EPI susceptibility correction introduces significant differences far from local areas of high distortion

John P. Begnoche , Kurt G. Schilling , Brian D. Boyd , Leon Y. Cai , Warren D. Taylor , Bennett A. Landman

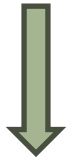
Magnetic Resonance Imaging

2022

EPI susceptibility correction introduces significant differences far from local areas of high distortion

- **Goal of the paper:**

Applying a deep learning technique to generate an undistorted volume to correct susceptibility artifacts and make improvement in image fidelity and diffusion-based inference outside of areas where high focal distortion is present



Assessing a method for EPI susceptibility distortion correction

PreQual

Begnoche JP, Schilling KG, Boyd BD, Cai LY, Taylor WD, Landman BA. EPI susceptibility correction introduces significant differences far from local areas of high distortion. Magn Reson Imaging, 2022.
Cai LY et al., PreQual: An automated pipeline for integrated preprocessing and quality assurance of diffusion weighted MRI images. Magn Reson Med. 2021.

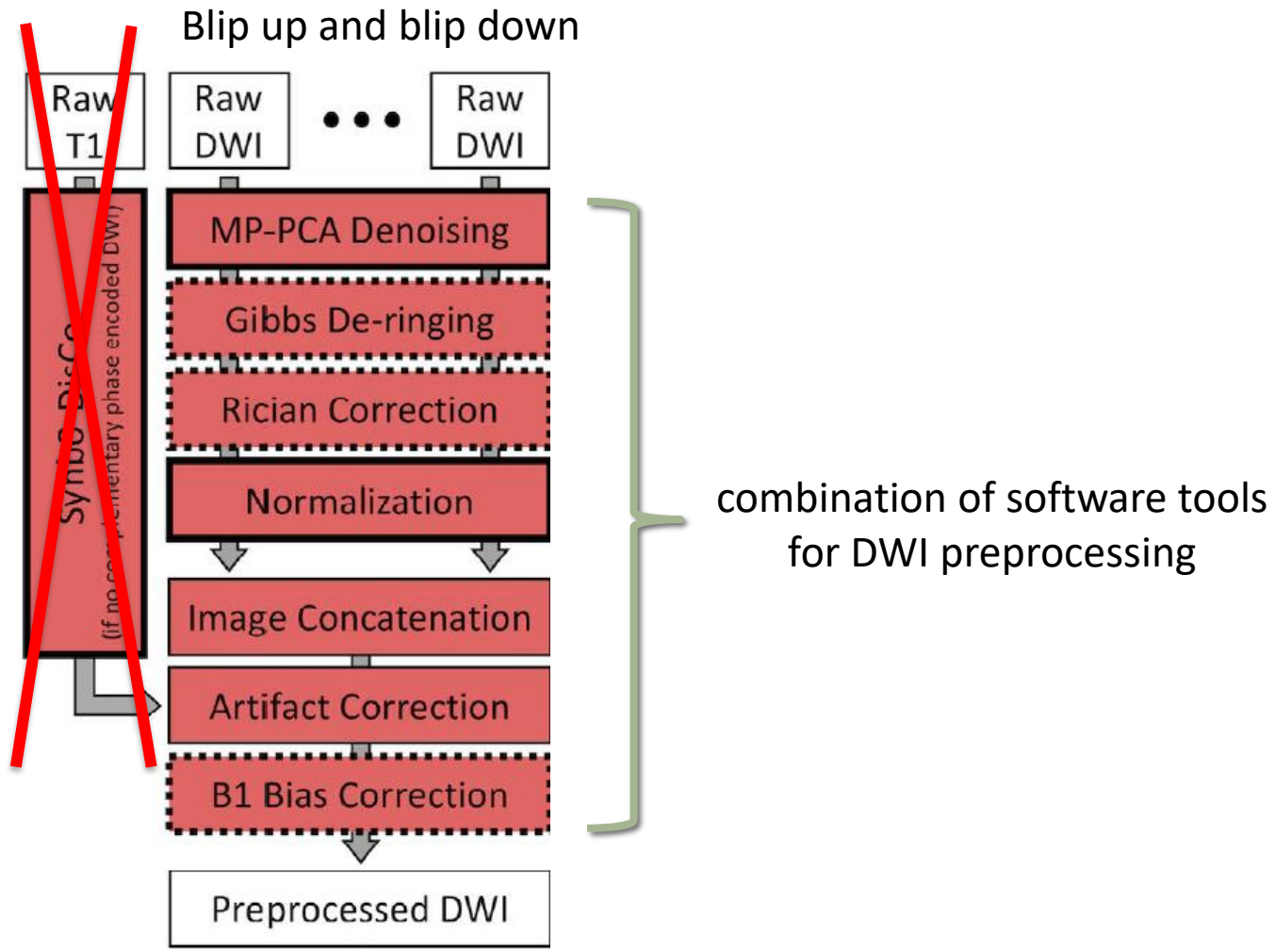
EPI susceptibility correction introduces significant differences far from local areas of high distortion

