UPDATE

Covert consciousness: what's in a name?

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Abstract

Over the past decade, it has become apparent that up to 25% of behaviorally unresponsive patients with acute or chronic disorders of consciousness either reveal high spatio-temporal complexity following a direct electrical or magnetic pulse to the brain, or highly differentiated electroencephalographic responses, or can, voluntarily modulate their brain activity on command, each of which has been interpreted, to varying degrees, as evidence of consciousness. Practitioners designate this phenomenon using a dizzying variety of terms. The realization that *unresponsiveness* does not equate to *unconsciousness* changes the way patients should be assessed and how the medical team communicates with the patient, their families and the world at large. We here propose that the term *covert consciousness* be used in all such communications to designate this subcategory of behavioral unresponsive patients, with context-appropriate qualifiers and counseling accompanying its use.

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Introduction

'What is essential is invisible to the eye.' From *The Little Prince* by Antoine de Saint-Exupéry.

The central aspect of life is consciousness, for without it we are nothing to ourselves, as in dreamless sleep. To be conscious is to feel like something, whether that is to be in love, angry,

bored, in pain, dreaming, fearing, imagining, remembering, seeing, hearing, and on and on. Closely related, if not identical, concepts include subjective experience, awareness, phenomenology, the mental. How to integrate consciousness into the scientific worldview remains a fiercely contested question that goes back to Aristotle, if not earlier.

As René Descartes famously concluded, our own consciousness is indubitable, for in doubting it, we affirm it. However, given the private, first-person aspect of experience, determining that others are conscious is *always* an abduction, a likely explanation of all facts, a powerful form of probabilistic reasoning widespread in science, law, and medicine. Ontological solipsism, the belief that only I am conscious, is logically impossible to conclusively refute. It would, however, require one psycho-physical law to explain why my brain appears to subserve my conscious mind, and a different law for everyone else, to explain why they, with very similar brains to mine, are not conscious. This is extremely unlikely.

Consciousness and Behavior – It's Complicated

We infer that other people are conscious because they can directly tell us about their state of mind. We ask, "How do you feel?", and they answer appropriately. This inference becomes more challenging in babies and young children, unresponsive patients, and in non-human animals, where other considerations become relevant, such as similarity in behavior or in underlying brain circuits, or a close evolutionary relationship.

However, the usual association between consciousness and behavior in neurotypical individuals can come apart in either of two ways.[1,2]

On the one hand, many behaviors, foremost rapid and/or stereotyped ones such as some eye-movements or posture adjustments, may bypass consciousness altogether. This is particularly true for *reflexes* that involve spinal cord and/or brainstem circuits, such as blinking, coughing, sneezing, or being startled, but may also involve cortical activity. Milner and Goodale[3] identified two cortical visuo-motor systems: vision-for-perception and vision-for-action. The former is involved in visual consciousness and object recognition while the latter is focused on action and may not involve visual experience, as illustrated by unconscious processing of visual

stimuli in neglect.[4] *Blindsight* is a rare condition during which patients with visual cortex lesions reach out or fixate objects that they deny consciously seeing.[5] Thus, sensory processing *per se* may not necessarily constitute evidence for consciousness.

On the other hand, vivid experiences can occur without overt, externally directed behaviors. Every night while we dream, a form of consciousness distinct from waking consciousness, most voluntary muscles, except for rapid eye movements, are actively shut down (sleep atonia). Unusual experiences, such as pure presence, are the endpoints of many meditative traditions, when the meditator remains immobile for long stretches on their cushion, or during non-ordinary states of consciousness, such as with psychedelics. The associated experiences, including near-death and mystical experiences, are considered by subjects to be among the most meaningful of their lives.[6]

That is, consciousness is primarily about *being* and not about *doing*.

