



MRC Cognition  
and Brain  
Sciences Unit



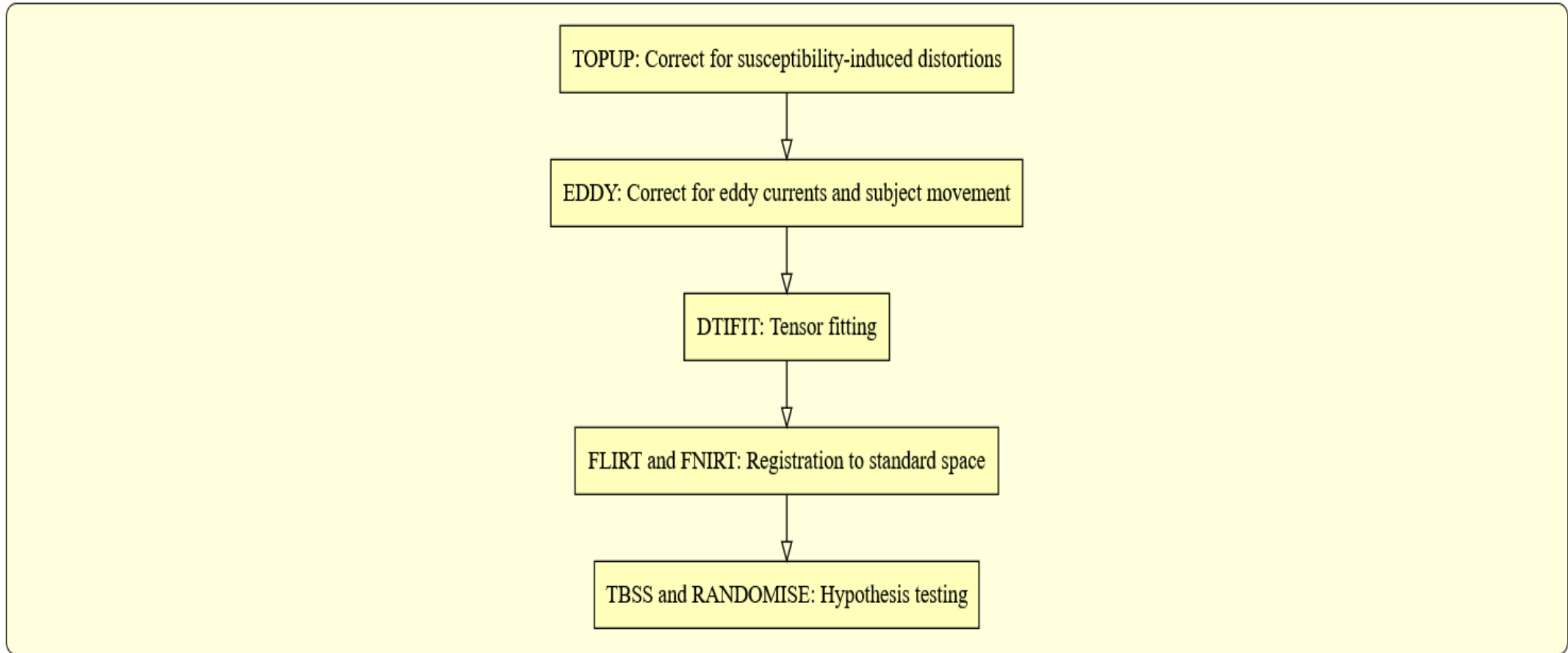
UNIVERSITY OF  
CAMBRIDGE

# DTI Model Fitting and Group Analysis in FSL

Marta M. Correia

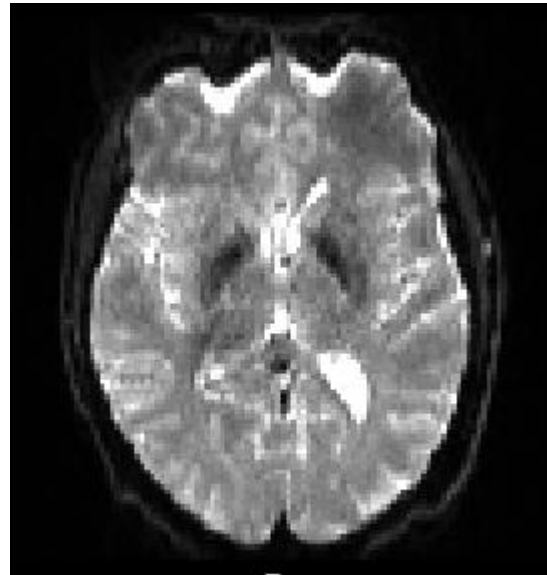
MRC Cognition and Brain Sciences Unit

# Overview of the FSL Diffusion Toolbox pipeline

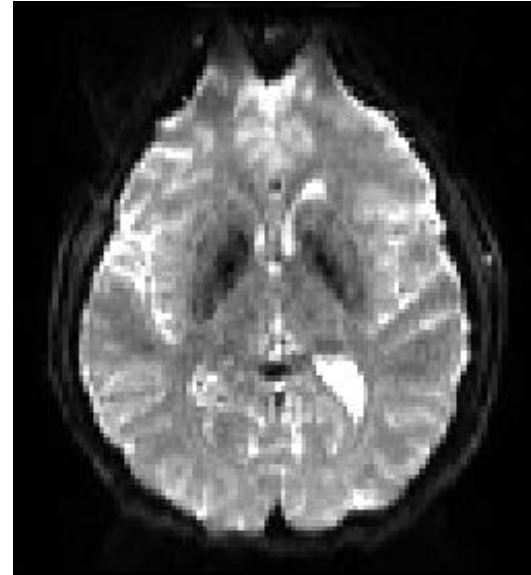


# TOPUP: correction for EPI distortions

- EPI distortion due to B0 inhomogeneity depends on phase-encode direction



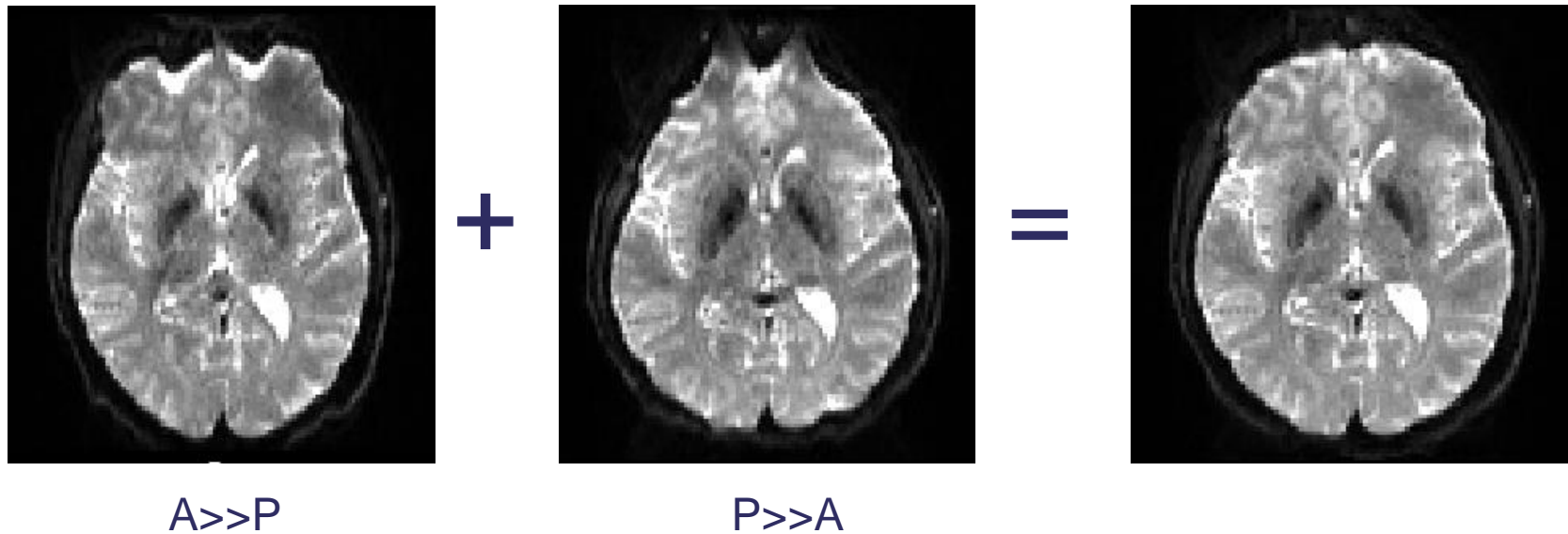
A>>P



P>>A

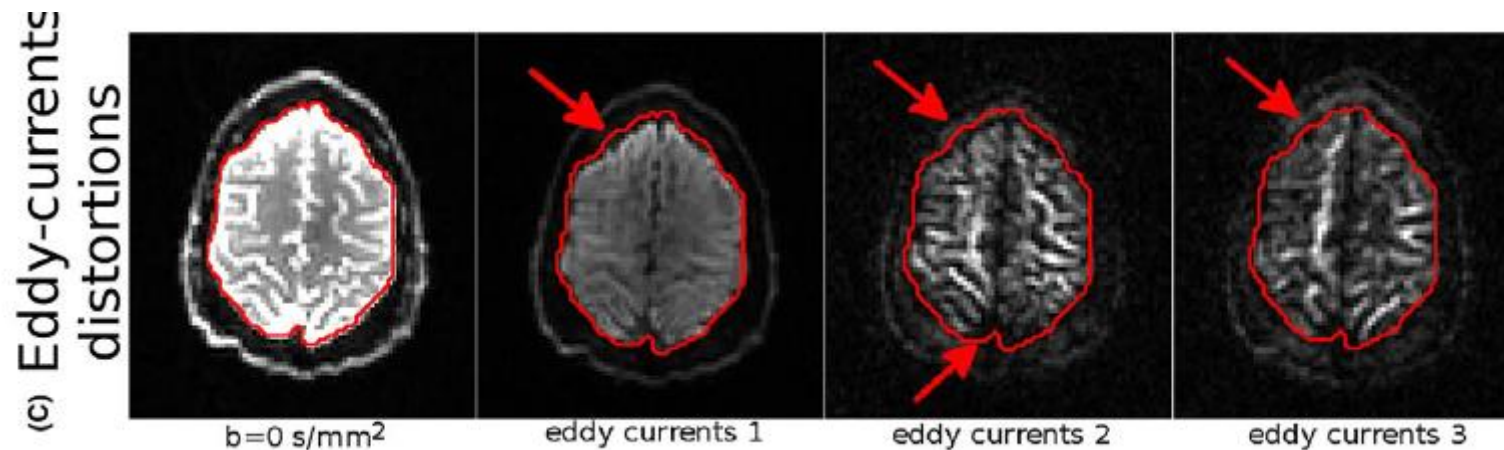
# TOPUP: correction for EPI distortions

- EPI distortion due to B0 inhomogeneity depends on phase-encode direction
