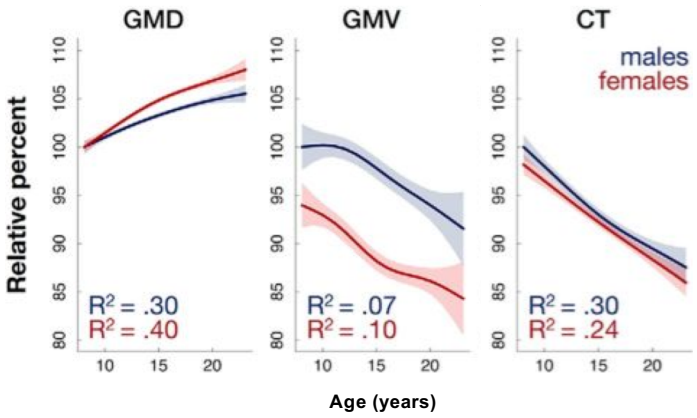
Development of white matter structural covariance networks is associated with executive functioning

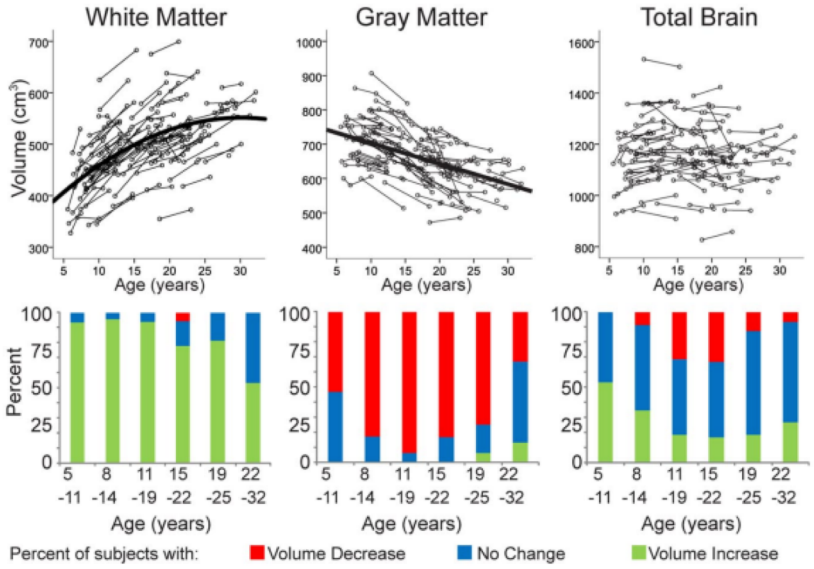
Josiane Bourque

September 20th 2021

Brain development

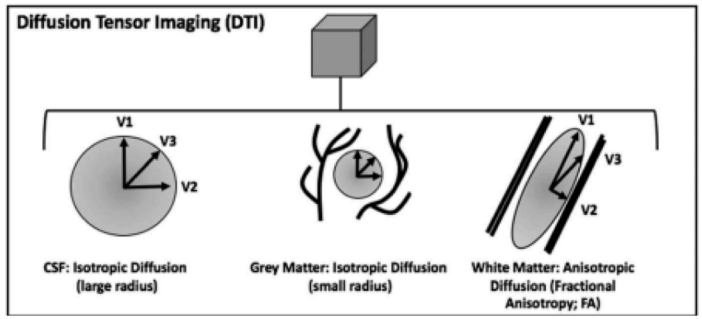


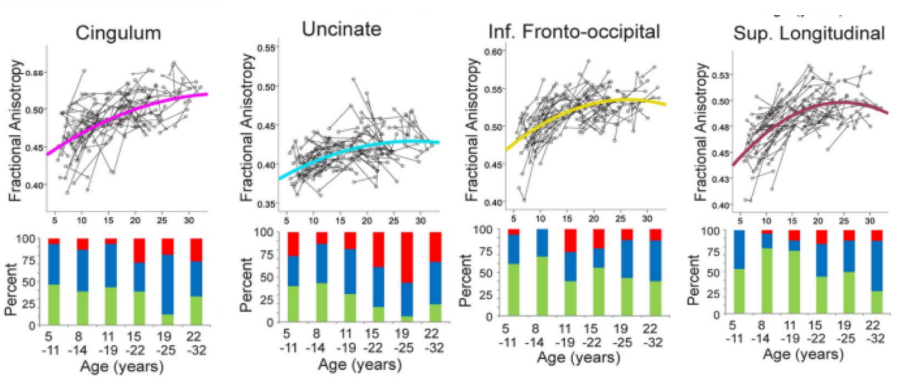
Gennatas, 2017 JN

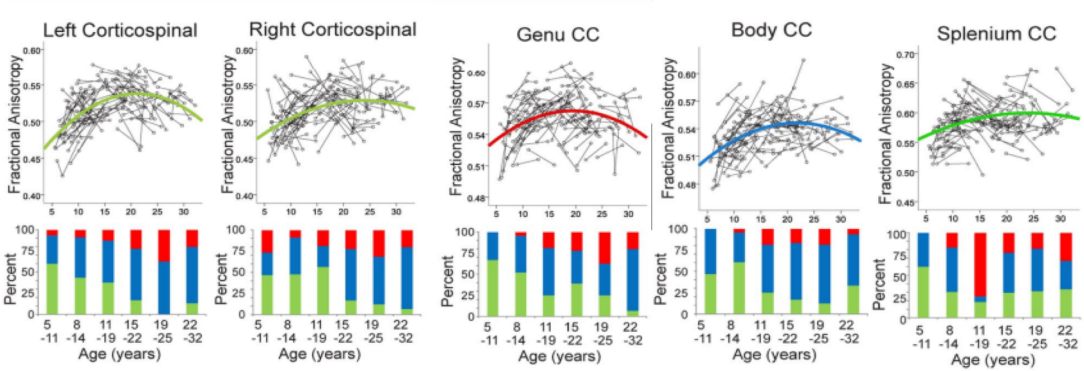


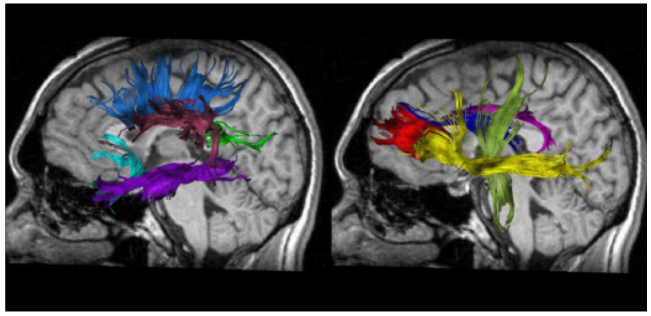
Lebel & Beaulieu 2011 JN

Development of white matter microstructure (DTI)



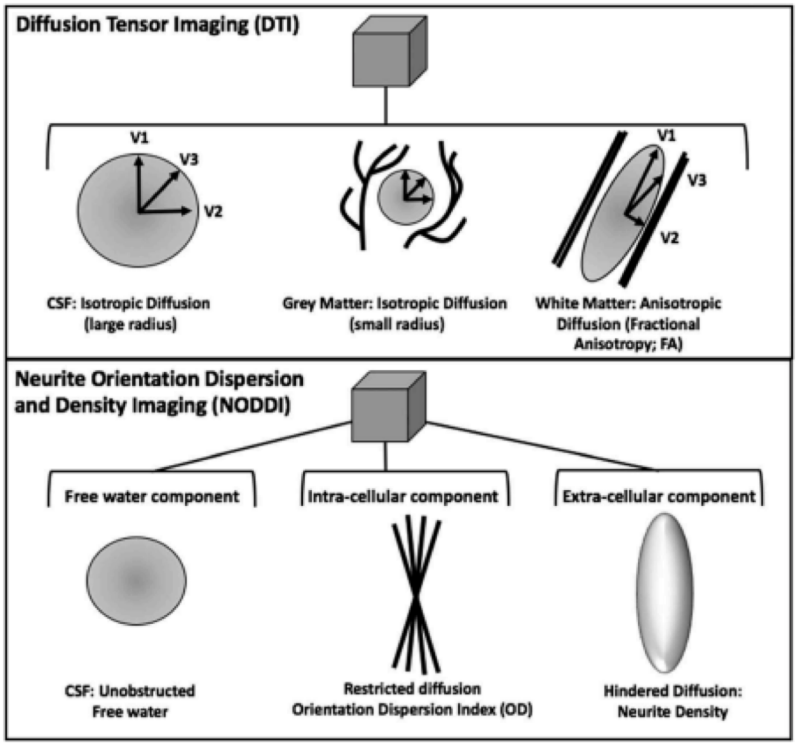




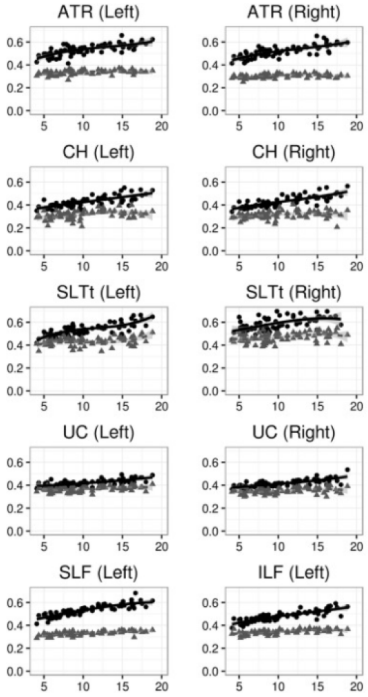


Lebel & Beaulieu 2011 JN

Development of white matter microstructure (NODDI)

