Intersite effects in task-based fMRI: the fBIRN Traveling Subjects

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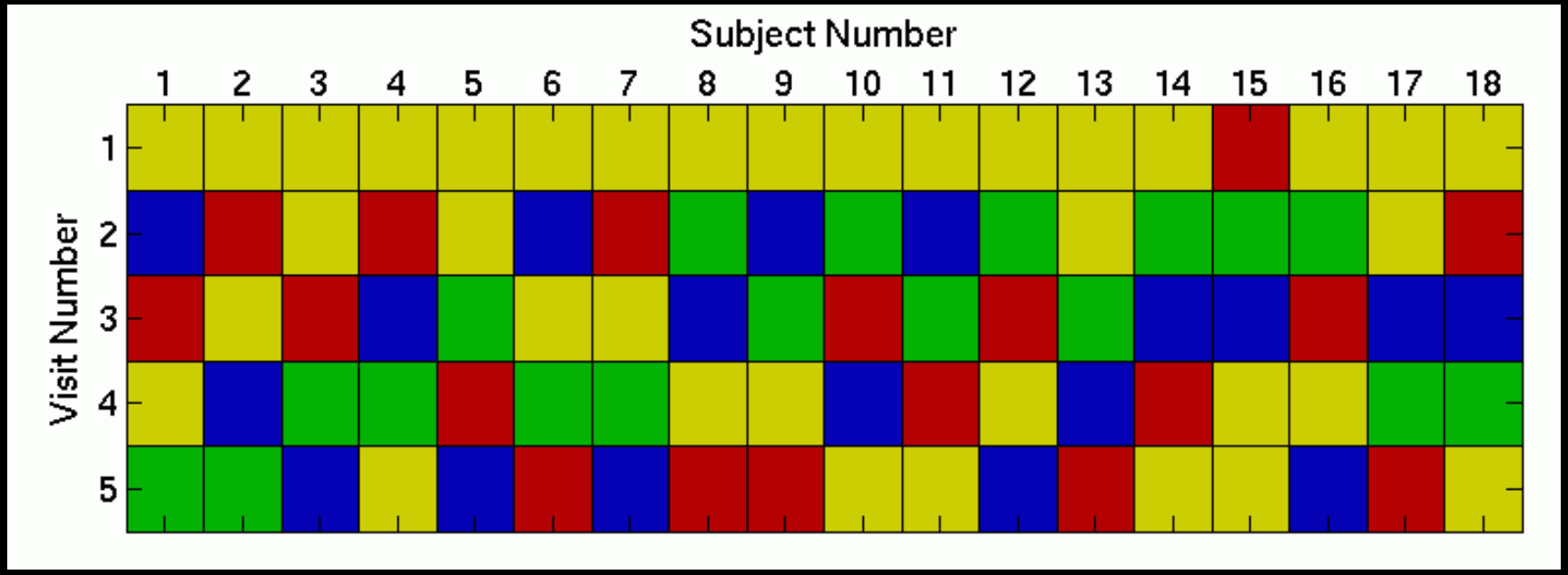
fBIRN Traveling Subjects



Yale (Siemens)

BWH (GE)

MGH (Siemens)

Duke (GE)

- Acquisition parameters closely matched across site
- Working memory paradigm

Functional Biomedical Informatics Research Network (fBIRN, www.birn.net)

Outline

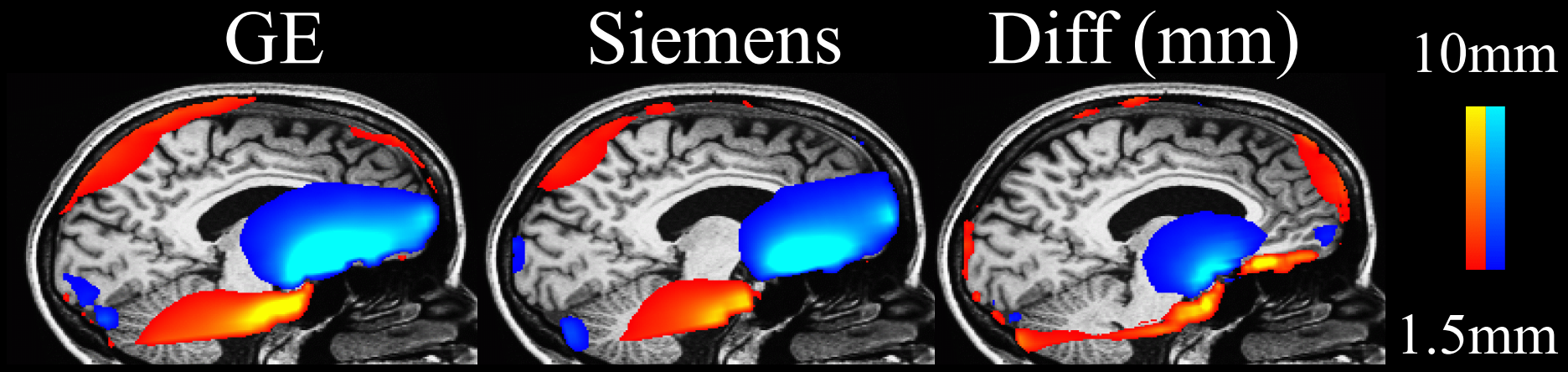
- fMRI Analysis manipulations
- Scanner QA/QC
- Subject Motion

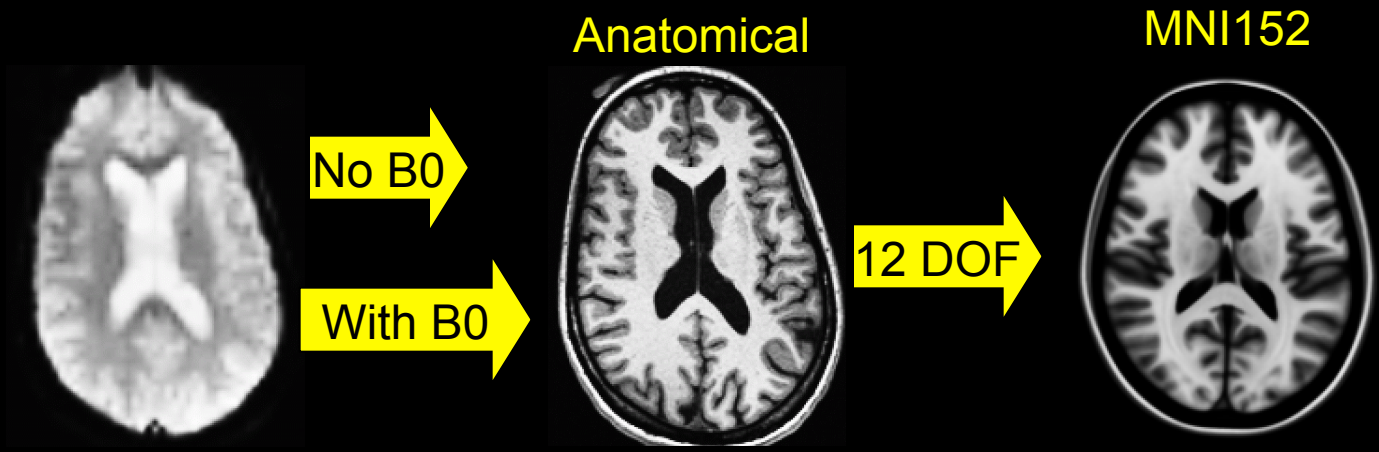
Analysis Manipulations

1. B0 Distortion Correction
2. Functional-Structural Registration method
3. Intensity Scaling

Look for site effects in paired differences in group maps in MNI152 space.