- Can it be corrected?



# EDDY: correction for eddy currents and motion

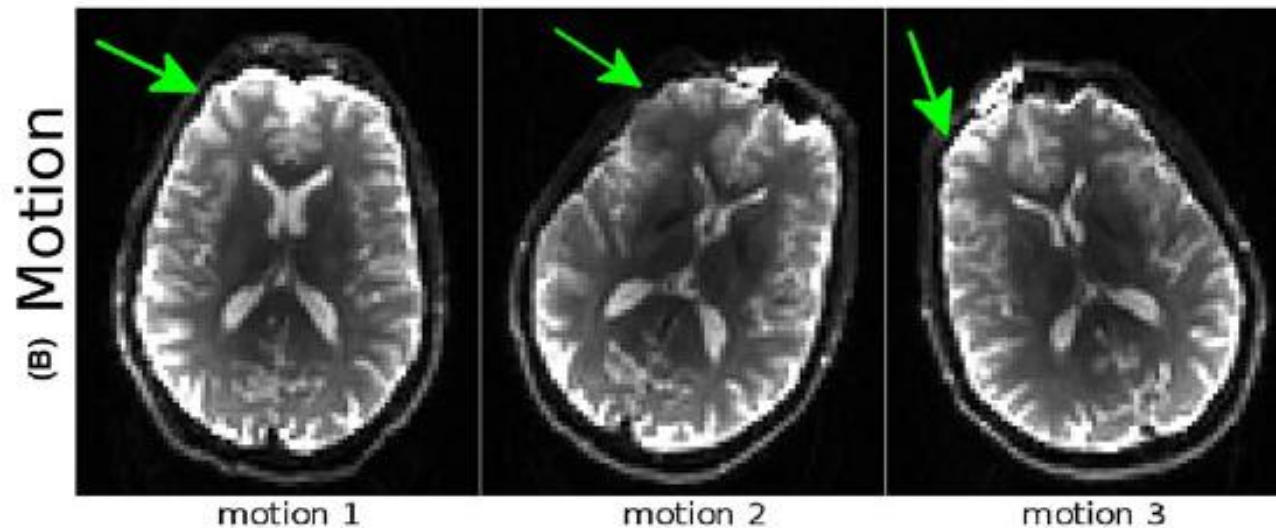
- Eddy-current distortions occur due to the rapid switching of diffusion gradients.
- Depend on gradient magnitude and direction.
- They affect the diffusion weighted images (DWI) but not the  $b=0$  image.
- Results in mismatching between  $b=0$  and DWI volumes.



Irfanoglu et al, MRM 2018

# EDDY: correction for eddy currents and motion

- Motion artefacts occur due to involuntary head movements.
- Results in mismatching between DWI volumes.
- Can also result in signal changes due to coil sensitivity.



