

# **Unresponsive but not necessarily unconscious: An introduction to the Special Focus**

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A growing body of evidence from empirical research reveals that humans may be outwardly unresponsive but still experience episodes of *disconnected consciousness* (e.g., Darracq et al., 2018; Martial et al., 2020a; Sanders et al., 2012). *Disconnected consciousness* refers to the mental experience of events, in the absence of concurrent awareness of the sensory environment, while in an outwardly unresponsive state (Martial et al., 2020a; Sanders et al., 2012). This construct is distinct from everyday examples of *internal awareness*, such as mental imagery, inner speech, or mind-wandering, because these need to entail either disconnection from the outside world or unresponsiveness. Canonical examples include dreaming during sleep (Baird et al., 2019; Siclari et al., 2014) or during clinical states, such as general anesthesia or cardiac arrest (Bonhomme et al., 2019; Martial et al., 2020a; Sanders et al., 2012). Indeed, it is increasingly being recognized that episodes of disconnected consciousness may arise in various contexts and conditions in which the individual is unresponsive or outwardly unresponsive (i.e., spontaneous or stimuli-induced responsiveness may still occur), which may vary in terms of wakefulness levels. A few examples are dream-like experiences reported upon awakening from general anesthesia (Mashour, 2011; Radek et al., 2018), epilepsy seizures (Picard & Friston, 2014), meditation (Brandmeyer et al., 2019; Martial et al., 2020b), hypnosis (Timmermann et al., 2022), trance (Gosseries et al., 2020; Martial et al., 2020b), and life-threatening situations (e.g., coma; Martial et al., 2020a). If a series of specific prototypical features such as out-of-body experience or seeing a bright light arise during an episode of disconnected consciousness after a life-threatening situation, we may call them *near-death experiences* (Martial et al., 2020a; 2020b).

These episodes of disconnected consciousness can be accompanied with some fragments of (disturbed or limited) connection to the environment, the latter indicating an experience of *connectedness* (Martial et al., 2020a; Sanders et al., 2012). This may occur in the context of general anesthesia for example when people anecdotally report upon awakening the perception of some external stimuli from the period of general anesthesia, on top of a dream (e.g., Lopez et al., 2006). In parallel, it is now known that some psychedelic drugs such as ayahuasca and N,N-Dimethyltryptamine (DMT) may induce an immersive altered state of consciousness with vivid and complex imagery and a sense of entering an alternative reality (Timmermann et al., 2023). These hallucinations may be considered as episodes of disconnected consciousness when they are not associated with the perception of the environment, that is, when they refer to perception of non-real-life-based events.

This emerging field of research recently has started to grow from clinical observations, notably collected in the context of general anesthesia (e.g., Gyulaházi et al., 2016) and near-death situations (e.g., Rousseau et al., 2023). Yet it was soon realized that basic science carried out in controlled experimental settings was also essential given the unpredictable occurrence of these episodes, and the fact that these events are explicitly recalled and inherently relied on memory. Further empirical studies using rigorous methodology are needed, notably to assess subjective experiences reported upon awakening with objective measures, and to investigate the neural mechanisms of such states.

The subjective reports of disconnected consciousness suggest that underlying neural mechanisms of conscious experience should be distinct from the ones allowing the integration of the external stimuli (i.e., connectedness). Research shows that corticocortical connections at the back of the brain may be required to produce conscious experience such as dreaming (Boly et al., 2017), but the neurophysiological mechanisms by which external stimuli are blocked from further processing within episodes of disconnected consciousness are still unknown. Collecting a great deal of new data will inform our understanding of the neurophysiological mechanisms associated with (the experience of self in) disconnected consciousness. More generally, studying states of disconnected consciousness, including how the experience of self may be disturbed or limited and how the process of dissociation operates in such states, is one of the most interesting ways to study the broader construct of human consciousness. Furthermore, studies have already compared and highlighted substantial overlaps between these different states (e.g., Timmermann et al., 2018, 2022). Ultimately, the findings of this field of research could be used in everyday clinical practice, whether in resuscitation rooms, operating rooms, or elsewhere. It is nevertheless worth mentioning that since this terminology is still recent, it may certainly influence the way scientists approach the evaluation of these episodes, frame their research questions and conceive their methodology.

Multiple recent lines of evidence suggest that episodes of disconnected consciousness may arise in varying contexts and conditions. Accordingly, the articles in this Special Focus on *the Experience of Self and its Boundaries within the Scope of Disconnected Consciousness* are intended to showcase research on disconnected consciousness in four classical non-ordinary states of consciousness in which episodes of disconnected consciousness may occur: ecstatic epilepsy, hypnosis, out-of-body experience, and ayahuasca drug intake. In accordance with the *Journal of Cognitive Neuroscience*'s emphasis on basic science, the articles of this Special Focus present findings from neuroscience, but also from clinical and behavioral studies. Picard (2023) gives an

overview of the phenomenological characteristics and the neurocognitive underpinnings of the ecstatic experience induced by epileptic seizure resulting in rich disconnected consciousness. Next, Ramaekers and colleagues (2023) relate the subjective ratings of the experience of ego dissolution, as well as some other characteristics of the psychedelic experiences induced by ayahuasca (e.g., the feeling of oceanic boundlessness) to peak DMT concentrations in serum. This work extends existing evidence that the primary phenomenological characteristics of ayahuasca may be driven by DMT (Riba et al., 2003). Next, Panda and colleagues (2023) show that hypnosis is associated with two distinct patterns in measures of brain connectivity: decreases in the alpha and beta bands in fronto-midline regions; and an increase in the delta band in fronto-parietal regions. Some networks also became richer during hypnosis, with a reconfiguration of network segregation and integration in low and high frequency bands. The authors consider how these findings may relate to the decrease of external awareness and dissociation from the environment characteristic of this state. Finally, Martial and colleagues (2023) introduced a procedure for studying the electrical brain activity of healthy participants associated to the subjective experiences induced by a virtual reality scenario acting out an out-of-body experience in laboratory settings. They notably revealed an increase of relative power in the delta band and a decrease of relative power in the alpha band, compared to baseline resting state. This finding supports the recent empirical literature revealing a prominent role of delta activity during particular conscious states, such as psychedelic states (Frohlich et al., 2021; Timmermann et al., 2023). These four studies help understand the phenomenology and the neural mechanisms through which an experience of dissociation, sometimes leading to rich episodes of disconnected consciousness, may emerge.

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