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Willful Modulation of Brain Activity in Disorders of Consciousness

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Presented by: OLA ☺

Background and Questions

- Improved intensive care allows for more survival after severe brain injuries
- Some recover, others show no signs of awareness = defined as a vegetative state (or "wakefulness without awareness")
- Some of those eventually develop inconsistent, but reproducible signs of awareness, and are referred to as "minimally conscious state"

- 1 – What proportion of the patients retain the ability to purposefully respond to a stimulation?
- 2 – Can this response be trained and transformed into a form of communication?

Patients and Controls

- 54 patients were examined – 23 in vegetative state (VS) and 31 in minimally conscious state (MCS)
- Functional MRI was calibrated according to 16 healthy volunteers
- Causes of disorder:
  - Traumatic brain injury
  - Anoxic brain injury
  - CVA / Brain stem stroke
  - Meningitis / Encephalitis
- Ages 15-87

Question Number 1 – Response?

- Imagery tasks:
  - 1 – Motor imagery task (supplementary motor area)
  - 2 – Spatial imagery task (parahyppocampal gyrus)
- Out of 54 patients, 5 could willfully modulate their fMRI pattern following an appropriate instruction
- All of them were with traumatic brain injury
- Ages 22, 22, 23, 27, 46; Males x3, Females x2
- 5 could activate motor patterns, 4 spatial patterns
- 4 were considered VS, 1 was considered MCS
- Upon careful revision, 2 of the 4 that were considered VS, were eventually re-diagnosed as MCS

