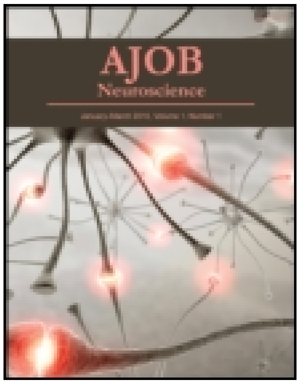

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Ethics, Neuroimaging and Disorders of Consciousness: What Is the Question?

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Editorial

Ethics, Neuroimaging and Disorders of Consciousness: What Is the Question?

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Antoine de Saint-Exupery once wrote that "the machine" plunges man deeply into the great problems of nature. While he was reflecting over the technology of flight, in this issue of *AJOB Neuroscience,* two contributions focus on the extent to which brain imaging technologies are plunging us deeply into the study of mental life after severe brain injury, and the ethical implications of this newly found knowledge.

In the past decade and a half, neuroimaging techniques such as positron emission tomography (PET), functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) have contributed enormously to shaping our understanding of conditions such as the Vegetative State (VS) and the Minimally Conscious State (MCS). Collectively, the contribution of brain imaging technology to our understanding of these conditions has been at least three-fold. First, neuroimaging studies have clearly shown that the vegetative state is not an apallic syndrome (i.e., without a pallium, or cortex), despite the fact that that the two terms were often used interchangeably. Rather, extensive and relatively complex cortical processing can still take place in response to noxious stimulation, sounds, speech and non-speech sequences, as well as visual stimuli (see Monti 2012, for a comprehensive review). Of course, in the absence of a state of consciousness, this cortical processing is understood to be insufficient to give rise to the subjective feeling of perception. So unconscious, yes, but not *just* vegetative. The second main contribution of brain imaging to this field was the demonstration, by Owen and colleagues (2006), that operationalizing consciousness as the presence of voluntary, interactive, behavior—as done in standard bedside clinical assessments—is prone to false negatives. For, while the presence of non-reflexive behavior is sufficient to allow inferring the presence of a state of consciousness, inferring the absence of consciousness from the absence of non-reflexive behavior is a logical fallacy. In other words, absence of evidence is not evidence of absence (an issue that, in this context, had already been raised in the 1994 guidelines by the Multi-Society Task Force on PVS). Thus, the case of a patient who appeared non-responsive during bedside examinations but could nonetheless voluntarily engage in specific mental activities (e.g., imagining playing tennis), as detected with fMRI, made the probabilistic nature of VS diagnoses extremely salient, and opened up the possibility of integrating standard behavioral protocols with neuroimaging assessments. Finally, this newfound ability of a small number of patients to voluntarily modulate their brain activity was harnessed into a form of simple binary communication (Monti et al. 2010; Bardin et al. 2011), paving the road for the development of more sophisticated brain-computer interfaces which might return to some patients the ability to interact with their environment, communicate their thoughts, and participate in the clinical decision-making process.

As science and technology take strides, rapidly advancing our understanding of brain function after severe injury, several difficult questions arise concerning the clinical, legal and ethical management of these patients. In particular, as novel technologies develop further, it becomes important to fully assess their potential as well as the agenda motivating their use. In this issue of *AJOB Neuroscience*, Fischer and Truog (2013) reflect over the contributions of neuroimaging in this context, and propose a novel (if cryptic) nomenclature distinguishing subcategories of patients suffering from disorders of consciousness. First, they distinguish two types of minimally conscious patients; namely, MCS3, which includes patients who can demonstrate some level of consciousness by producing voluntary motor behavior, and MCS2, which refers to patients who cannot demonstrate any level of consciousness *via* motor responses, but can voluntarily modulate their own brain activity in a fashion that can be observed and recognized with neuroimaging. On the one hand, this distinction reminds us of the limitations of our current understanding of consciousness, and distinguishes between patients for whom standard bedside tools are a viable mode of interaction (e.g., blinking or pressing a buzzer in response to a question) from patients for whom brain–computer interfaces might be applicable. On the other hand, however, this distinction is entirely irrelevant "*insofar as ethical management [of these patients] is dictated by the presence or absence of consciousness*" (Fischer and Truog 2013, 7). From this point of view, with the understanding that the validity and sensitivity of our

