

Prehabilitation: Promoting Neuroplasticity Before Tumor Resection to Preserve Postoperative Function

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Introduction

Gliomas are the most common primary brain tumors in adults and often infiltrate language cortices¹. Surgery in these cases carries a high risk of language deficits, and meticulous preoperative planning using fMRI and intraoperative cortical stimulation is the primary strategy currently used to mitigate this risk². No established interventions exist to proactively improve the brain's resilience before surgery. A growing body of neuroimaging literature in glioma patients demonstrates spontaneous reorganization of language networks, including recruitment of both perilesional and contralateral regions³. Furthermore, activation of language regions in the contralesional hemisphere has been associated with reduced aphasia following surgery, suggesting that proactively enhancing contralateral or perilesional language engagement could support functional resilience^{4,5}. Prior studies using neuromodulation approaches such as transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (tDCS) have demonstrated the feasibility of inducing clinically meaningful reorganization by creating temporary "virtual lesions" followed by intensive therapist-guided language training⁶. However, these approaches typically require 10–20 training sessions and therefore do not fit within the standard pre-surgical time window. The aim is to test whether real-time fMRI neurofeedback (rt-fMRI NF) administered within the brief pre-surgical window can increase engagement of healthy language regions (both ipsilateral and contralateral) and decrease dependence on tumor-involved cortex, representing a step toward noninvasive and clinically feasible neuro-oncology prehabilitation.

Methods

Four adults (≥18 years) with supratentorial gliomas involving or abutting language-eloquent cortex in the language-dominant hemisphere will be enrolled. Tumors must involve regions corresponding anatomically to Broca's or Wernicke's areas and patients must be scheduled for surgical resection with at least 7 days between diagnosis and surgery to allow two rt-fMRI NF sessions. Eligible participants must be MRI-compatible, able to provide informed consent, and capable of performing the language tasks required for fMRI and neurofeedback. Personalized training targets for each patient based on tumor location and functional language mapping will be generated. The training will target upregulation of healthy language regions and downregulation of tumor-overlapping cortex. Participants will complete two rt-fMRI NF sessions prior to surgical resection. Each session will include task-based neurofeedback training and resting-state acquisitions to support pre and post-training assessment of language-network organization. This pilot has threefold objectives: (i) to do the groundwork for a randomized trial by obtaining necessary regulatory approvals and developing the required software infrastructure (ii) to demonstrate that individualized target generation, rt-fMRI NF training, and pre/post assessments can be successfully completed within the available presurgical interval (iii) to collect pilot data to explore whether rt-fMRI NF could facilitate reorganization of language networks in glioma patients.

Concluding remark

We plan to present the study design and available pilot data at the meeting. This prehabilitation approach is designed to shift language activation away from tumor-involved cortex, with the goal of enabling greater extent of resection while preserving language function. Because greater extent of resection has been associated with improved survival in glioma patients, we would welcome feedback before initiating the trial.

References

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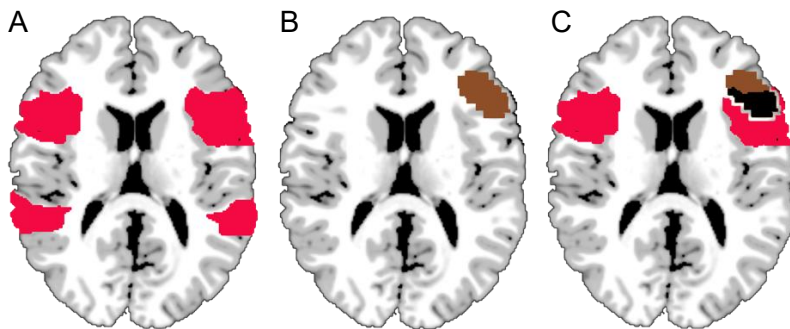


Figure 1. Defining personalized training regions of interest (ROI). (A) Canonical Broca's and Wernicke's masks are shown in red. (B) A representative patient's tumor mask is shown in brown. (C) Patient-specific training ROIs are generated by identifying healthy language regions outside the tumor overlap, shown in red, and tumor-overlapping Broca's-region tissue, shown in black. During training, the healthy language regions will be upregulated, while the tumor-overlapping region will be downregulated.