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Imaging biomarker discovery in major depressive disorder with diffusion MRI multi-compartment models

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**Introduction**

- Major depressive disorder (MDD) is a disease widespread all over the world associated with a large and increasing economic, societal, and personal burden [Ferrari 2013]
- Despite a large number of studies, the pathophysiology underlying MDD is not well understood
- We propose a tract-based pipeline analysis using multi-compartment models (MCM) that allows to model water diffusion under the voxel resolution

**Data**

- Actidep: Major depressive disorder in the elderly population 40 patients and 28 controls
- Clinical interest: Depressive symptoms in late life are associated with an increased risk of developing dementia [Barnes 2012]
- MRI acquisitions
  - Cusp: DWI with 1.5 mm isotropic resolution, 60 gradient orientations and 7 b0 [Scherrer 2012]
  - MPRAGE: T1-weighted images 1 mm isotropic
  - Resting state fMRI

**Methods**

**Input:**

- DWI with several b-values to estimate complex models
- T1-weighted image for registration purpose

**DWI preprocessing**

- Eddy current correction
- Block matching distortion correction
- NL-means denoising
- Brain masking

**Multi-compartment models**

- Estimate MCM [Stamm 2016] that decomposes the water diffusion as a weighted sum of anisotropic and isotropic compartments
- Extract scalar maps (FA, MD, FW ...) from MCMs
- MCM FA is the average of each anisotropic compartment FA
- Rigid registration of preprocessed DWIs and scalar maps on MNI152 Atlas

**Tractography**

For each subject:
- TractSeg performs a tractography for all registered DWIs based on ODF resulting in 72 identified fiber bundles [Wasserthal 2018]
- For each bundle a centroid is estimated and values (FA, MD, ...) are provided [Chandio 2020]

**Statistics**

- Performs group to group comparison along tracts
- Covariable (age, sexe ...) can be removed

**Results**

**Statistic along fiber tracts**

- Pipeline tested on the Actidep database
- Group controls (26 subjects) vs group patients (39 subjects) for different MCM metrics
- Corrected for age, sex and duration of depression

**Conclusion & perspectives**

- We developed a pipeline to perform tractography analysis using multi-compartment models
- We tested this pipeline on the Actidep database
- In the future we will extend this study to explore different database with additional MRI sequences, such as relaxometry, to derive new metrics and develop a multi-modal approach

Ferrari, Alze J., et al. “Burden of depressive disorders by country, sex, age, and year: findings from the global burden of disease study 2010.”
Scherrer, Benoit, and Simon K. Warfield. “Parametric representation of multiple white matter fascicles from cube and sphere diffusion MRI.”