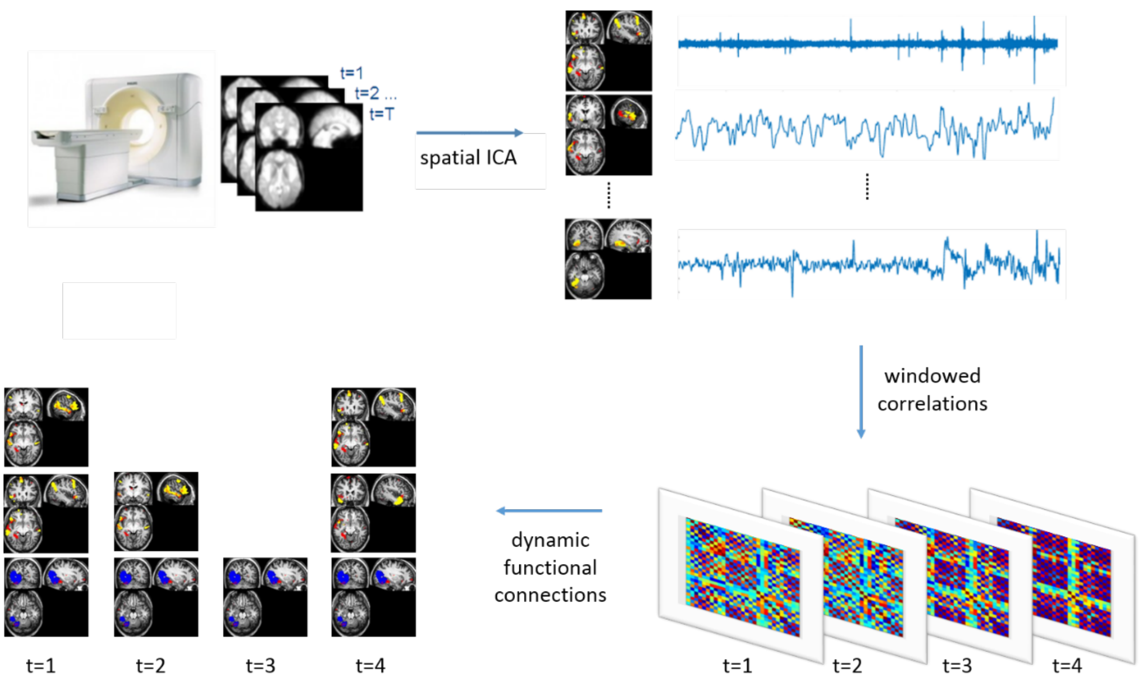
Visualization of dynamic functional network connectivity in epilepsy

fMRI is a useful technique to observe brain activity with high spatial resolution. It has been shown recently [1], that regions involved in epileptic activity can be revealed by an independent component analysis (ICA) of fMRI data. Each independent component is characterized by a 3d spatial map or topography, and an activation time course. Besides the epileptic network, ICA also reveals so-called resting state networks (RSNs), which consist of several brain regions and which are fairly consistent in their topography among healthy subjects. These stereotypical networks are responsible for the execution of specific cognitive/motor/etc. tasks, but they also spontaneously synchronize during rest. Many studies revealed that these networks are affected by epilepsy, e.g. they show altered connectivity, or deactivation during interictal activity. However, the dynamic interaction between the epileptic network and other RNSs has not been studied extensively.

The goal of this thesis is to develop a visualization tool which helps to investigate the time-varying connectivity among these functional networks in epilepsy. Two main considerations have to be made.

1. Patient-by-patient variability

Previous studies investigating dynamic functional network connectivity start from group-based ICA to reveal robust and consistent RSNs across healthy subjects [2]. However, this approach will fail to extract epileptic networks, which are specific to each individual patient. Therefore, ICA is performed on the individual patient data. First, we need to match those ICs across patients which correspond to the same RSNs, using openly available RSN atlases. Second, we are interested to see which RSNs have consistent topography across patients and which ones are affected by epilepsy. Finally, the epileptic IC will be identified based on provided clinical information.



2. Time-scale and strength of connectivity

After the RSNs and the epileptic networks have been identified, their dynamical interactions can be studied. This is normally achieved by a windowed correlation analysis of their activation time courses [2]. Two networks may be considered functionally connected if the correlation of their activation time course exceeds a certain threshold. We are interested to see which RSNs and how often connect with the epileptic network and whether these dynamics are consistent across individual patients. The visualization tool should reveal how the chosen window length and correlation threshold influence these findings and, eventually, help to choose optimal parameters.

[1] Hunyadi, B., Tousseyn, S., Mijovic, B., Dupont, P., Van Huffel, S., Van Paesschen, W., De Vos, M. (2013). ICA extracts epileptic sources from fMRI in EEG-negative patients : a retrospective validation study. *PLoS One, 8* (11), 1-9.

[2] Allen, E. A., Damaraju, E., Plis, S.M., Erhardt, E.B., Eichele, T. And Calhoun V.D. (2014) Tracking whole-brain connectivity dynamics is the resting state. *Cerebral Cortex*, *24*, 663-676.

- Requirements: Interest in design, interaction and in-depth discussion with the user is a must. Interest in neuroscience is a plus.
- Type of work: Literature: 20%, Implementation: 50%, Experiments and Results: 30%
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