Reducing individual differences in task fMRI with OGRE preprocessing for FSL

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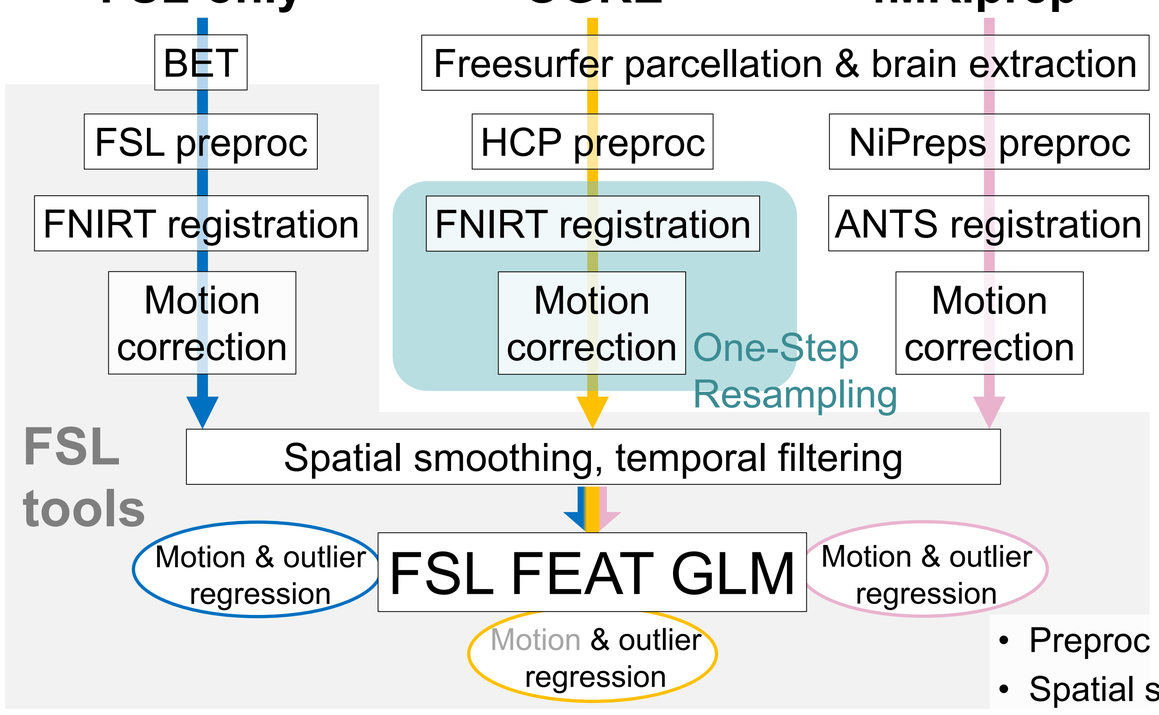
Introduction

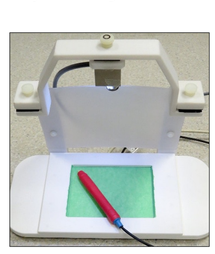
- FSL[1] volumetric analysis remains popular for task fMRI, but FSL creates suboptimal brain extractions,[2,3] which affects registration
- Human Connectome Project (HCP)[4] methods use Freesurfer brain extraction for simultaneous nonlinear registration (FNIRT)[5] & motion correction ("one-step resampling"), but no software yet exists to adapt this for FSL analysis.
- **OGRE (One-Step General Registration and Extraction)** implements Freesurfer & "one-step resampling" for FSL volumetric GLM

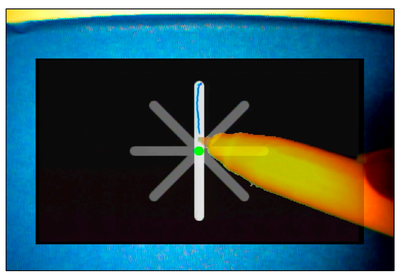
Methods



Task & Data

- 37 right-handed adults (12 with peripheral nerve injury)
  - 28 female, age 48 ± 18 (24-82)
- Task fMRI: right hand precision drawing task[7]
  - TR = 662 ms, voxel size 3 mm^3, 3 runs * 5.4 min
  - Block design (15.2 sec draw/rest); key contrast Draw > Rest
  - Total task volumes: 690
- T1w, T2w, field maps
- **Quantified via 300-ROI volumetric atlas**[8]
  - Paired-sample t-tests within ROI