An empirical science of consciousness emerged in the closing decades of the last millennium, focused on tracking the neuronal footprints of consciousness in humans and related mammalian species.[7] The distinction between being and doing is reflected in the cognitive neuroscience community by research using the *no-report* paradigm.[8] As in a canonical psychophysical experiment, on most trials, subjects perceive a stimulus and push a button to report, say, its orientation (if the stimulus is a grating). On a minority of trials, subjects are confronted by the identical stimulus but without the need to report ("just look and see!"). This seemingly small modification has a profound effect on the underlying neural footprints that become more circumscribed.[9–11]

In parallel, advances in the clinical arts and in resuscitation technologies and infrastructure enabled patients with severe brain injuries due to cardiac arrest, traumatic brain injury, stroke, or opioid overdose, to survive. Following a series of landmark monographs and consensus papers,[12–14] patients with disorders of consciousness (DoC) are considered to fall within a spectrum of syndromes, ranging from *coma*, a state of unresponsiveness with closed eyes but some intact brainstem reflexes, to *vegetative state* (VS) with higher arousal and, usually, preserved sleep-wake cycle, to the minimally conscious state (MCS) with an often-fluctuating ability to track objects with eyes, localize painful stimulation, or purposefully move limbs (MCS-) or evidence of preserved language skills such as following a spoken command (MCS+).

Critical was the recognition by Plum and Posner[14] that high arousal can be dissociated from awareness of self and environment in VS, for which the unresponsive wakefulness syndrome (UWS) has been proposed as an alternative label.[15]

DoC can manifest acutely or chronically, potentially for years and often changes over time, as the underlying condition progresses or remits. Such patients are evaluated using standardized assessment scales based on simple eye, limb or other movements, the most common being the *Glasgow Coma Scale* (GCS), the *Full Outline of UnResponsiveness Score* (FOUR), and the *Coma Recovery Scale-Revised* (CRS-R). Patients in MCS are considered conscious to the extent that they follow simple commands or demonstrate purposeful movements, such as tracking with their eyes or orienting to a source of pain, while patients in coma and VS/UWS are assumed to be unconscious.

Coma is not an etiological diagnosis and is therefore not readily identifiable in electronic medical records or billing codes. A thorough crowd-sourcing study estimated that the annual incidence of coma (of any duration requiring admission to the ICU) in the US was a staggering 850,000 patients.[16]

Consciousness beyond unresponsiveness

Brain injuries impairing executive or motor functions can prevent conscious patients from moving deliberately, leading to significant underreporting of residual consciousness. A famous instance of such a dissociation was a behaviorally unresponsive patient,[17] with a traumatic brain injury that had occurred five months earlier, who was asked to imagine walking around her house or playing tennis while undergoing functional magnetic resonance imaging (fMRI). Remarkably, she evinced strikingly similar patterns of cortical modulation as healthy neurotypical volunteers. A follow-up study confirmed that of 54 patients with DoC, five could willfully, and repeatedly, modulate their brain activity, with one even answering simple yes/no questions in this manner in the MRI scanner.[18] Other studies use electroencephalography (EEG) to detect the brain signals associated with motor imagery in the absence of any overt movement or speech.[19] Around 25% of both acute and chronic patients with DoC who cannot speak or communicate can willfully and repeatedly modulate their brain activity, measured by either fMRI or EEG, in response to verbal commands.[20]

Two decades ago, Schiff and colleagues[21] presented auditory narratives to two MCS patients, eliciting cortical activity in the superior and middle temporal gyrus, in line with healthy subjects. Other stimuli include patients' name, music, and emotionally engaging narratives from movie scenes.[22,23] Recognizing that some patients who are conscious may nonetheless be unable to, overtly or covertly, follow commands given the relatively high cognitive demands of active paradigms (including vigilance, selective attention, language comprehension, short term memory, and motivation), less demanding paradigms such as passive fMRI and EEG-based tasks (e.g., involving language/music listening) are under investigation; the preservation of these responses can provide varying degrees of evidence for the presence of covert consciousness.[24] Behavioral evaluations can be improved by searching for other potential indicators of consciousness, such as resistance to eye opening or changes in pupil size.[25,26]