Irfanoglu et al, MRM 2018

# EDDY QC: quality control

- For individual subjects: eddy\_quad

## Volume-to-volume motion

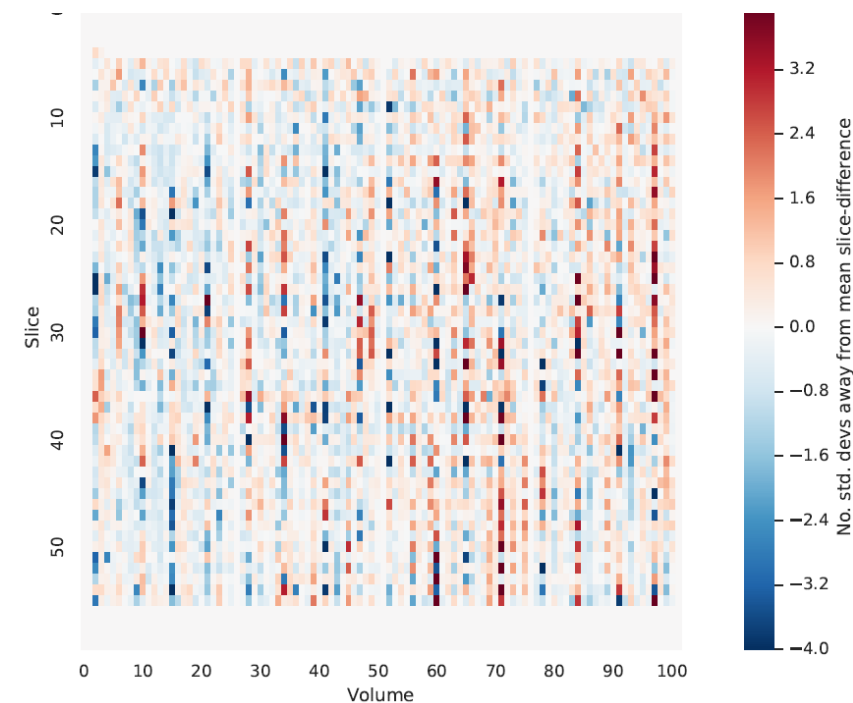
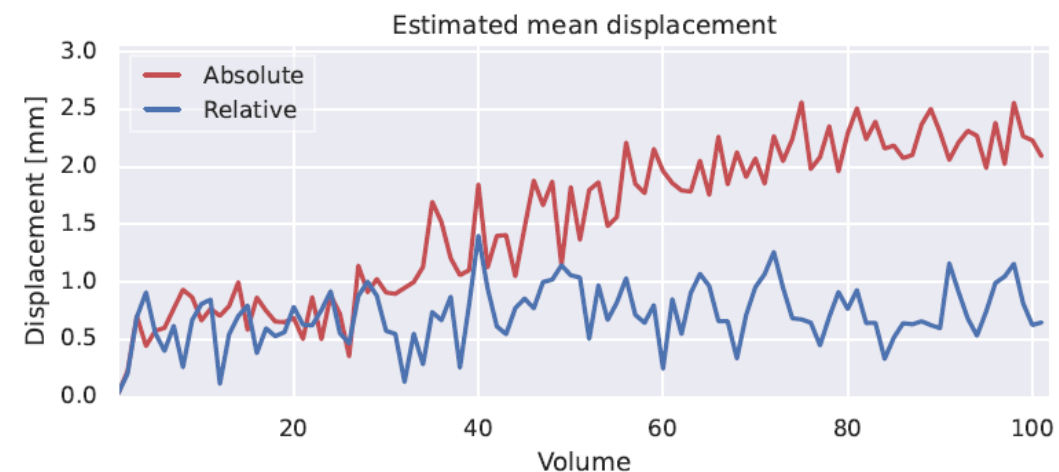
Average abs. motion (mm)	1.52
Average rel. motion (mm)	0.70
Average x translation (mm)	0.10
Average y translation (mm)	-0.90
Average z translation (mm)	0.98
Average x rotation (deg)	-0.02
Average y rotation (deg)	0.19
