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# Cognitive Control Network and Language Reorganization in Patients with Brain Tumors

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## Abstract

**Background and purpose:** The interaction between language and other cognitive networks in patients harboring brain tumors is poorly understood. We studied the modification of the cognitive control network (CCN) induced by brain tumors and its participation in language reorganization. We hypothesized that patients with brain tumors and reorganized language would show modification of the CCN compared to patients who remain left dominant.

**Materials and methods:** Patients were selected with the criteria: newly diagnosed, pathologically-confirmed left hemispheric tumor; single lesions; right handedness; task-based and resting-state fMRI; no artifacts. Age-matched healthy controls (HC) were recruited from open sources databases. Language laterality was calculated using task-based fMRI. We obtained the CCN through ad hoc independent component analysis on resting-state fMRI. Difference in CCN between patients and HC were characterized through cosine similarity (CS) and earth mover's distance (EMD). Changes related to language reorganization and patients' speech were assessed with t-test ( $p < 0.05$ ). Results were corrected for multiple comparisons.

**Results:** 142 right handed patients (35 low grade, 88 high grade glioma; 19 metastases) and 184 HC were included. Two independent components of the CCN were obtained. T-test confirmed significant effects of lateralization on the CCN ( $p = 0.004$ ). Modification of CCN was associated with less speech deficits 1 week after surgery ( $p = 0.005$ ).

**Conclusions:** This study provides evidence that modifications of CCN occur in the setting of language reorganization. Patients exhibiting these modifications perform better at speech evaluation after surgery, suggesting a role of cognitive control in compensating for speech deficits when language reorganizes.

**Abbreviations:** AD = atypical dominant; CCN = cognitive control network; CS = cosine similarity; EMD = earth mover's distance; fMRI = functional magnetic resonance imaging; GIG-ICA = group-information guided ICA; HGG = high-grade glioma; LD = left dominant; LGG = low-grade glioma; LI = laterality index; ROI = region of interest; RSNs = resting state networks.

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