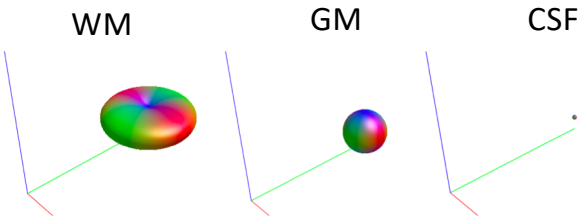


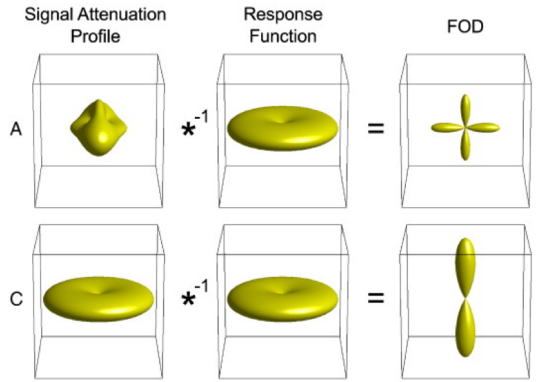
Uddin & Karlsgodt 2018



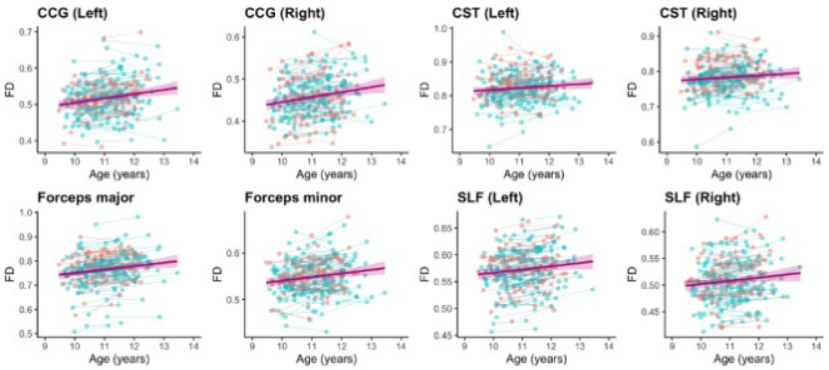
Genc, 2017 Neuroimage

Fixel-based Analysis – Fiber orientation distributions (FODs)