The processing of visual or auditory stimuli can be impaired after brain injury, as can attentional and memory resources, and motor commands. This mandates biomarkers of consciousness independent of sensory inputs, executive functions, and motor outputs, by directly probing brain activity. DoC patients have been assessed using resting state fMRI connectivity,[27,28] multivariate EEG classifiers based on evoked or spontaneous EEG recordings,[29,30] PET measurements of cerebral glucose metabolic state,[31] or causal, spatio-temporal complexity.[32] The perturbational complexity index (PCI), motivated by the theoretical principle that the physical substrate of consciousness must be at once highly integrated and differentiated, grounds another prominent assessment method.[33] This is tested by perturbing cortico-thalamic circuits using a brief pulse delivered through the skull via a magnetic coil (transcranial magnetic stimulation or TMS) and quantifying the complexity of the resultant evoked potential recorded by EEG. Brain complexity is high in healthy volunteers who are awake, in REM sleep, during dissociative ketamine states, in overtly conscious patients with localized brain injuries, and in patients with locked-in-syndrome (100% sensitivity).[28] PCI is low in volunteers who are in deep sleep or deeply anesthetized (100% specificity). Notably, when applied to MCS patients, TMS-EEG has a 5% false negative rate,[28] compared to the 62% false negative rate of task-based fMRI and/or EEG.[17] In unresponsive patients (VS/UWS), PCI detects high levels of complexity in about 20% of patients,[34] consistent with the incidence of covert command-following, as detected by task-based fMRI or EEG.[17] Like spontaneous EEG classification, TMS-EEG does not depend on the patient's ability to hear, understand and execute

instructions, as it directly probes the aroused brain, yet with a high sensitivity and specificity. Ongoing experiments seek to clarify the overlap among patients with high brain complexity, and those with preserved ability to voluntarily modulate their brain activity in motor imagery tasks. Each of these testing paradigms demand further study to determine comparative and combined sensitivities, specificities and reliabilities, coupled with effort to reconcile potentially discordant results. A multimodal, tiered assessment strategy may ultimately offer the most accurate, reliable and clinically feasible approach.[35,36]

Detecting consciousness is good news as the prognosis for meaningful functional recovery is much higher than in those without such evidence.[19,37] Furthermore, our growing ability to decode volitional brain activity can be exploited to enable the stranded mind to communicate with the outside via brain-machine interfaces. Finally, knowing that a patient is *present* has enormous implications for one of the gravest decisions the family and the team caring for the patient is called upon to make – whether to continue or limit life-sustaining therapy. Currently, four out of five patients with acute DoC die following withdrawal of life-sustaining treatment.[38] These decisions are often predicated on incomplete information: growing evidence indicates that a substantial proportion could have recovered consciousness and functional independence if life-sustaining treatments were continued.[38,39]

What's in a Name?

Various terms, not necessarily synonymous, describe patients who can imagine moving or speaking without being able to do so, who show specific cortical responses to visual or linguistic stimuli or who have high brain complexity. These terms include (CMD), motor dissociation, covert awareness, covert cognition, covert consciousness, functional locked-in syndrome, non-behavioral MCS, MCS*, cortically mediated state (CMS), covert cortical processing, covert brain complexity, and others.

All these designations have their well-justified rationales. However, as we expand on below, the failure to converge on a single term to describe closely overlapping phenomena is problematic for clinical reasons, such as tracking the incidence and prevalence of these states, and counterproductive when engaging the wider public outside the clinic.

What is probed for in an unresponsive patient, given the exigencies of the clinic and the limitations of our tools, is the presence of consciousness. Does it feel like something to be this patient? Today, this question cannot be answered with certainty and thus requires diagnostic humility.[2,39,40]

Different techniques have different sensitivities (true positive rate) and specificities (true negative rate) – someone who passes a fMRI or EEG motor imagery test is likely conscious while a patient who does not may be conscious but unable to process the task instructions or lack the cognitive resources required for engaging with this task. Indeed, only 75-85% of overtly conscious individuals have positive motor imagery tests as these require sustained attention.[41,42]

Given the complex, often ambiguous and fluctuating relationship between arousal, consciousness, and behavior in brain-injured patients, it is critical for the clinical community to be clear about what is being assessed and for what purpose. It is also important to align the phenomenon being diagnosed with what is being communicated to families and caretakers and trumpeted in press releases and videos meant for the public. These overwhelmingly use 'consciousness', as compared to any other word, such as 'awareness'. Consciousness also encompasses a broader range of subjective experiences, including self-consciousness, than awareness, which is why we think 'covert awareness' is less useful than 'covert consciousness'. The terms 'non-behavioral MCS' and 'MCS*' are likewise problematic insofar as they imply that a patient's consciousness is minimal, when testing can only reveal that overt behavioral responsiveness is minimal, leaving open the possibility that consciousness may be more intact than the term implies. This misalignment can mislead clinicians, scientists, families, and the public who may misinterpret such terms as suggesting liminality of a patient's internal experience, when in fact these may be preserved, something current bedside tools are not well-equipped to assess. On the other hand, reductive alternatives may falter in meaningfully delineating the condition at hand, guiding clinical reasoning, or informing families.

