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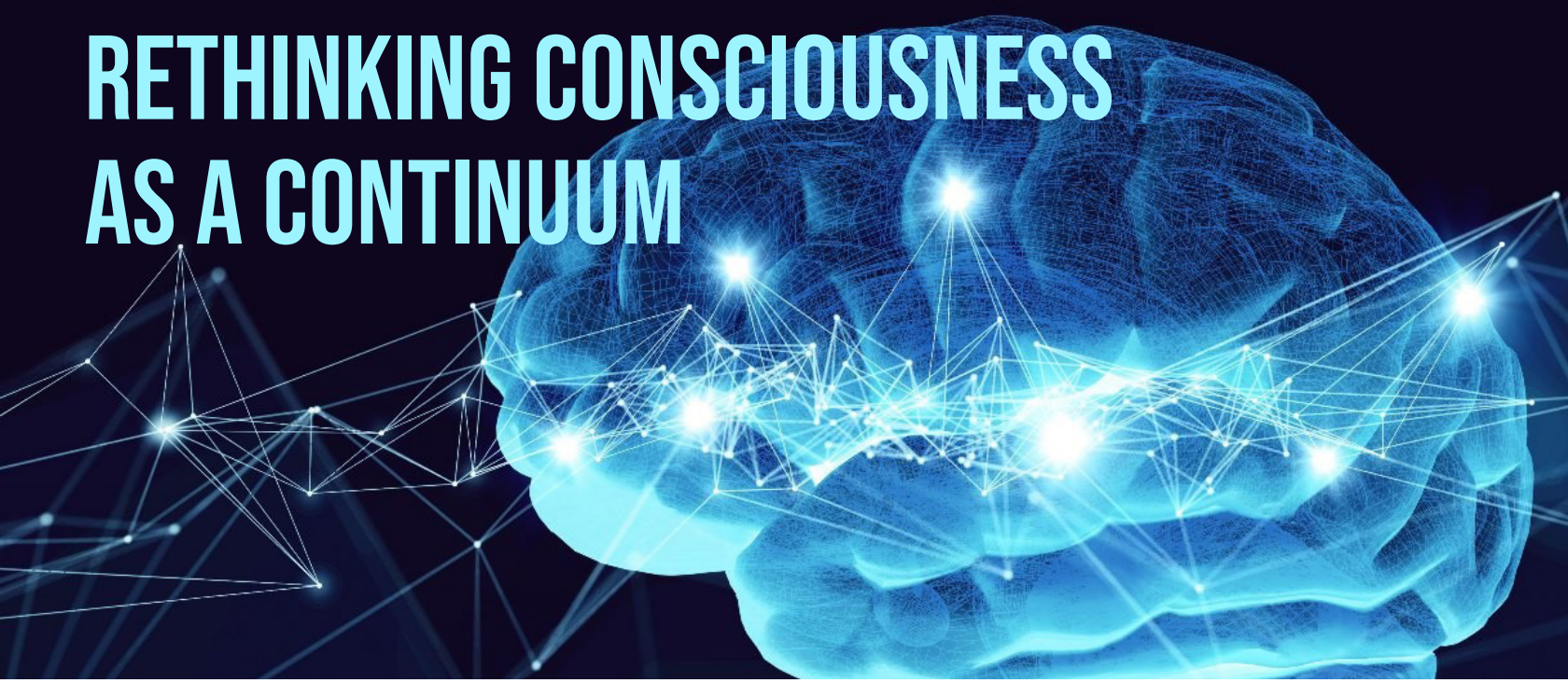
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TO BE OR NOT TO BE:
RETHINKING CONSCIOUSNESS AS A CONTINUUM

BY: EBRAR ORUC



INTRODUCTION

A patient lies motionless in a hospital bed. Their eyes are open, but they cannot speak. When a doctor asks if they can move their fingers, they can't. The patient is in a vegetative state—awake, but unaware. The question remains: have they lost consciousness?

We often speak of losing consciousness as though it drops away entirely; a switch that can be turned on and off. Someone is either awake or not; aware or not. We draw sharp boundaries between consciousness and unconsciousness, and medicine, law, and philosophy have long depended on this binary distinction.