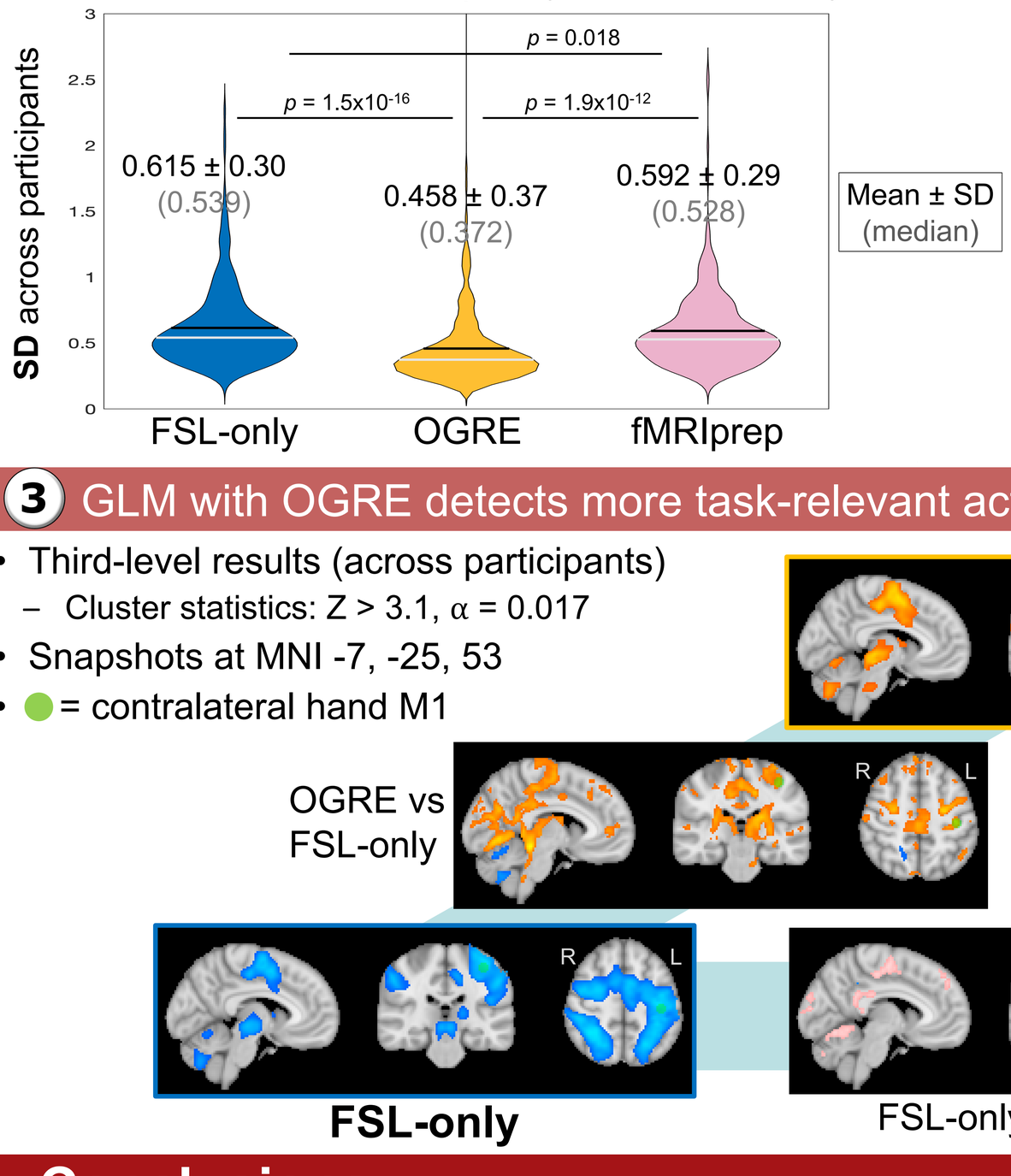


- Preproc = EPI unwarp, intensity normalization, motion estimation
- Registration = 2 mm MNI
- Spatial smoothing = 6 mm FWHM; temporal filtering = high pass, 60 sec