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techniques should never be taken for granted, whether a patient can exhibit consciousness *via* purposeful motor behavior or voluntary brain activity is no more important than whether a patient demonstrates interactive behavior during a CRS-R (Coma Recovery Scale-Revised) or a SMART (Sensory Modality Assessment and Rehabilitation Technique) assessment. Once it is accepted that, under some non-trivial conditions, neuroimaging can reveal purposeful brain responses, drawing a distinction between MCS2 and MCS3 is irrelevant with respect to the issue of what role a patient might be granted *vis-à-vis* clinical, legal and ethical decision making (if not with respect to the practical side of how to enable a patient to participate). If anything, this distinction further encourages an unproductive and unnecessary antagonism between techniques that should be seen as complementary. In addition to the two categories above, Fischer and Truog, also distinguish VS patients from MCS1 patients, which is to say patients who lack consciousness, from patients who retain some level of consciousness but are unable to demonstrate so by behavioral, neuroimaging, or any other technique presently available. This distinction is theoretically very important, but, in the context of their writing, appears to serve the main purpose of further placing in opposition neuroimaging and clinical methods. As the authors state, "*[the] inability to definitively diagnose unconsciousness complicates the finding from the fMRI studies*" (29), which is correct (as demonstrated by Bardin et al. 2011) but applies equally to behavioral assessments (as demonstrated by Owen et al. 2006, among several others). Similarly, Fischer and colleagues point out the large number of assumptions that must be met for a patient to be able to respond to a question by willfully engaging in a specified mental activity (e.g., imagining playing tennis). For example, a patient must be able to "*hear a question, know the language, extract the semantic content of that question, remember the concepts referenced in the question [..], and then deliberately [engage in the mental activity]*" (29). Yet, Fisher and Truog fail to point out that asking a patient to respond to a question by, say, blinking twice for "yes" and once for "no" makes all the same assumptions, but for replacing "mental activity" with "motor behavior." It just seems inescapable that, crippled by our lack of understanding of how consciousness arises in the human brain, different methodologies might suffer from a number of very similar constraints.

In the face of limited time and resources, establishing which tools are the most efficient, effective and reliable at detecting consciousness is extremely important. In the broader clinical, scientific, legal and ethical context, however, the question that needs answering is "which cognitive processes can we observe, and therefore ascribe, to a patient suffering from disorders of consciousness?" One of the most significant contributions that neuroimaging and behavioral assessments can provide to this field is the ability to reveal the extent, and perhaps someday the quality, of mental life a patient might retain, a *conditio sine qua non* for society to make any informed decision concerning medical care, legal status and ethical management. Bruno and colleagues (2011), for example, refine the standard nomenclature by distinguishing patients who exhibit relatively complex interactive behavior (e.g., response to command; MCS+) from patients exhibiting limited non-reflexive behavior (e.g., orientation to painful stimulation; MCS-). Similarly, Peterson and colleagues (2013), also in this issue of *AJOB Neuroscience*, discuss the possibility of employing neuroimaging to evaluate whether a conscious but behaviorally non-responsive patient might possess sufficient mental abilities to meet the criteria necessary for establishing decision making capacity (i.e., understanding, appreciation, reasoning and communication). Although it is understood that several other crucial issues must be carefully evaluated, including co-morbidities such as depression, as well as the legal requirements concerning competence, it might well be possible in the future for a patient to participate, *via* brain-computer interfaces, in the medical decision-making process. For this approach to be a viable strategy, it is necessary that we exploit neuroimaging techniques to assess whether a patient might be in a position to participate.

As our scientific understanding of the human brain progresses, and technology turns into clinical practice, one of our main endeavors must be to employ all of the tools available to abandon the false binary view that a "*patient is either in an immutable state of permanent unconsciousness or has a heartwrenchingly normal inner life*" in favor of a rich description of continuous gradations and shades of disorders of consciousness (Fins & Schiff 2006, 8). It is only armed with this knowledge that we can start answering the many difficult ethical questions raised by these conditions.

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