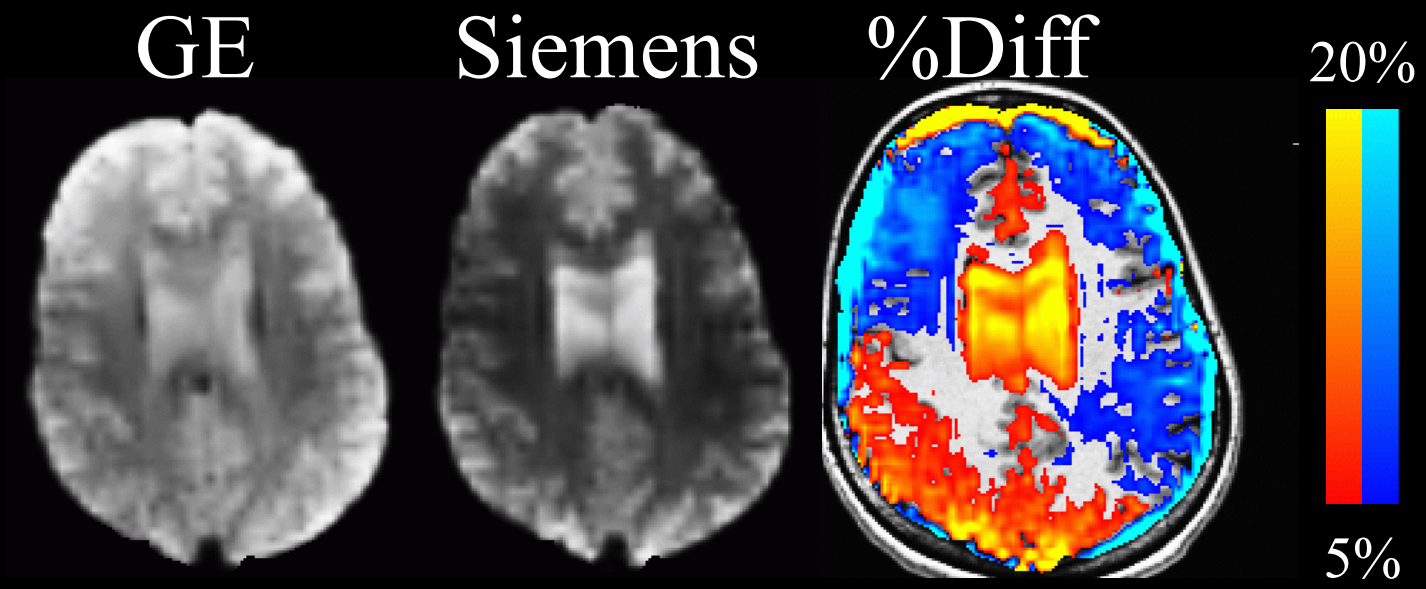
B0 Distortion Site Effects





BBR = Boundary-based registration

Site Effects in Bias Field, Intensity Inhomogeneity

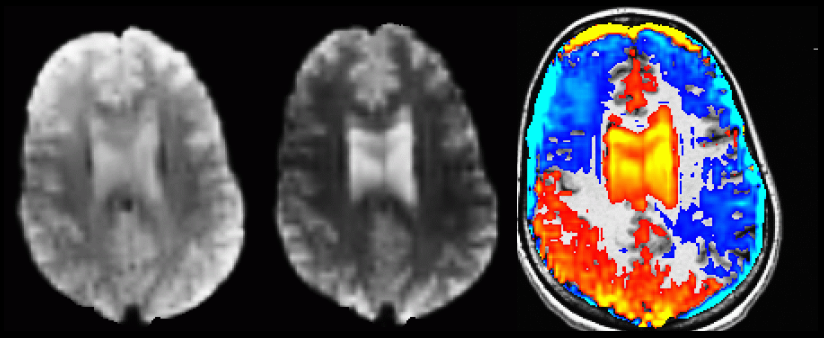


Mean brain intensity is the same.

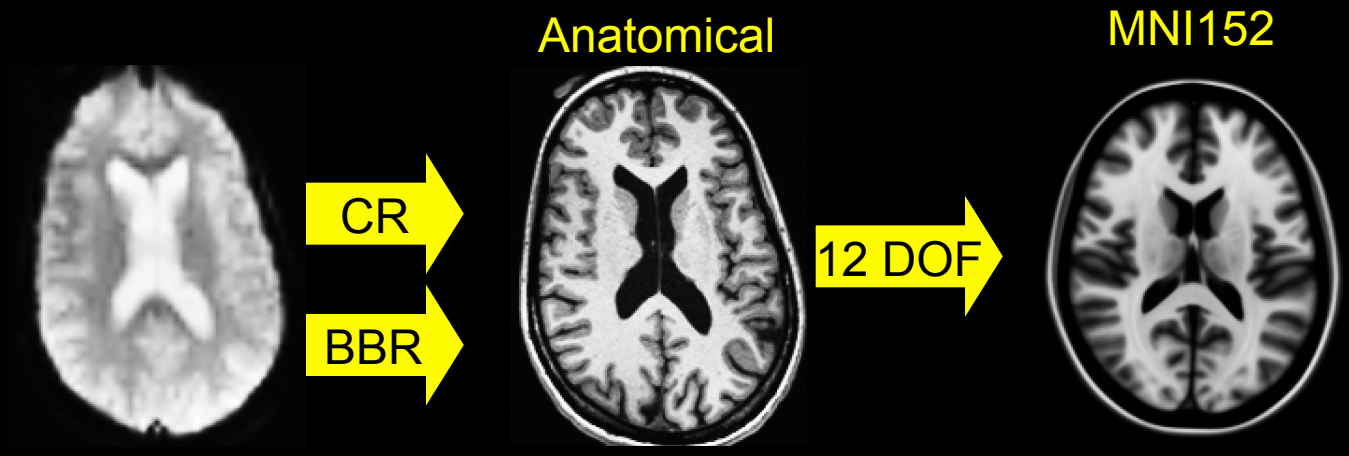
Bias Field and Scaling

Scaling Methods

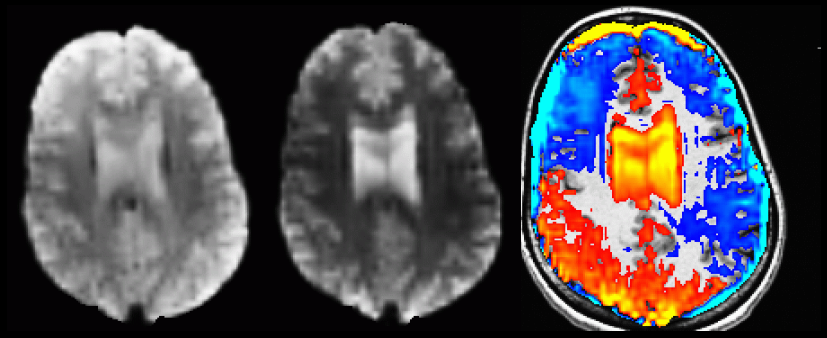
- Grand mean – divide functional by mean across all voxels and time points
- Voxel-wise – divide each voxel by temporal mean



Bias Field and Registration



CR = Correlation Ratio – Sensitive to bias fields
BBR = Boundary-based registration – Insensitive to bias fields
(Greve and Fischl, NI, 2009), see also Local Pearson Correlation (LPC), Saad et al, NI, 2009