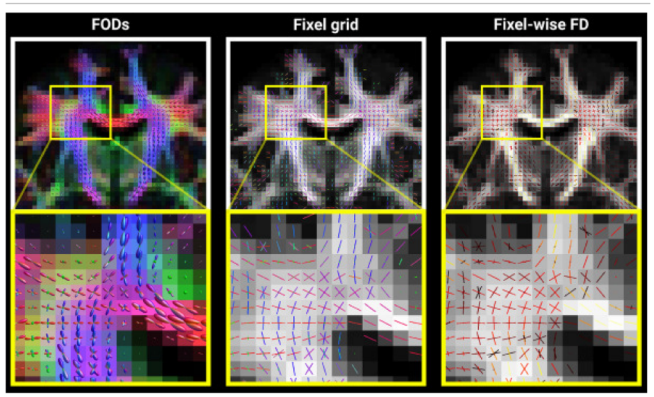




Raffelt, 2012 Neuroimage

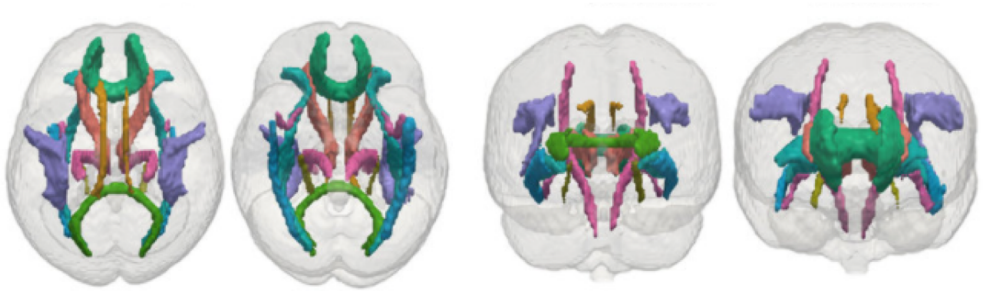


Genc, 2020 DCN

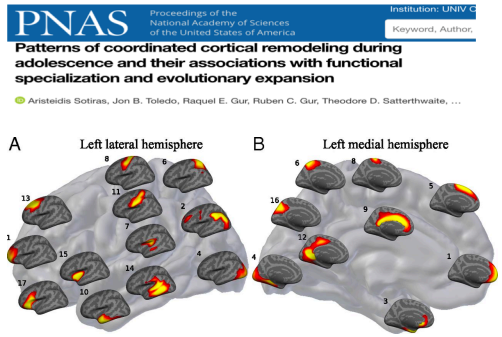


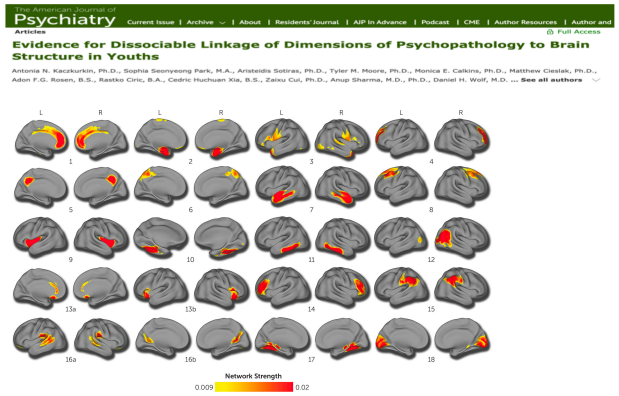
Dhollander, 2021 Neuroimage

Data driven decomposition instead of WM DTI atlas



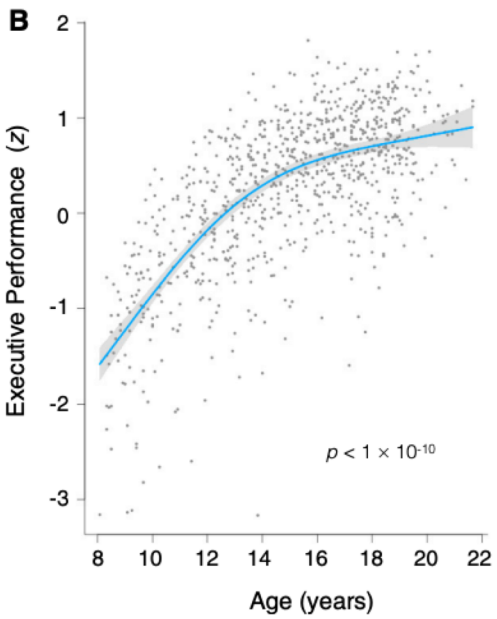
Kievit, 2016 Neuroimage



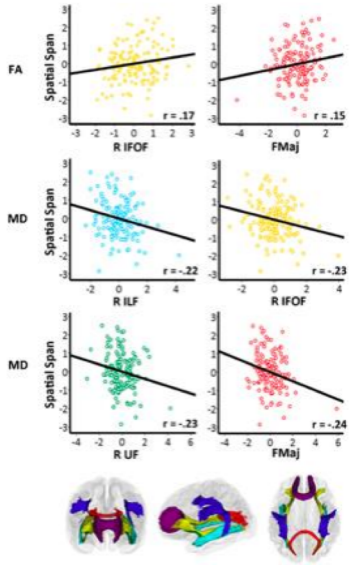


