

Zhizhao Jiang, Philipp Kuhnke, Anika Stockert, Max Wawrzyniak, Ajay Halai, Dorothee Saur, Gesa Hartwigsen, Dynamic reorganization of task-related network interactions in post-stroke aphasia recovery, *Brain*, 2025, <https://doi.org/10.1093/brain/awaf036>

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Abstract

Post-stroke aphasia is a network disorder characterized by language impairments and aberrant network activation. While patients with post-stroke aphasia recover over time, the dynamics of the underlying changes in the brain remain elusive. Neuroimaging work demonstrated that language recovery is a heterogeneous process, characterized by varying activation levels in several regions of the left-hemispheric language network and the domain-general bilateral multiple-demand network. Crucially, this activation seems to depend on the time elapsed since stroke and the lesion location. Yet, beyond task-related brain activation, the degree and nature of interactions between regions of the language and the multiple-demand network are not well understood. In this longitudinal functional neuroimaging study, we characterized task-related functional interactions between regions of the language and the multiple-demand network during language processing. We hypothesized that interactions between language regions and between language and multiple-demand regions should change over time and depend on lesion location.

We compared changes in effective connectivity in patients with left-hemispheric frontal or temporo-parietal stroke (n=17 per group) and healthy controls (n=17) with Dynamic Causal Modelling. All patients repeatedly underwent an auditory sentence comprehension paradigm during functional neuroimaging in the acute (≤ 1 week), subacute (1-2 weeks), and chronic (> 6 months) phases after stroke.

We found overall increased task-related connectivity from regions of the multiple-demand to the language network across patients, resembling the principal pattern of task-related interactions in controls. Early facilitation from multiple-demand to language regions correlated with later language improvement across both groups. Crucially, recruitment of specific connections from regions of the multiple-demand to language network depended on lesion location and changed over time. In the chronic phase, patients with frontal stroke showed facilitatory modulation from the right dorsolateral prefrontal cortex, while patients with temporo-parietal stroke integrated the supplementary motor area/dorsal anterior cingulate cortex. Besides this across-network reorganization, facilitatory connectivity between regions of the language network emerged in all patients in the subacute phase. Additionally, patients with frontal stroke showed facilitatory influences from the right lesion homologue to the remaining undamaged left inferior frontal cortex in the acute phase.

Collectively, we provide first evidence that functional interactions of regions within and across the language and the multiple-demand network facilitate aphasia recovery. The identified dynamic reorganization principles over the time course of recovery may inform the future use of personalized treatment protocols with neurostimulation in aphasia rehabilitation. These protocols should be tailored to the individual lesion location and recovery phase.