Atelier
« Dynamiques invariantes d'échelle et réseaux en neurosciences »
21-24 octobre 2013

Workshop on
Scale-Free Dynamics and Networks in Neurosciences
October 21–24, 2013

Resting state functional connectivity in epilepsy

Christophe Grova*

christophe.grova@mcgill.ca

WEB: apps.mni.mcgill.ca/research/gotman/members/christophe.html

---

Epileptic activity during seizures arises from the seizure focus, whereas epileptic activity without clinical manifestations might originate from a broader area and propagate to surrounding or distant brain regions, defining a patient-specific epileptogenic network. As a target for surgery, several modalities are considered to localize this epileptic focus, using notably source localization from spontaneous discharges measured using Electro- and Magneto-Encephalography (EEG/MEG) or simultaneous EEG/fMRI acquisitions to detect local hemodynamic changes at the time of the discharges. The main limitation of these studies is the recording of spontaneous epileptic discharges during a short recording session (2 hours max). Therefore, we proposed to investigate whether resting state fluctuations of hemodynamic signals, measured using fMRI, could reveal specific patterns that could potentially be considered as a biomarker of the disease even when no epileptic discharge could be recorded. The first part of the presentation will present inter-individual group studies describing fMRI functional connectivity (FC) patterns specific to idiopathic generalized epilepsy (IGE) and temporal lobe epilepsy (TLE). Using hypothesis driven approaches, we showed, using seed regions in the epileptic focus, significant decreases in resting state functional connectivity in TLE [1], when compared to age-matched healthy controls. For IGE patients, we found no significant difference in FC when using seeds in the regions showing a fMRI activation to spike and wave discharges [2], whereas we found singnificant increases and decreases in FC when using seed regions in the attention network [3]. Since the choice of the seed region was critical in these studies, we present a new data driven decomposition method, specifically designed to extract FC patterns that are shared and specific when comparing groups of subjects [4]. We were able to reproduce most of these findings without any priori hypothesis. These results suggest that the epilepsy disease is indeed interfering with resting state FC patterns even when no epileptic discharges are generated. Except for IGE and TLE, the epileptogenic network is patient

*Biomedical Engineering Department, McGill University, 3775 University Street, Montréal, QC H3A 2B4, CANADA.

specific and its location will differ from one patient to the other. Therefore, it is important to develop methods able to extract patient-specific FC patterns. To do so, we propose a method denoted DANI –Detection of Abnormal Networks in Individuals – to identify, for each patient, the outlier resting state networks (RSN) that statistically differ from the consistent RSNs of the healthy population, thus suggesting the occurrence of "abnormal" networks. We first used the spatial clustering method denoted BASC, Bootstrap Analysis of Stable Clusters [5], in order to identify statistically reproducible RSNs either at the individual level or at a group level. Then, DANI consisted in a statistical detection method to identify outlier RSNs. DANI was carefully validated using simulated data and promising preliminary results on patients with focal epilepsy will be presented. Finally we will introduce how we combined the resampling technique proposed in BASC with a new data driven sparse modeling technique [6], in order to identify reliable hubs at the individual level, as another promising approach to detect epilepsy specific patterns.

[1] Pittau F et al., Patterns of altered functional connectivity in mesial temporal lobe epilepsy. Epilepsia 2012: 53(6):1013-23.

[2] Moeller F et al., Functional connectivity in patients with idiopathic generalized epilepsy. Epilepsia 2011: 52(3):515-22.

[3] Maneshi M. et al., Resting-State Connectivity of the Sustained Attention Network Correlates with Disease Duration in Idiopathic Generalized Epilepsy. PloS ONE 2012;7(12):e50359.

[4] Vahdat S. Et al., Shared and Specific Independent Components Analysis for Between-Groups Comparison. Neural Computation 2012;24(11):3052-90.

[5] Bellec P, Rosa-Neto P, Lyttelton OC, Benali H, Evans AC. Multi-level bootstrap analysis of stable clusters in resting-state fMRI. Neuroimage. 2010;51(3):1126-39.

[6] Lee K, Tak S, Ye JC. A data-driven sparse GLM for fMRI analysis using sparse dictionary learning with MDL criterion. IEEE Trans Med Imaging. 2011 May;30(5):1076-89.