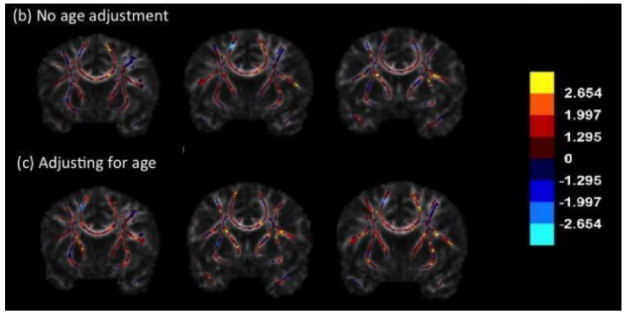
Sotiras, 2017 PNAS, Kaczkurkin 2019, AJP

The protracted development of executive functions



Baum, 2017 Cur Biol





Goddings, 2021 BioRxv

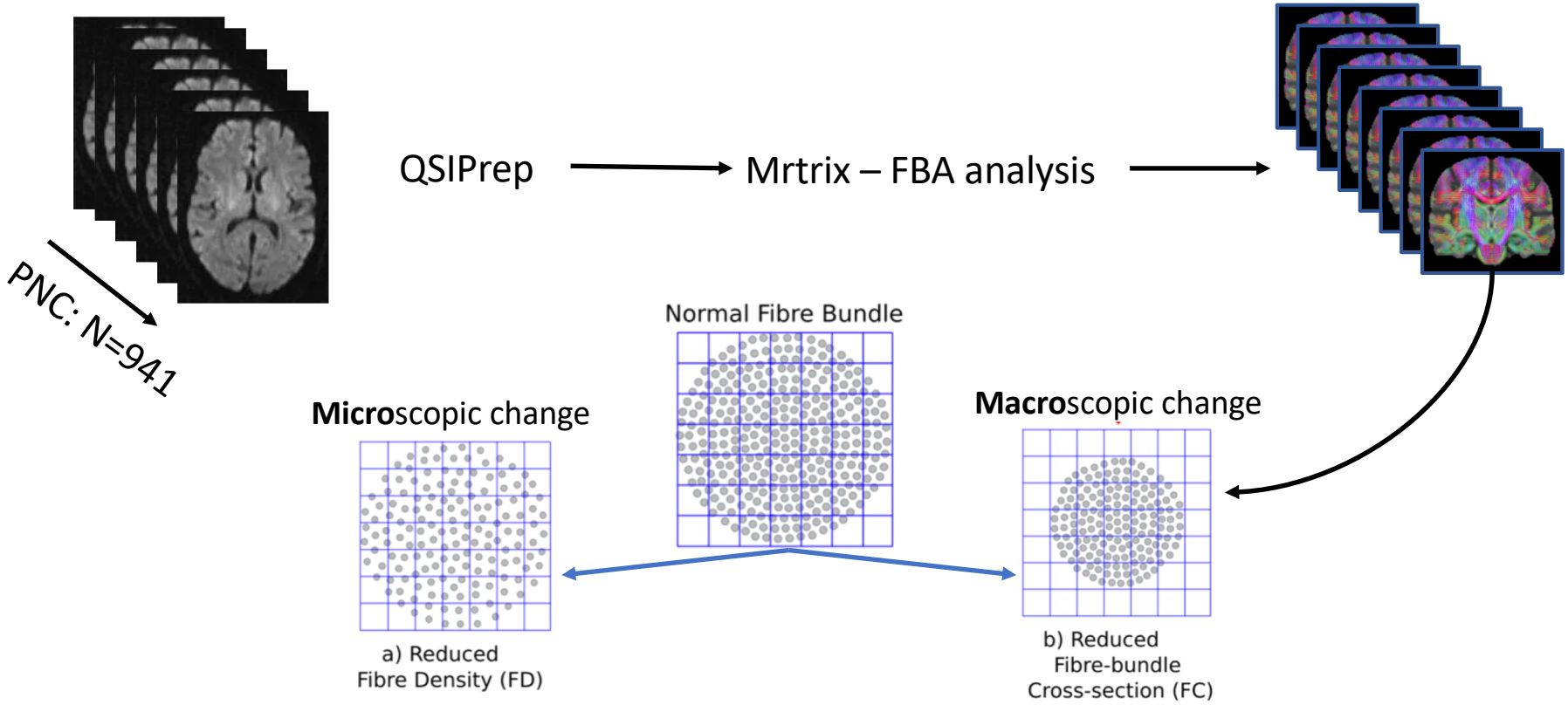
Aims

1. Explore WM micro- and macro-structural porperties by delineating structural covariance networks
    - Whether these covariance networks map well onto WM tracts atlas

