SCALES: Studying Cognitive Activity at two Levels with Simultaneous depth and surface recordings

Main area: HBP01_Human brain intracranial data and their relationship to other aspects of brain organisation
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Abstract

Intracerebral EEG (stereotaxic EEG, SEEG) is an invasive measure of brain activity performed during presurgical evaluation of epilepsy. It consists in implanting 10 to 18 electrodes, resulting in up to 250 distinct channels recording directly from brain structures. SEEG is performed on purely diagnostic motivations; collaterally, it provides a unique opportunity for investigating cognitive brain networks in humans across multiple time scales, with an exquisite spatial specificity and matchless signal to noise ratio. Advances in cognitive neurosciences have come from analysis of SEEG recordings, notably in the fields of memory and language. Still, SEEG provides only a partial view of brain activity due to its limited spatial sampling. Non-invasive methods such as EEG and MEG remain the only way to obtain a large-scale view of brain activity at its temporal scale of functioning (i.e., at the millisecond level). Recent research has started bridging the gap between these two scales of description by recording simultaneously invasive (SEEG) and non-invasive (EEG, MEG) neurophysiological signals. Such recordings could be used jointly for characterizing brain networks, surpassing the simple addition of modalities. Crucially, simultaneous recordings provide a view of the exact same brain activity at the two scales, and allows applying powerful single-trial analysis which would not be available on separate recordings.Our objective is to better define the spatio-temporal signature of the brain networks involved in simple cognitive tasks using simultaneous surface and depth recordings. Depth recordings will be instrumental in guiding the exploration of functional task networks, either by allowing the analysis at the level of single trials or by providing high resolution seeds for connectivity measures. Part of the project will be dedicated to methodological issues. The other part will focus on the application of this unique technique to unravelling multi-scale cognitive networks. The partners involved have extensive experience on non-invasive electrophysiology (EEG, MEG), on SEEG recordings and on their simultaneous recording. The consortium includes experts on signal processing for brain neurophysiological data, notably in the service of cognitive questions. Most of the resulting datasets will be made available to the scientific community. Such reference datasets should reveal particularly useful for i) optimizing signal processing methods on surface data by providing a "ground truth" (SEEG) and ii) developing computational models of the brain that will be able to incorporate knowledge from activity both at local and global scales. In summary, simultaneous recordings expand the view of each modality taken separately, and allow unprecedented developments in signal analysis. This project will thus bring a better understanding of cognitive networks, as well as provide unique reference datasets for computational neuroscientists.

Consortium

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