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Commentary

Comment on Laureys et al. Self-consciousness in non-communicative patients ☆

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Man is born to act. His health depends on movement. Diderot (1875).

Until comparatively recently, say the middle of the last century, spinal cord injury was fatal as pressure sores and other infections took their toll. Those with severe brain injuries, unable to move or even communicate, fared even worse; without movement or feeding such patients were nursed until nature took its course. Over the last few decades medical and nursing advances have enabled some of these vegetative patients to survive for considerable time, provoking, at times, ethical and legal dilemmas. Though they survived, without overt behaviour or clear communication their carers were frequently unsure how much residual function remained. Now real progress is occurring in this area thanks to the application of neuro-scientific methods by some outstanding groups of workers.

Subjects with severe brain injury may begin in complete, unresponsive coma but then 'lighten' to one of three categories. In vegetative state (VS), patients are apparently awake but without evidence of voluntary behaviour and have no apparent awareness of self or environment, whilst in minimally conscious state (MCS) patients have some behaviour beyond the reflex but are not able to communicate effectively. These conditions usually result from widespread brain damage at either or both cortical and subcortical levels due to injury or anoxia, though they can also be seen in end stage neurological conditions like Alzheimer's. In locked in syndrome (LIS), patients 'awake' from coma, usually due to stroke, aware of their surroundings and their situation but unable to speak or move, beyond eye lid control and eye movement. For many, LIS will be recognised from Bauby's extraordinary account in 'The Diving Bell and the Butterfly,' though, incidentally, it was presaged in Samuel Beckett's novella 'The Unnameable.' LIS reflects a profound disconnection between brain and body, except for the upper cranial nerves involved in eyelid movement.

The overriding question is how much awareness these patients have. In their review in the present volume Laureys et al. suggest consciousness in another can only be inferred by action and by reaction. Yet these patients, LIS excepted, are largely unable to react. It is use of functional imaging and evoked potentials (EPs) which have allowed new insights into residual functioning in the brain of these patients. The latter are electrical waves seen either to sensory stimuli (electric to peripheral nerves or sounds to ears), or more complex, late 'cognitive' tasks like odd ball paradigms in which one sound is repeated and another one occasional inserted into the sequence; these appear to depend on widespread cortical networks.

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Some EPs are of use in the prognosis in coma. Hinterberger et al. (2005) has used increasingly complex tasks, including semantic congruent and incongruent sentences, in patients with VS and showed near normal responses in some patients. Though encouraging, it is recognised that such processing does not require, or imply, attention towards the stimuli.

As yet only a few studies have used PET or fMRI in MCS or VS. In a single, fascinating case markers of axonal regrowth were seen (with diffusion tensor MRI) as a patient with MCS recovered language sometime after the insult. Such late recoveries, sometimes after years, are not well understood. Coleman et al. (2005) compared PET and EEG to look at the metabolic coupling to neural response; a tight relationship was seen in four MCS patients but not in six with VS, providing evidence for the latter group's more severe problems.

In parallel studies Nicholas Schiff's group studied five patients in persistent VS with a variety of functional imaging, brain metabolic and neurophysiological tests (Schiff et al., 2002). They showed that three out of five patients had evidence of relatively preserved islands of cortical functioning, some of which were related to minimal behavioural functioning, e.g. utterance to sound. In one who had suffered severe injury to subcortical areas there was widely preserved cortical metabolism, raising the possibility of preserved areas of cortical activity (Zekian consciousnesses?) but no communication between them. They concluded that 'some cerebral regions can retain partial function in catastrophically injured brains.'

In view of this evidence Owen et al. (2005) have argued for a hierarchical approach to testing patients in VS, with progressively more complex tests. The response to speech versus matched sound might be assessed first and, if a response is recorded, then congruous versus incongruous speech and then finally sentences with ambiguous words might be tried, asking for more and more difficult analysis whilst functional imaging is performed.

It is against this background that Laureys et al.'s present paper should be considered. They argue that one of the most salient of stimuli is self, either as a spoken name or as a flashed face. In control subjects one's own name does appear to capture attention and to involve widespread activations in right prefrontal and parietal areas and in left temporal and prefrontal areas. Vocalised own name recognition must presumably involve auditory cortex and association or auditory memory areas, as well as (frontal) areas involved in discrimination between self and not self, though data on the functional imaging of this discrimination is not given.

