

Exploring Neurophysiology of Yogic Breathing with Open BCI

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Breath is the rhythm of life, yet its deeper role in shaping brain activity and body physiology is only beginning to be understood by science. For centuries, yogic breathing practices (prāṇāyāma) have been described as ways to calm the mind, improve focus, and support health. But how does each inhale and exhale truly affect the brain and the heart? My research attempts to make this hidden synchrony visible using low-cost, open-source tools.

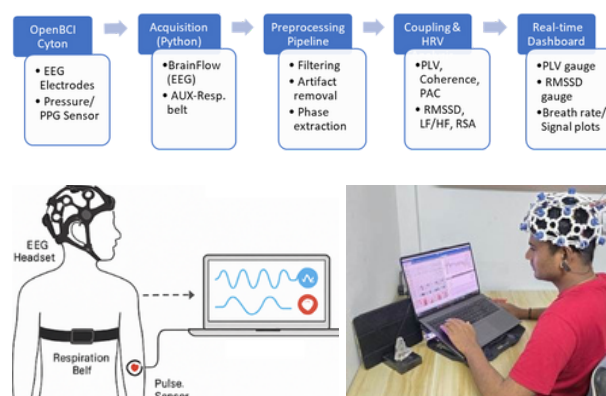
Research in neuroscience shows that breathing does more than move air—it modulates neural oscillations, particularly in the alpha (8–13 Hz) and theta (4–7 Hz) brainwave bands. This phenomenon—known as respiration–EEG coupling—may underlie the sense of calm and awareness often reported in yogic practice. At the same time, slow and mindful nasal breathing enhances heart rate variability (HRV), a key indicator of parasympathetic nervous system activity and stress resilience. Together, these insights point to breath as a “bridge” connecting mind and body.

To explore this, I built a system that combines multiple signals into a single synchronized stream. Brain activity is captured through an OpenBCI Cyton board, chest movement is monitored using a custom respiration belt with a pressure sensor, and heartbeats are recorded through a lightweight pulse sensor. By aligning these streams in real time, I am able to extract the phase of each breath, track how alpha and theta rhythms fluctuate, measure heart rate variability indices such as RMSSD and respiratory sinus arrhythmia, and finally compute coupling metrics like Phase Locking Value that reveal how strongly breathing is locking onto brain activity. Instead of leaving these as raw numbers in a spreadsheet, I designed a live dashboard—a “synchrony meter”—which shows, in real time, how breath, brain, and heart are working together. The system streams shows how strongly the breath is aligning brainwaves and heart rhythms at any moment.

The important aspect of this system is its affordability and portability. Unlike expensive laboratory instruments, it can be carried into yoga studios, clinics, or even used in a home environment. This opens the door to multiple applications. In yoga research, it can provide concrete scientific evidence for long-held traditional practices. In the field of mental health, it can become a biofeedback tool for managing anxiety, stress, or sleep-related issues. In education and training, yoga teachers and therapists could use such technology to give their students objective feedback on practice quality. In healthcare, the same platform could evolve into rehabilitation devices designed to strengthen mind–body synchrony.

Looking beyond these immediate applications, the vision is even more exciting. By combining this hardware system with a mobile app,

it can transform into a personalized therapeutic guide. The app could analyze the user’s state of mind in real time and recommend suitable pranayama or kriya techniques based on their physiological signals. A feedback loop would allow the system to compare expected outcomes with actual results, correcting technique and guiding practice more effectively. In other words, the ancient wisdom of yoga could be delivered as a personalized, adaptive, and science-informed wellbeing tool—available in your pocket. This project is about bringing ancient wisdom and modern neuroscience together; this work seeks to illuminate how conscious breathing reshapes our inner rhythms. The long-term vision is empowering individuals to observe, train, and strengthen the synchrony of their own breath, brain, and heart—a step towards accessible, science-informed wellbeing.



References

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