Results

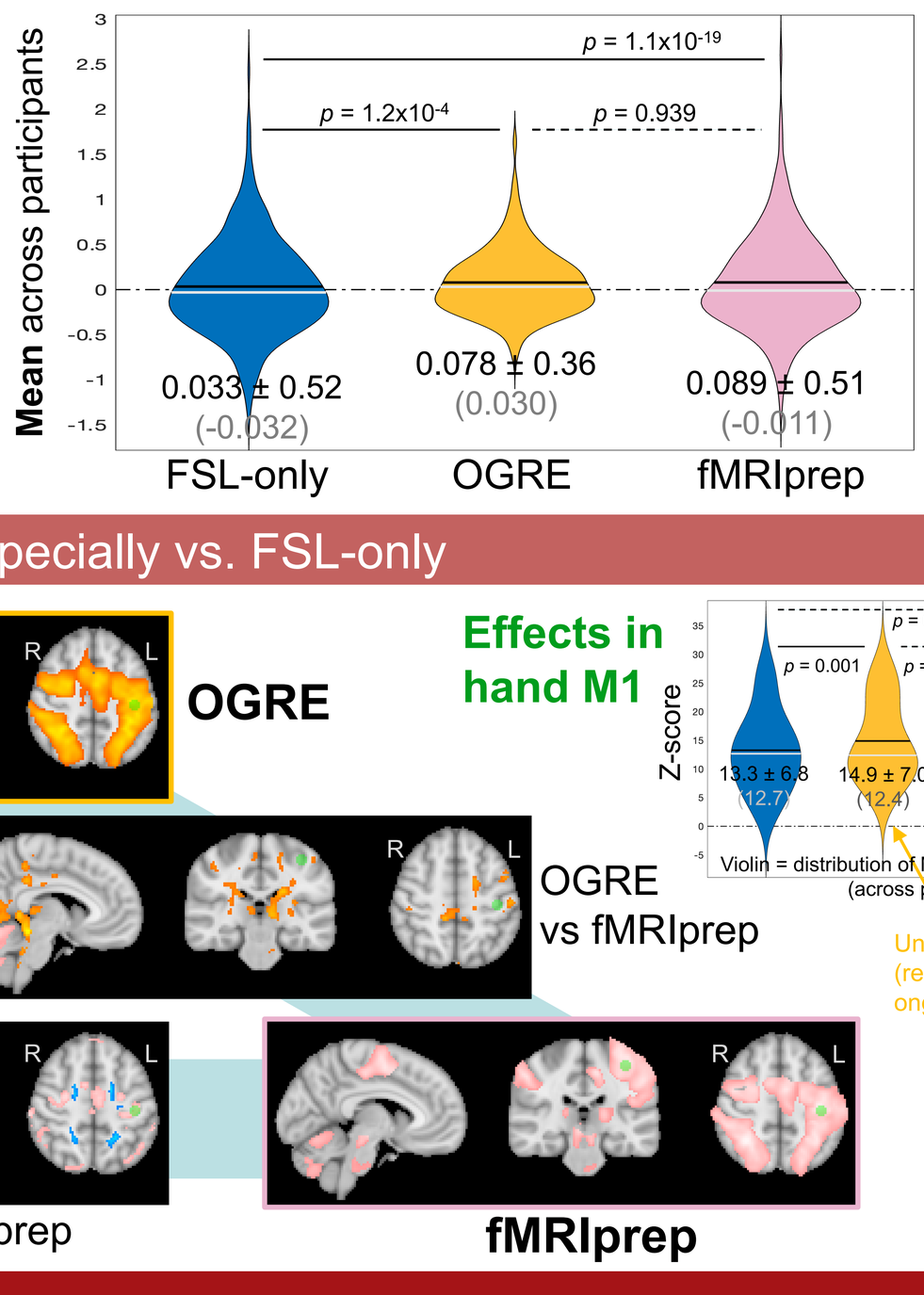
1 OGRE produces lower inter-individual variability than other methods