Average z rotation (deg)	-0.15

## Outliers

Total outliers (%)	0.45
Outliers (b=700 s/mm <sup>2</sup> )	2.71
Outliers (b=1200 s/mm <sup>2</sup> )	0.00
Outliers (b=2800 s/mm <sup>2</sup> )	0.00
Outliers (PE dir=[0. 1. 0.])	0.42

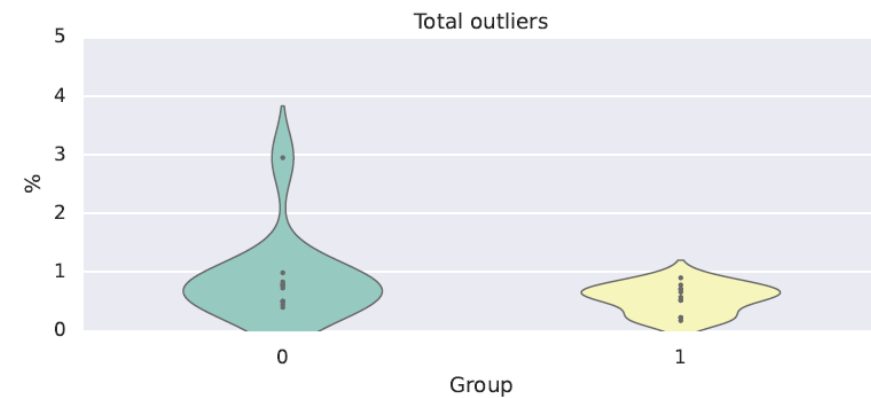
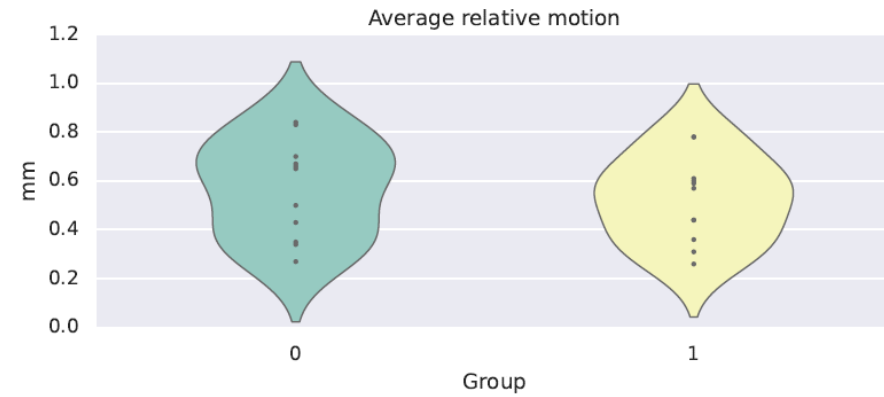
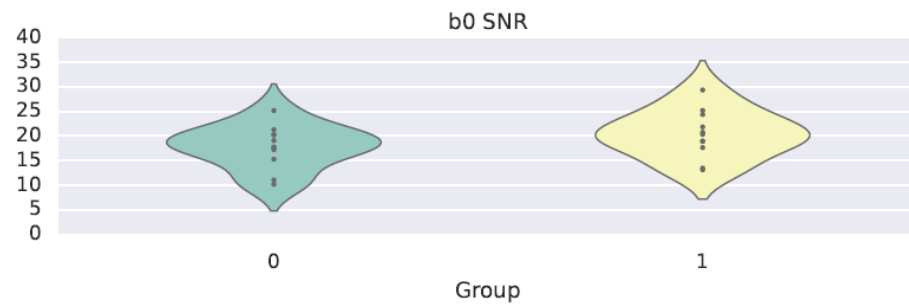
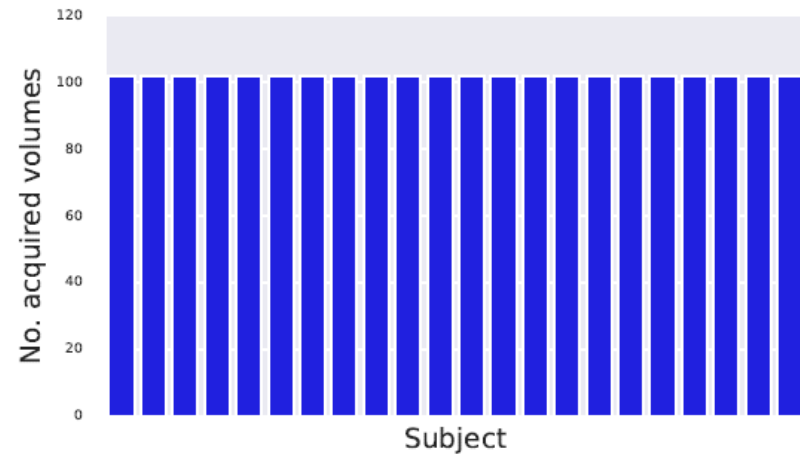
## SNR/CNR

