Differentiated, Not Disconnected: Neural Dynamics and Phenomenological Synergy of Samadhi and Vipassana in Buddhism

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Abstract

This paper argues that structural and functional neuroimaging, namely fMRI, MRI, and EEG, demonstrate unique neural correlates of samadhi and vipassana; therefore, identifying them as distinct meditative practices. Buddhist ideas integrated with neuroscience can bridge the gap between objective empirical correlates of consciousness and subjective descriptions of conscious experience.

Introduction

Bridging the gap between objective neural correlates of consciousness and subjective phenomenological descriptions of conscious experience remains difficult. Buddhism offers the integration of different styles of meditative practice into consciousness research which can help fill this gap. This paper will explore how Buddhist practices, such as samadhi and vipassana, provide rich phenomenological accounts of conscious experience[1,2] that can inform the structure of neuroscientific consciousness research. Samadhi (meditative absorption) and vipassana (insight) stand out as separate yet complementary practices for meditative development that can serve as the substrate for consciousness research. In turn, functional and structural magnetic resonance imaging (fMRI/MRI) along with Electroencephalography (EEG) can provide empirical validation of samadhi and vipassana as distinct meditative practices with unique neural correlates. These unique neural correlates provide objective validation for the integration of Buddhism in consciousness research, as it can bridge the gap between phenomenological self-reports of conscious experience and objective measures experiences. The following paragraphs will explore Samadhi as a focused attention (FA) or type practice and vipassana practice as an open monitoring (OM) type practice[3]. Objective measures of structural and functional neural activity such as fMRI,

MRI, and EEG have explored how FA and OM practices modulate neural activity and associated behavioural outcomes.

Neural Activity and Associated Phenomenology of Samadhi

This section will first demonstrate how fMRI and then EEG research shows that samadhi, a FA type practice, is associated with distinct neural modulation during meditation. This modulation is correlated with phenomenological outcomes such as decreased self-referential thought[1,4] and heightened sensory awareness[4,5]. fMRI research demonstrates that brain networks known to generate self-referential thought, such as the default mode network (DMN), are downregulated during tasks which cultivate attention, such as samadhi[1,4,6]. Specifically, DMN associated prefrontal brain regions (e.g. posterior cingulate cortex (PCC) and precuneus) are deactivated during goal oriented tasks versus their activation during an introspection or non-goal oriented tasks[4,5]. This downregulation of self-referential thought during FA type practices parallels phenomenological descriptions of key aspects of samadhi. One key part of samadhi is the jhanas — states of meditative absorption with increasing phenomenal subtlety — which can be traversed by engaging in Samatha bhavana (samadhi training)[1]. Samadhi practice requires the practitioner to access the jhanas; upacaara, or "access consciousness", refers to the ability to make the breath the only component of conscious experience and is necessary to traverse the jhana continuum[1]. The idea of upacaara provides the theoretical basis as to why self-referential thoughts are downregulated during samadhi practice as attentional emphasis is placed on sensory awareness.

EEG data corroborates this view as practices which cultivate attention, such as samadhi, demonstrate cortical phase-locking[5,7]. Cortical phase-locking refers to neurons firing at specific task-associated frequencies — alpha-band synchronization for awareness of the breath[5,8]

— across the span of a specific task. Sensory decoupling is the idea that internal cognition is desynchronized from external stimuli. This along with mind-wandering (MW) can be lessened by cortical phase-locking. Therefore, the ability of FA practices, like samadhi, to promote heightened sensory awareness can be explained by increased cortical phase-locking its effects on dampening sensory decoupling and MW. Evidence from fMRI and EEG research underscores that samadhi, as a focused attention practice, modulates neural activity—through DMN downregulation and cortical phase-locking—to reduce self-referential processing and enhance sensory awareness.

Neural Activity and Associated Phenomenology of Vipassana

In contrast to samadhi, vipassana — an OM type practice[3,9] — is associated with unique neural signatures that support its insight-oriented nature, such as increased self-referential thought and heightened sensory awareness. fMRI research shows that DMN, or self-referential, activity is increased during insight problem solving (INPS)[10]; this means that DMN activity must be increased during vipassana as well. Vipassana ultimately aims to generate insights[2] via a sort of ontological inquiry of one's mind which can be seen as a sort of INPS. These insights are generated as nonjudgemental open awareness is ascribed to all phenomenological experience — as opposed to one-pointedness toward the breath in samadhi — to promote deconstruction of one's thought processes during vipassana[2]. Insight generation and inquiry into one's mental processes require an increase in self-referential thought[9] which explains why DMN activity is enhanced during vipassana.