Then, in 2006, a groundbreaking research study challenged this distinction.[1] A patient in a vegetative state was placed into an fMRI scanner and was told to imagine playing tennis. In healthy patients, such a task activates the supplementary motor area, a region in the brain involved in planning movement.[2] The patient in a vegetative state had the same region of her brain light up when asked to imagine playing tennis. Similarly, when asked to imagine walking through her house, her parahippocampal gyrus, associated with spatial navigation, lit up.[1] Her body remained still, but her brain responded.

THIS RAISES THE QUESTION:
IS CONSCIOUSNESS TRULY AN ON-AND-OFF SWITCH? OR DOES IT SHIFT ALONG A CONTINUUM?

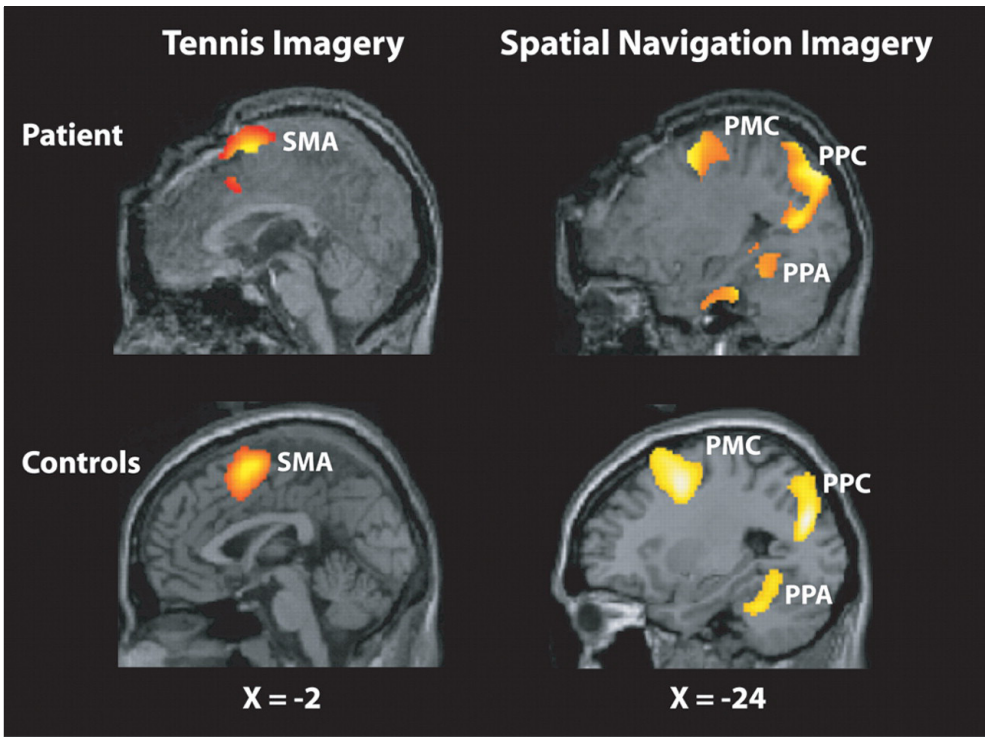


Figure 1. Comparison of brain activity in patient vs. controls. Supplementary motor area activity during tennis imagery was compared between the patient and a group of 12 healthy volunteers. Similar patterns of brain activity were observed in the patient and the controls.

MAPPING THE NEURAL CONTINUUM

Neuroscience has begun to map gradations across the continuum of consciousness, revealing that consciousness is not dependent on whether or not the brain is active, but rather it depends on how neural networks communicate.[3,4] Awareness is thought to arise from dynamic integration across distinct regions of the brain's cortex—the folded outer layer of gray matter plays an important role in consciousness, and the thalamus regulates information related to consciousness, sleep, alertness and sensory perception.[4] When communication between those regions becomes fragmented, simplified, or disrupted, consciousness begins to dim. When it becomes more flexible and interconnected, consciousness is associated with higher levels of awareness.