- **Evaluating the benefits of PreQual**

PreQual tool:

A novel diffusion preprocessing pipeline

FSL's TOPUP



Begnoche JP, Schilling KG, Boyd BD, Cai LY, Taylor WD, Landman BA. EPI susceptibility correction introduces significant differences far from local areas of high distortion. Magn Reson Imaging, 2022.
Cai LY et al., PreQual: An automated pipeline for integrated preprocessing and quality assurance of diffusion weighted MRI images. Magn Reson Med. 2021.

EPI susceptibility correction introduces significant differences far from local areas of high distortion

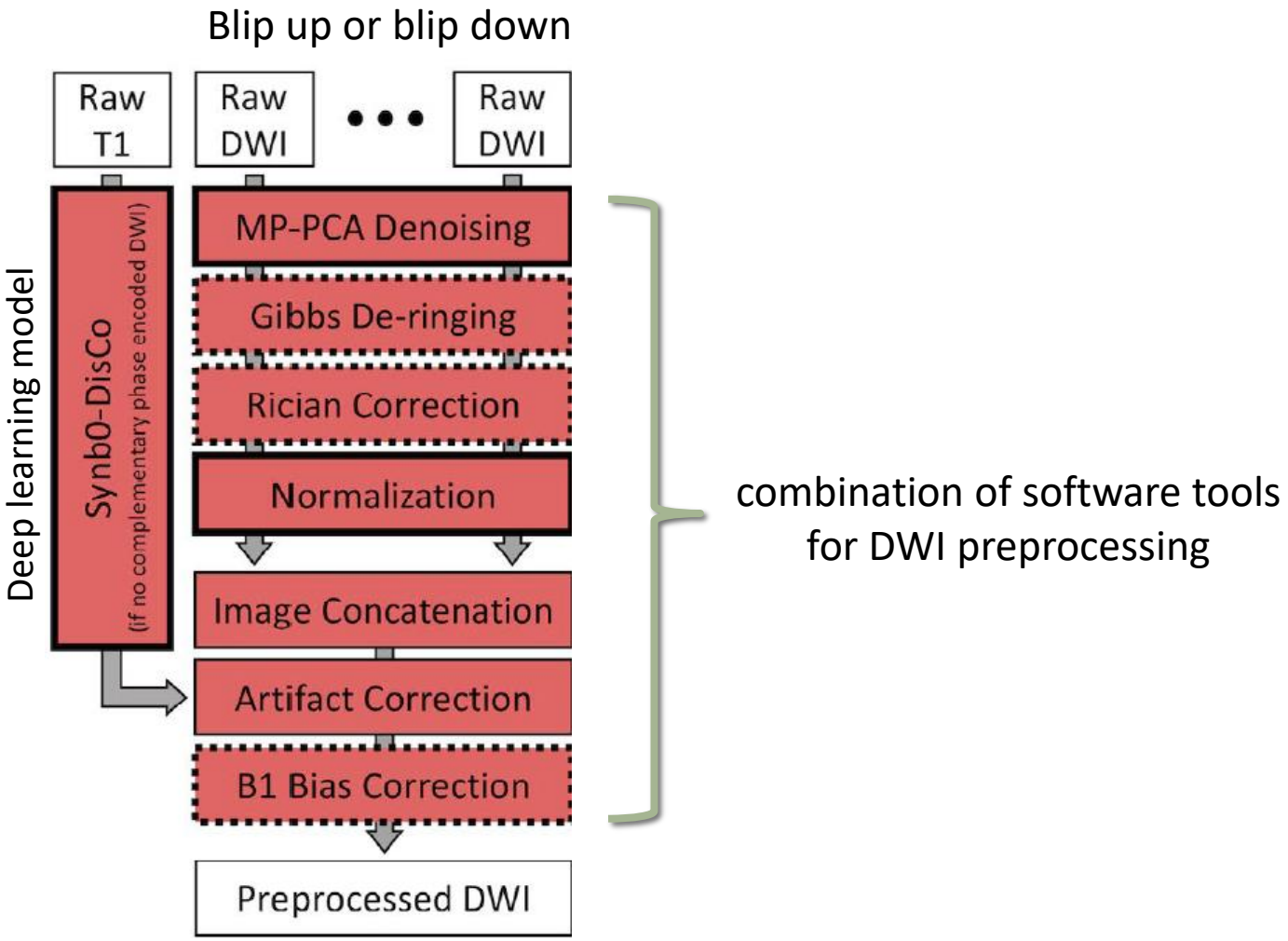
- **Evaluating the benefits of PreQual**