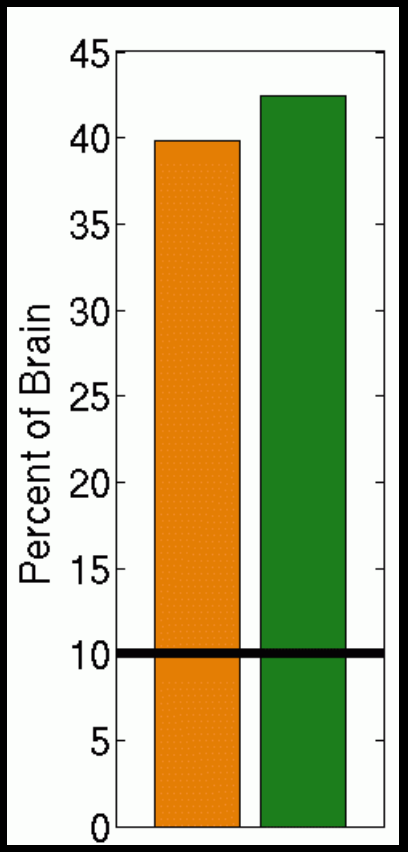


Experimental Manipulations

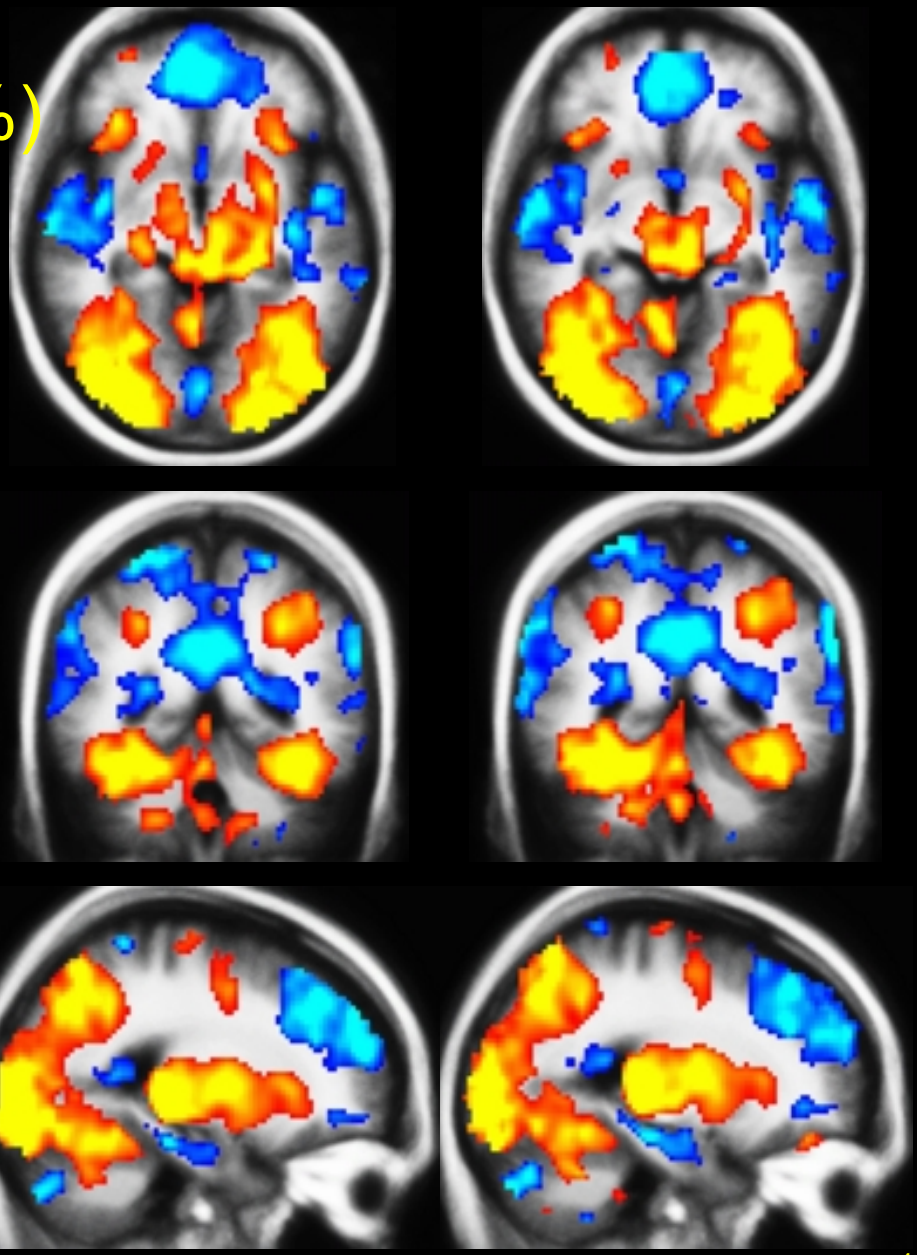
	Method 1	Method 2
B0 Correction	Off	On
Registration Method	CR	BBR
Intensity Scaling	Global	Voxel-wise

Task Activation

- Widespread activation (40%)
- Modest Increase (6%)



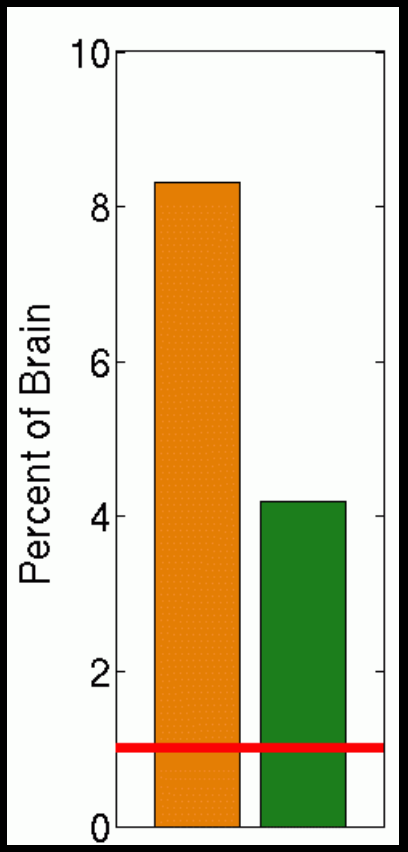
Method 1 Method 2



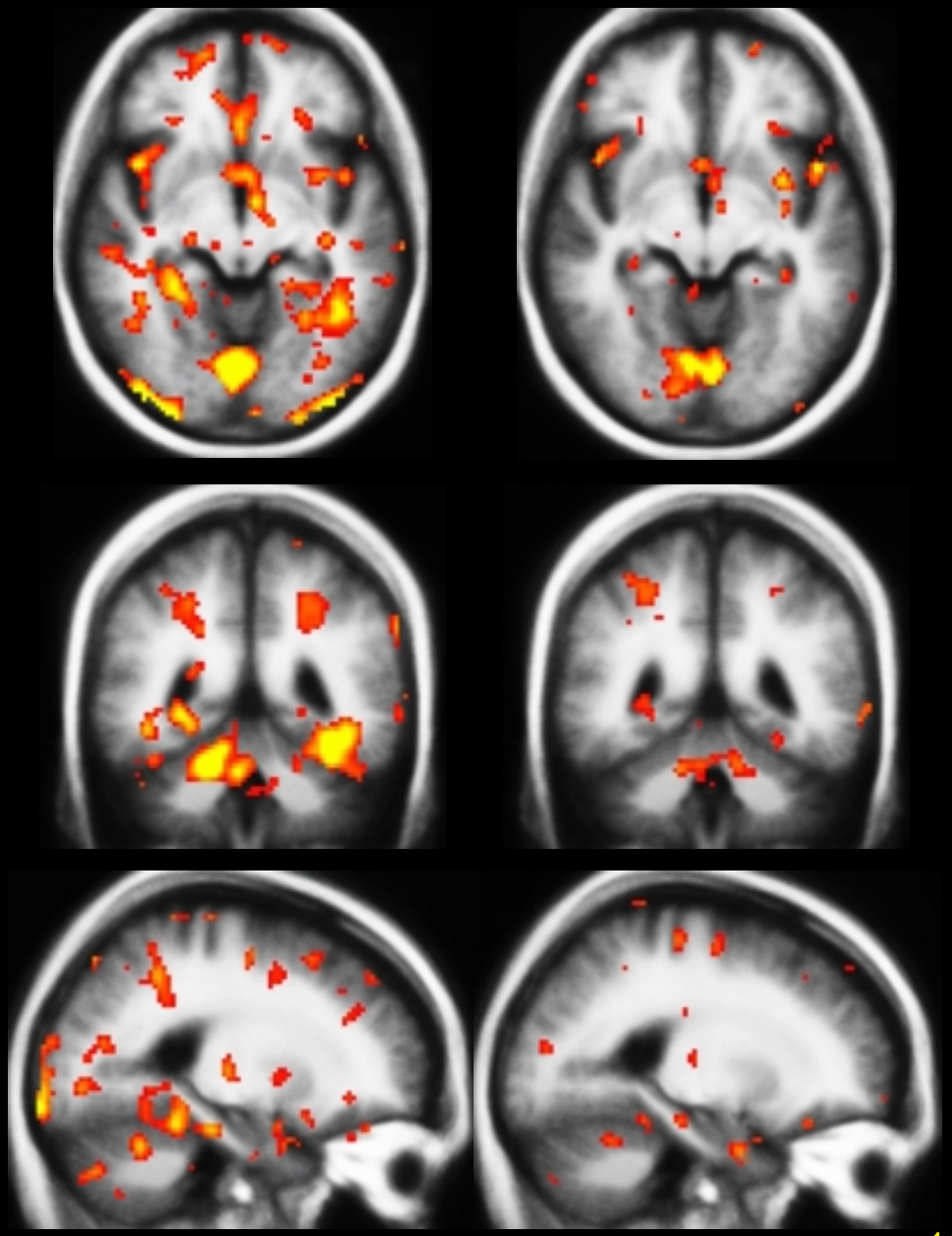
p < .01

Site Effect

- Reduced by 65%
- Mostly Duke-MGH



Method 1 Method 2



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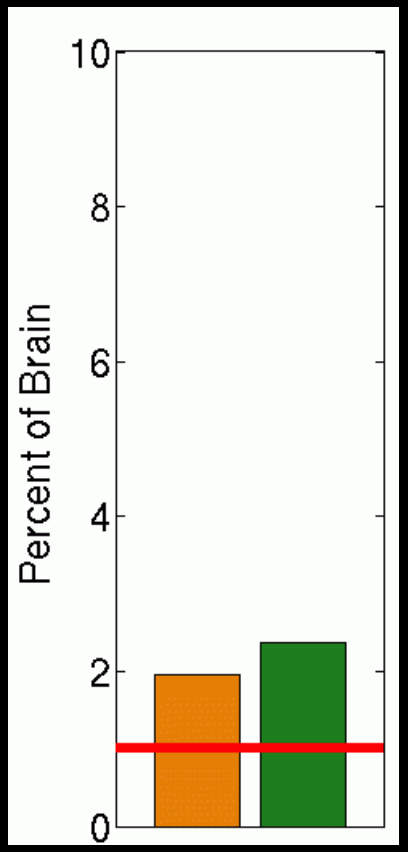
Visit Effect