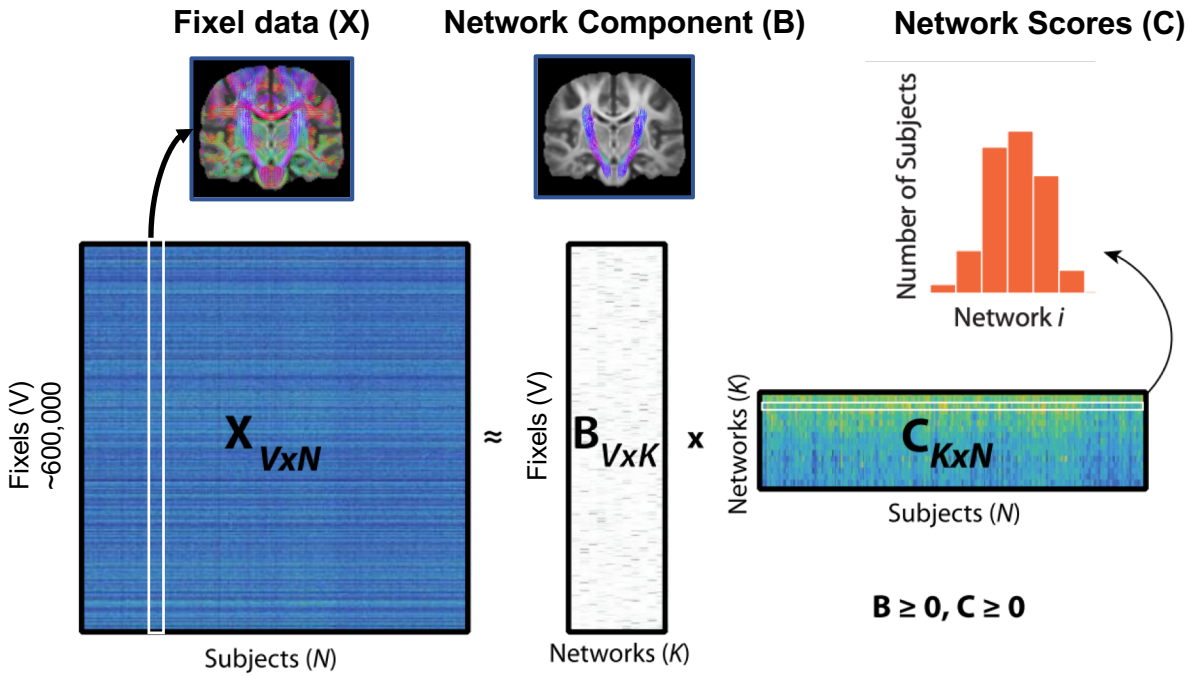
2. How the covariance networks develop during adolescence
    - Are there sex difference?

