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LEARNING OBJECTIVES

1. Articulate the mechanisms underlying the effects of yoga practices.
2. Understand key physiological and psychoemotional processes that make yoga effective.
3. Apply this framework of knowledge to work with yoga therapy clients to facilitate adaptations for whole-person care.

We Know Yoga Works, but Why? Mechanisms Behind the Practices' Effects

By Laura Schmalzl and Marlysa Sullivan

There has been an exponential increase in research on yoga over the past decades, with more and more studies providing well-documented evidence that yoga is beneficial for the alleviation of symptoms in various clinical conditions (e.g., cancer, chronic pain, posttraumatic stress disorder [PTSD], depression, anxiety, etc.)[1] and that it can elicit a broad range of measurable changes in healthy populations (physiological parameters, brain activation, emotional states, body awareness, cognitive functioning, and more).[2]

This article outlines an evolving conceptual framework of the mechanisms underlying yoga practice, formulated in a way that can be understood across different lineages. When we understand the underlying mechanisms of a practice, we are no longer locked into protocols but can instead adapt the practice more constructively according to clients' needs. When we understand why and how something works, we can provide a more precisely targeted practice to each individual and arrive at the heart of client-centered care. It is beyond the scope of this article to delve deep into the science; rather, the intention here is to provide an overview citing relevant research that readers can refer to should they be interested in the details.

Mechanisms Underlying the Components of Yoga Practice

Movement

As yoga therapists well know, movement in yoga can range from powerful overt motion, to gentle subtle motion, and even to purely internal or imagined motion.[3] Yoga movement is often performed in a slow and controlled manner that requires balance, coordination, and constant tracking of the body's position in space. In addition to promoting physical health (e.g., musculoskeletal, cardiovascular, and metabolic health), this type of movement also helps to fine-tune interoceptive and proprioceptive awareness and provides a context for training attention.

Many of the movement-related aspects of yoga engage basal ganglia (BG) and cerebellar circuits. The BG comprise a group of subcortical gray-matter nuclei embedded deep in the brain that are connected to the cortex as well as the cerebellum.[4] The BG support movement that requires a high degree of coordination through their involvements in cortical circuits that include premotor and supplementary motor areas.[5] These circuits are part of the extrapyramidal motor system, which is responsible for the modulation of neural impulses that originate in the cerebral cortex. Such modulations are involved in initiating certain movements while suppressing others, coordinating these movements, and setting their rate and force.

Most of the initial studies investigating the functional role of the BG were based on patients with motor dysfunction such as Parkinson's disease[6] or Huntington's disease,[7] leading to the hypothesis that the BG are primarily associated with motor functions. However, it has since been shown that the BG are also implicated in cognitive disorders such as attention-deficit/hyperactivity disorder[8] and obsessive compulsive disorder.[9] In addition, studies in healthy populations suggest that BG are also involved in more complex functions, including somatosensation, higher-order cognitive functions, and even social behavior.[5] Similarly, the cerebellum, which has long been known for its involvement in motor coordination, is now also recognized for its involvement in cognitive functioning and emotional processing.[10–12] It has been hypothesized that yoga practice may promote increased connectivity within—and dynamic shifting between—motor, cognitive, and emotional neurocircuitry of both the BG and the cerebellum, with potential beneficial effects for mind-body integration and self-regulation.[13]