- Very small
- Left anterior insula (same)
- Remainder different



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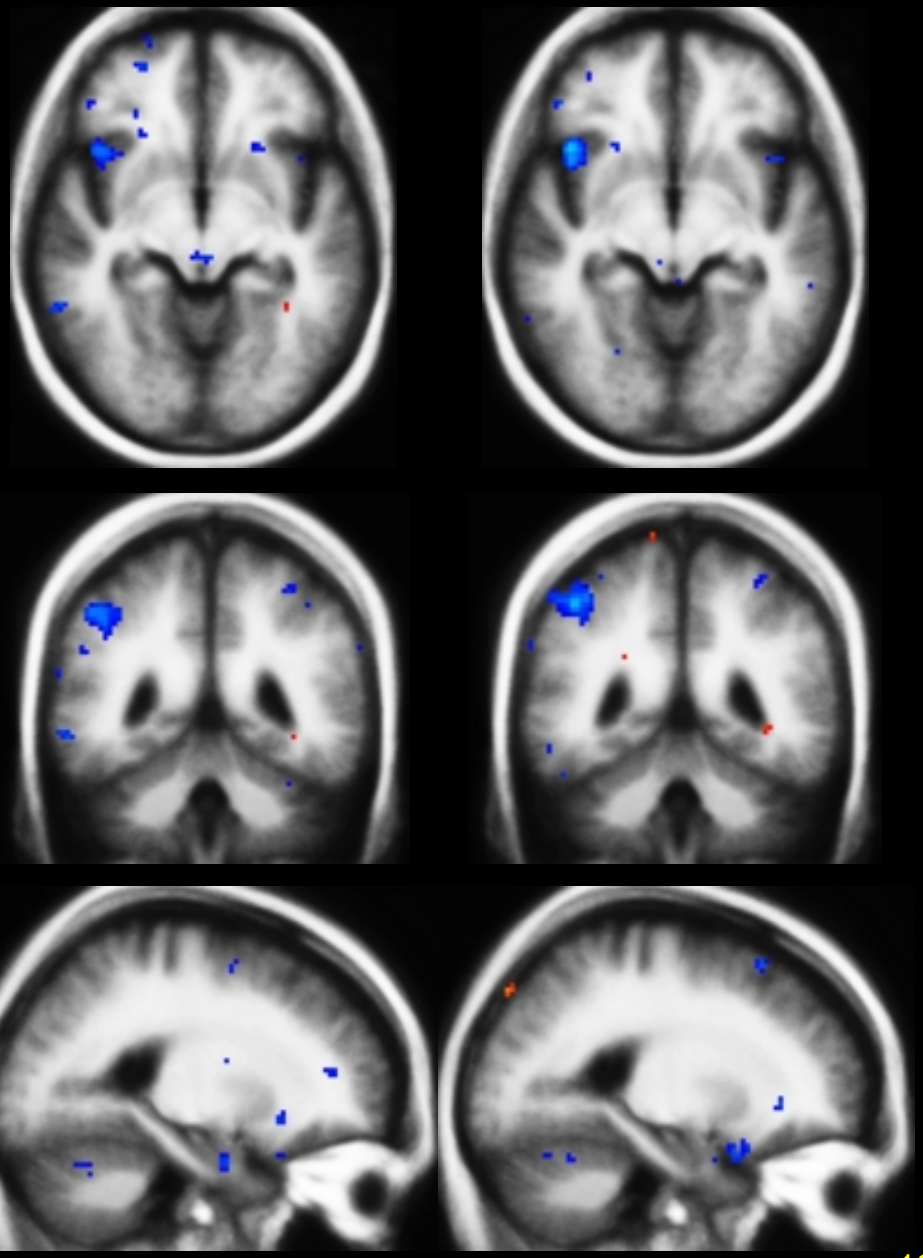

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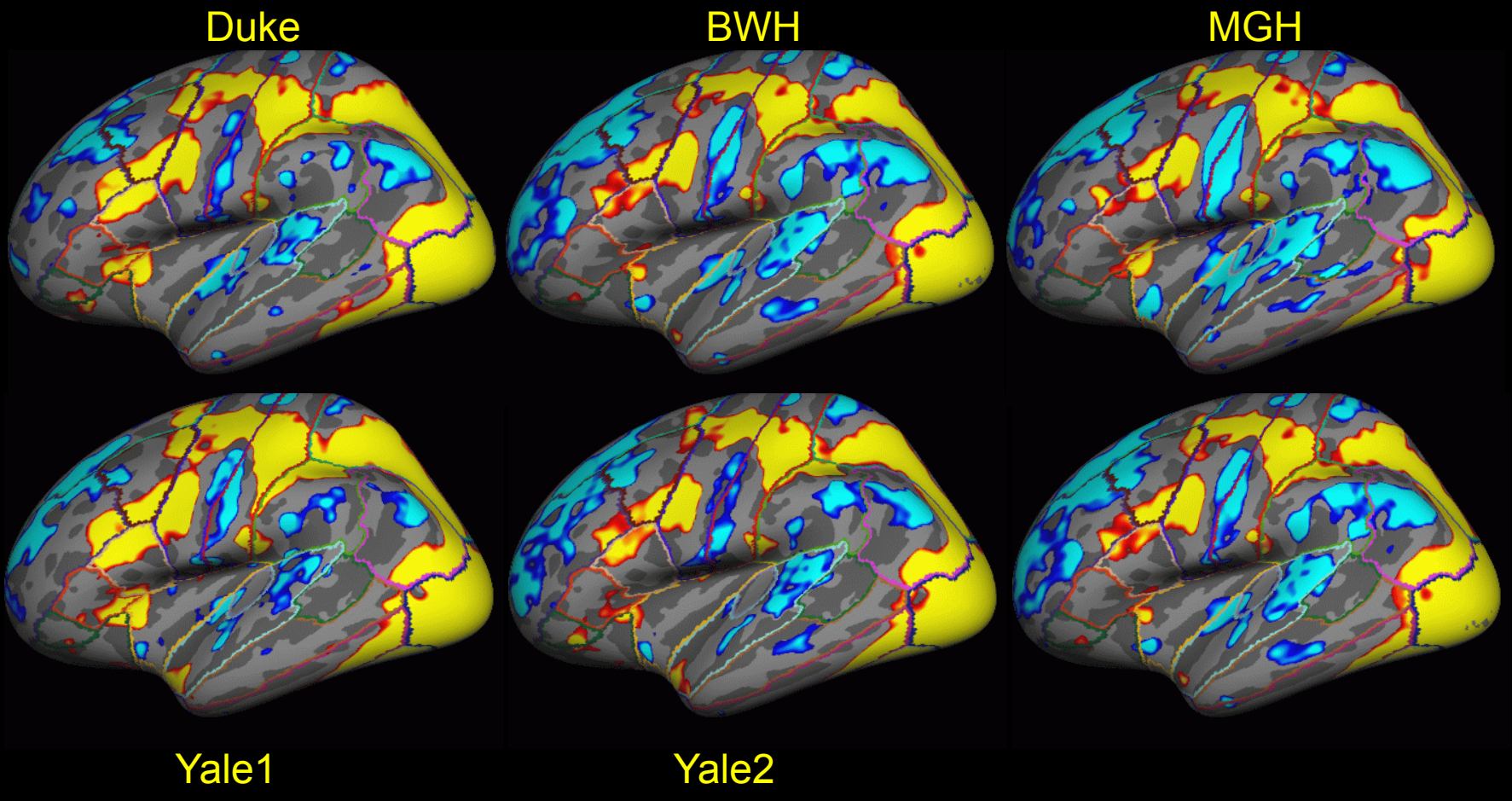
Working Memory Paradigm: Distracting Pictures vs Baseline



Scanner Quality Control/Assurance

Sources of Scanner-related Variance

- Background/Thermal
- Scanner Instability

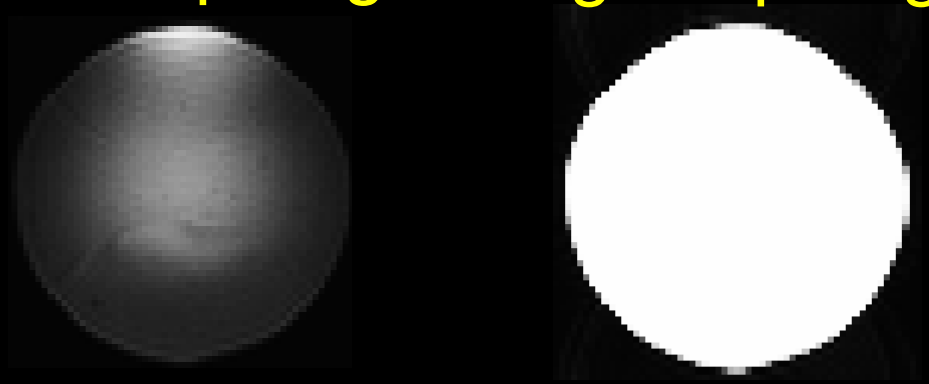
How big relative to scanner-unrelated variance?

