



Bridging the Gap Between Yoga and Science: A Mini Review

Shimul Sujit Sen¹ and Gabriele Deidda*¹

¹Laboratory of Neurophysiology, Department of Physiology and Biochemistry, University of Malta, Msida, Malta

Abstract. Yoga is an ancient tradition arising from the evolving cultures of ancient India originating from a variety of sources like primeval texts, oral transmissions through lineages, iconography and songs. It has a complex history of spiritual exploration, philosophical reflection and creative expression. Yoga has evolved over time to suit the needs of the current population. At present, humanity at large views things, especially the mystical arts, through the lens of the sceptical scientist. Despite countless benefits of yoga and meditation to the overall health and mind of a person that have been documented over time, they have mostly been seen as informal and only a few studies using a rigorous scientific methods have been performed. Most recently, through the advent of cutting-edge scientific tools (i.e., electroencephalogram, EEG), the gap between the subjective and objective has been bridged. Nevertheless, the path to scientific inquiry supporting yoga is a work in progress. In this minireview, we will make a short historical resume of the scientific studies carried out to investigate the effect of yoga in the physiology of the body and the brain, and its possible use to ameliorate pathological conditions.

Keywords: Yoga, EEG, anxiety, epilepsy

1 Introduction

The role of yoga has evolved over the centuries with several different sources such as the *Vedas* meaning sacred knowledge (1700–1100 BCE), the *Upanishads* which include contemplative practices for finding oneness (first millennium BCE), the *Bhagavad Gita* or the song of god, the *Yoga Sutras* of Patanjali or the aphorisms (around 200 CE) where Patanjali begins with a simple question of “what is yoga?” leading to a simple answer centred around steadying the mind (Stephens, 2010). The path to modern yoga from these sources was not straightfor-

ward. *Tantra Yoga* has a major part to play as it offers an integrative approach to yoga, that every and any experience is divine, thus, establishing the bedrock of the modern yoga body-oriented practices of yoga under the all-inclusive tantra ideology. Finally, we have *Hatha Yoga* from the sources of the *Hatha Pradipika*, *Gheranda Samhita* and *Shiva Samhita* which form the roots of the ever-expanding modern hatha yoga traditions of *Vinyasa*, *Iyengar*, *Anusara*, *Ashtanga Vinyasa* and others that are variations on a tradition with a branded name (Stephens, 2010). There are three main aspects of yoga which seem to be universally agreed upon despite their various forms and styles: *i*) *Asana*, the physical seat or series of movements, *ii*) *Pranayama*, the sequences of breath refinements, and *iii*) *Dhyana*, the meditation or contemplation.

Yoga has been always associated with providing general benefits to the body and mind. Nevertheless, reports had always been informal and only recently thanks to the development of new scientific tools have the benefits of yoga been investigated with a proper scientific method.

2 Effect of Yoga in the Physiology of the Body

The remarkable effect of yoga has to be reported in the general physiology of the body. In 1970, Wallace and co-workers investigated the physiological effects of transcendental meditation (Wallace, 1970), a technique defined as “turning the attention inwards towards the subtler levels of a thought until the mind transcends the experience of the subtlest state of the thought and arrives at the source of the thought” (Yogi, 1969). The study reported a decrease in oxygen consumption and heart rate as well as an increase in skin resistance during meditation. In another study, Kamei and co-workers found a decrease in blood levels of serum cortisol during yoga exercise (Kamei et al., 2000). Gathered together

*Correspondence to: Gabriele Deidda (gabriele.deidda@um.edu.mt)

these findings provide a scientific basis to support the anti-stress benefits of yoga and meditation practices.

3 Effect of Yoga in the Physiology of the Brain

Apart from the effects on the general physiology, important effects of yoga have been reported in the brain (Table 1), for example in modulating the level of some neurotransmitters. By means of modern imaging techniques, an increased endogenous dopamine release in the ventral striatum during *Yoga Nidra* meditation has been reported (Kjaer et al., 2002). Nevertheless, the most remarkable and interesting effect of yoga has been reported on the activity of the brain, and most of the scientific studies aimed to investigate it used electroencephalogram (EEG), a non-invasive technique that allows the recordings of the overall activity of the brain by means of electrodes attached to the scalp.

Vialatte and co-workers employed high-density array EEG system (128 electrodes) to record the brain activity in subjects performing a specific form of yoga breathing technique called *Bhramari Pranayama*. They found that low-frequency power was diminished with the increase of the high-frequency gamma waves (Vialatte, Bakardjian, Prasad & Cichocki, 2009) which is usually a characteristic of a high state of arousal even if recorded in a state of relaxation (breathing). A follow-up study showed that the increase in gamma power activity is something common to a variety of meditation practices such as *Vipassana*, *Himalayan Yoga* and *Isha Shoonya*, and was positively correlated with the meditation experience (Braboszcz, Cahn, Levy, Fernandez & Delorme, 2017). High-band power in alpha and theta spectra has also been reported in *Rajyoga* meditators (Sharma, Chandra & Dubey, 2018). Interestingly, in this latter study researchers found an overall higher power spectrum in parietal and frontal areas (Sharma et al., 2018), demonstrating the ability of meditators to specifically increase brain activity in specific areas of the brain.