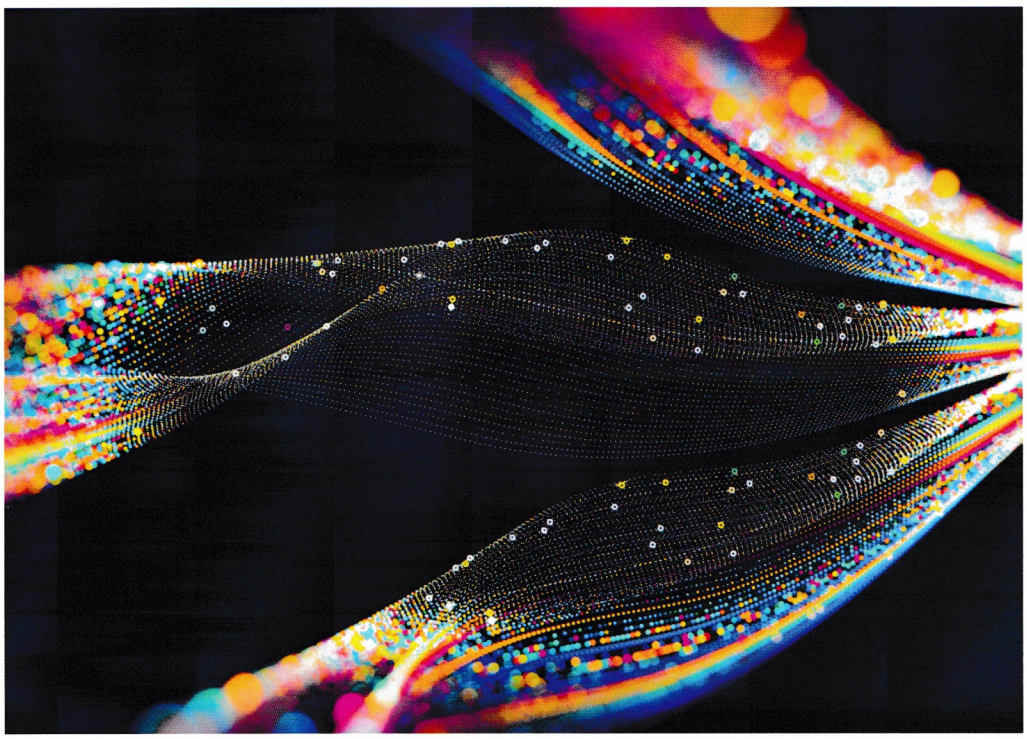
Breath

One of the reasons for practicing breath awareness and conscious breath regulation in the context of movement is to promote the use of supportive breathing patterns in everyday life situations. The breath can also help in directing attention to specific body parts while holding a posture or performing a movement and to consequently increasing interoceptive and proprioceptive awareness. Moreover, when offered within a context of safety, the breath can be used to "turn toward" unpleasant or stressful sensations that arise in the physical practice and to "breathe into them" rather than avoid or fight them.

A view shared by many yoga traditions, and supported by Western science on respiratory physiology, is that emotional states

are expressed in breathing patterns, and subsequently that voluntary changes of the breathing patterns can alter emotional states and influence well-being.[14–16] In fact, a typical autonomic reaction to stressful events is rapid thoracic breathing, which can in turn lead to hyperventilation (i.e., excessively rapid breathing), altered tidal volume (i.e., lesser amounts of air moving in or out of the lungs with each respiratory cycle), and hypocapnia (i.e., a decrease in alveolar and blood carbon dioxide levels below the normal range).[17] Such symptoms are often observed as chronic manifestations in individuals with anxiety and depressive disorders[18] and may be alleviated by specific breathing techniques.[19]

Generally speaking, slow and rhythmic breathing promotes activation of the parasympathetic nervous system, which in turn facilitates stress reduction.[20] More specifically, slowing the breath rate to about six breaths per minute with matched inhalations and exhalations decreases chemoreflex sensitivity (the naturally occurring change in breathing rate in response to changes in the concentration of oxygen and carbon dioxide in the blood)[21] as well as oxidative stress (an imbalance between the production of reactive oxygen species and antioxidant defenses).[22] Slow and rhythmic breathing also increases the release of prolactin and oxytocin; these hormones can promote feelings of calmness and social bonding.[23] Lastly, breath practices that involve the contraction of laryngeal muscles to create an increase of airway resistance—think ujjayi, or victorious breath—are hypothesized to stimulate somatosensory vagal afferents to the brain[15] and, consequently, to promote improved autonomic regulation.[24]



Attention/Concentration (Including Attention to Bodily Sensations/Interoception)

Regulation of attention is a fundamental aspect of yoga, so here are some of the main mechanisms at play in this facet of practice.

