

# Healthy Brain: Neural Dynamics of Vipassana Meditation Proficiency

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Several scientific studies have shown Vipassana meditative training to result in the flourishing of both psychological and physiological health leading to an improved sense of well-being. A large body of research suggests that meditation has effects ranging across psychology, physiology and biochemistry and is observed to enrich mental and physical health (Walsh, 2001). Proficient meditative practice is known to enhance brain functions and capacities towards attaining higher cognitive capabilities and greater psychological development through the nurturing of mental attributes such as unselfishness, compassion and equanimity. Corresponding changes have also been observed in brain networks associated with cognition and emotion.

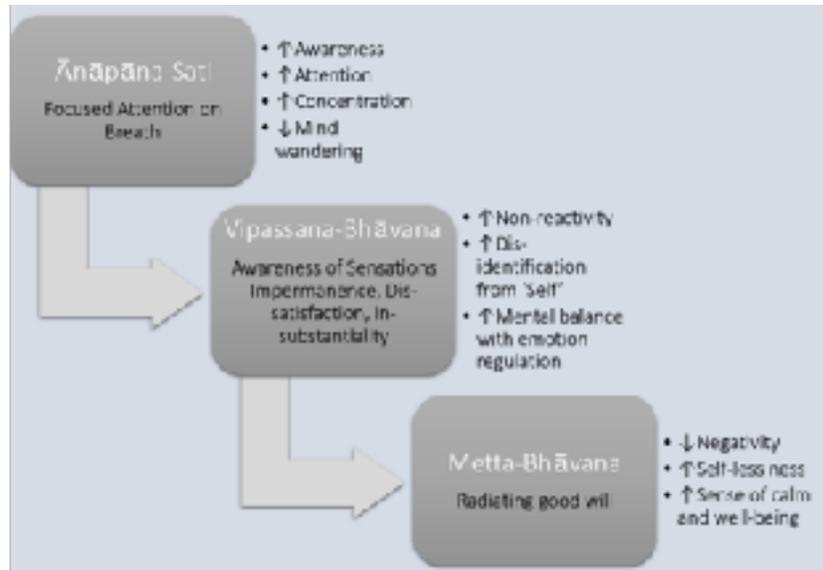
However, there is a lack of research studies on neural correlates of the key meditative states of the widely practiced Vipassana meditation (in the tradition of Sayagyi UBa Khin as taught by S. N. Goenka). Also, the relative impact of meditation on brain waves and their functional significance is not clearly known. Our study has been specifically designed to address these research gaps. For the first time, we have attempted to identify the distinct neural correlates of the key meditative states of the widely practiced Vipassana meditation using the technique of EEG (Electroencephalography).

## WHAT IS VIPASSANA MEDITATION?

Vipassana Meditation is the process of cultivating ‘insight’ into the fundamental characteristics (Impermanence, Insubstantiality and Suffering) of mind-body phenomena. To cultivate ‘insight’, Vipassana meditative training in the tradition of Sayagyi UBa Khin (as taught by S.N. Goenka) employs a set of three inter-related meditative states. The outcome of long-term Vipassana practice is collectively influenced by all three meditative states. The following are the three meditative states.

- *Ānāpāna Sati* (known as Focused Attention-FA)
- *Vipassana Bhāvana* (known as Mindfulness/Open Monitoring Meditation-OM)
- *Metta Bhāvana* (known as Loving Kindness/Compassion Meditation)

We have employed the technique of EEG to identify the distinct neural correlates of each of these practices in proficient Vipassana practitioners and their functional significance.

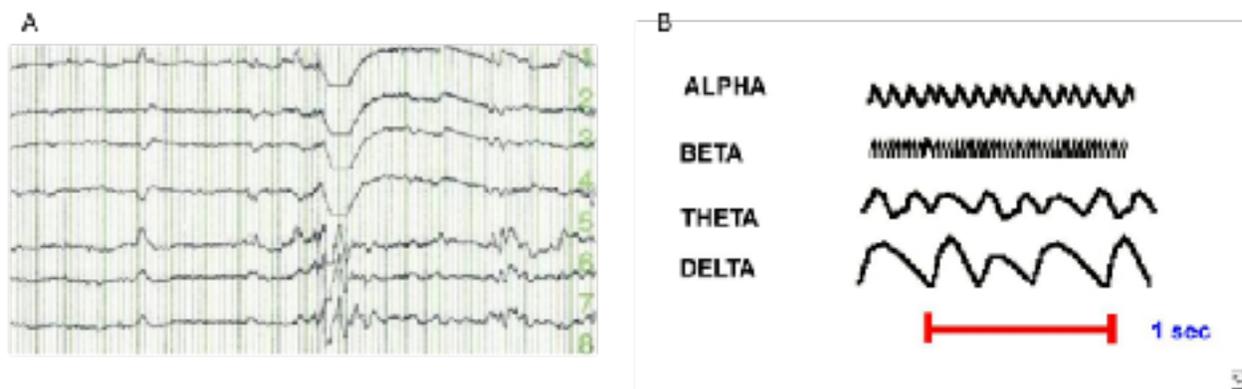


**Figure 1 Outline of Vipassana Meditation Practice (in the tradition of Sayagyi U Ba Khin).**

The salient features and the outcomes of each practice have been represented. (Note: The outcomes are never strictly isolated)