Altogether, these studies showed that yoga practice does have an effect on the activity of the brain by increasing the power of high-frequency bands in the EEG resulting in a more desynchronized pattern.

4 Yoga and Epilepsy

Given the remarkable effect of yoga in desynchronizing the EEG, researchers have tried to apply yoga to get seizure-control in patients affected by epilepsy, a neurological disorder characterized by recurrent paroxysmal alterations in behaviour associated with synchronous and abnormal discharges of large neuronal populations. Overall, 0.5–2.0% of the world's population is affected by epilepsy (Fisher, 2017). In a study of Panjwani and co-workers, researchers selected patients with idiopathic

Table 1: Summary of the effects of Yoga in the physiology and the pathology of the brain.

Effect in the brain	Reference
Yoga Nidra meditation increased endogenous dopamine release in the ventral striatum	Kjaer et al. (2002)
Yoga Bhramari Pranayama diminished the low-frequency power and increased the high-frequency gamma waves	Vialatte, Bakardjian, Prasad and Cichocki (2009)
Vipassana, Himalayan Yoga and Isha Shoonya increased gamma power activity	Braboszcz, Cahn, Levy, Fernandez and Delorme (2017)
Rajyoga increased the power of alpha and theta waves	Sharma, Chandra and Dubey (2018)
Sahaja yoga meditation decreased seizure frequency and shift the frequency EEG from lower to higher bands in patients with idiopathic epilepsy	Panjwani et al. (1996)
Yoga decreased anxiety	Hardt and Kamiya (1978), Field, Diego and Hernandez-Reif (2010)
Rhythmic breathing helped to control the tobacco habit	Kochupillai et al. (2005)
Yoga reduced the risk of alcohol and drug abuse consumption in veteran and civilian women with posttraumatic stress disorder	Reddy, Dick, Gerber and Mitchell (2014)

epilepsy and assessed the effect of Sahaja yoga meditation on seizure control and EEG alterations.

Patients practicing yoga reported an 86% decrease in seizure frequency. Moreover, EEG recordings showed a shift in frequency from lower (0–8 Hz) to higher (8–20 Hz) bands (Panjwani et al., 1996). Then, yoga practice could support seizure control providing a way to ameliorate the quality of life in those affected by epilepsy.

5 Yoga and Anxiety

Since yoga is a practice known to induce relaxation, researchers had studied its effect on anxiety. Among the EEG rhythms, alpha waves (8–15 Hz) are mostly involved in anxiety because they are present during relaxed wakefulness and thereby generally associated with a relaxed state of mind. An earlier study showed that when individuals with high anxiety traits were able to increase their alpha wave activity, they showed less anxiety-associated symptoms (Hardt & Kamiya, 1978). Field and co-workers reported a decreased (self-reported) anxiety in participants practicing yoga (combined with tai-chi). Moreover, a trend for increased EEG theta activity (non-significant) was also reported (Field, Diego & Hernandez-Reif, 2010).

6 Yoga in the Treatment of Addiction of Drugs of Abuse

Given the pivotal positive effects of yoga in the general wellbeing of the individual, it does not come as a surprise that yoga has been proposed to be used in the treatment of addiction of drug of abuse, in particular in ameliorating the withdrawal symptoms. For example, in a group of cancer patients rhythmic breathing (Sudarshan Kriya and Pranayam) helped to control the tobacco use in 21% of individuals (Kochupillai et al., 2005). Also, individuals with posttraumatic stress disorder are more likely to experience high-risk substance behaviours associated to drug abuse and, thus, complementary therapies are needed. A pilot randomized controlled trial reported that a yoga therapy intervention reduce the risk of alcohol and drug abuse consumption in veteran and civilian women with posttraumatic stress disorder (Reddy, Dick, Gerber & Mitchell, 2014).

7 Conclusion

In conclusion, despite the informal positive effects of yoga and meditation on body and mind reported over the centuries, only recently have we pushed away the scepticism and developed the scientific tools to start investigating it through thorough factual experiments that led to positive results and, thus, setting a solid foundation for further experimentation as science progresses. These studies do demonstrate that yoga does influence the physiology of the body and the brain. More importantly, the ongoing investigation of yoga needs to take a forefront if we are to successfully increase the overall quality of life, and alleviate pathological conditions.

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