A defining characteristic of most styles of yoga is the emphasis on becoming increasingly attentive to sensory experiences, which includes the cultivation of interoceptive, proprioceptive, kinesthetic, and spatial awareness, while primarily paying attention to the movement and breath components described earlier. *Interoceptive awareness* refers to the awareness of internal body states and sensations, including heart rate, respiration, and several autonomic nervous system (ANS) responses related to emotional states.[25] There is increasing consensus that body awareness and the ability to detect the body's subtle cues play an important role for health and self-regulation.[26] The key from a therapeutic perspective is to promote an increased ability to observe signals without getting caught up in them,[27] that is, to increase interoceptive awareness while reducing self-evaluative processes (e.g., getting someone to experience a sensation of pain without the emotional reaction of suffering).[28] Neuroimaging studies investigating the effect of body-centered meditation practices have consistently shown structural and functional changes in both the somatosensory and limbic areas.[29,30] Of particular note are repeated findings of practice-driven changes in the insula, a part of the brain that plays a key role in interoceptive awareness.[31,32]

Another kind of attentional process employed in yoga practice is metacognition, which is broadly defined as the conscious monitoring of our own mental processes and behaviors.[33] The repeated practice of simply monitoring one's sensations and thoughts without trying to interpret or judge them is said to lead to a gradual lessening of one's identification with those sensations or thoughts. The positive effects of engaging in this kind of practice are an enhanced sense of equanimity[34] and reduced negative self-referential rumination.[35] Negative self-referential thoughts are progressively experienced as mere temporary mental events, as opposed to self-defining reifications. In terms of neural correlates, metacognition is said to predominantly engage regions of the prefrontal cortex as well as limbic regions including the anterior cingulate cortex and the anterior insula, which may promote meta-awareness of internal body states.[32]

Some styles of yoga use gaze, or *drishti,* as a tool for training attention and inducing a calm state of mind.[36] Typical practice instructions are to avoid eye movements to potentially distracting stimuli in the visual environment and to instead cultivate a controlled gaze toward a specific body part or point in space. Yogic texts also describe specific eye exercises,[37] including gazing techniques in which the eyes are held in particular positions (e.g., upward, straight ahead, or downward) that are proposed to aid powers of concentration[38] and prevent one's attention from being distracted.[39] Relevant information about the neural processes affected when gaze is used to train attention comes from studies investigating the relationship

between gaze and self-regulation of alpha waves in the brain. The presence of alpha rhythm in occipital/visual brain regions is associated with a state of relaxed wakefulness. Alpha waves typically occur with closed eyes, but individuals can be trained to induce alpha waves with eyes open as long as they turn their attention inward.[40] Alpha-wave production in this case is said to be related to a defocus and relaxation of ocular convergence, a technique similar to a yogic gazing practice known as *bhrumadhya drishti* (focus on the third eye).[39]

Psychosocial Elements

The psychoemotional domain of health involves cognition, intellect, beliefs, emotion, and mood. It includes our ability to understand concepts, organize and process information, synthesize and generate ideas, recognize feelings and emotions, and regulate our mood. Similar to the attentional components described above, emotion and mood regulation can also be affected by many aspects of yoga—including movement and posture practice, breath regulation, meditation, as well as lifestyle and ethical principles. For example, it has been proposed that postures characterized by expansion—a sense of lifting and freely flowing movement—can support positive emotional states.[41,42] Breathing practices have been shown to reduce clinical symptoms of anxiety, depression, and PTSD.[43] Yoga practices that involve a focus on lifestyle and ethical principles have been shown to have a stronger effect on anxiety than practices that don't.[44] Lastly, interoceptive awareness, mindfulness, and self-compassion have been proposed as potential mechanisms underlying yoga's stress-reducing effects.[45]