3. Whether WM covariance networks's developmental effects are related to executive functions

Data processing

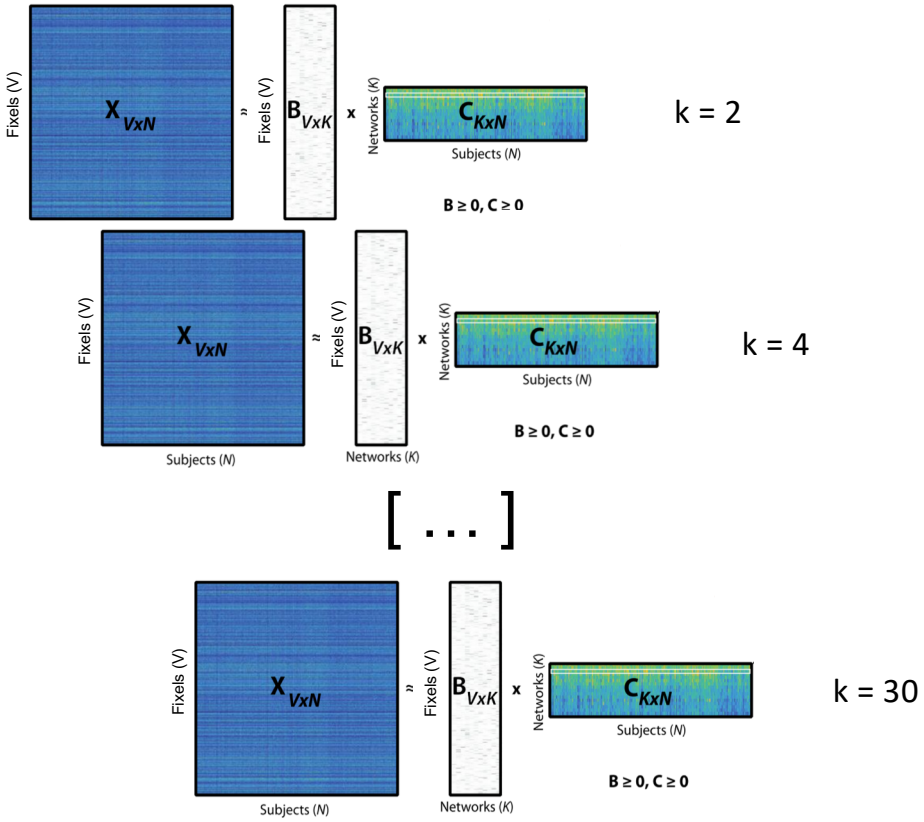


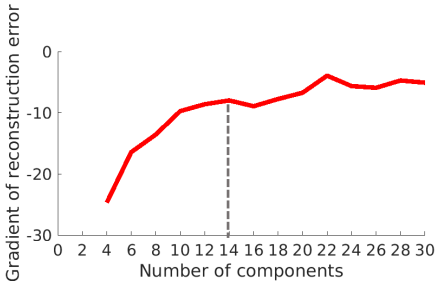
Fixel covariance networks with OPNMF

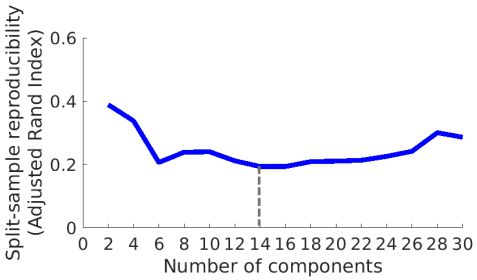


Kaczkurkin et al. 2019, AJP

14-network resolution

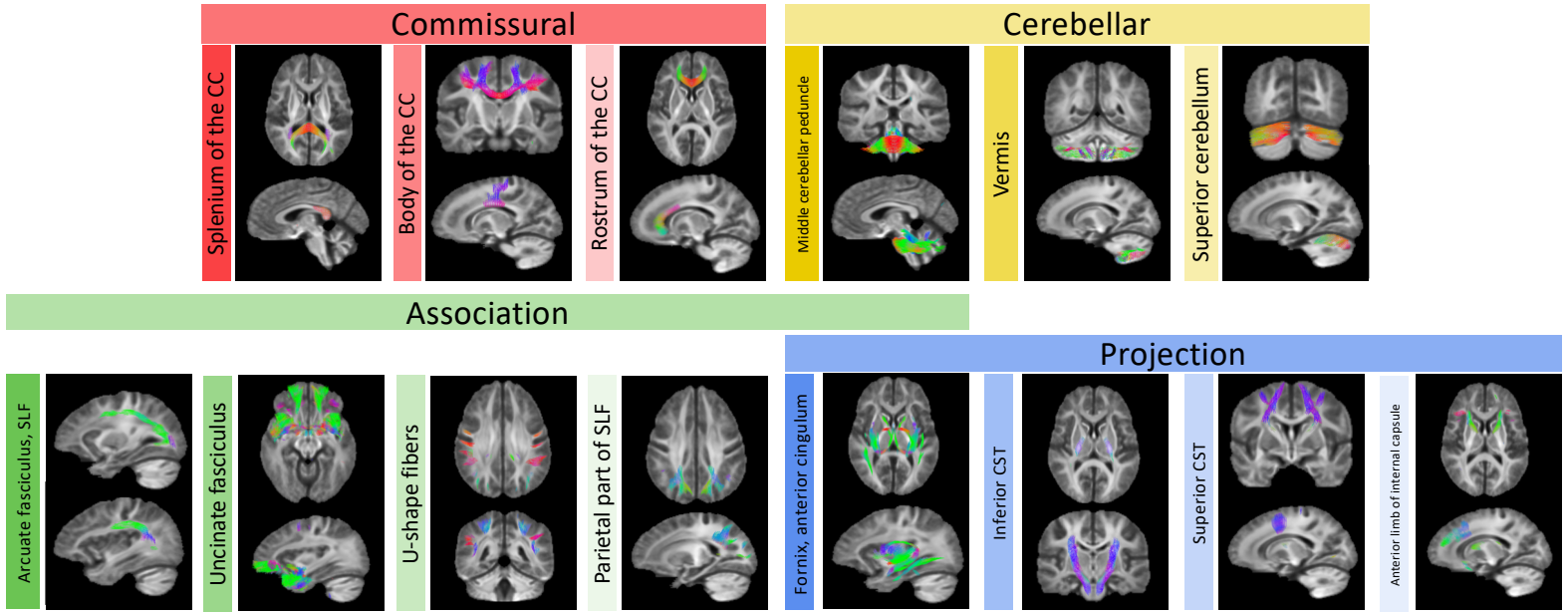






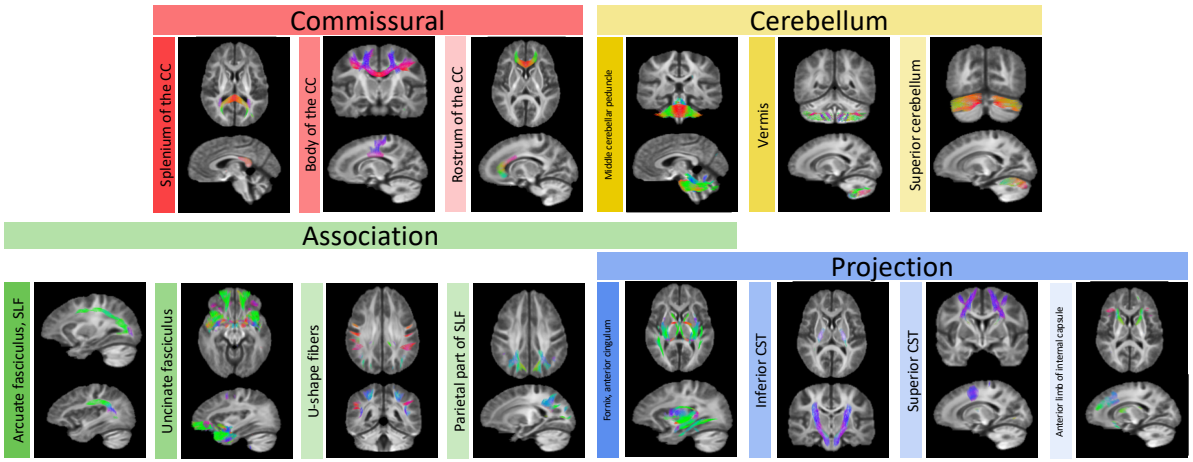
Sparse, symmetric, and spatially compact fixel networks