Average SNR (b=0 s/mm <sup>2</sup> )	17.57
Average CNR (b=700 s/mm <sup>2</sup> )	0.96
Average CNR (b=1200 s/mm <sup>2</sup> )	1.33
Average CNR (b=2800 s/mm <sup>2</sup> )	1.54



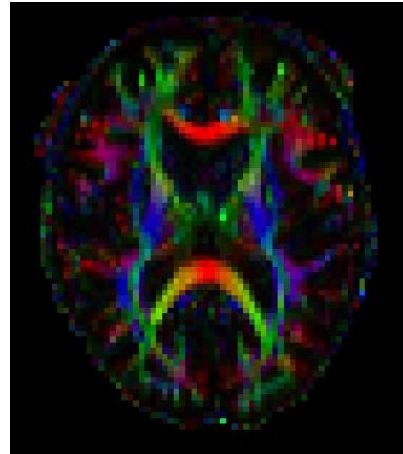
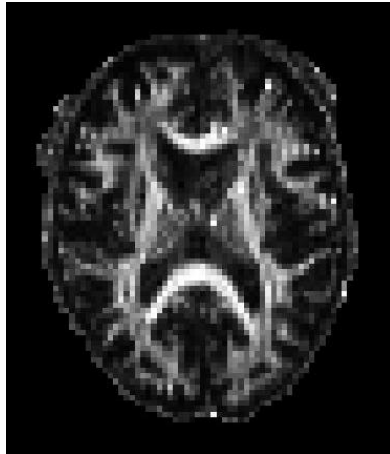
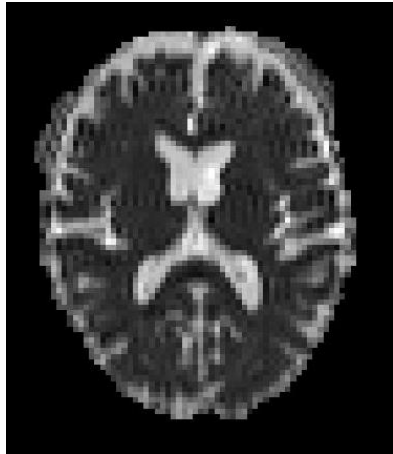
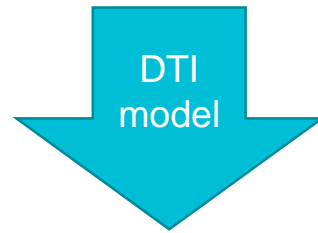
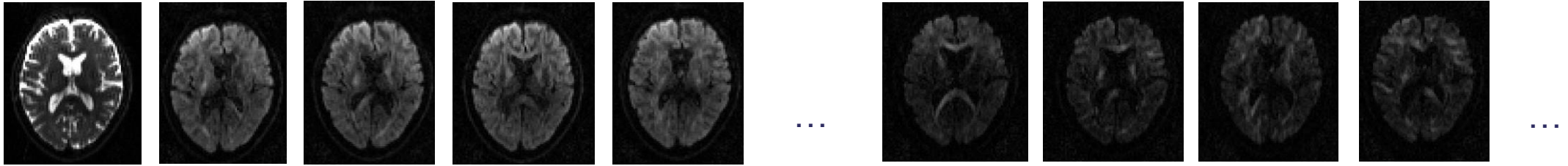
# EDDY QC: quality control

