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# Bridging Brain Structure and Function by Correlating Structural Connectivity and Cortico-Cortical Transmission

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## Résumé

Elucidating the structure-function relationship of the brain is one of the main open questions in neuroscience. The capabilities of diffusion MRI-based (dMRI) techniques to quantify the connectivity strength between brain areas, namely structural connectivity (SC), in combination with modalities such as electrocorticography (ECoG) or electroencephalography (EEG) to quantify brain function have enabled advances in this field. However, so far, the actual relationship between SC measures and measures of information transport between neuronal patches has not been determined. In this project, we aim to establish a relationship between dMRI SC measures, direct measures of electrical properties of the human brain cortex obtained with ECoG, and response elicited by direct electrostimulation of the brain (DES).

Our methodology assumes obtaining a unique dataset composed of state-of-the-art dMRI and cortico-cortical conductivity measures obtained with ECoG for 10 neurosurgical patients. First, a dMRI is acquired prior to the surgery, in order to extract SC indices through probabilistic tractography. Then, following the classical procedure of awake craniotomy, a brain cartography is performed using DES (low-intensity current, bipolar electrode) to identify the functional cortical sites for sensori-motor, language, visual and cognitive functions. To obtain intrasurgical cortico-cortical electrical measures, the ECoG electrodes are positioned on the cortical terminations of the designated bundles previously identified by dMRI and DES. The electrical signal is recorded spontaneously and after DES of the cortex. These measures are correlated a posteriori to the individual dMRI parameters and functional responses obtained during the cortical cartography.

The results of this multi-modal approach combining structure and function explorations of the brain should help to elucidate the relationship between non-invasive (dMRI) SC measures and cortico-cortical transmission properties (delays, transfer functions), and should help in understanding the organization of the brain for cognitive functions as well as neurosurgical planning for resection of brain tumors and drug-resistant epilepsy.

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**Mots-Clés:** ccep, structural connectivity, effective connectivity, functional connectivity, dmri, electrical stimulation