### WHAT IS EEG?

Electroencephalogram (EEG) is the recording of ongoing brain electrical activity using electrodes placed on the scalp. EEG at any electrode location is a record of summated postsynaptic field potentials of many pyramidal neuronal columns of the cortical gyri underlying the electrode and is influenced by volume conduction effects (Luck & Kappenman, 2012). EEG represents dozens of different neural sources of activity and contains neural responses associated with specific sensory, cognitive and motor events which can be extracted by sophisticated analytical techniques. EEG is a summation of several ongoing brain rhythms or oscillations which can be classified into various frequency bands called delta (0 to 4 Hz), theta (4-8 Hz), alpha (8-12 Hz), beta (12-30 Hz), gamma (30-100 Hz).



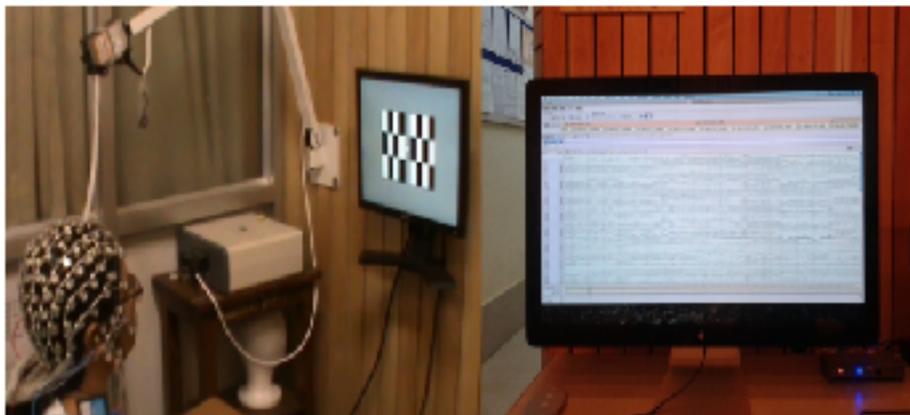
**Figure 1 Panel A:** Electrical activity in the brain is recorded as a 'wave' and an EEG is a record of several brain waves (Adapted from <https://www.healthgrades.com/procedures/understanding-your-eeeg-results>)

**Panel B:** Examples of alpha, beta, theta, and delta electroencephalography frequencies. (Adapted from [emedicine.medscape.com/article/1139332-overview](http://emedicine.medscape.com/article/1139332-overview))

Many studies have associated specific oscillations with particular cognitive processes (Klimesch, 1999; Sauseng et al., 2006). According to recent investigations, theta and alpha oscillations reflect activity of neuronal networks associated with orienting, attention, memory, affective and cognitive processing (Aftanas & Golosheikin, 2003). Individuals exhibiting greater theta activity tend to have lower state and trait anxiety scores (Inanaga, 1998). In particular, theta oscillations are known to be associated with affective states such as positive emotional disposition and stability (Aftanas, Varlamov, Pavlov, Makhnev, & Reva, 2001). Alpha in lower frequency band (8-10 Hz) reflects predominantly attentional task demands while upper alpha (10-12 Hz) reflects semantic memory processes (Klimesch, 1999).

## CURRENT RESEARCH STUDY METHODOLOGY

This research project has been carried out with permissions from Vipassana Research Institute (VRI), Igatpuri, India. The study has been carried out on Vipassana practitioners who were categorized into three groups (Novice practitioners; Senior practitioners; Vipassana Teachers) based on the duration and quality of meditative experience. Data acquisition was carried out for one hour on the participants using high-resolution EEG system (128-channel). The experimental design simulates the one hour intense meditation session practiced in the Vipassana centers. The acquired EEG data was pre-processed and analyzed for 128 electrode locations in low-frequency bands.



*Figure 4 Participant performing a task (Left) while EEG gets recorded (Right).*

## RESULTS & DISCUSSION

We observed meditation proficiency related distinct state-trait effects unique to each meditative state. Overall our results show proficient Vipassana meditators to have higher theta-alpha powers (6-10Hz) when compared to novice meditators. Theta-alpha power is known to positively correlate with meditation proficiency (Cahn & Polich, 2006).

Theta-alpha power rise in proficient meditators is a meditation proficiency induced neural-plasticity event. This is because normal controls (non-meditators) show decreases in theta and localized increases in

low and high alpha powers (Hinterberger, Schmidt, Kamei, & Walach, 2014). In normal controls, by default, cognitive and emotional processes revolve around the subject and not on current events (Gusnard, Akbudak, Shulman, & Raichle, 2001). On the contrary, theta-alpha power rise in proficient meditators indicates altered default brain activity suggestive of decreased mind wandering with improved objective stance (towards oneself and others). This functional alteration is the collective outcome of the practice of all meditative states (Ānāpāna, Vipassana and Metta).

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