- Study-wide quality control: eddy\_squad





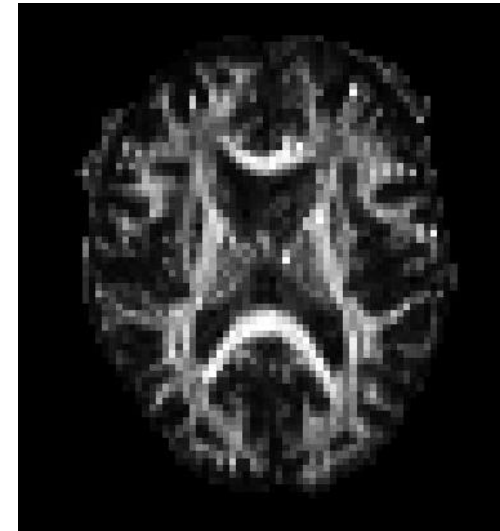
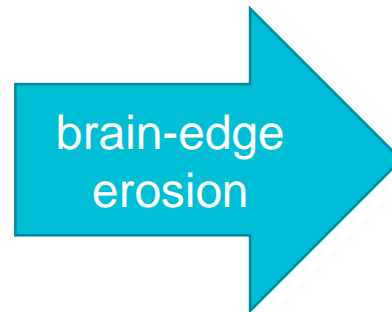
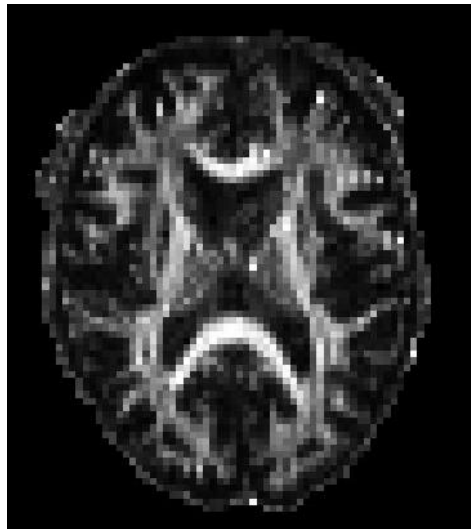
# DTIFIT: diffusion tensor model fitting



# TBSS: Group Analysis of DTI data

## 1. Preparing FA data for TBSS:

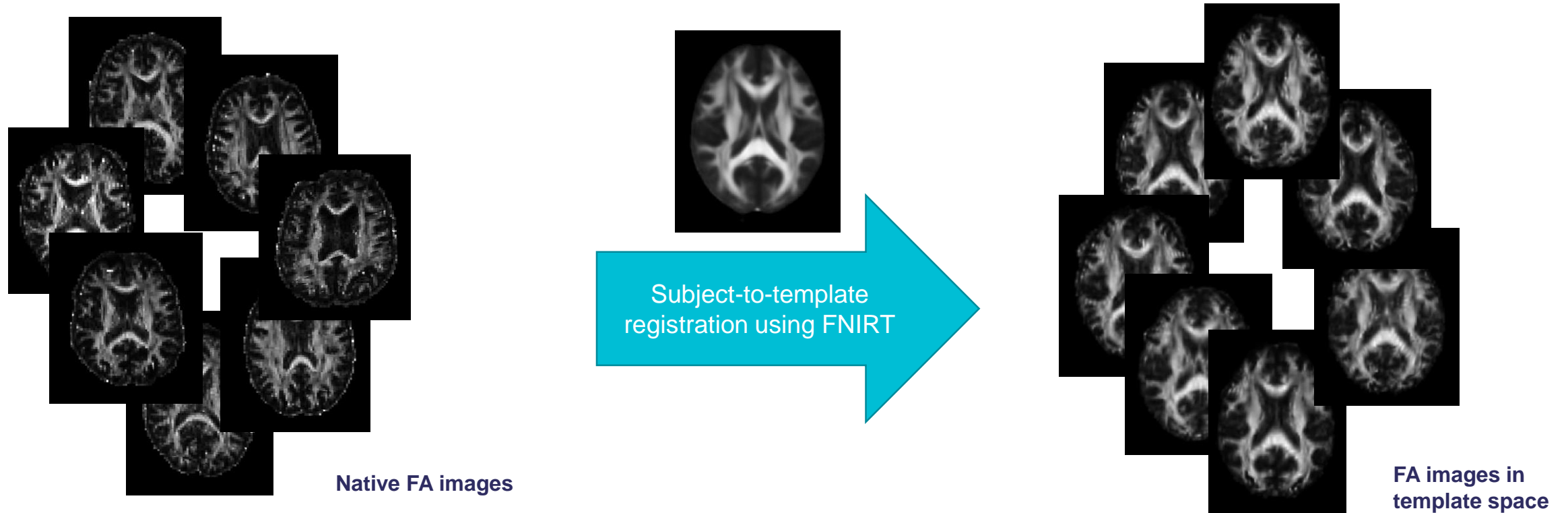
- Rename files
- New folder structure
- Erode FA images to reduce brain-edge artefacts