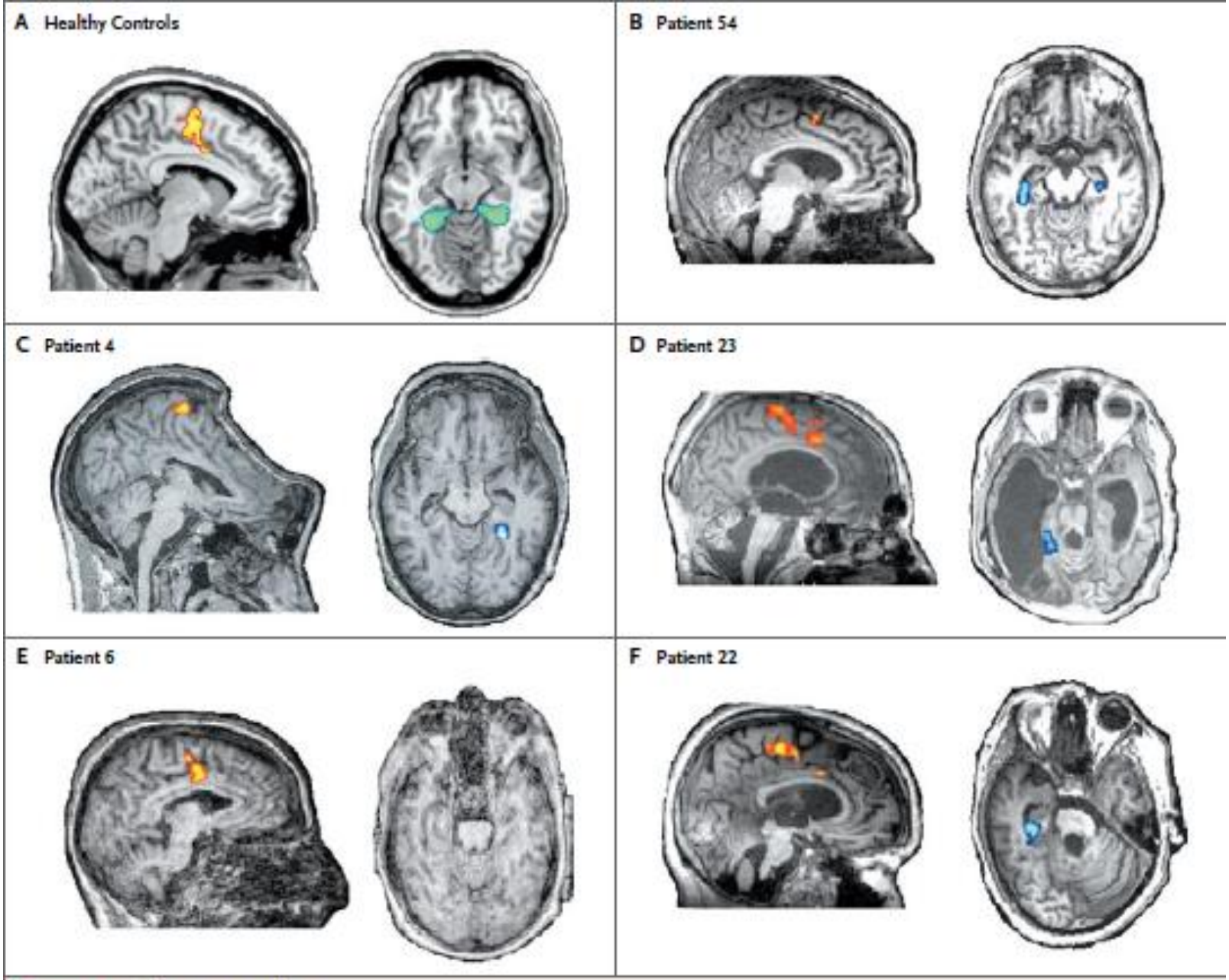


Figure 1. **Mental-Imagery Tasks.**

Functional MRI scans show activations associated with the motor imagery as compared with spatial imagery tasks (yellow and red) and the spatial imagery as compared with motor imagery tasks (blue and green). These scans were obtained from a group of healthy control subjects and five patients with traumatic brain injury.