A

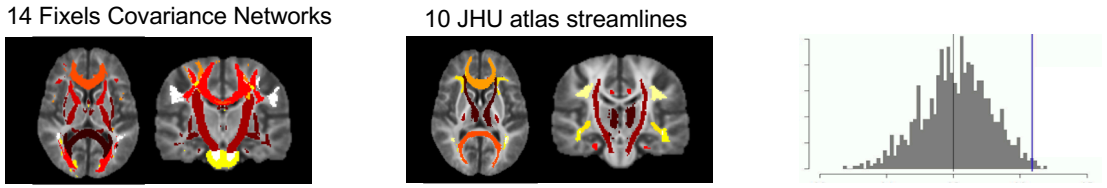


Spatial correlation with WM tract atlas

A



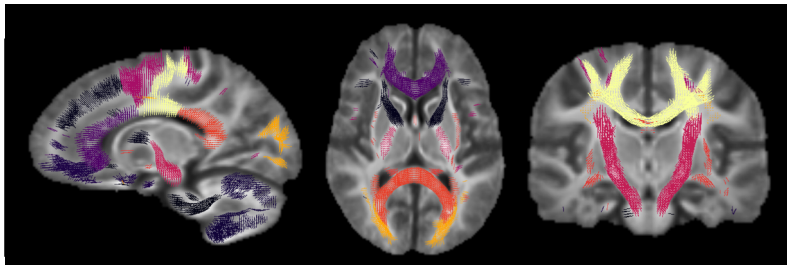
B

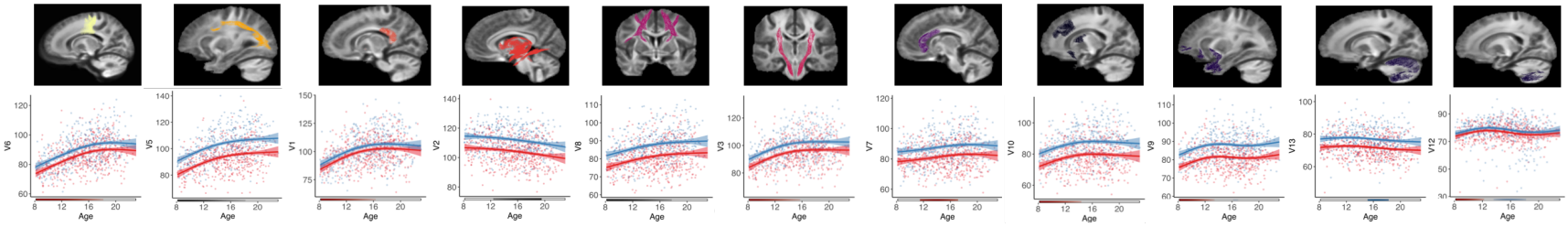


Fixel networks display different developmental effects

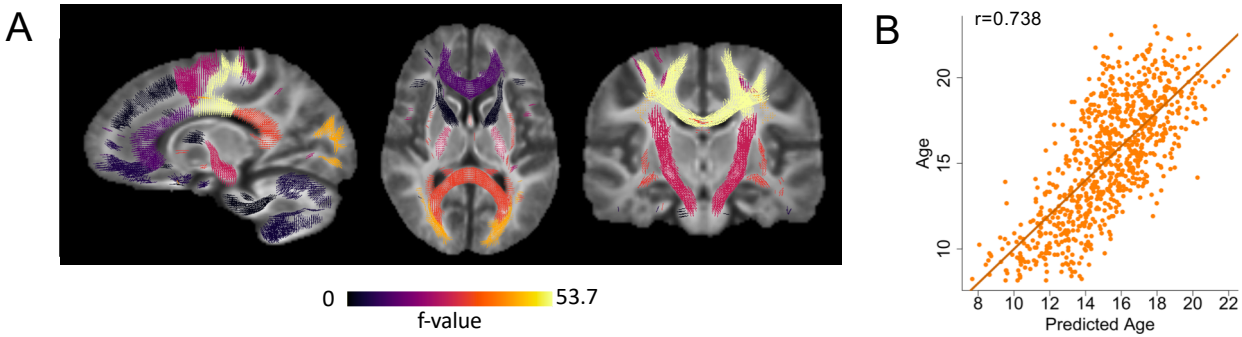
FDC ~ sex + QC measures + s(Age)

