Pathological Functional Connectivity under Epilepsy with iEEG

Our movements depend on our mental state. However, our understanding of how mental state reflects both on neural brain activity and on the interconnectivity across brain areas, it all remains poorly understood. In particular, in the case of epilepsy, the leading of epilepsy is that seizure are generated by an excess of synchrony across brain areas. As part of the therapy, we recorded sets of intra-cortical and surface electro-encephalographic signal from different brain areas, under different mental states from epilepsy patients. Here we propose to test the hypothesis that the frequency of their crisis may be traced to the degree of pathological (over-) connectivity across brain areas in a quantitative fashion.

Can we distinguish different brain states on the neural data as a function of the mental state recorded experimentally? Are our metrics of functional connectivity across brain areas capable of capturing this pathological state?

The project we propose aims at the following goals:

1) To assess the separability of correlation matrices in the EEG sensory space within the dataset of each individual subject, recorded under each experimental condition. Are these motivated states separable with specific machine learning techniques? (Gilson et al., 2016)
2) If we transform the EEG signals from sensory to source space (Hindriks et al., 2017), can we identify differences in functional/effective brain connectivity as a function of state different than those typically recorded from healthy subjects?

The student's goal would be that of developing computational models of the brain, to identify and quantify differences of neural connectivity across brain areas as a function of the person's mental state. The student will also be at charge of the preparation of scientific manuscripts for publication and of presenting these results at scientific conferences

References:

Gilson M, Moreno-Bote R, Ponce-Alvarez A, Ritter P, Deco G (2016) Estimation of Directed Effective Connectivity from fMRI Functional Connectivity Hints at Asymmetries of Cortical Connectome. PLoS Comput. Biol. 12

Hindriks R, Schmiedt J, Arsiwalla XD, Peter A, Verschure PFMJ, Fries P, Schmid MC, Deco G (2017) Linear distributed source modeling of local field potentials recorded with intra-cortical electrode arrays. PLOS ONE 12:e0187490