# TBSS: Group Analysis of DTI data

## 2. Registering the FA data:

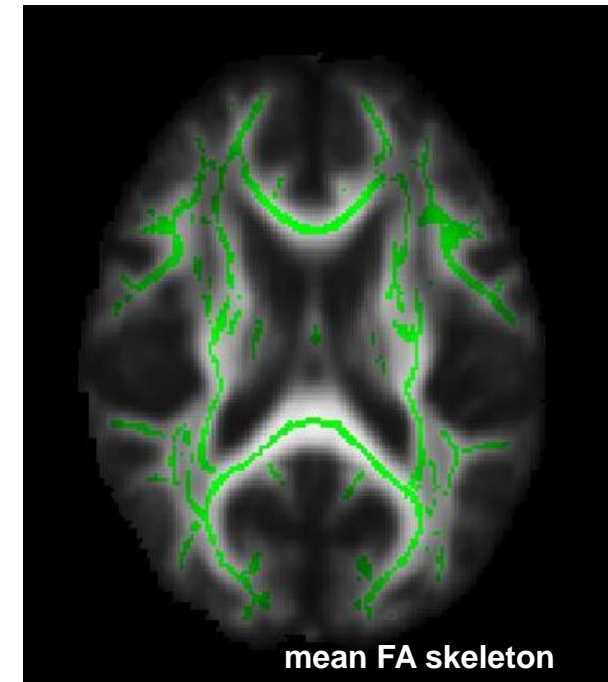
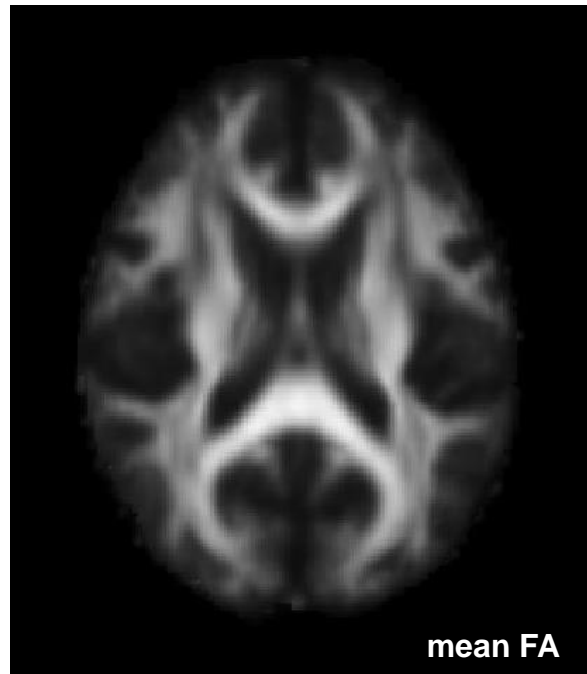
- Register FA images to the FMRIB58\_FA template using non-linear registration (FNIRT)



# TBSS: Group Analysis of DTI data

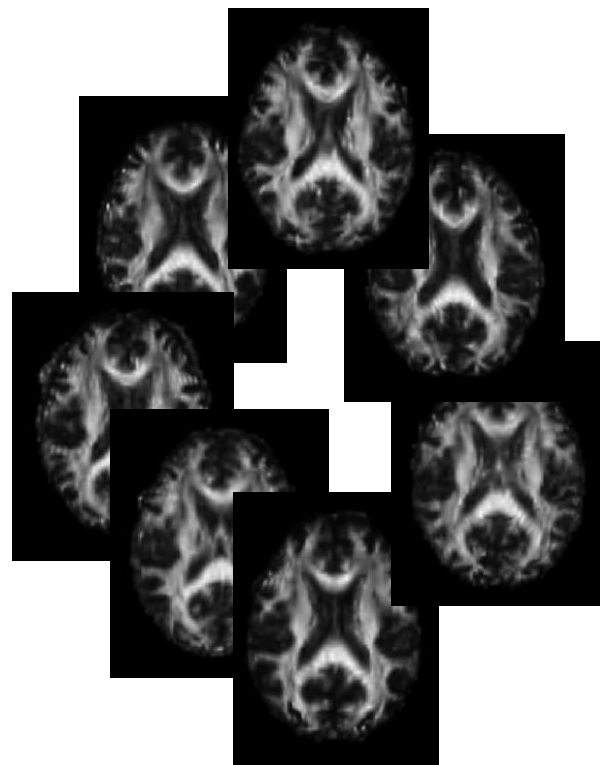
## 3. Post-registration processing:

