

# Task-Based Functional MRI to Detect Signs of Consciousness after a Severe TBI: A Case Report of Cognitive-Motor Dissociation

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## Introduction

- Severe TBI can result in a disorder of consciousness (DOC), defined as the inability to maintain awareness and arousal. The DOC spectrum includes coma, unresponsive wakefulness (UW), and minimally conscious state (MCS).
  - UW patients have no behavioral evidence of awareness
  - MCS patients have fluctuating behavioral signs of awareness
- While DOC classification has been traditionally based on clinical evaluation with standardized scales such as the Coma Recovery Scale-Revised (CRS-R), they are limited by an individual's ability to hear, comprehend, and perform behavioral tasks.
- Advanced neuroimaging, specifically functional magnetic resonance imaging (fMRI), may assist in classification by assessing covert signs of consciousness not limited by the aforementioned abilities.

## Case Report

- 34-year-old male was discharged to rehabilitation 48 days after sustaining a severe traumatic brain injury with an admission CRS-R score of 6, consistent with UW. On day 100, he remained in a UW state and underwent fMRI via a previously established protocol.
- Temporal and occipital activation occurred when playing normal meaningful speech (**Figure 1A**) and no observed activation with backward speech.
  - This was consistent with processing meaningful speech more deeply than backward speech.
- Tactile stimulation of the right hand with abrasive material showed left somatosensory cortex activation and no activation at rest (**Figure 1B**).
  - This suggests he was processing sensory information.
- Right prefrontal cortex activation occurred when asked to imagine squeezing the left hand (**Figure 1C**), left prefrontal cortex activation occurred when asked to imagine squeezing the right hand (**Figure 1D**), and there was no activity seen at rest.
  - This suggests that he was able to follow commands.

## Discussion

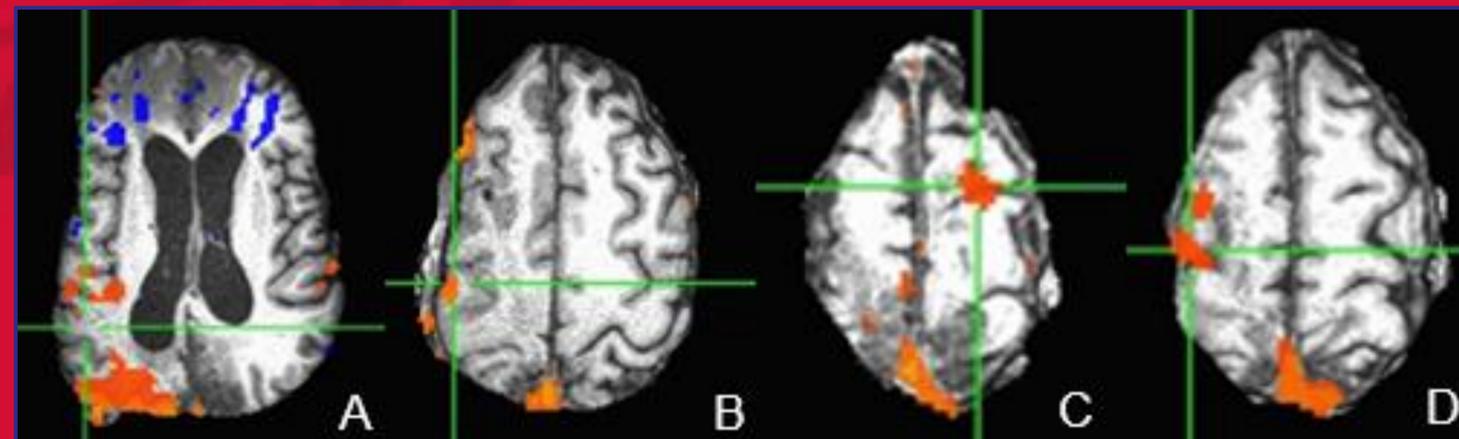
- Patients with DOC sustain a disruption in the neural networks required to maintain awareness and arousal.
- Distinctions between UW, MCS, and emergence are essential for treatment and outcome prognostication.
- Misclassification can be minimized by using standardized behavioral assessments, such as the CRS-R. However, speech, motor, and visual impairments can limit accuracy.
- fMRI offers the ability to assess for non-overt signs of consciousness through neuroimaging techniques.
- UW patients are unable to overtly perform tasks. However, there are reports of these patients showing task-based activation in the expected cerebral location on fMRI, suggesting some degree of preserved consciousness, as seen in this case.
- DOC patients who show command following on fMRI without evidence of behavioral command following exhibit Cognitive-Motor Dissociation (CMD), also seen in this case.
- However, the long-term functional impact of these findings on patient outcomes are currently unknown.

## Conclusions

- This case describes a UW patient by CRS-R with non-overt signs of processing auditory and tactile information while following motor imagery commands on fMRI, consistent with Cognitive Motor Dissociation.
- This adds to the current literature for assessing subclinical signs of consciousness in DOC patients with fMRI.
- Further research is needed to determine the sensitivity and specificity of fMRI on detecting evidence of consciousness and clarify the clinical implications of CMD on outcomes.

## References

- Coleman MR, Davis MH, Rodd JM, et al. Towards the routine use of brain imaging to aid the clinical diagnosis of disorders of consciousness. *Brain*. 2009;132(9):2541-2552. Naci L, Sinai L,
- Owen AM. Detecting and interpreting conscious experiences in behaviorally non-responsive patients. *Neuroimage*. 2017;145:304-313.
- Bodien YG, Giacino JT, Edlow BL. Functional MRI motor imagery tasks to detect command following in traumatic disorders of consciousness. *Frontiers in neurology*. 2017;8:688.
- Schiff ND. Cognitive motor dissociation following severe brain injuries. *JAMA neurology*. 2015;72(12):1413-1415.
- Edlow BL, Chatelle C, Spencer CA, et al. Early detection of consciousness in patients with acute severe traumatic brain injury. *Brain*. 2017;140(9):2399-2414.



**Figure 1A-D:** fMRI Axial views, orange areas are increased activity, blue areas are decreased activity. A. Brain activation with auditory task; showing left brain activation in the temporal and occipital regions when playing meaningful speech. B. Brain activation with tactile stimulation task; showing somatosensory cortex activation. C. Brain activation with left hand motor imagery task, showing activation of the right prefrontal cortex. D. Brain activation with right hand motor imagery task, showing activation of the left prefrontal cortex.