Revealing consciousness after severe brain injury
Lorina Naci

Coma is the acute state of behavioural non-responsiveness occurring immediately after a severe brain injury, during which the patient is thought to lack consciousness.

Improvements in intensive care have led to increased survival rates for coma patients but patient outcome remains highly variable and, currently, no clinical tool offers accurate prognostic indicators of recovery for individual comatose patients. Some go on to make a good recovery, while others progress into the so-called ‘vegetative stage’ or minimally conscious states.

The first days and weeks following a serious brain injury are a time of tremendous prognostic uncertainty; if the patient appears non-responsive during this period, this frequently biases medical decisions in favour of withdrawing life-sustaining therapies - this might happen as early as within the first 72 hours post-injury.

My research suggests that, in some cases, this may be a mistake since a proportion of comatose patients may retain consciousness despite their apparent non-responsiveness.

MRI — I have shown that functional Magnetic Resonance Imaging (fMRI) is a highly sensitive tool for uncovering covert consciousness in long-term behaviourally non-responsive patients, who are diagnosed as vegetative state. I have demonstrated that a significant minority of patients thought to lack consciousness for many years, can modulate their brain activity wilfully, accordingly to commands. Not only can they demonstrate that they are conscious, they can also communicate while inside the MRI scanner, by using brain activity to answer questions such as “Is your name John?” and “Are you in a hospital?”

Other patients, such as those in a comatose state, are unable to follow commands in order to communicate in this way. But despite their apparent profound non-responsiveness, we suspect that a significant proportion of these may actually retain some consciousness and the ability to process information around them.

Feeling suspenseful — To test this hypothesis, I have developed an innovative approach in which patients view suspenseful movies by, for instance, Alfred Hitchcock, or listen to engaging stories. Through this, I was able to demonstrate that a patient who was non-responsive for 16 years was not only consciously aware, but critically, able to follow the story and feel suspense, from moment to moment, as well as every healthy individual that we tested.

Due to its scientific novelty and impact, my work has been strongly cited and has received international coverage, including in Science, Nature, New Scientist, BBC, The Times, International Business Times, NBC News, Reuters, Irish Times, the Irish Independent, and Discovery News. Speaking to the journal Nature, Dr Russell Poldrack, a cognitive neuroscientist at Stanford University in California, said that this study “provides the best evidence to date that fMRI can be used to identify consciousness in vegetative patients.”

Currently, my group is working to determine the clinical prevalence of covert consciousness in comatose patients and identify novel and objective prognostic markers of recovery in this group. This work could have profound implications for the diagnosis and clinical care of comatose patients, as well as the medical and legal decision-making relating to life after severe brain injury.

“...I have shown that functional Magnetic Resonance Imaging (fMRI) is a highly sensitive tool for uncovering covert consciousness in long-term behaviourally non-responsive patients, who are diagnosed as vegetative state.”

Lorina Naci is Assistant Professor at the School of Psychology and Global Brain Health Institute (GBHI). She received her PhD from the University of Cambridge as a Cooke Fellow in 2011. In 2017, she received the L’Oréal – UNESCO International Rising Talent Award. Professor Naci is member of the Governing Board of GBHI, held at Trinity and University of California San Francisco, USA. She is funded by the Wellcome Trust, the Irish Research Council, and Enterprise Ireland, among others.

Contact: nacil@tcd.ie
Fig 1. A patient, who had been clinically diagnosed as being in a vegetative state for 12 years, uses his brain activity to correctly respond ‘Yes’ to the question “Are you in a hospital?”

“Are you in a hospital?” (Attend to the word that is your answer)

Yes

No

Fig 2. A patient, who had been clinically diagnosed as being in a vegetative state for 12 years, uses his brain activity to correctly respond ‘No’ to the question “Are you in a supermarket?”

“Are you in a supermarket?” (Attend to the word that is your answer)

Yes

No
→ To read the full publication, please click here