PreQual tool:

A novel diffusion preprocessing pipeline

FSL's TOPUP

FSL's EDDY



Begnoche JP, Schilling KG, Boyd BD, Cai LY, Taylor WD, Landman BA. EPI susceptibility correction introduces significant differences far from local areas of high distortion. Magn Reson Imaging, 2022.
Cai LY et al., PreQual: An automated pipeline for integrated preprocessing and quality assurance of diffusion weighted MRI images. Magn Reson Med. 2021.

EPI susceptibility correction introduces significant differences far from local areas of high distortion

- **Evaluating the benefits of PreQual**

Tract-Based Spatial Statistics (TBSS) ⇒ voxel-wise comparison method to assess white matter integrity across the brain

TBSS aims to compare fractional anisotropy (FA) between groups

i. Aligning individual FA images to MNI space
ii. Creating FA skeleton of major white matter tracts
iii. Performing a voxel-wise comparison of FA values across groups at every point on the skeleton

- **Participants**

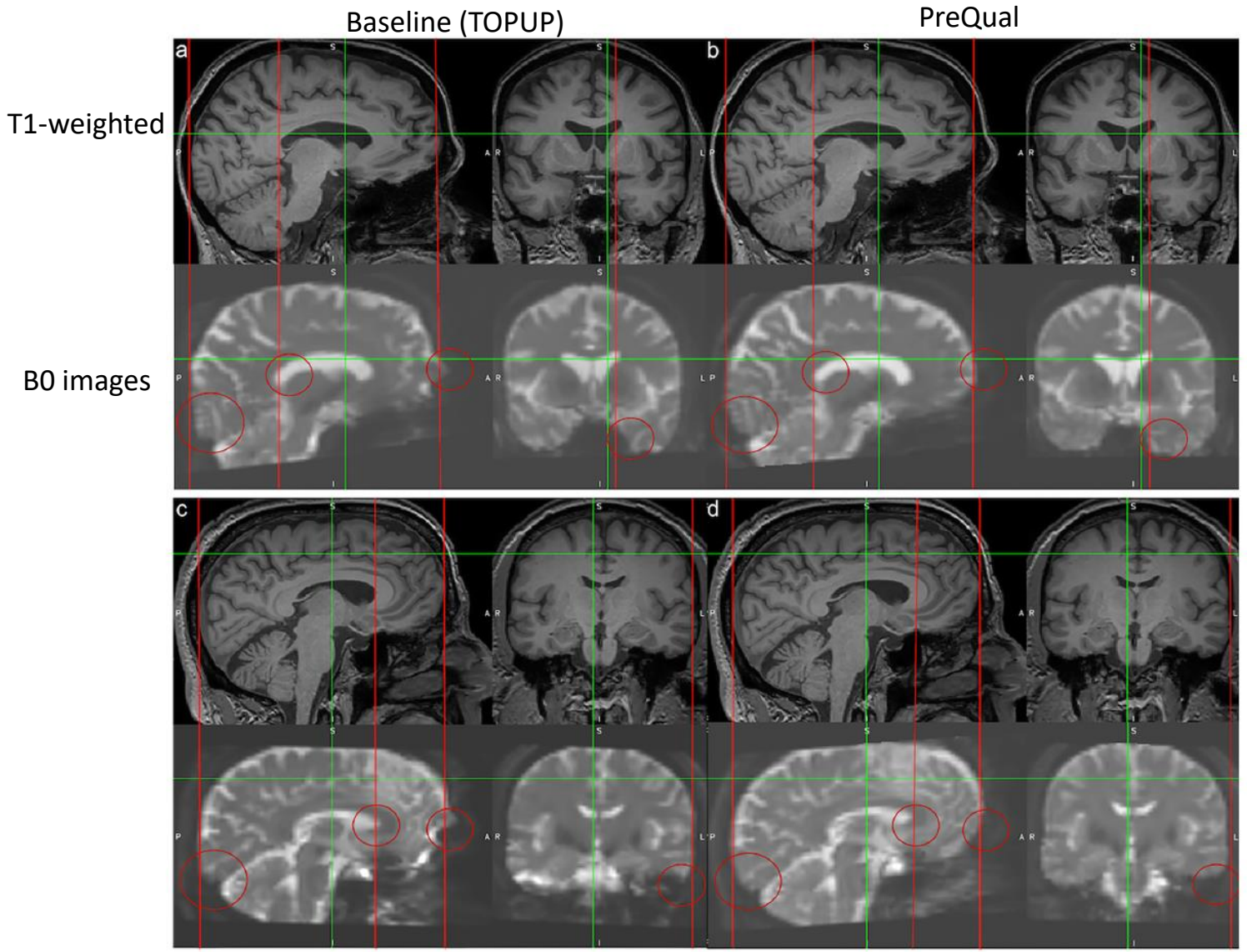
94 participants (range 60–86) in a study examining late-life depression
- 53 with major depressive disorder (MDD)
- 41 without psychiatric or neurological history

