

A Human Brain Network Linked to Restoration of Consciousness after Deep Brain Stimulation

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Abstract

Introduction: Disorders of consciousness (DoC) are characterized by severe impairments of arousal and awareness. Deep brain stimulation (DBS) has emerged as a potential therapeutic option, but clinical outcomes remain inconsistent. This variability may stem from differences in patient characteristics, electrode placement, or the specific brain networks modulated by stimulation.

Method: We investigated 40 patients with DoC who underwent DBS targeting the centromedian-parafascicular complex of the thalamus. Structural MRI was used to assess gray matter preservation, and electrical field modeling was applied to estimate the spatial extent of stimulation. Connectivity analysis was conducted to identify common cortical targets associated with positive outcomes.

Results: Improvements in consciousness were linked to greater gray matter preservation, particularly within the striatum. Electrical field modeling showed that the most effective stimulation sites extended ventrally below the centromedian nucleus, engaging the ventral tegmental tract—an important pathway connecting the brainstem and hypothalamus. Furthermore, these effective sites were functionally connected to a cortical network overlapping with regions previously associated with impaired consciousness in conditions like seizures and stroke.

Discussion: These results suggest that targeting a subcortico-cortical network—including the ventral tegmental tract and its cortical projections—may be critical for therapeutic response in DBS for DoC. Incorporating imaging-based network analysis into DBS planning could enhance patient selection and electrode targeting, improving clinical outcomes.

Conclusions: This study highlights the importance of structural integrity and precise network engagement in successful DBS treatment for DoC. The findings support future clinical trials and provide a framework for refining DBS targets based on a therapeutic consciousness network.

References

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