academy of Sciences, 1088*, 361–372. doi:10.1196/annals.1366.014.

van der Kolk, B. A. (2006). Clinical implications of neuroscience research in PTSD. *Annals of the New York Academy of Sciences, 1071*, 277–293. doi:10.1196/annals.1364.022.

Vasiliev, V. (2006). *Let every breath…Secrets of the Russian breath masters*. Toronto, Canada: Russian Martial Art.

Winnicott, D. W. (1965). *Maturational processes and the facilitating environment: Studies in the theory of emotional development*. London: Hogarth Press.