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Functional and structural connectivity data obtained with Magnetic Resonance Imaging

Abstract

Magnetic resonance imaging (MRI) allows non-invasive investigation of brain connectivity[1]. How grey matter nuclei or cortical areas are connected can be studied from different perspectives.

The relationships of the neural activity time courses between spatially distinct gray matter regions can be exploited using blood oxygenation level dependent (BOLD) resting-state functional MRI (rsfMRI)[2].

The characterization of the white matter bundles connecting different gray matter regions can be performed using diffusion-weighted imaging (DWI) and tractography[3].

A lot of studies have been conducted in the last decade in order to define the human "connectome"[4] of healthy subjects and pathological cases. The acquisition and processing of these quantitative MRI techniques, i.e. rsfMRI and DWI, involves various steps and methodological choices.

As to acquisition, rsfMRI can be acquired using different parameters and for 5 to 10 minutes. DWI can be acquired using one or more diffusion gradient amplitudes and along 6 to hundreds of diffusion directions.

For data processing[5], pre-processing options include – but are not limited to – de-noising procedure, temporal alinement, distortion correction. Then, the co-registration of structural and functional data to a common spatial system can be performed using affine or non-linear transformation. Then, the functional connectivity can be explored using data-driven methods, such as spatial independent component analysis (sICA), that extracts reproducible resting state networks (RSN) involved in integrative and sensory-motor functions, e.g., the default mode network, the visual and the sensory-motor networks. Alternatively, the temporal correlation of the signals from different gray matter regions can be studied. The selection of cortical and subcortical gray matter regions can be performed segmenting anatomical MRI or using the parcels provided by various functional or structural atlases. This procedure can be used also for the structural connectivity, where the white matter bundles can be virtually reconstructed using deterministic or probabilistic tractography between couples of regions.

Some studies also aimed at integrating functional and structural connectivity[4,6].

This talk aims at describing the different acquisition and processing strategies that can be used and read in functional and structural MRI studies.

References

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