

## Research Article

# Meditation and Its Neurophysiological Effects: A Review of Scientific Evidence

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## Abstract

Meditation, an ancient mind–body practice, has become more and more important in the world of science because of its benefits on psychological and neurological health. Recent neurophysiological studies show that meditation affects brainwave states, regulation of neurotransmitters, autonomic nervous system balance and neural plasticity. Differences in the type of meditation have been observed to lead to changes in alpha, theta and gamma electroencephalographic (EEG) activity and modulation of neurotransmitters such as serotonin, dopamine and gamma-aminobutyric acid (GABA). The neurophysiology changes that happen in the body as a result of these practices help to regulate emotions, manage stress, boost cognitive functions, and promote psychological health. This review article is a discussion of the neurophysiological evidence on the effects of meditation and its therapeutic applications in mental and physical health.

**Keywords:** Meditation, Neurophysiology, EEG, Neurotransmitters, Brainwaves, Mindfulness, Neuroplasticity.

## 1. Introduction

Meditation is a mental activity that focuses attention, awareness and uses emotional regulation to create a state of inner calmness and clarity. It has been used in spiritual practices like Yoga and Buddhism for centuries to promote a sense of spiritual growth and psychological balance.

Meditation has been a significant area of scientific research in recent decades due to its positive psychological impacts on stress management, emotional balance, and cognitive function, as well as its positive effects on general well-being.

Today's neuroscience research has shown that meditation actually creates tangible changes in the human brain and nervous system. Using techniques like electroencephalography (EEG), functional neuroimaging and biochemical analysis, researchers have found important changes in brainwave patterns, neurotransmitter release, autonomic nervous system function and neural connections during meditation. The results indicate that meditation is a more than a relaxation exercise, but a complex neurological activity that can have an impact on cognitive and emotional processes. Meditation is also a viable alternative treatment approach for treating anxiety, depression, hypertension, insomnia, and chronic stress. Studies have shown that the practice of regular meditation increases activity of the parasympathetic nervous system and decreases activation of the sympathetic system, which leads to better mental and physical health.

## 2. Literature Review

There are several scientific studies that have investigated the neurophysiological effects of meditation that adopted EEG analysis, neuroimaging techniques, and biochemical measures. Evidence from multiple studies shows that meditation changes the activity in the brain and balance of neurotransmitters linked to relaxation, emotional regulation, and cognition.

Yadav et al. (2026) carried out a narrative review focusing on 21 scientific research reports about meditation, EEG patterns and neurotransmitter modulation. It was observed that meditation techniques like Yoga Nidra, Transcendental Meditation, Mindfulness Meditation, Vipassana Meditation and Cyclic Meditation not only increased alpha and theta brain wave activity, which suggests improved relaxation and attentional stability, but they also reduced the activity of gamma, gamma gamma, and gamma delta. The review also mentioned elevated levels of serotonin, dopamine, and GABA levels, and decreased levels of norepinephrine, which is a chemical involved with stress.

Davidson et al found that mindfulness meditation was able to produce a significant activation of the left frontal region of the brain, linked to positive emotional states and better immune function. Likewise, research on Transcendental Meditation found that their practice led to an increase in frontal alpha coherence, which is a sign of a greater integration of the brain's functioning and a more relaxed mental state.

Studies using Yoga Nidra showed an increase in the amount of theta in the brain during meditation, which corresponds to a highly relaxed yet conscious state of mind, where dopamine levels are higher. Theta synchronization and distractibility were measured during the Vipassana Meditation studies, and better attentional control and emotional regulation were observed.

Studies on neurotransmitter regulation further support the neurophysiological benefits of meditation. Increased serotonin levels have been observed in long-term Vipassana practitioners, while Amrita Meditation has been shown to increase plasma GABA levels and reduce anxiety symptoms. Meditation practices also reduce norepinephrine and epinephrine levels, contributing to reduced physiological stress responses and improved autonomic balance.

There are also neuroimaging findings that support the idea of structural brain changes in meditation. Long-term meditators demonstrate thicker cortex and increased gray matter density in areas including the prefrontal cortex, hippocampus and insula. These changes have been linked to better attention, emotional control, memory functioning and self-awareness. While the results are encouraging, there are some drawbacks in current research on meditation. The studies are frequently small, have different methodologies, and different meditation times and techniques. Hence, further, well-designed and standardized studies are needed to provide more conclusive scientific data on meditation's neurophysiological processes.

### **3. Objectives of the Study**

1. To examine the effects of meditation on brainwave activity and EEG patterns.
2. To analyze the influence of meditation on neurotransmitter regulation and emotional stability.
3. To study the role of meditation in improving cognitive, psychological, and physiological health.

## **4. Neurophysiological Effects of Meditation**

### **4.1 Effects of Meditation on Brainwave Activity**

EEG is a method that can measure brainwave activity, and meditation creates a multitude of changes in brainwave activity. In the scientific studies, people consistently report that meditation practices increase Alpha and Theta waves. Alpha waves represent a state of relaxed awareness, calm, stability and relaxation. Alpha coherence, such as with Transcendental Meditation and Acem Meditation, suggests better neural communication and lower psychological stress. High alpha activity also corresponds with higher concentration and emotional balance.

Meditations like Yoga Nidra and Vipassana Meditations also improve Theta waves. Theta waves are associated with relaxation, creativity, memory processing, and awareness of the self. Yoga Nidra creates a relaxed but awake state of mind with higher levels of theta brain waves and dopamine. Likewise, Vipassana Meditation improves the synchronization of the theta brain waves, increases attentional control, and limits distractions such as mental and emotional reactions.

