



THE NEUROSCIENCE OF MEDITATION

AN INTRODUCTION TO THE SCIENTIFIC
STUDY OF HOW MEDITATION
IMPACTS THE BRAIN

BY ERIC THOMPSON

The Neuroscience of Meditation

*An Introduction to the Scientific Study of How Meditation
Impacts the Brain*

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Contents

Introduction

1. Contemplative Neuroscience, Neuroplasticity and the Transformative Power of Consciousness
2. Brainwaves - What They Are
3. Brainwave States in Science
4. **Brainwave States in Meditation**
5. Brainwave States in Traditional Buddhist and Hindu Teachings
6. Attention-Gate Theory: How Awareness Changes the Brain
7. Meta-Awareness: Deepening the Transformative Power of Attention
8. Neurological Processes During Passive Meditation
9. Meditation and the Tao of the Human Nervous System
10. How The Brains of Advanced Meditators Differ from Non-Meditators - Part 1
11. How The Brains of Advanced Meditators Differ from Non-Meditators - Part 2
12. Scientific Studies on Tibetan Buddhist Loving Kindness Meditation
Meditation & Cortical Thickness

CHAPTER 4

Brainwave States in Meditation

Phase Synchrony and Coherence: The Difference That Makes ALL the Difference



As mentioned in Chapters 2 and 3, the Alpha and Theta bandwidths are most commonly associated with meditation. But as we'll soon discover, the specific ways in which these patterns emerge make the crucial difference between Alpha and Theta rhythms associated with cognitive dysfunction and those associated with higher-order cognitive processes. *Synchrony* and *coherence* seem to be two of the essential factors differentiating the Alpha and Theta bandwidths linked to impaired cognitive functioning from those correlated with exceptional processing.

To illustrate this important distinction, we can acknowledge the numerous studies demonstrating a preponderance of Theta activity in Attention Deficit Hyperactivity Disorder (ADHD) as well as many other studies that have also connected both Alpha and Theta rhythms with meditation and higher-order cognitive processes. The former body of studies seems to place Theta activity in a negative light, while the latter collection of work paints a much grander picture. The former finding once prompted a neurofeedback professional to ask me how any health professional could recommend the use of brainwave entrainment (BWE) to an ADHD sufferer and seriously expect a good outcome. After all, wouldn't the excess Theta rhythms generated through the use of this modality increase ADHD symptoms?

I responded to this gentleman by stating that both my personal experience with BWE and those of whom I had encountered over the years clearly indicated a dramatic lessening of ADHD

symptoms, but I couldn't at the time explain why that was the case. This encounter ignited within me a desire to answer that question, so I pondered all the evidence I had gathered up to that point and came to the conclusion that research involving phase synchronous brainwave patterns and coherence held the answer. I recalled that the key difference between the Theta rhythms in cognitive dysfunction and those of highly efficient functioning was that exceptional processing featured either inter- or intra-hemispheric coherence or both.

When a specific area of the brain features smooth waveforms that rise and fall in fluid rhythmic fashion, the resulting brainwave pattern is said to be *phase synchronous*. And when distant areas of the brain are firing phase synchronously in a particular brainwave pattern, this is referred to as *coherence*. As mentioned in Chapter 3, research on “mental Theta” (the phase synchronous Theta involved in focusing on mental tasks) and Sahaja Yoga meditation clearly showed a positive correlation between phase synchronous/coherent Theta rhythms and high levels of cognitive processing and emotional wellbeing.

An example of phase synchrony in action can be seen in the tragic collapse of the Angers Bridge in Angers, France in 1850. As 483 soldiers marched in lockstep—that is, in phase synchrony—across the bridge, the bridge's resonant frequency was triggered, causing the upstream anchoring cable on the right bank to snap several feet inside the concrete mooring, killing 226 people. 150 years later, the Millennium Bridge in London began to wobble when 600 people began to match the sway of the bridge and walk essentially in phase synchrony. To gain a sense of balance, each person switched her step to approximate the rhythm of the swaying bridge. This created a steady increase in amplitude, which eventually began to resonate the bridge's suspension system at precisely the frequency when it vibrates with the greatest magnitude. After being open for only two days, the bridge was closed for two years in order to address the its suspension problems.

While the “marching soldier” example is only one illustration of the power of phase synchrony and coherence, numerous other examples exist. And wherever phase synchrony and coherence are found, we also find *high levels of order*. Indeed, additional studies conducted by Farrow and Herbert as well as David Orme-Johnson and colleagues demonstrated a positive correlation between phase synchronous Alpha rhythms and exceptionally clear thinking. Desimone and associates conducted a study which suggests that important neurological communications are amplified through synchronous neuronal firing, creating a positive feedback loop that grows in amplitude. These researchers further speculated that various neurological disorders arise as the result of a neural incapacity for synchronous firing.

In a sense, synchrony is a kind of harmony. If the human brain is likened to the world, the phenomenon of transcortical coherence is analogous to distant countries cooperating with one another, communicating *empathetically* and *harmoniously* with one another. Viewed from this perspective, both world peace and exceptional neurological synchrony and coherence (which are positively correlated with reports of bliss and peace in deep states of meditation) represent dramatically improved communication.

Let us not forget that all phase synchronous marching is ordered by a specific cadence. We might imagine that, in the case of BWE, the overarching entrainment signal acts as the “drill sergeant” that sets the pace for large cortical and subcortical areas, leading to phase synchrony and coherence. Indeed, Sadigh and Kozicky found significant increases in Alpha and Theta coherence in response to BWE stimuli. Continued meditation practice, too, has been repeatedly linked to steady increases in Alpha and Theta synchrony. In this case, sustained attention (either passive or active), cultivated by persistent subtle intention, seems to act as the enlightened drill sergeant

to induce phase synchrony and coherence.

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