Thus, the attendees of a recent workshop on "Disorders of Consciousness" of the *Neuroscience School of Advanced Studies* in Crans-Montana, Switzerland, propose that clinicians consistently use 'covert consciousness' in their communications as the more all-encompassing term for what people care about most when assessing patients.

This proposed label would only apply to patients who show no behavioral signs of consciousness. That is, it would not apply to patients with MCS-, MSC+ or locked-in-syndrome but would identify a subset of patients in coma and VS/UWS as having covert consciousness. This is important for both diagnostic and therapeutic purposes; furthermore, these patients might well benefit from specialized treatment. As our ability to probe and record from the brain in health and disease improves, we become better at discerning subgroups of patients based on specific techniques, driving clinical progress. As a notable analogy, molecular diagnostic using transcriptional profiling of single cells enhances rather than supersedes the way brain tumors are classified via extant histological and immunohistochemical characteristics.[43]

The adjective 'covert' does not imply that consciousness in this state has lesser content or is of a more restricted variety than 'overt' or everyday consciousness. Instead, it conveys the notion that consciousness is hidden from bedside observers. Communicating 'covert consciousness' also does not preclude the use of other terms to circumscribe the specific techniques used to make this inference, or of diagnostic qualifiers.

Next steps would be to work with national and international standard setting bodies, such as the WHO's *International Classification of Diseases*, to achieve a consensus on this diagnosis, such that the incidence and prevalence of *covert consciousness* can be tracked across geography and time.

Our overriding goal with this proposal is to enhance terminological clarity for bedside decision-makers and families. In clinical meetings and family meetings, we routinely see surrogates and often clinicians struggle with labels such as CMD, CMS, MCS*. The surface meaning of these terms is not clear to family members, and only slightly less so to most clinicians.[44] The family primarily focus on one question "Is my loved one / my patient conscious?" And they need a plain-language answer, that can then be tailored as needed with qualifiers about confidence, mechanism, or prognosis. Our proposal thus submits the intelligible umbrella term, 'covert consciousness', that can be used in initial conversations, with the understanding that finer grained distinctions and sub-stratifications can follow as appropriate. A tiered approach, which may include qualifiers such as possible/probable/indeterminate, and descriptive language about the testing modality used to arrive at the diagnostic assessment, avoids over- and under-ascription while retaining appropriate gradations. Such a classification

system can sit comfortably alongside existing constructs while offering a family- and clinician-friendly communication strategy.

The landscape of tools to diagnose covert consciousness is evolving rapidly; thus, we also suggest that this designation should trigger an interdisciplinary case conference (neurology, neuro rehab, radiology/electrophysiology, ethics and where relevant spiritual care) to plan and safeguard communication and cognate care planning. Given the expanding range of assessment techniques (including resting-state, stimulus-driven, task-based, behavioral approaches), future work might prioritize constructing a tiered, clinically practical multimodal framework that integrates available testing approaches, and rigorously quantifies individual and composite positive and negative predictive values toward advancing epistemic robustness, clinical utility and feasibility.

The realization that *unresponsiveness* does not equate with *unconsciousness* changes the way brain-injured patients are assessed and how the medical team communicates with the patient, their families and the world at large.[44] If we were responsive yet unconscious, like a philosopher's zombie, we would be nothing to ourselves. Being conscious is what we value the most. The gravity of this situation should be reflected in the language clinicians use to describe what they are inferring – consciousness *tout court*.

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C.K. holds an executive position, and C.K. and M.M. have a financial interest in *Intrinsic Powers, Inc.*, a company whose purpose is to develop a device to assess the presence of consciousness.

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