- Each sample = one **SD** value (across 37 participants)
- Violin = distribution of samples (across 300 ROIs)



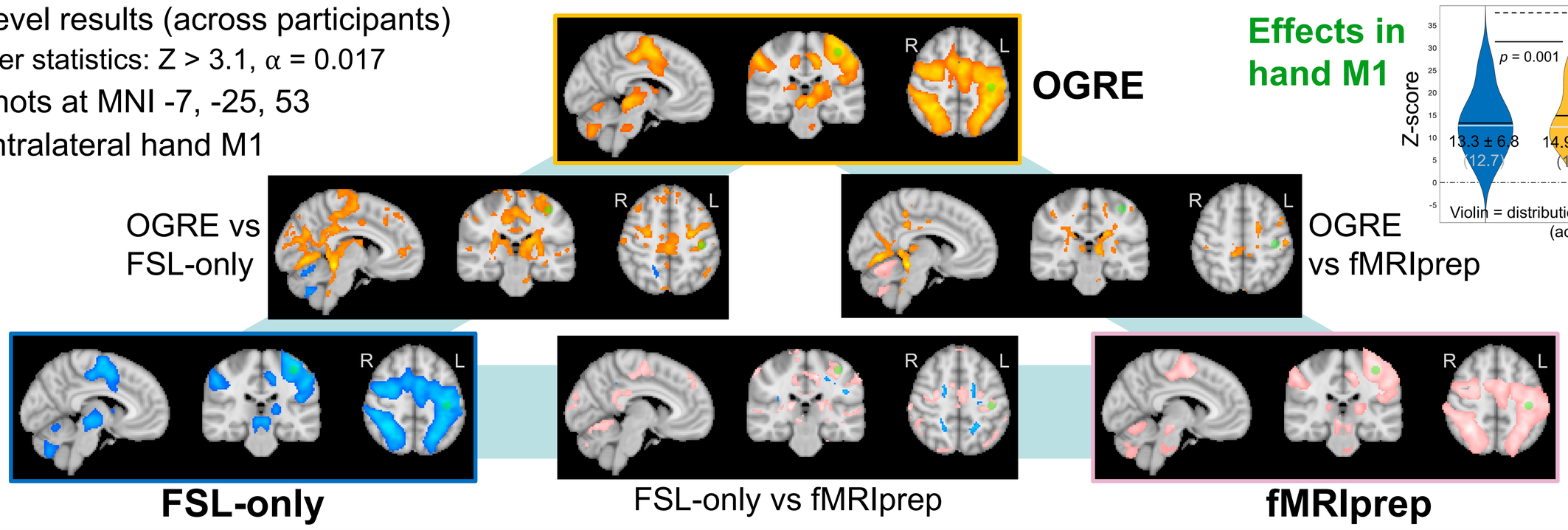
2 OGRE and fMRIprep lead to marginally higher mean activity than FSL-only

- Each sample = one **mean** value (across participants)



3 GLM with OGRE detects more task-relevant activity, especially vs. FSL-only

- Third-level results (across participants)
  - Cluster statistics: Z > 3.1, α = 0.017
- Snapshots at MNI -7, -25, 53
- ● = contralateral hand M1



Effects in hand M1

Conclusions

- OGRE improves detection of task-relevant activity via lower between-participants variability in volumetric task fMRI, compared to FSL-only and fMRIprep analysis
  - Optimized for low-infrastructure users: FSL-ready outputs, can run locally on Mac
  - Future directions: functional connectivity, multivariate analyses, large datasets
- FSL, fMRIprep, and OGRE are highly consistent & can provide a foundation for additional methods

GitHub

References & Acknowledgments

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