eg, physiological noise

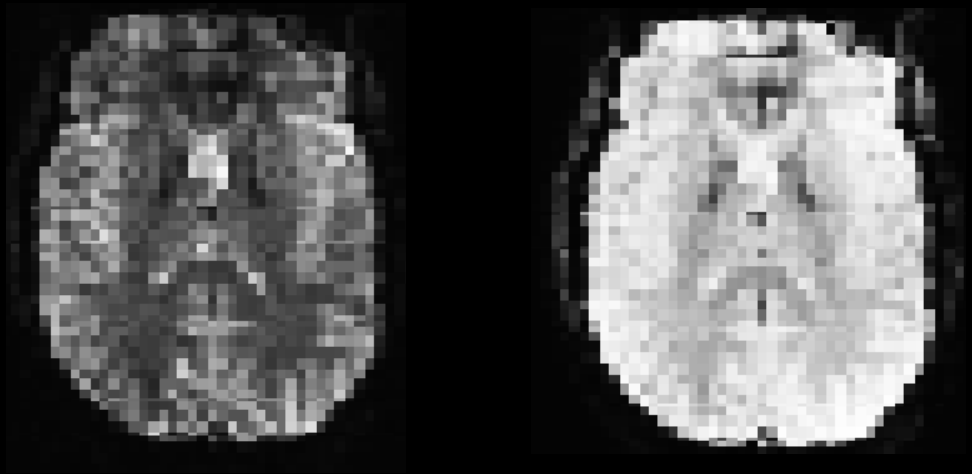
Scanner Noise and Instability

Low Flip Angle High Flip Angle

Phantom



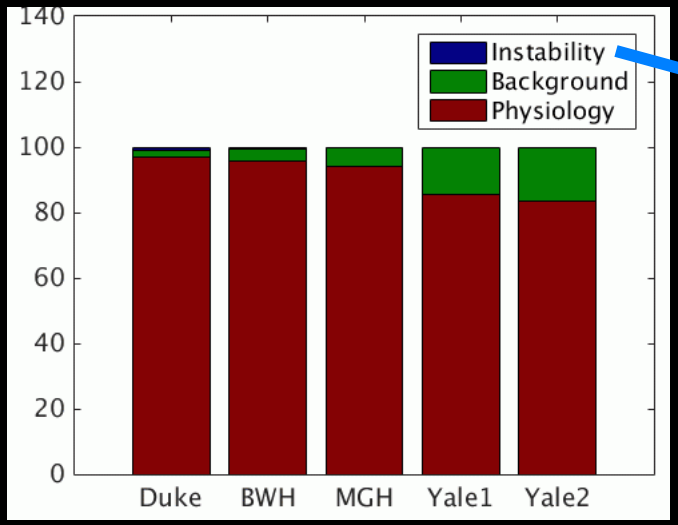
Human



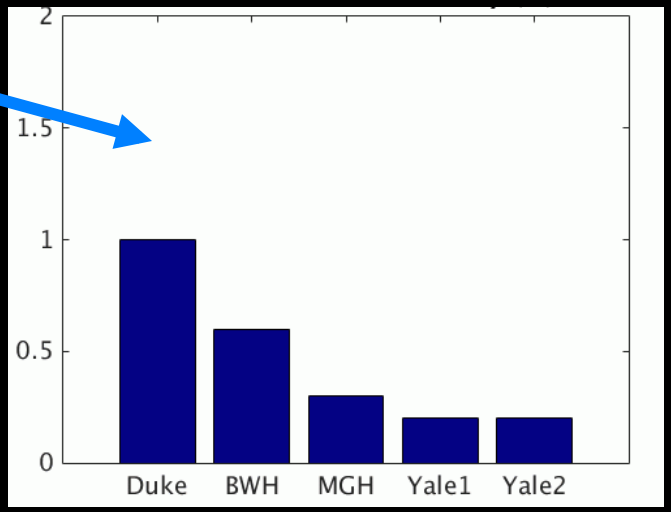
Greve, et al, 2010, MRM

Variance Composition (%)

Three Noise Sources



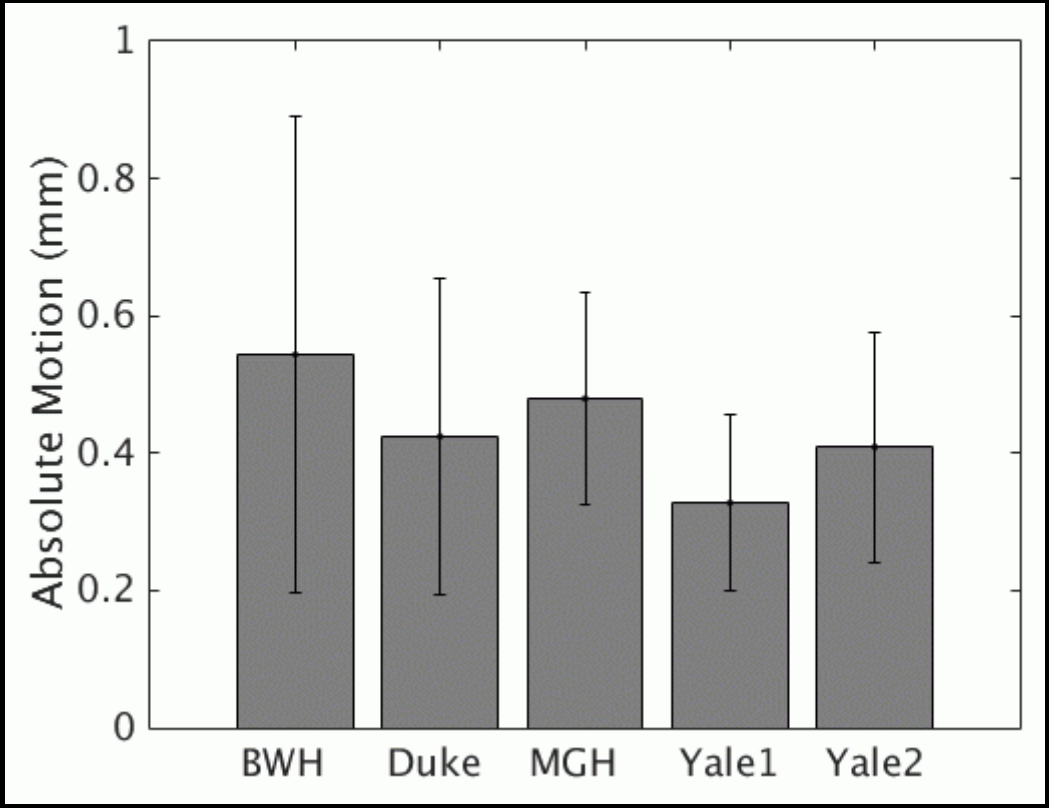
Scanner Instability



- Physiological noise (including motion) dominates
- Background (Thermal) noise more for Yale, but still small
- Instability negligible
- Assumes smoothing by 5mm FWHM
- Repeatability (Yale1 vs Yale2)