The social domain of health looks at our ability to have and maintain healthy relationships and to interact with others in meaningful ways. The importance of this domain is underlined by studies showing that the *quality* of relationships has a stronger influence on health and well-being than the quantity.[46] Essential to connection with others are prosocial attributes such as compassion, empathy, and forgiveness. The foundations of yoga philosophy and practice are ethical principles (e.g., patience, acceptance, contentment, and nonharming) that can support relationships and help individuals develop insights into habitual ways of interacting that may be getting in the way of healthy relationships. In addition, yoga invites us all to recognize the same inherent nature within all beings, which can support connection and relationship with others and allow for inherent compassion and empathy to emerge. It has been shown that when yoga includes these ethical components, as opposed to being mere physical exercise, the practice has a more significant effect on depression, anxiety, mindfulness, and physiological markers such as cortisol levels.[44,47] These ethical and social aspects have also been reported as motivators for continued practice and predictors of long-term benefit.[48–50]

Spirituality/Meaning and Purpose

The definition of spirituality includes meaning and purpose, internal resourcing that may involve connectedness to something more transcendent, and positive attributes as described above in relation to psychosocial aspects.[51,52] Spirituality has been proposed to be linked to many positive health outcomes including reduced mortality; morbidity; and experiences of pain, anxiety, and depression; and improved quality of life, coping, and adjustment to chronic pain or illness.[51,52] The development and cultivation of meaning and purpose in particular has been linked to decreased inflammatory responses, mortality, pain, and use of pain medication and improved well-being and immune processes.[53,54] Spiritual well-being has also been proposed as an important mechanism through which yoga affects stress reduction.[45]

Mechanisms Linking These Aspects of Practice

Regulation of Allostatic Load

Allostasis refers to the ability of an organism to maintain stability through change by actively adjusting to both predictable and unpredictable events.[55] The primary mediators of allostasis in humans include hormones of the hypothalamic-pituitary-adrenal axis (e.g., cortisol), excitatory catecholamines (e.g., adrenaline/epinephrine), and immunomodulatory cytokines (e.g., interleukins). An imbalance of these primary mediators leads to an allostatic state, and the cumulative effects of such a state sustained over time lead to allostatic load.[56]

One of the key components for the regulation of allostatic load in humans is the vagus nerve, the 10th cranial nerve. The majority (80% to 90%) of vagal nerve fibers are afferent, communicating peripheral information about body states to the brain.[57] Among other processes, the vagus nerve is involved in mediating stress responses through parasympathetic innervation of the heart.[58] An indirect but reliable measure of vagal tone (tonic parasympathetic activation) is heart rate variability (HRV),[58] especially HRV within the frequency of a normal respiration rate (i.e., respiratory sinus arrhythmia).[24]

Yoga practice is intrinsically tailored to promote vagal tone and reduce allostatic load in several ways. First, slow and rhythmic breathing (especially when performed with increased airway resistance) promotes activation of the parasympathetic nervous system and increases HRV.[15] Second, yoga postures often enhance the depth of the breath (e.g., active expansions and contractions of the rib cage during back or forward bends), thus boosting the effects of the breathing practices themselves.[59] Third, postures that emphasize abdominal tone through interior muscle activation additionally promote peripheral vagal stimulation and afference.[60] Fourth, attempting to maintain a slow and steady breathing rhythm during physical, mental, and emotional challenges elicited by the yoga practice itself represents an opportunity to practice nonreactive awareness and cultivate a state of equanimity in the face of stress.

Polyvagal Theory

Dysfunction of the ANS is a hallmark of, and can contribute to, many health conditions. Polyvagal theory provides a framework for looking at how yoga practices affect biopsychosocial-spiritual health and well-being through affecting autonomic neural platforms. *Neuroception* is the subconscious detection of environmental safety or danger, which in turn influences autonomic activations and subsequent physiological, emotional, and behavioral responses.[61,62] For

example, a subconscious detection of threat may activate the sympathetic fight-or-flight response from which activations of cardiorespiratory, endocrine, immune, and muscular systems co-occur with emotional and behavioral responses from excitement, fear, anxiety, or anger.

When we understand the underlying mechanisms of a practice, we are no longer locked into protocols but can instead adapt the practice more constructively according to clients' needs.

