Mapping the effects of stroke lesions on gradients of resting-state functional connectivity

Şeyma Bayrak1,2, Ahmed Khalil3,4, Kersten Villringer3, Jochen Fiebach3, Arno Villringer3,4, Daniel S. Margulies5, Smadar Ovadia-Caro1,4,6

1 Department of Neurology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany
2 Faculty of Medicine, University of Leipzig, Leipzig, Germany
3 Center for Stroke Research Berlin, Charité - Universitätsmedizin Berlin, Berlin, Germany
4 Berlin School of Mind and Brain, Humboldt-Universität zu Berlin, Berlin, Germany
5 CNRS UMR 7225, Institut du Cerveau et de la Moelle épineure, Paris, France
6 Department of Neurology, Campus Benjamin Franklin, Charité - Universitätsmedizin Berlin, Berlin, Germany

1 bayrak@cbs.mpg.de

Introduction

Stroke provides a unique model to study widespread effects of a focal brain disruption. Distal effects of stroke lesions were previously studied using network parcellations [1, 2, 3]. Recently, a continuous representation of brain organization was shown by gradients of resting-state functional connectivity [4]. The advantage of gradients is that no a-priori assumption is being made concerning network boundaries, and whole-brain connectivity is represented using a low dimensional embedding.

Here, we aim to study how a lesion (the acute infarct) affects connectivity changes over the course of stroke recovery, using gradients of connectivity. We hypothesized that the location of lesions along the gradients will influence the degree of changes in functional connectivity in the acute to subacute stroke phase.

Methods

A nonlinear decomposition on healthy controls

average functional connectivity (FNC) data was performed at individual patient level and using whole-brain functional representation. Brain's overall graph and disruptions in such associative e-functions sit central to brain's small graph and disruptions in such associative modalities better correlated with disruptions in functional connectivity, rather than lesion anatomy [3].

Our results extend previous findings. The extremes of Gradient 2 are dominated by short-range connections and thus were not sensitive to long-distance impact of focal lesions. Large-scale modules located at the extremes of Gradients 1 and 3 enable them to capture global and longitudinal effects of stroke lesions.

Discussion

We found that stroke-induced connectivity alterations are reflected along specific gradients of a low-dimensional connectivity embedding. Brain areas close to lesion locations along Gradients 1 and 3 demonstrated a more pronounced functional connectivity alteration over time.

Gradients 1 and 3 emphasize transmodal (DMN) and multimodal domains (attention), whereas Gradient 2 reflects a dissociation within unimodal domains (somatosensory/motor, visual) [4].

It was previously shown that regions processing integrative functions sit central to brain's small graph and disruptions in such associative modalities better correlated with disruptions in functional connectivity, rather than lesion anatomy [3].

References