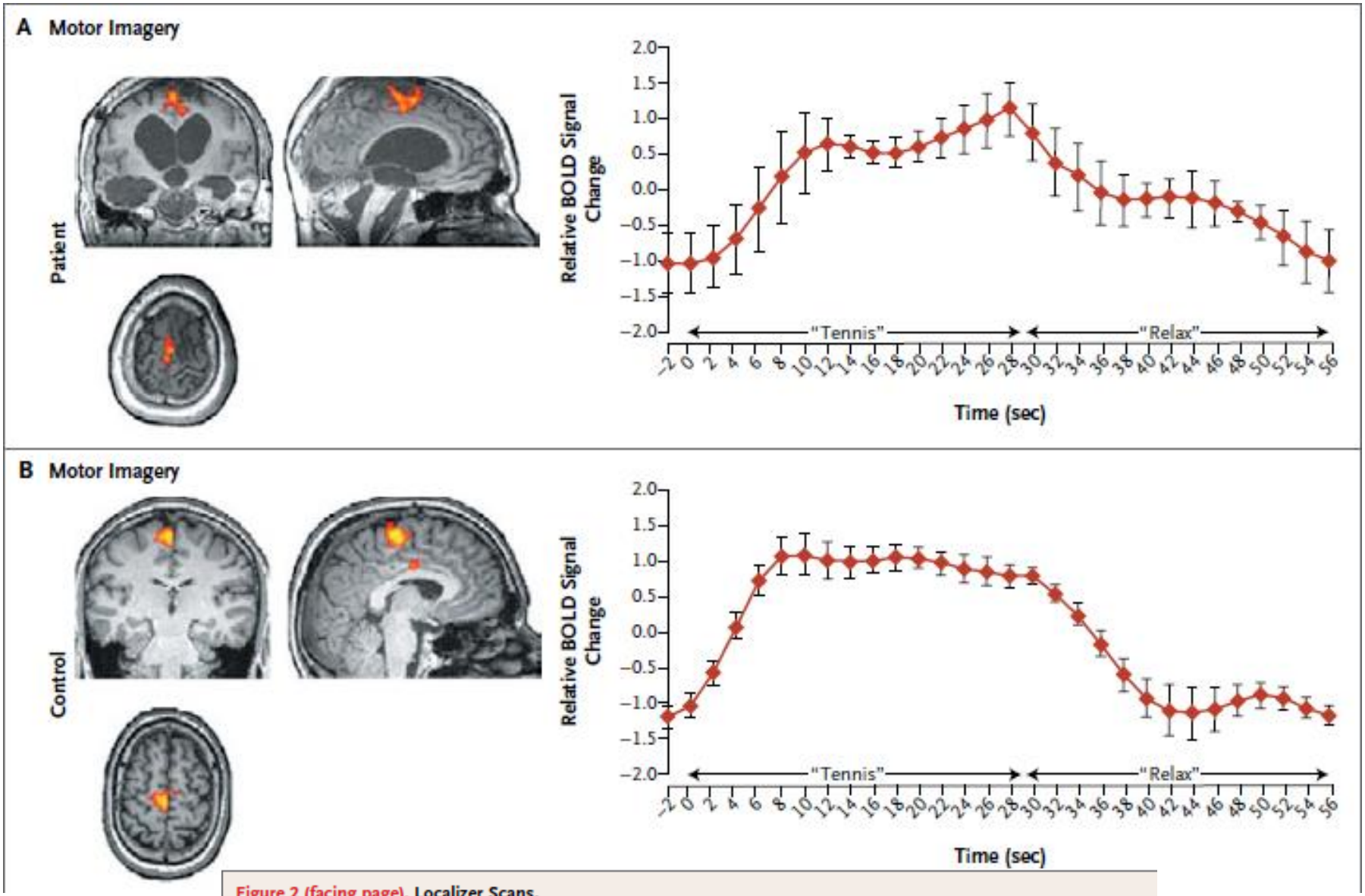
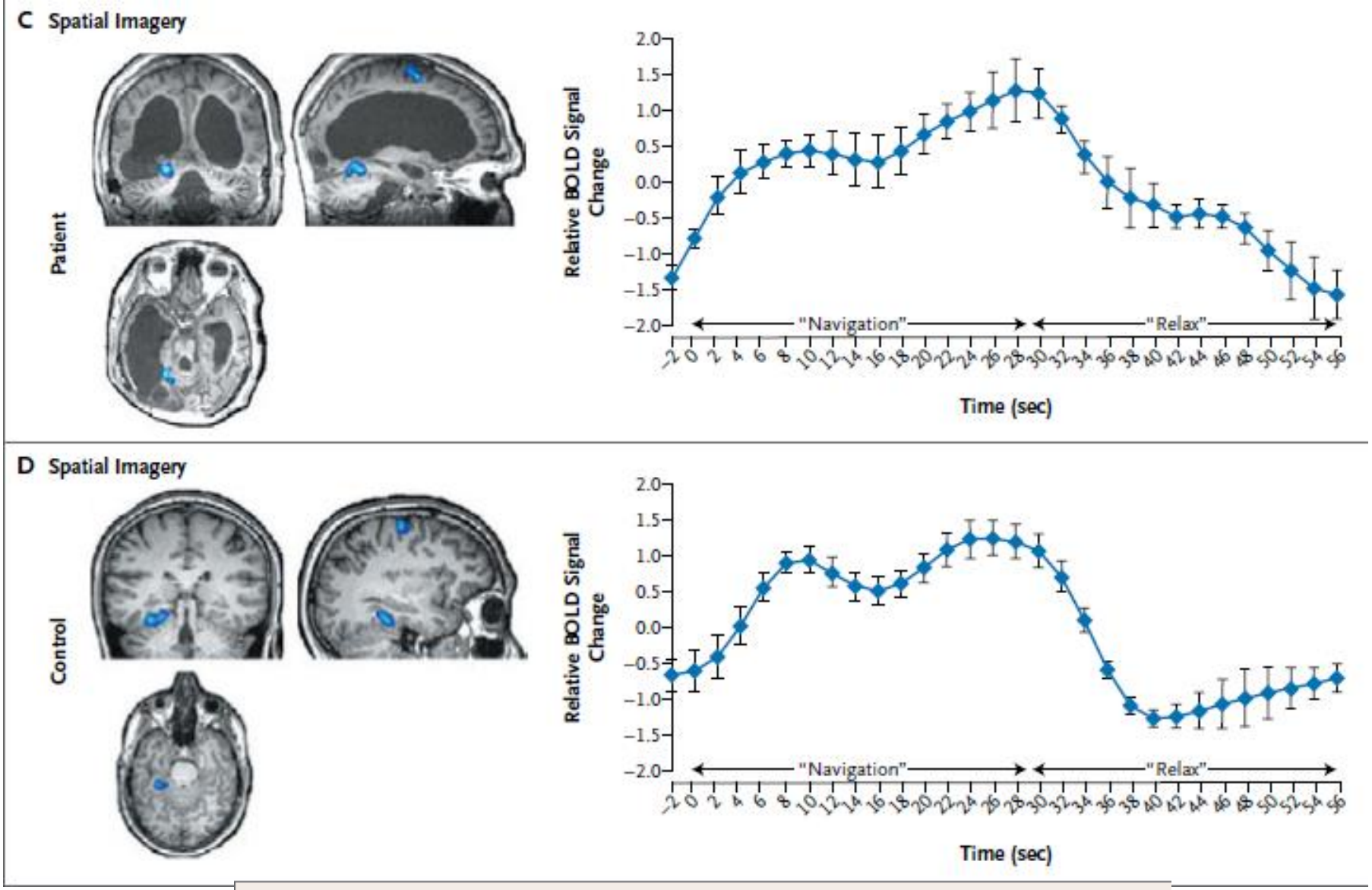


Figure 2 (facing page). Localizer Scans.