Laureys et al. give an outline on early work in this area of self-consciousness before reviewing the small number of studies of self-referential stimuli in patient groups. An event related EP to own name was recorded in patients with LIS and MCS and in 3/5 with VS. These may not reflect awareness, since similar responses can be seen during sleep in controls (though not during profound general anaesthesia). They suggest the presence of such a P3 may reflect preserved (automatic?) cerebral processing of speech comprehension. In VS patients, thus far, noxious and auditory stimuli have (only) led to activations in primary sensory cortices with no involvement of higher processing areas in cohort studies, tempering ideas that these patients suffer. But individual subjects have shown wider activations both with ERP and functional imaging. The brain areas involved in identification of one's own face have not been well demarcated in controls and no experiments have been performed in cohorts with VS or MCS.

One must also be careful in what the experiments mean. In control subjects recognition of a face or name presumably does mean that this person is recognised to be oneself. But in a subject with VS it is theoretically possible that a previously frequently met name or face is recognised differently without, necessarily, it being known (whatever know means here) that it is 'me.'

The authors are well aware of the difficulties in showing that brain activity in these patients is related to awareness rather than automatic processing. It is for this reason that a recent study from Owen et al. (2006) is of great significance.

They investigated a subject in VS with fMRI to measure neural responses to spoken sentences versus matched sounds and to sentences with ambiguous words, and observed metabolic changes in similar areas of the brain to controls. They argued that these results offered evidence for continuing semantic processing, though they made no claims for awareness during this. To probe this they did further fMRI experiments during which they asked the subject, via spoken instruction, to perform two mental imagery tasks, imagining playing tennis and imagining going round the rooms of her house. During the former the SMA was activated but during the latter a wider network of regions was activated including the parahip-

pocampal gyrus, the posterior parietal and the lateral premotor cortices—similar areas to those activated during the same task in controls.

They concluded that this patient retained an ability to understand spoken commands and respond to them through brain activity alone, and that she had decided to cooperate in the tasks thereby showing intentional mental activity and confirming that she was consciously aware of herself and her surroundings. They concluded that such patients might be able to use residual cognitive ability to communicate their thoughts.

As might be imagined these results have intrigued and provoked. Nachev and Husain (2007) and Greenberg (2007) both suggested that the different task commands had very different word and sentence structures, especially at their ends ('house' and 'tennis'), and that this might reflect the results. Though there is no evidence for such widely differing cortical activation for differing words, Owen et al. ran a further study on a control subject during two non-instructional sentences involving house and tennis and found no such widespread activations during either.

But, by using the words 'consciously aware,' they have focussed attention on the exact definition(s) of consciousness itself. When I was first involved in consciousness studies I was surprised that people did not feel a need to define it, though I appreciated how difficult that might be. Philosophers might consider higher order theories, while neuroscientists opted to avoid the 'c-word' and, instead, use what they could study; attention, behavioural responses, etc. Clinicians were even lower in level, measuring simple responsiveness to word and pain for instance. Returning to Owen et al.'s patient, Naccache (2006) commented that since she could not report her mental state, which some have suggested is necessary for consciousness, we might be led to consider reporting and its role in consciousness very differently. Without embodied response, her maintenance of mental representations over time (the task took 30 s or so), strategic processing and intentional behaviour might replace action as communication and so reflect consciousness.

Thus far only one such patient has been found; though enormously important her situation, fortunately, may not be common. One can scarcely imagine what the contents of her consciousness, though Beckett tried. Sentience with minimal communication and action, self without agency or embodiment is, as Laureys et al. suggest, a 'rare but horrifying situation.' Whatever sort of consciousness she and others have, this stunning work necessitates further work refining communication with and from these patients.

Recent developments in the assessment of these patients has been heartening, and moving, as an interacting, widespread group of clinicians and neuroscientists in the US and Europe, has been making real progress in this complex and important area. Gratifying not only for clinical and humane reasons—though that might be sufficient—but also because it is important for the study of consciousness to keep a clinical perspective. Gratifying also because when Laureys et al. write of their work as being demanding they are, if anything, understating. Scientific work with these patients is very difficult, time consuming and at times frustrating. Their results show the importance of painstaking acquisition of empirical data, whether in lab or at the bedside or both. Their observations not only open up ways of considering consciousness and its breakdown, but also have the potential to improve management in this group of people, hanging as they do to their lives, and their selves, by the slenderest of margins.

In the late 1940s Wittgenstein anticipated, and immediately, questioned imagined functional imaging.

> *'Imagine that people could observe the functioning of the nervous system in others. In that case they would have a sure way of distinguishing genuine and simulated feeling: or might they after all doubt in turn whether someone feels anything when these signs are present?'* (Wittgenstein, 1981).

We are some way from answering these questions, relating brain activity to experience and feeling, for instance, but one hopes he might be delighted by the progress being made now.

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