Begnoche JP, Schilling KG, Boyd BD, Cai LY, Taylor WD, Landman BA. EPI susceptibility correction introduces significant differences far from local areas of high distortion. Magn Reson Imaging, 2022.
Cai LY et al., PreQual: An automated pipeline for integrated preprocessing and quality assurance of diffusion weighted MRI images. Magn Reson Med. 2021.

EPI susceptibility correction introduces significant differences far from local areas of high distortion

- **Results**

✓ Improvements in overall geometric fidelity not limited to localized areas



Begnoche JP, Schilling KG, Boyd BD, Cai LY, Taylor WD, Landman BA. EPI susceptibility correction introduces significant differences far from local areas of high distortion. Magn Reson Imaging, 2022.
Cai LY et al., PreQual: An automated pipeline for integrated preprocessing and quality assurance of diffusion weighted MRI images. Magn Reson Med. 2021.

EPI susceptibility correction introduces significant differences far from local areas of high distortion

- **Results**

Red regions : areas of FA for healthy compared to depressed subjects

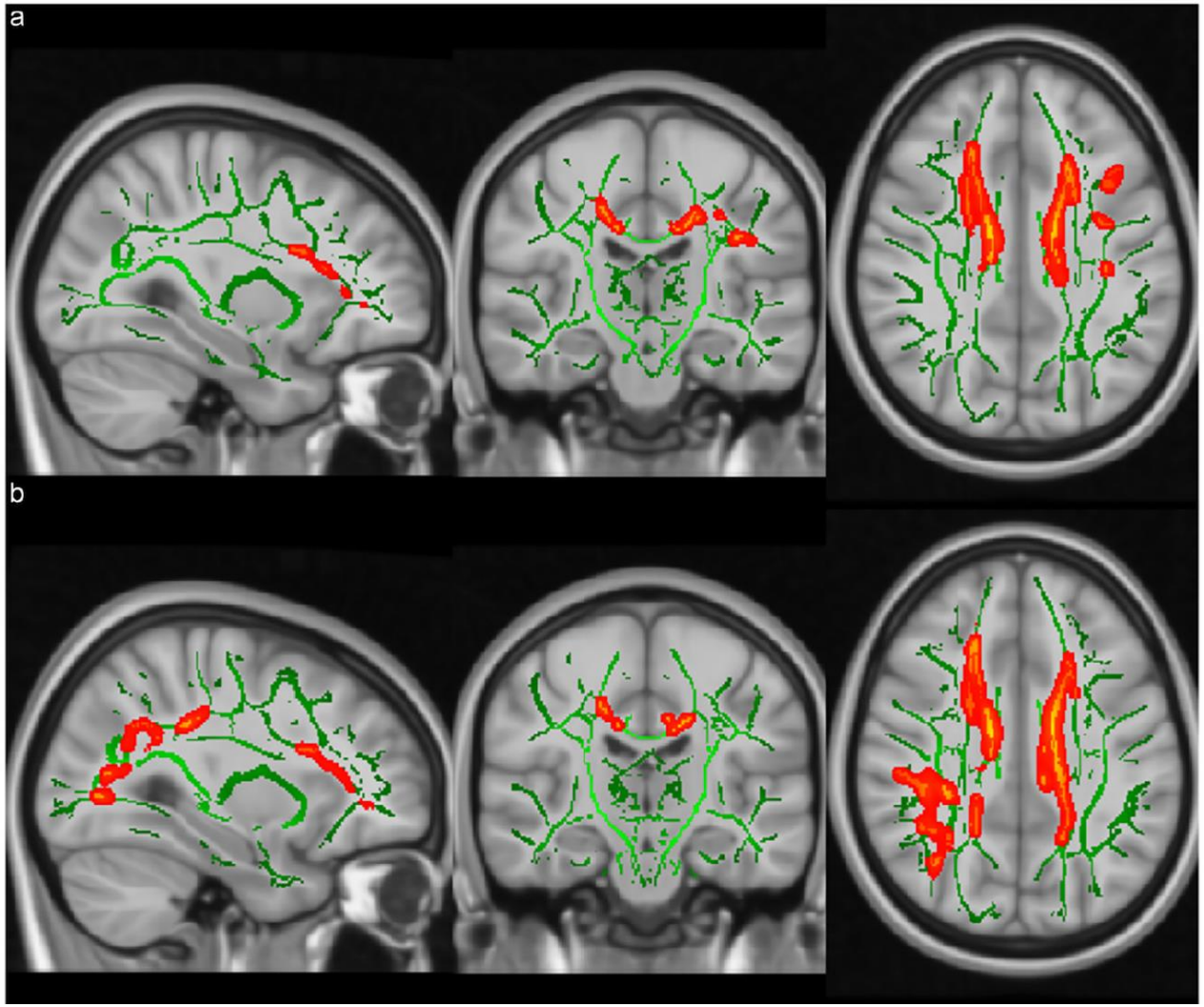
Green tracts : mean FA skeleton from entire sample

✓ larger number of voxels included in the mean FA skeleton

Comparison of TBSS

Baseline (TOPUP)

PreQual



Begnoche JP, Schilling KG, Boyd BD, Cai LY, Taylor WD, Landman BA. EPI susceptibility correction introduces significant differences far from local areas of high distortion. Magn Reson Imaging, 2022.
Cai LY et al., PreQual: An automated pipeline for integrated preprocessing and quality assurance of diffusion weighted MRI images. Magn Reson Med. 2021.

EPI susceptibility correction introduces significant differences far from local areas of high distortion

- **Takeaways**

  i. EPI distortions are not focal

  ii. EPI distortions are not random

  iii. Interpreting dMRI in distorted space is not equivalent to corrected space, even in areas remote from focal distortions

- **Limitations of using Synb0-DisCo**

  i. Image contrast may be affected by filtering

  ii. Learned network structure may be affected by large differences in acquisitions settings

  iii. Appropriate image contrast may not be predicted in certain abnormalities (e.g., tumors)

Begnoche JP, Schilling KG, Boyd BD, Cai LY, Taylor WD, Landman BA. EPI susceptibility correction introduces significant differences far from local areas of high distortion. Magn Reson Imaging, 2022.
Cai LY et al., PreQual: An automated pipeline for integrated preprocessing and quality assurance of diffusion weighted MRI images. Magn Reson Med. 2021.

Thank you