Yoga, with its rich set of practices that involve both "bottom-up" (physiological) and "top-down" (cognitive) components, is an effective tool to strengthen our capacity to self-regulate, develop resilience, return to a balanced autonomic state, and widen the window of tolerance to neural activations in response to internal or external triggers. Through shifting autonomic states, yoga practice can concurrently affect physical, mental, and behavioral health. In addition, when yoga therapy is informed by an understanding of the ANS, it can move from a pathology-oriented practice to an integrative whole-person framework through which facilitation of autonomic regulation and resilience promotes biopsychosocial and spiritual health and well-being.

Applications to Our Work with Clients

The importance of understanding these frameworks and mechanisms can be seen in how we apply yoga practices in client care. A biomedical application of yoga would be to look at how movement can be used solely for physical health, breathing practices for relaxation, and meditation for attention or emotion regulation. However, knowledge of the underlying mechanisms can empower us to describe, demonstrate, and apply the practices synergistically for whole-person health and well-being. It also allows us to make a case for the unique and necessary role of yoga therapy in integrative healthcare.

Given a foundational understanding of the mechanisms behind yoga's effects, we can begin therapy sessions with an assessment that supports insight into what a client is experiencing on all layers—the physical, energetic, psychoemotional, social, and spiritual. Following this holistic assessment, the practices can be applied for synergistic effect on these layers of health and well-being. Part of the significance to this approach is that we are adapting and applying the practices to the person as a whole, not to the conditions or symptoms. This is very different than prescribing piecemeal practices to fit particular conditions, diagnoses, or symptoms. Medical conditions or symptoms may be a useful factor in determining contraindications or considerations for the practice, but they do not form the sole basis for using specific practices. This perspective opens us up to truly practicing client-centered care and to an empowering approach that highlights shared decision-making. Rather than trying to fit a preconceived notion of needing to use a certain pose, breathing technique, or meditation, we can work with the individual to explore the practices that promote the mechanism we are aiming to strengthen.

If we want to enhance physical functioning, for one person this may be targeted by going straight to movement, while for someone else it might be through working with neural platforms to enhance both relaxation of the body and the ability to strengthen with greater mindfulness; for yet another person it may be by working with a focus on compassion for what is happening in the body. For some individuals with chronic pain it could be effective to work directly with physical function, but for others it could be more effective to focus on insight into emotions or autonomic regulation and resilience, or on their connection to meaning and purpose that facilitates greater well-being. If we want to help strengthen attention, we may find that for some clients we can do this with a posture or movement, for others it could be through a breathing practice, and for some it might be by means of a meditation with directed gaze. To support the experience of compassion, it may work for some to reflect on ethical principles of compassion or kindness, whereas for others it could be by supporting an autonomic platform of social engagement through movement and breathing practices.

This approach of understanding mechanisms frees the yoga therapist to work together with the client to discern which of the mechanisms need to be strengthened or supported and how to individualize the experience of the practice to work toward that intention. Ultimately, this co-facilitated process with the client is how we adapt the philosophy and ethical principles, movement, breath, and attention practices to address the above-described mechanisms and to affect conditions, symptoms, and (most importantly) whole-person health and well-being. An understanding of the mechanisms underlying the practices we recommend provides us with the opportunity to step out of preconceived notions and allows us instead to engage in a synergistic process with the client to explore meaning, purpose, and their unique needs for health and well-being. YTT

Laura Schmalzl, PhD, is a clinical neuropsychologist and cognitive neuroscientist. She has also been a yoga instructor for 15 years and is currently completing a yoga therapy training. She is passionate about the intersection of yoga and neuroscience from research, educational, and clinical perspectives.

Marlysa Sullivan, DPT, C-IAYT, is the coordinator of the Empower Veterans Mindful Movement Program for Pain Care at the Veterans Administration and a professor at Maryland University of Integrative Health and Emory University and teaches at Kripalu. She is the author of Understanding Yoga Therapy and Yoga *and* Science in Pain Care.