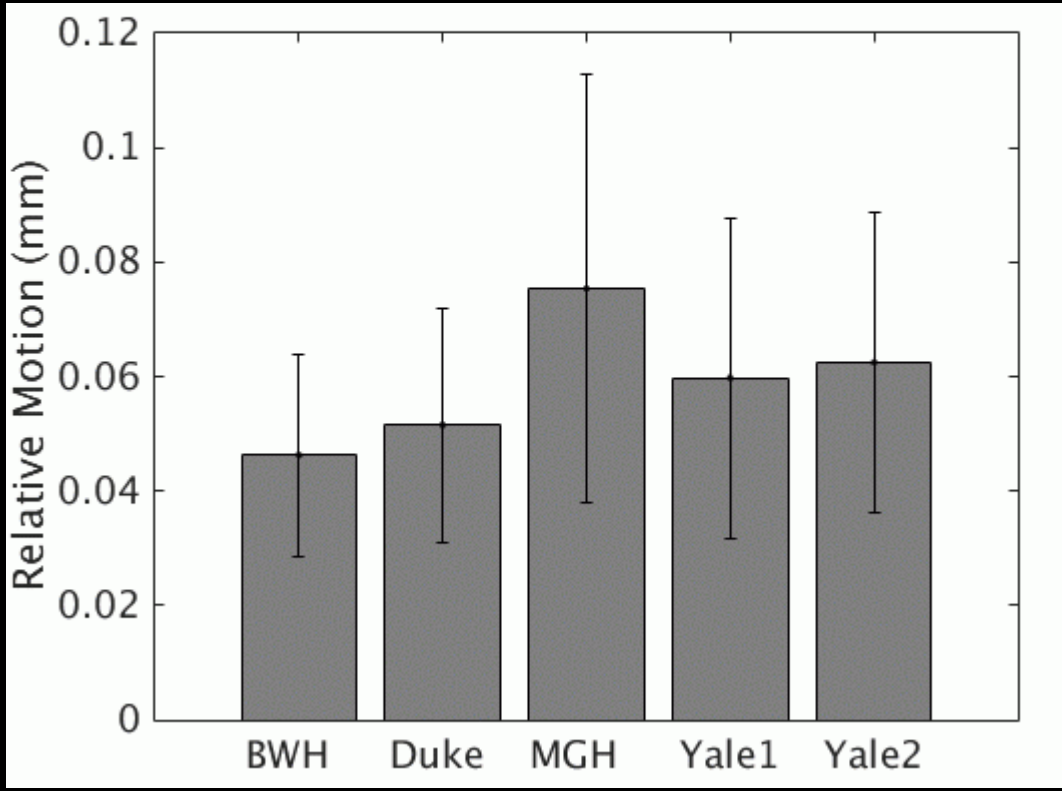
Greve, et al, 2010, MRM

Max Absolute Motion



- Max RMS deviation from middle time point
- No significant differences between site

Relative Motion



- Max RMS deviation from previous time point
  - Frame-wise displacement
- Significant differences between site

Conclusions

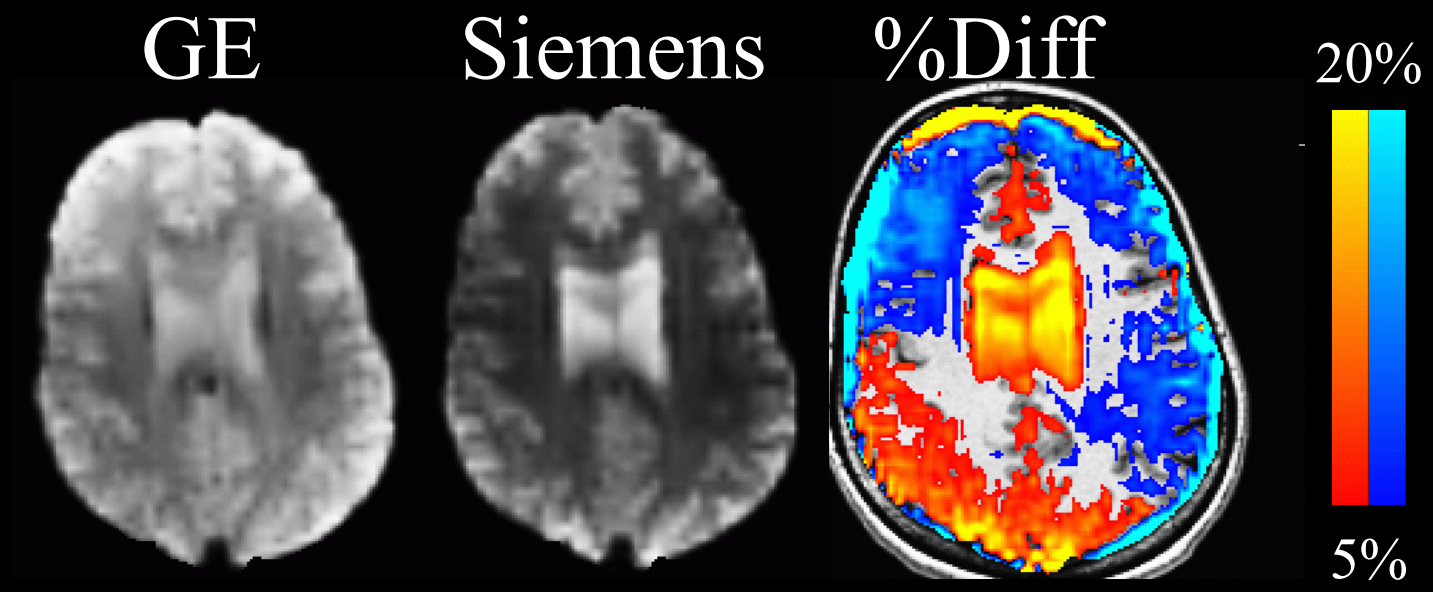
- Site effects are detectable
  - Worse-case scenario
- Manipulations:
  - B0 – biggest effect
  - Registration Method – moderate
  - Intensity Scaling – small effect
- Scanner noise negligible
- Site effect in relative motion (not abs)

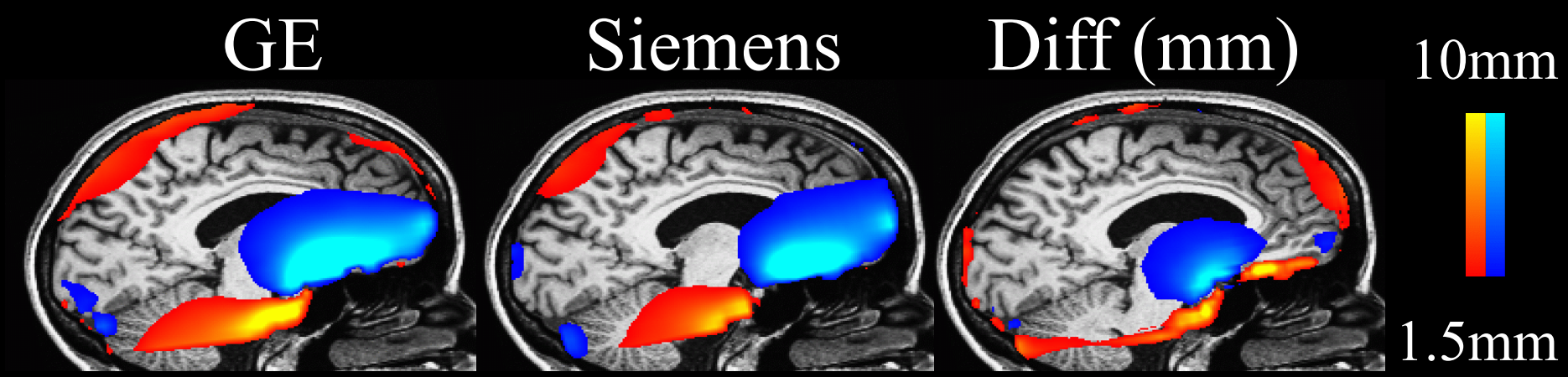
Thanks to fBIRN and Collaborators!

Comparison Methods

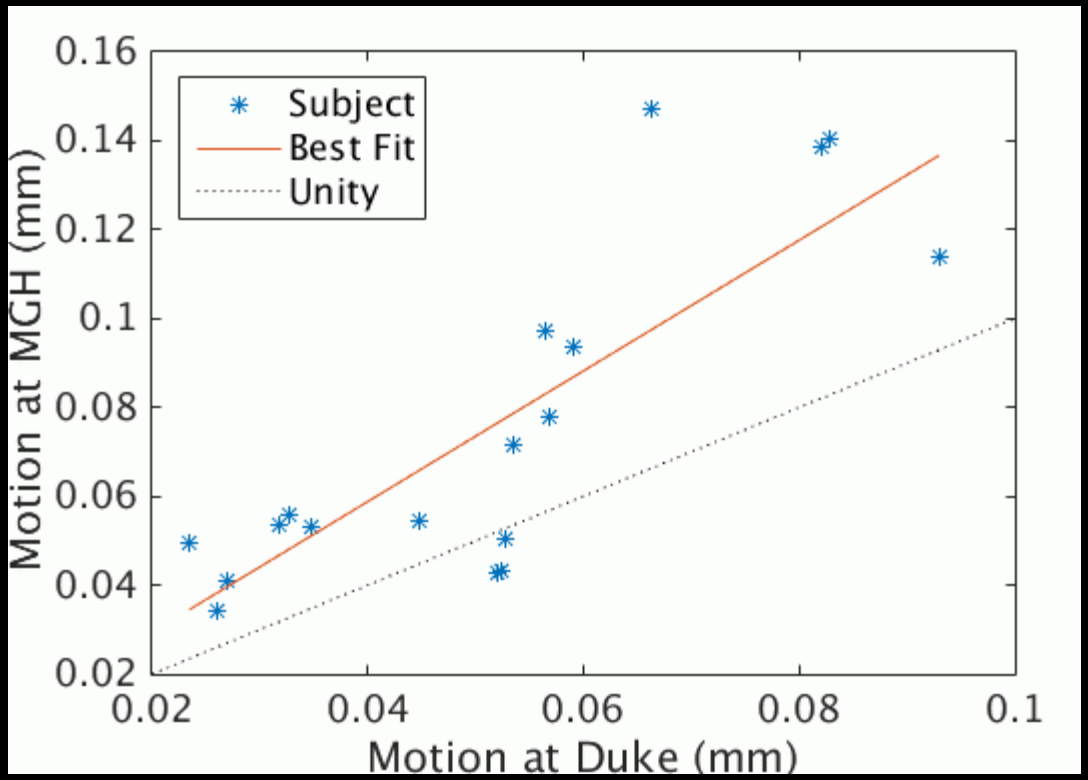
1. Site Effect: Percentage of brain p<.01 in Repeated Measures ANOVA
2. Main Task: Percentage of brain p<.01 in group/site average.
3. Visit Effect: Percentage of brain p<.01 in Visit Difference (paired-t test)