Functional MRI scans obtained from Patient 23 and one healthy control subject are shown. The top sets of scans obtained from the patient (Panel A) and the control subject (Panel B) show activation (yellow and orange) resulting from the motor imagery task (cued with the word "tennis") as compared with rest periods (cued with the word "relax"), as well as the time course of the peak voxel in the supplementary motor area. The bottom sets of scans obtained from the patient (Panel C) and the control subject (Panel D) show activation (blue) resulting from the spatial imagery task (cued with the word "navigation") as compared with rest periods, as well as the time course of the peak voxel in the parahippocampal gyrus. I bars represent standard errors. BOLD denotes blood-oxygenation-level–dependent.



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Question Number 2 – Communication?

- The 2 different patterns were used as Boolean variables to answer yes/no questions
- MRI was again calibrated according to healthy volunteers
- 1 of the patients who could voluntarily evoke brain activity was tested for the ability to answer questions
- Out of 6 questions the patient was asked, responses to 5 could be distinctively recognized as one of the previous patterns, response to the last question was not recognizable
- Out of 5 questions answered, 100% were answered correctly (investigators not knowing the answers a-priori)

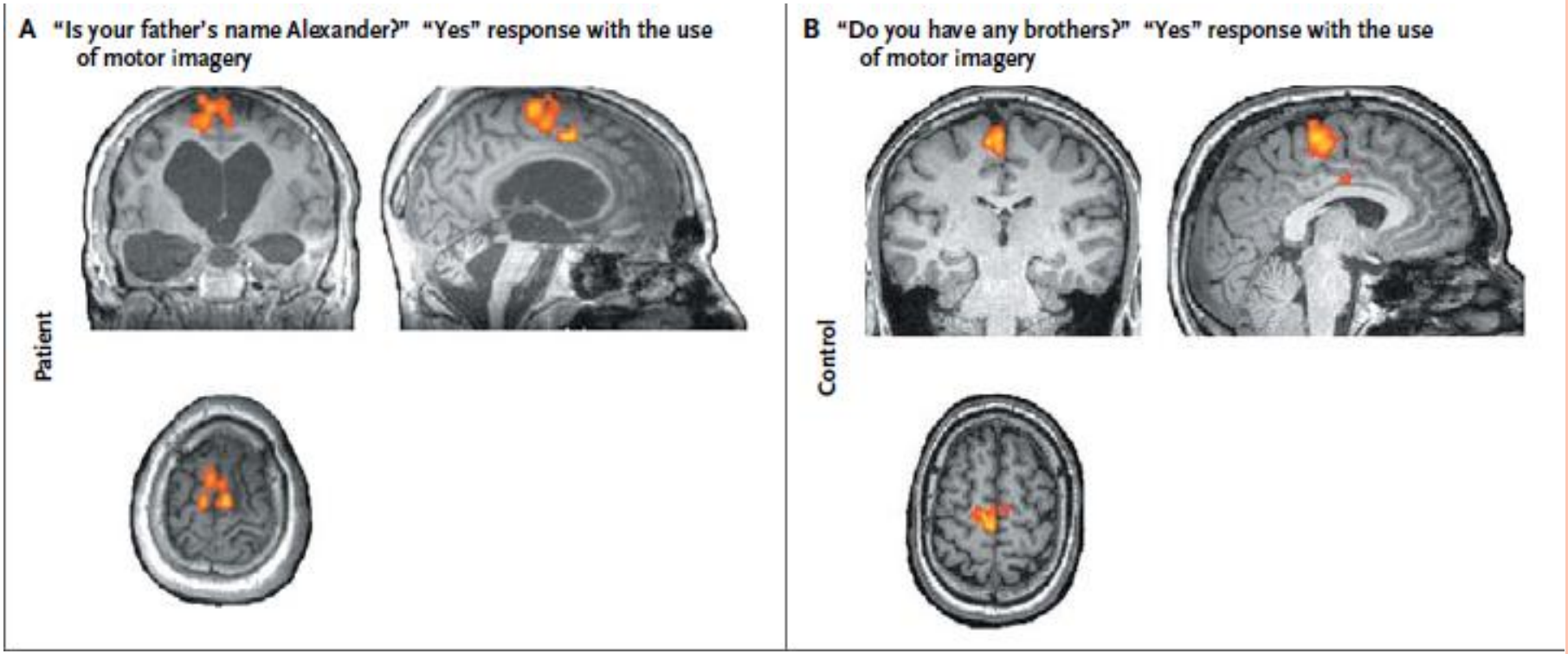