- Average all registered FA images
- Create the mean FA skeleton

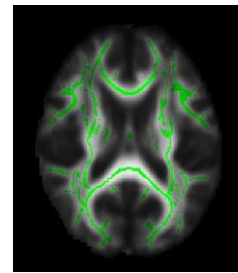


# TBSS: Group Analysis of DTI data

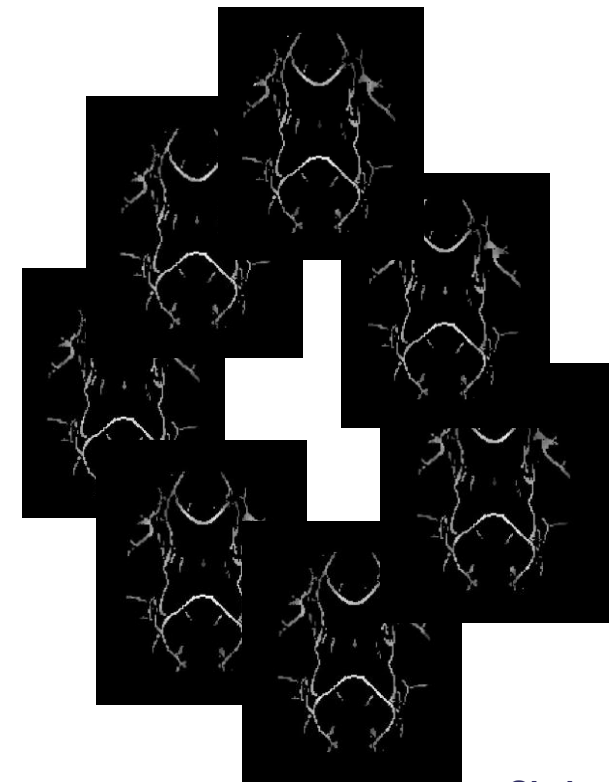
## 4. Projecting each subject's FA map onto the skeleton:



FA images in  
template space



Projection onto  
skeleton



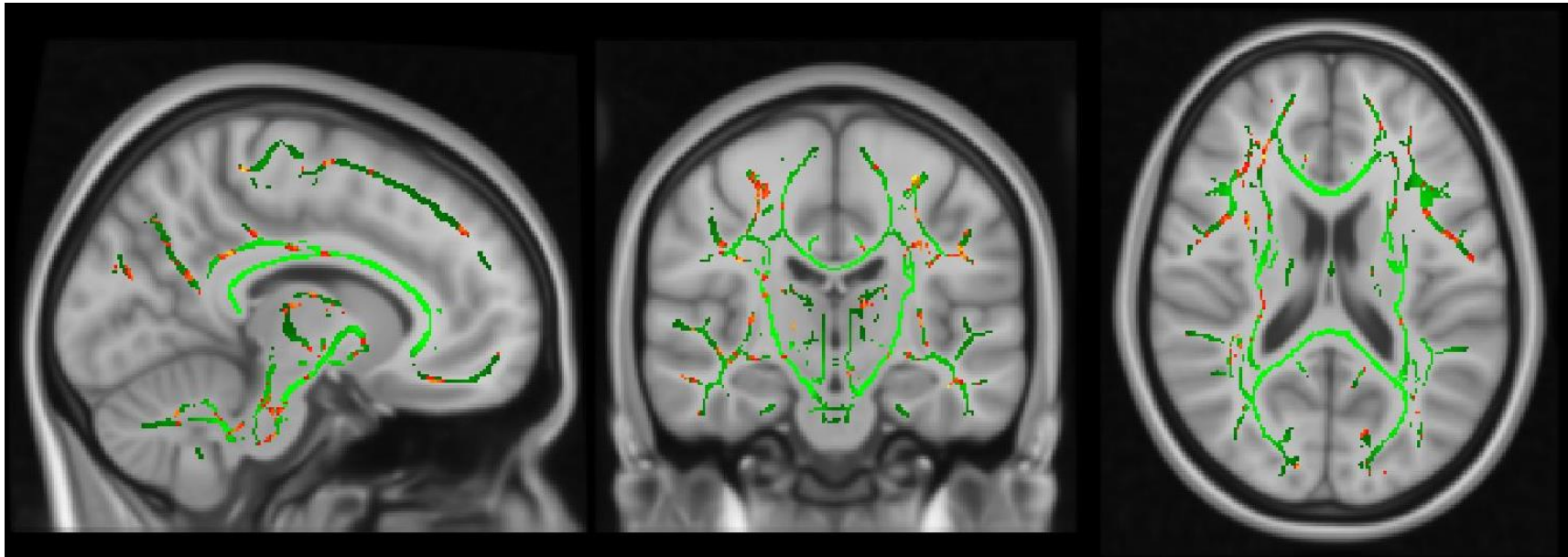
Skeletonised FA  
images



# VBM using FSL tools

## 5. Statistical analysis:

- Create the design matrix
- Use **randomise** for non-parametric inference



# Interpretation of results

- FA skeleton does not represent the center of a specific WM tract.
- Significance maps should be interpreted with care: post-registration misalignments and voxel misassignments may confound the FA values from structures in close proximity.
- Choice of parameters, e.g. the registration target, can lead to large variation in the FA skeleton and subsequently the statistical results.



## Methodological considerations on tract-based spatial statistics (TBSS)

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Bram Stieltjes <sup>a</sup>, Klaus H. Maier-Hein <sup>a,e,\*</sup>





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**Thank you**

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