To study something as complex as consciousness, neuroscientists first had to make it measurable, separating it into two primary components: arousal and awareness.[4,5] Arousal refers to the degree of wakefulness and responsiveness to environmental stimuli maintained by the brainstem and thalamic systems.[4,5] Simply put, arousal encapsulates whether or not the brain is physiologically "on." On the other hand, awareness refers to the subjective, individual experience of thoughts, sensations, and the surrounding environment.[4,5] These two components are not always active at the same time. Thus, the boundary between consciousness and unconsciousness is often layered, dynamic, and a result of large-scale neural network connectivity and integration.

DIMINISHMENT: NEURAL DISORDERS OF CONSCIOUSNESS

Various disorders of consciousness have provided some of the strongest empirical evidence that consciousness exists along a spectrum rather than within a rigid binary. While historically, conditions such as coma, vegetative state, and minimally conscious state (MCS) were defined based on observable behavior, advancements in neuroimaging techniques have led to discoveries showing that behavioral unresponsiveness does not necessarily indicate the absence of consciousness.[6] Neuroscientists often study consciousness through neural correlates of consciousness (NCCs) which are specific patterns of brain activity that correspond to conscious experiences.[7] These are also thought of as the neural conditions sufficient for the manifestation of conscious awareness. Rather than localizing consciousness to one area of the brain, researchers have found that it emerges from distributed activity across neural networks such as thalamocortical communication and cortical integration (different regions of the cerebral cortex combining information to produce a unified perception) which links neural activity across multiple areas.[8]

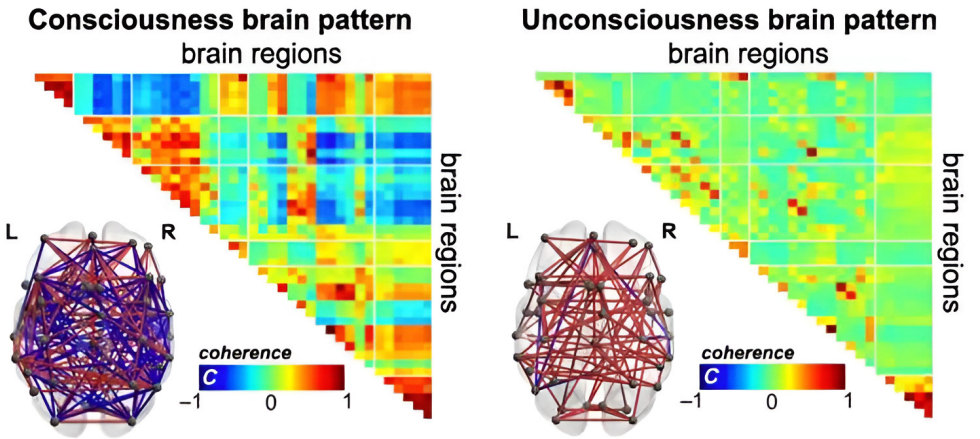


Figure 2. Brain connectivity in consciousness vs. unconsciousness. Red pixels indicate positive connections, while blue pixels indicate negative connections. In conscious individuals, brain patterns show both positive and negative connections while unconscious individuals show brain patterns that indicate less network connectivity.

At one end of the consciousness spectrum lies coma, clinically characterized by the absence of both arousal and awareness.[9] Comatose patients do not open their eyes, exhibit sleep-wake cycles, or respond to external stimuli.[9] Comas are associated with reduced cortical metabolism and disrupted thalamocortical connectivity which limits large-scale communication across the brain.10 Thus, the neural networks that support consciousness cannot sustain activity.[10]

Further up the spectrum lies the vegetative state, where patients regain arousal. This is evident in spontaneous eye opening and sleep-wake cycles.[11] However, patients in a vegetative state have no consistent behavioral signs of awareness which, for decades, was interpreted as a complete loss of consciousness.[11] It wasn't until a study conducted in 2006 that this assumption was challenged. A patient in a vegetative state was asked to perform mental imagery tasks, and activation was observed in areas such as the supplementary motor area and parahippocampal gyrus through fMRI.[1] This indicated that some patients in a vegetative state still have preserved brain activity despite a lack of observable motor output, indicating retained signs of consciousness.[1]