(Some) Site Differences





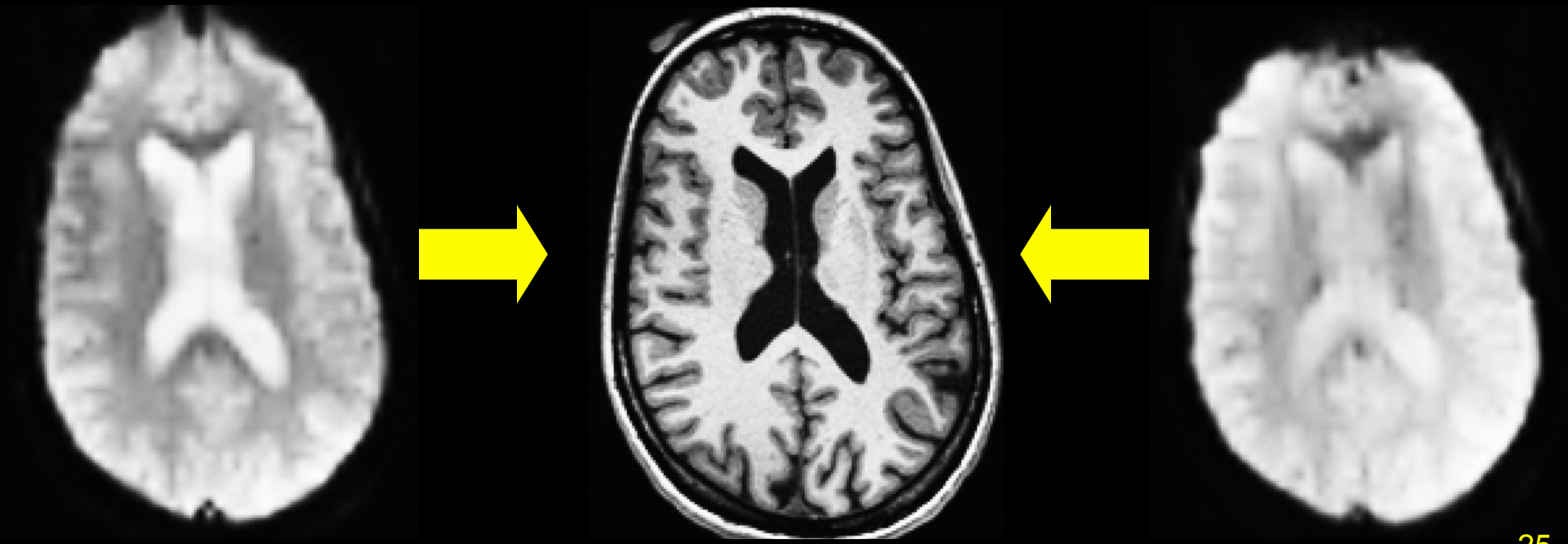
Relative Motion



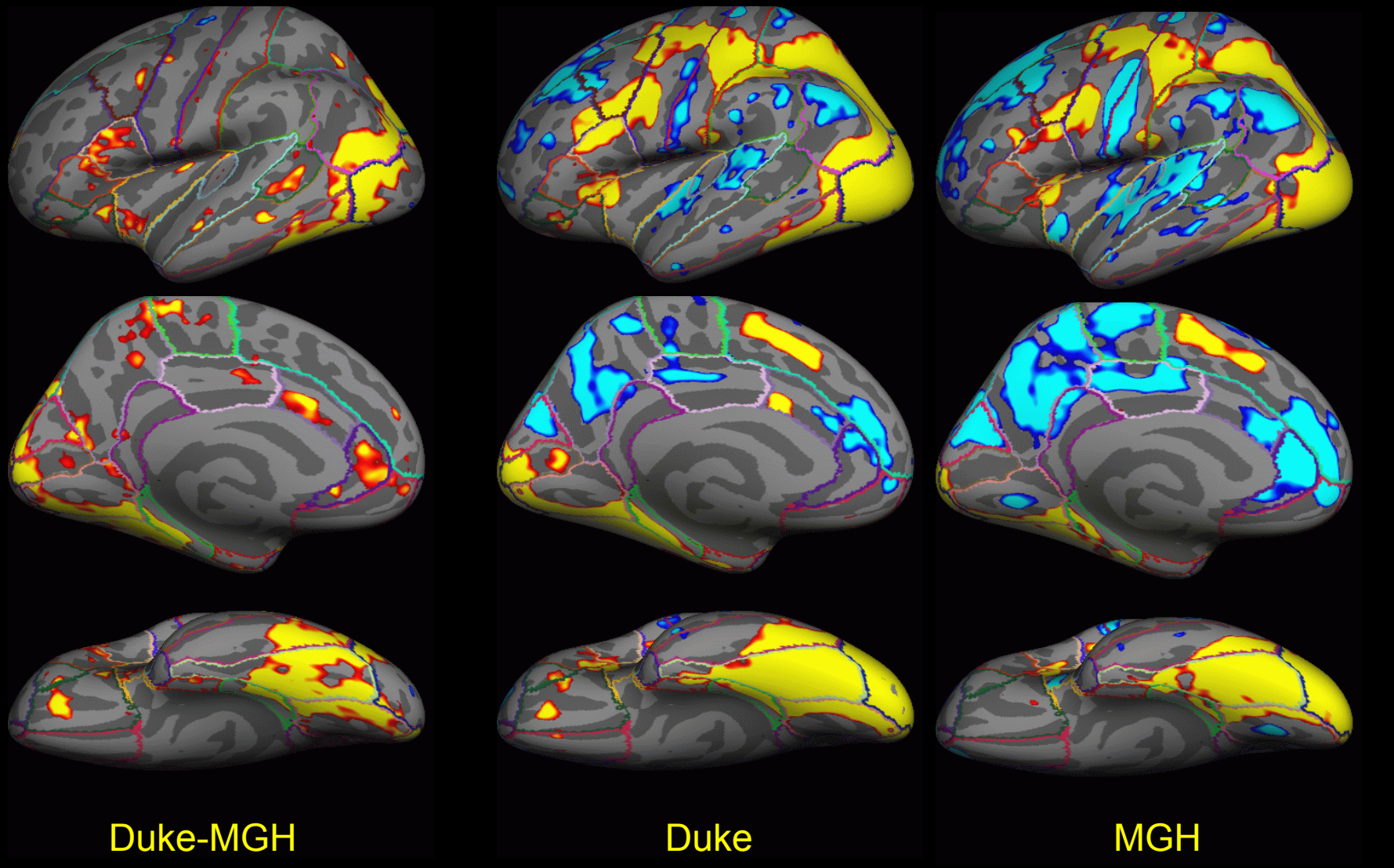
- Relative motion is a subject trait (van Dijk 2010)
- MGH = 1.4*Duke