The synchronization of gamma waves also increases with meditation, particularly for more advanced meditators. High frequencies of wave cycles (gamma waves) relate to higher levels of cognitive processing, awareness, learning and neural integration. Greater gamma activity means greater attention, mental clarity and cognitive efficiency. Meditation has profound effects on the neurotransmitter systems which modulate mood, cognition and emotional reactions. One of the key neurotransmitters impacted by meditation is dopamine, linked to attentional functions, reward, pleasure, and also motivation. Studies of Yoga Nidra indicate that during meditation there is an increase in the release of endogenous dopamine, which leads to emotional satisfaction, concentration and a decrease in stress.

#### **4.2 Effects of Meditation on Neurotransmitter Regulation**

The activity of serotonin is also enhanced with meditation. Serotonin is a significant factor in emotional control, mood and sleep quality. Research on Vipassana Meditation and Transcendental Meditation has found increases in serotonin levels and in the efficiency of serotonin metabolism in the people who practice these techniques. A rise in serotonin levels leads to decreased anxiety, better emotional regulation and mental health.

Another key brain chemical that is affected by meditation is called gamma-aminobutyric acid (GABA), which is the predominant inhibitory neurotransmitter in the brain. GABA is a neurotransmitter that helps calm down the overactive neurons. Plasma GABA levels are greatly elevated by meditation and various other techniques like Amrita meditation, thus decreasing anxiety and emotional tension. Meditation also lowers stress related catecholamines (norepinephrine and epinephrine) which reduces sympathetic nervous system activity and enhances autonomic balance.

#### **4.3 Effects of Meditation on Brain Structure and Cognitive Function**

The long term practice of meditation creates neuroplasticity and this leads to structural and functional changes in the brain. Neuroplasticity is the brain's ability to reorganize itself and strengthen neural connections as a result of repeated mental activity. Regular meditators have thicker cortex and higher density of grey matter in key brain regions including the prefrontal cortex, hippocampus, and insula, as shown by neuroimaging studies. They are linked to areas of attention, memory, emotional control, self-awareness and decision making.

Meditation also quiets the amygdala, the part of the brain that processes fear, anxiety and stress responses. A decreased amygdala response explains why some people handle emotional situations better and have less emotional stress. The changes in structure and function underlie enhanced cognitive capabilities, emotional stability, attention to focus, and self-control that are frequently reported in meditation practitioners.

Meditation not only has a positive effect on the mind but also on physiological functioning, as it regulates the autonomic nervous system. Meditation causes an increase in parasympathetic tone and decreases sympathetic tone, resulting in a decrease in heart rate, blood pressure, respiratory rate and cortisol. These physiological benefits lead to relaxation, cardiovascular wellness, lowering stress and general health.

### **5. Findings**

The major findings of the review on meditation and its neurophysiological effects are as follows:

1. Meditation significantly increases alpha brainwave activity, which is associated with relaxation, mental calmness, and emotional stability.

2. Practices such as Yoga Nidra and Vipassana Meditation increase theta wave activity, indicating deep relaxation, internal awareness, and improved attentional control.
3. Experienced meditators show increased gamma wave synchronization, reflecting enhanced cognitive functioning, awareness, and neural integration.
4. Meditation increases dopamine release, contributing to improved mood, motivation, concentration, and emotional satisfaction.
5. Increased serotonin levels observed during meditation help reduce anxiety, depression, and emotional instability while improving psychological well-being.
6. Meditation enhances gamma-aminobutyric acid (GABA) activity, resulting in reduced neural excitability, lower anxiety, and greater emotional calmness.
7. Meditation reduces stress-related neurotransmitters such as norepinephrine and epinephrine, thereby lowering sympathetic nervous system activity and stress responses.
8. Neuroimaging studies indicate increased cortical thickness and gray matter density in the prefrontal cortex, hippocampus, and insula among long-term meditators.
9. Meditation decreases activity in the amygdala, leading to reduced fear, stress reactivity, and emotional disturbances.
10. Meditation improves autonomic nervous system balance by increasing parasympathetic activity and reducing sympathetic arousal.

## **6. Conclusion**

Meditation is a scientifically validated mind-body technique with powerful neurophysiological impact on the brain, nervous system and emotional tone. EEG research, neuroimaging studies, and biochemical research all show that meditation affects brainwave activity, regulates neurotransmitter activity and supports neuroplasticity. The higher the rates of these brainwaves in meditation, the greater the relaxation, attention, awareness and cognitive integration. Meditation also has a positive effect on neurotransmitters like dopamine, serotonin and GABA and also lowers the amount of stress hormones called catecholamines. These biochemical changes help to promote emotional stability, decrease stress, enhance mood, and psychological wellness. Moreover, the brain regions that are important for this kind of meditation appear to change structure over time, showing that long-term practice enhances emotional control, self-awareness and cognitive abilities. Based on the results of this review, meditation is a promising complementary therapy for the management of stress-related disorders, anxiety, depression, hypertension, insomnia and other psychosomatic diseases. It is a low cost, non-invasive and non-pharmacological way of enhancing mental and physical wellness. But despite the mounting evidence, there is still a need for more standardization of methodological approach and more sizeable clinical trials in order to arrive at more conclusive findings on the neurophysiological mechanisms and therapeutic uses of meditation. EEG analysis, neuroimaging, hormonal analysis and behavioural assessment may be used together in future studies to gain a better understanding of the long-term effects of meditation on human health.

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