Between these two conditions lies MCS, where awareness can be detected but often inconsistently.[12] Patients are often able to follow simple commands and exhibit purposeful behavior intermittently.[12] Functional imaging studies have shown that MCS patients have partially preserved cortical connectivity which leads to fluctuating levels of consciousness.[13]

Locked-in syndrome arguably complicates the spectrum of consciousness the most. Commonly caused by severe damage to the brainstem, locked-in syndrome leaves patients fully conscious but unable to move or speak.[14] However, electroencephalography (EEG) and fMRI studies have revealed intact cortical activity.[14] In contrast to vegetative state, where patients may appear awake but show little to no evidence of awareness, individuals with locked-in syndrome are consciously aware yet externally unresponsive. Thus, patients have high levels of awareness and arousal (similar to a healthy individual) as the brain systems that support consciousness are still intact.[14] However, movement and speech depend on motor pathways in the brainstem that are damaged in patients with locked-in syndrome.[14] Locked-in syndrome demonstrates that consciousness can remain intact even when the body cannot produce outward behavioral responses, showing that a lack of visible movement or speech does not necessarily mean a lack of awareness.

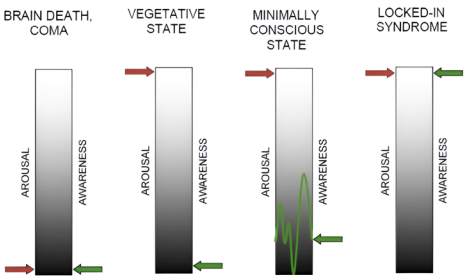


Figure 3. Comparison of two dimensions of consciousness (arousal and awareness) in various disorders of consciousness. In brain death and coma, both dimensions are absent; in vegetative state, arousal level is high while awareness is low; in MCS both dimensions are present (at different levels) despite inconsistent signs of behavioral awareness; in locked-in syndrome, both dimensions are present despite complete loss of speech and motor functions.

Such disorders are fundamental in understanding consciousness beyond external behavior, focusing on the organization and connectivity of neural networks that unfold along a clinical gradient rather than a binary divide.

ACTIVATION: REORGANIZATION OF CONSCIOUSNESS

While disorders of consciousness illustrate a diminishment of consciousness, altered states reflect a transformation of consciousness through changes or reorganizations of perception, cognition, and sense of self.

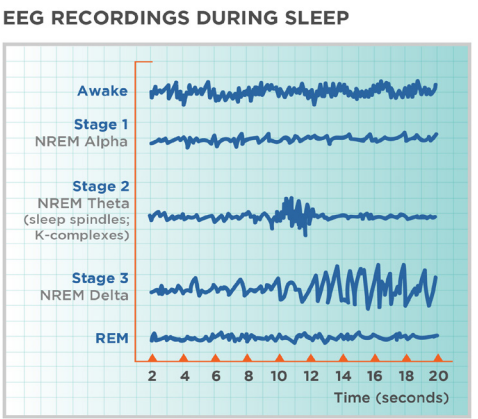


Figure 4. Comparison of brain activity during non-REM sleep and REM sleep. The three stages of non-REM consist of synchronized brain activity that moves from high-frequency, low-voltage waves in stage 1 (light sleep) to low-frequency, high-voltage delta waves in stage 3 (slow-wave sleep). In comparison, brain activity during REM sleep is similar to that of wakefulness.

Sleep is a well-documented example of these reorganizations. During deep, non-REM sleep, EEG studies show brain activity associated with minimal awareness and reduced neural activity.[14] During REM sleep, EEG studies show, despite low responsiveness to external stimuli, the brain exhibits high-frequency activity similar to that of an awake individual, suggesting that conscious-like awareness can persist even when external awareness does not.[14]

Psychedelic states provide further insight into the flexibility of consciousness. Magnetoencephalography (MEG) and fMRI studies have shown that substances such as psilocybin increase the unpredictability of brain activity leading to reduced activity in the brain's default mode network (DMN), a system associated with self-reflexive thought and increased connectivity across brain regions.[15] Individuals often report a distorted sense of time, lack of boundaries between the self and external environment, and altered perception, suggesting the possibility that consciousness may expand in complexity—increased variability and diversity in brain activity and elevated communication across neural networks—beyond "normal" states of consciousness.[15] Rather than a simple increase or decrease in consciousness, neural changes under psychedelic states suggest a reorganization of the structure of consciousness. For example, while processing related to the self may diminish with reduced DMN activity, sensory processing and cross-cortical communication often expand, producing a neural state that isn't necessarily "more" or "less" conscious, but differently organized. Psychedelic states support a multi-dimensional model of consciousness where distinct aspects of consciousness can shift independently on a continuum rather than across a binary.