Effect of Cross-site inconsistencies

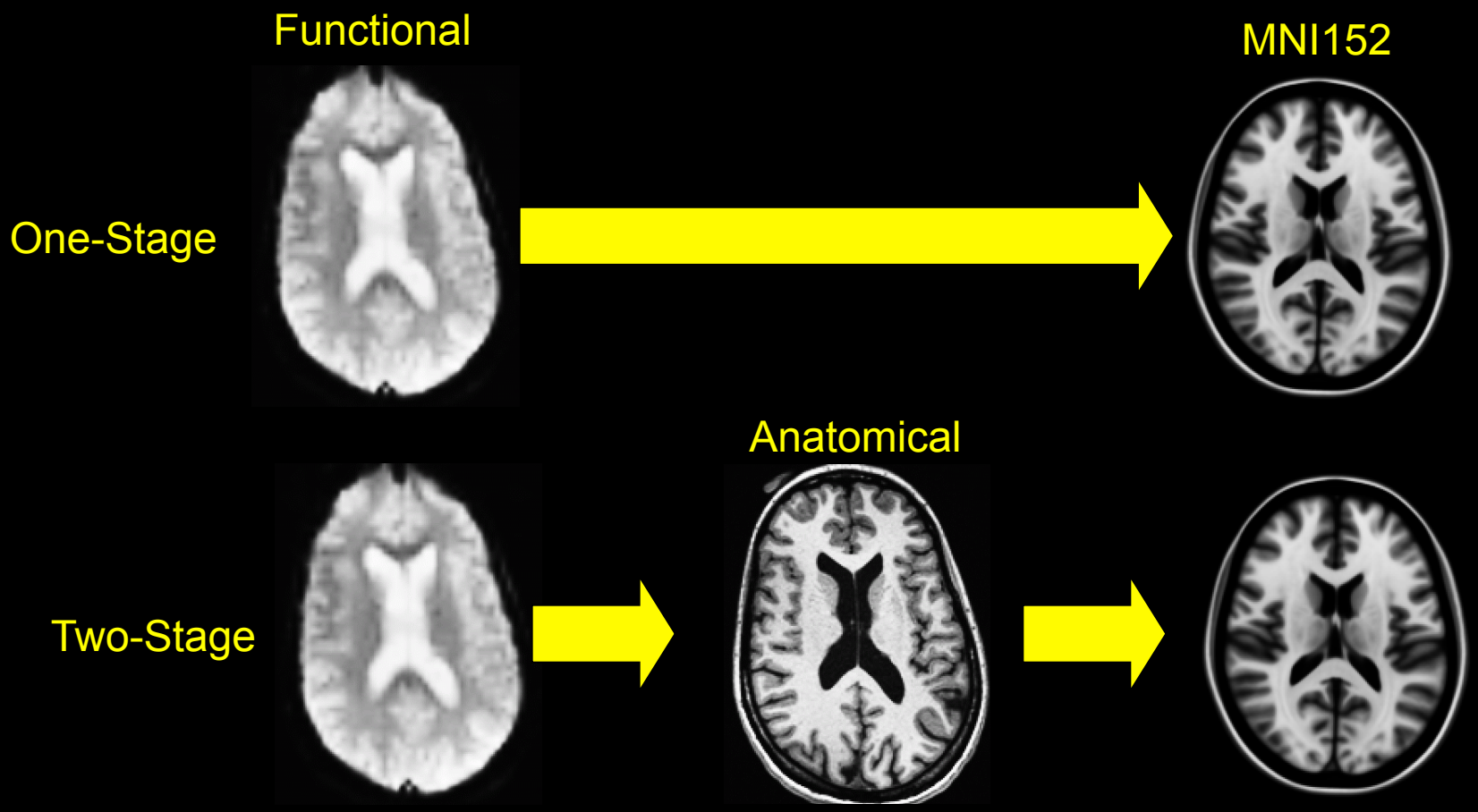
- Registration to anatomical or common space
- Hemodynamic Response Amplitude Estimation



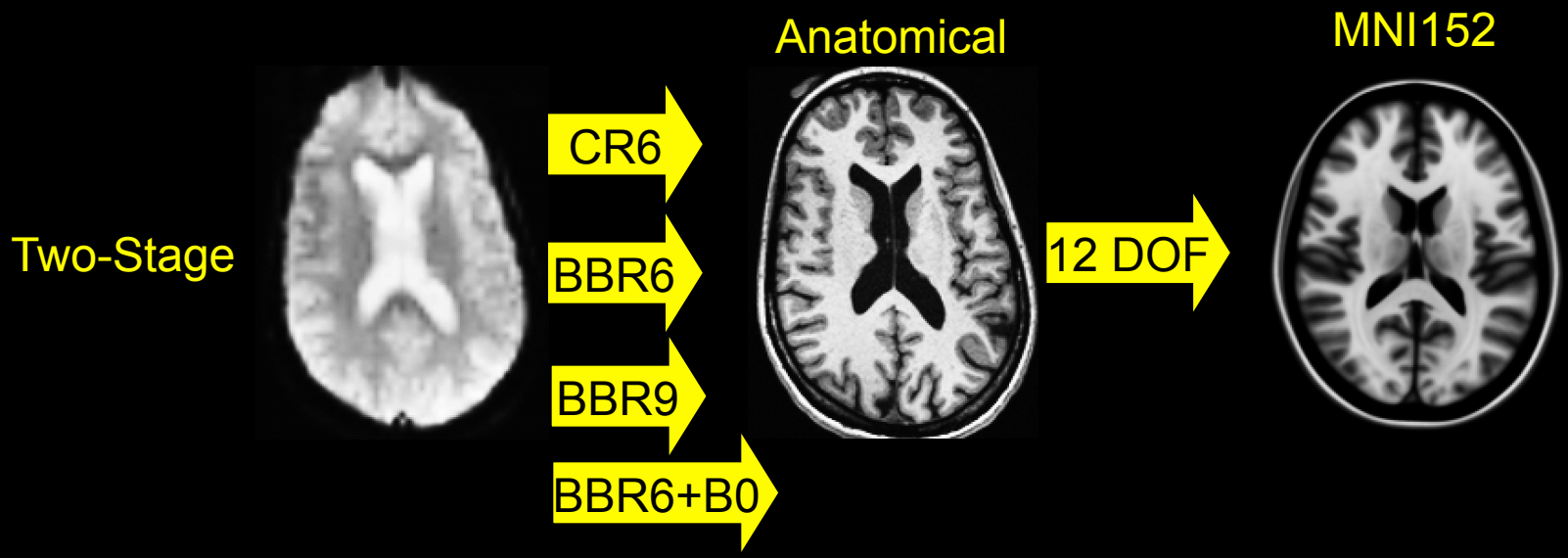
Pair-wise Differences



Registration to MNI152



Functional-Anatomical Registration



CR = Correlation Ratio
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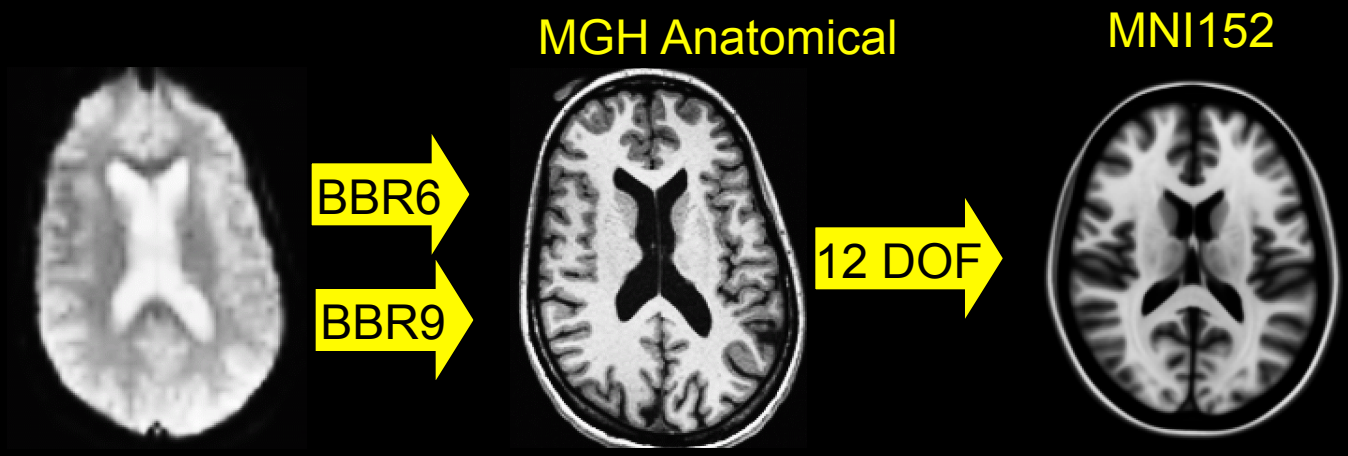
see also Local Pearson Correlation, Saad et all, NI, 2009

Metric Scaling in Functional-Anatomical Registration



BBR6 = Boundary-based registration with 6DOF (translation, rotation)
BBR9 = Boundary-based registration with 9DOF (translation, rotation, scale)

Metric Scaling Factors based on within-site Functional-Anatomical Registration

	R-L	A-P	S-I
Duke (GE)	0.9685	0.9836	0.9537
BWH (GE)	0.9816	1.0014	0.9613
MGH (Si)	0.9705	0.9922	0.9671
Yale (Si)	0.9716	1.0109	0.9712