This paragraph will demonstrate the importance of the superior temporal gyrus (STG) and orbitofrontal cortex (OFC) in generating heightened sensory awareness for insight generation. fMRI research shows that increased STG activation occurs with deconstructive practices, like

vipassana; furthermore, the STG is associated with INPS[10]. The STG is part of the salience network (SN) which is key for encoding salient external and internal sensory signals. Increased activation in this region parallels phenomenological descriptions of vipassana as enacting an attitude of open awareness to all incoming phenomena mandates awareness of all types of salient sensory signals. Furthermore, MRI data shows that OFC grey matter volume (GMV) in relation to emotional regulation[11] during deconstructive practices. Emotional regulation can be ascribed to heightened interoceptive awareness during vipassana as no specific object of meditative experience exists. This explains why the increase in the GMV of the OFC as this brain region is associated with self-monitoring and emotion-cognition[12]. Vipassana, a deconstructive meditation technique, has unique neural signatures — such as increased activation in the STG, OFC, and DMN — that highlight its insight-oriented nature, characterized by heightened self-referential thought and sensory awareness which collectively facilitate a deeper understanding of the mechanisms underlying phenomenal experience.

The Integration of Buddhism and the Neuroscience of Consciousness

Distinct fMRI and EEG data confirming phenomenological self-reports of samadhi and vipassana as distinct practices validates the structuring of consciousness research around Buddhist ideas while also demonstrating that Buddhism can bridge the gap between subjective descriptions of conscious experiences and objective neural correlates of consciousness. This section will explore the phenomenological systematization of samadhi through the Abhidharma lens and will then explore how this could be applied to the previously discussed neural correlates of samadhi.

Abhidharma is a systematization of Buddhist discourses that was developed to create an analytical lens through which to view Buddhist sentient experience[13]. The Abhidharmic systematization of

the jhana continuum and related jhana factors is one example of how Buddhism includes rich phenomenological descriptions of conscious states that can be used to structure consciousness research[1]. Jhana factors — Vitakka, Vicaara, Pitti, Sukha, Upekkha, Ekaggataa — are specific phenomenological components of the jhanas that fall away or appear (in the case of upekkha or equanimity) as one progresses through the jhanas. Each of these jhana factors can be paralleled to a scientific construct[1] which can inform the structure of neuroimaging research. Ekaggataa, or one-pointedness, can be understood as having one object as the sole feature of conscious experience. In the case of samadhi practice, this could take the form of attending to only the sensation of one's breath.

Neuroimaging can then provide empirical evidence to validate the presence of jhana factors, like ekaggataa, at specific time points in conscious meditative experience. The neural correlates of attending to only the breath would be cortical-phase locking in response to heightened sensory awareness and decreased activity of frontal DMN-associated brain regions due to less occurrence of self-referential though. Vipassana, and other OM practices, are less researched than FA practices[3]; however, analyzing the phenomenology and neural correlates of OM practices can prove to be just as valuable than consciousness research structured around FA practices. OM practices promote awareness of MW so the practitioner can engage in self-inquiry and potentially develop insight at a later point[9]; this structure is directly opposed to FA which aims to quiet MW. Therefore, increased activity and of brain regions associated with self-referential thought, the OFC and the DMN, during OM practices like vipassana is not surprising if we take a moment to understand the structure of these practices as described in Buddhism. By aligning Abhidharma's structured phenomenology—such as the jhana factors—with neuroscientific constructs, Buddhist frameworks not only guide the design of consciousness research but also gain empirical validation,

demonstrating how subjective descriptions of meditative states and their neural correlates mutually enrich our understanding of conscious experience.

Potential Critiques of Integrating Buddhism and the Neuroscience of Consciousness

It is important to note that Critics might argue that Buddhist phenomenological frameworks, such as the jhana factors, are too culturally specific or subjective to reliably inform neuroscientific research[14]. Skeptics could question whether first-person meditative reports—steeped in centuries of tradition—can be empirically validated without introducing interpretive bias. However, this critique overlooks the structured, replicable nature of practices like samadhi and vipassana, which are taught systematically across lineages and produce consistent phenomenological outcomes (e.g., jhana progression or insight states). Furthermore, neuroimaging tools like fMRI and EEG provide objective measures that correlate with these self-reported states (e.g., DMN suppression during samadhi or STG activation during vipassana), demonstrating that subjective Buddhist frameworks can generate falsifiable hypotheses. By grounding these traditions in testable neural correlates, Buddhism's phenomenological rigor aligns with scientific demands for reproducibility, bridging cultural specificity with universal neurocognitive mechanisms.

Conclusion

The integration of distinct Buddhist meditative practices like samadhi and vipassana into consciousness research offers a unique approach for linking subjective phenomenology with objective neural data in consciousness research. Samadhi, as a focused attention (FA) practice, aims to generate ekaggataa toward the object of meditative attention and is characterized by decreased self-referential thought and heightened sensory processing. In contrast, vipassana, an

open monitoring (OM) practice, elevates self-referential and salience network activity, aligning with nonjudgmental observation and self-inquiry for insight generation. Crucially, Buddhist frameworks such as the Abhidharma provide detailed phenomenological systematization that structure Buddhist ideas into testable hypotheses for neuroscientific investigation. Neuroimaging tools like fMRI, MRI, and EEG empirically validate these practices as having unique neural signatures, bridging experiential accounts of meditative practice with neuroimaging data. This symbiotic relationship legitimizes Buddhism as a resource for consciousness studies by linking subjective introspection and objective measurement. Future research leveraging this synergy could unravel deeper mysteries of consciousness, fostering dialogue that respects both the richness of meditative traditions and the rigor of scientific inquiry.

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