Across such states, consciousness doesn't just shift from increasing or decreasing, but rather it reorganizes. Changes in neural connectivity and complexity result in a multitude of consciousness experiences, shifting consciousness from a single axis to along multiple dimensions.

CONCLUSION: A SWITCH OR A SHIFT?

Understanding consciousness as a continuum rather than as a binary has significant implications, particularly in clinical and ethical settings. In medical settings, diagnoses of consciousness disorders often inform decisions about treatment and long-term care. Studies suggest a notable proportion of patients may regain consciousness, with signs only detectable through neuroimaging, raising concerns about potential misdiagnosis and the limitations of behavioral assessments.

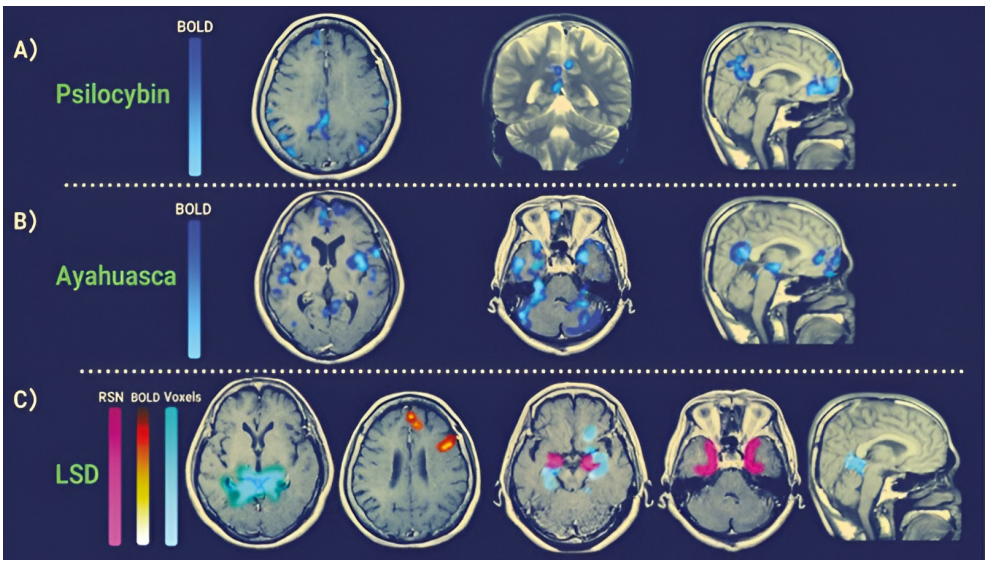


Figure 5. fMRI activity patterns of various psychedelics on regions of the DMN. Blue BOLD (Blood-Oxygenation-Level-Dependent) signals indicate significant brain deactivations and decreases of the DMN due to psilocybin and Ayahuasca. Orange represents increases in functional connectivity between the bilateral hippocampal seed (a key DMN node) and the parahippocampus while turquoise represents a decrease in connectivity due to LSD. Pink represents a mask of the parahippocampal gyrus to help compare and contrast the activity patterns between the three psychedelics featured.

The absence of a response cannot be taken as definitive evidence of absence of experience.[16] This raises difficult ethical questions: What does it mean if someone is neurologically conscious but unable to communicate? How should clinicians assess quality of life in such patients? How should discussions surrounding life support, rehabilitation, and patient autonomy be shaped when consciousness is understood as a continuum? Consciousness is one of the most complex topics in neuroscience and philosophy, with scholars attempting to define it across centuries.

Rather than something an individual can simply have or not have, consciousness is a dynamic process continually shifting in intensity, structure, and experience.

BUT THE BEAUTY OF CONSCIOUSNESS REMAINS IN ITS INABILITY TO BE CLEANLY DEFINED.

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