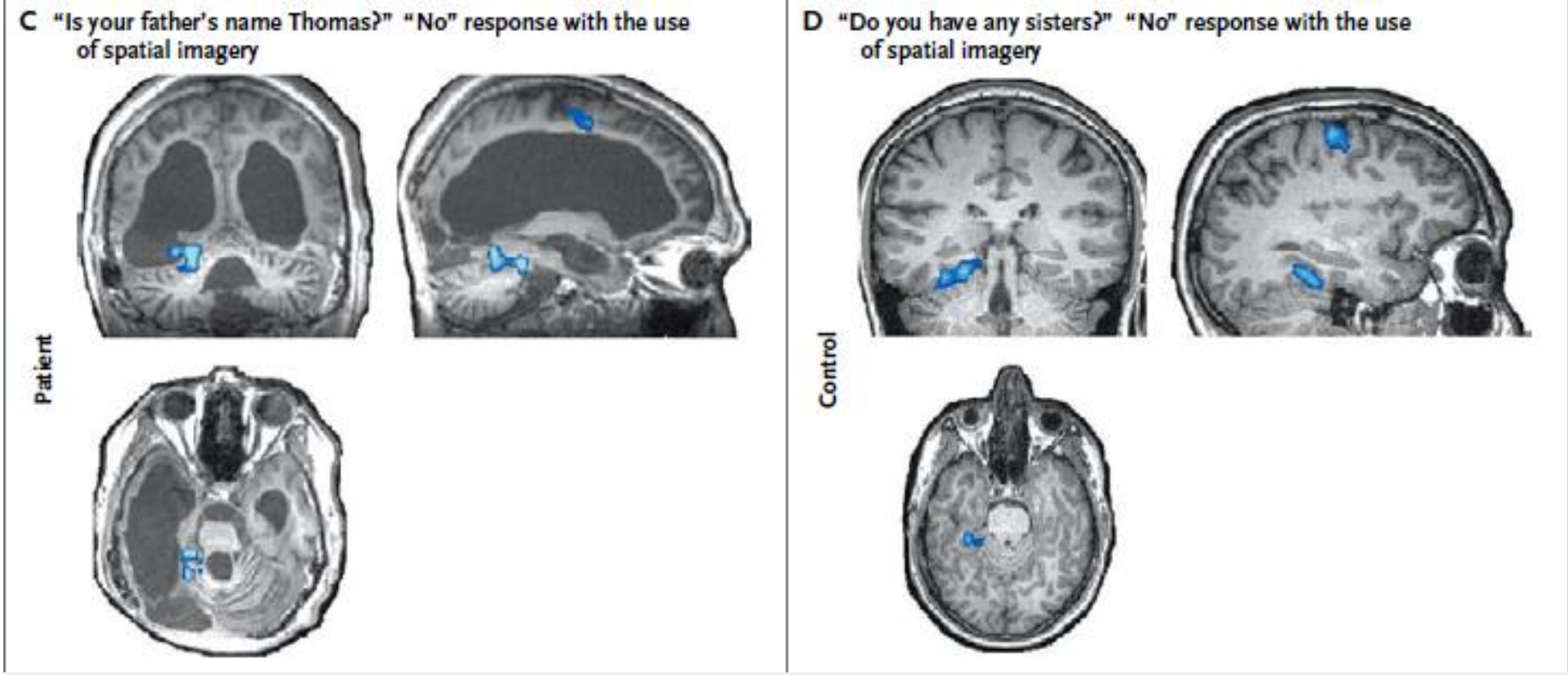


Figure 3. Communication Scans.

Results of two sample communication scans obtained from Patient 23 (Panels A and C) and a healthy control subject (Panels B and D) during functional MRI are shown. In Panels A and B, the observed activity pattern (orange) was very similar to that observed in the motor-imagery localizer scan (i.e., activity in the supplementary motor area alone), indicating a "yes" response. In Panels C and D, the observed activity pattern (blue) was very similar to that observed in the spatial-imagery localizer scan (i.e., activity in both the parahippocampal gyrus and the supplementary motor area), indicating a "no" response. In Panels A and C, the names used in the questions have been changed to protect the privacy of the patient.



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Conclusions?

- Vegetative state does not necessarily mean that there is no consciousness (awareness?) in the body
- According to article – more chances for consciousness in young people with traumatic brain injury
- Maybe fMRI could be used in future to communicate basic needs and decisions with patients with limited clinical response
- It is our responsibility as medical staff to be aware of the possibility that our patient may retain consciousness, thus keeping our approach respectful and compassionate, even if it might seems like we're treating an empty shell


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