A

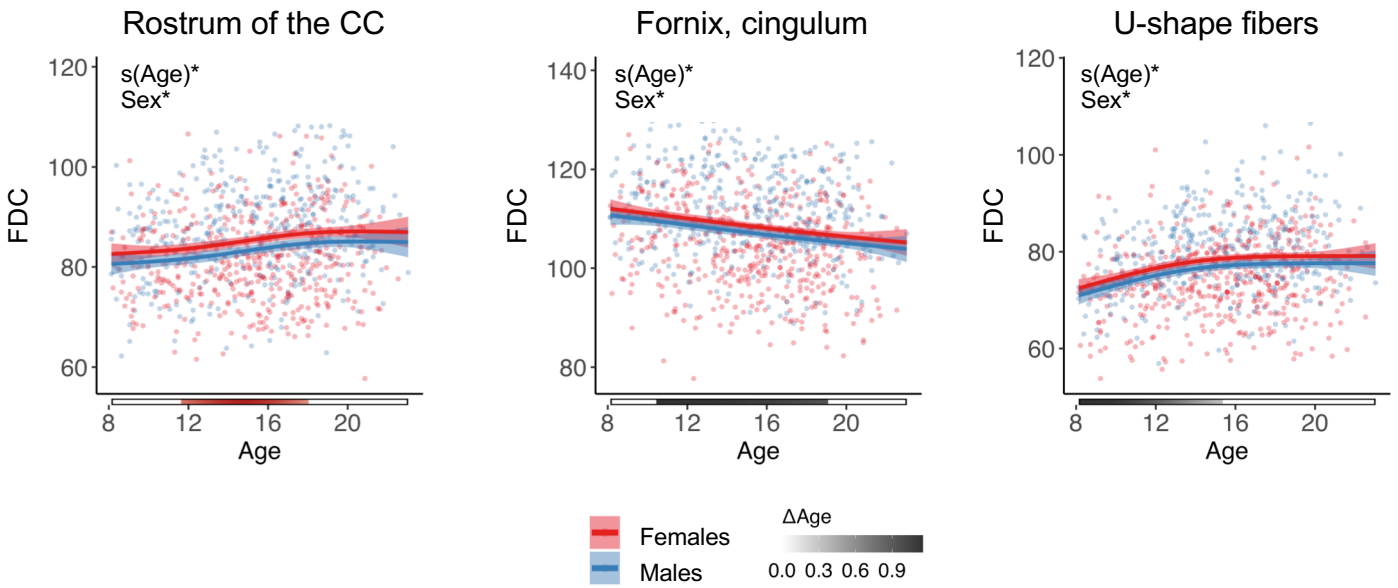




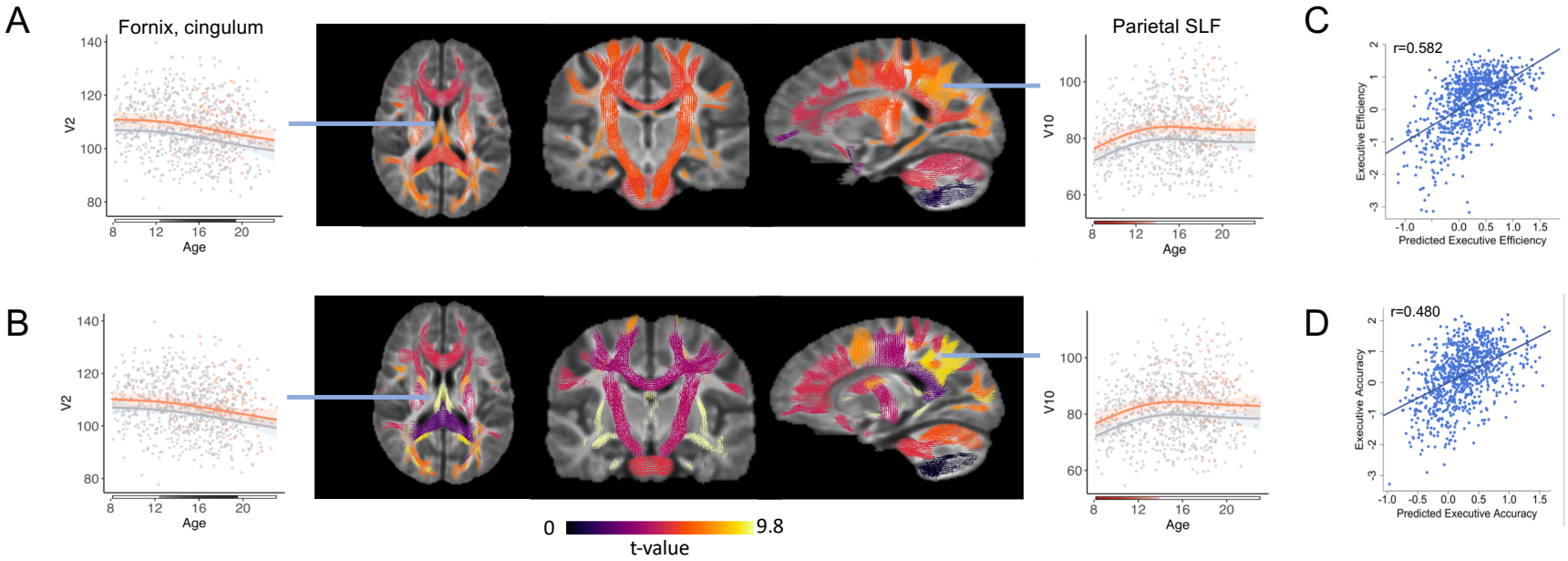
Fixel covariance networks predict age



Higher FDC in girls when controlling for brain volume



Developmental trajectories of FDC are associated with Executive Functioning



Conclusions

- We provided spatially meaningful WM microstructure covariance networks
- For most networks, we observed age-related increases in FDC (except for cerebellar WM, and limbic WM)
- Main effect of sex on the age-related increases in FDC (females showing higher FDC (FD) when controlling for TBV
- Better executive function performance is driven mainly by higher FDC in the SLF and fornix, cingulum

Future directions

- Investigate whether the development of white matter microstructure follows the S-A axis

- Whether functional connectivity within the fronto-parietal network drives changes in the underlying WM microstructure that explains gains in executive function performance

Thankful for a great team!

- Matt
- Val
- Max
- Bart
- Aris Sotiras
- Tinashe
- Chenying
- Sydney

- TED