

Developmental Variations in Corticostriatal Thalamocortical Circuits and their Relationship to Psychopathology

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Introduction

Background: Corticostriatal Thalamocortical (CSTC) circuits are critically important to skill learning and neurodevelopmental disorders. How these circuits are each differentially involved in brain development and dimensions of psychopathology are not yet well understood.

Current work: We assess how differences in structural and functional development are associated with age and dimensions of psychopathology using the Child Behavior Check List (CBCL) in a large public study, the Healthy Brain Network¹. We use advanced statistical methods including generalized additive models (GAMs), graph-based analysis, clustering, and random forests.

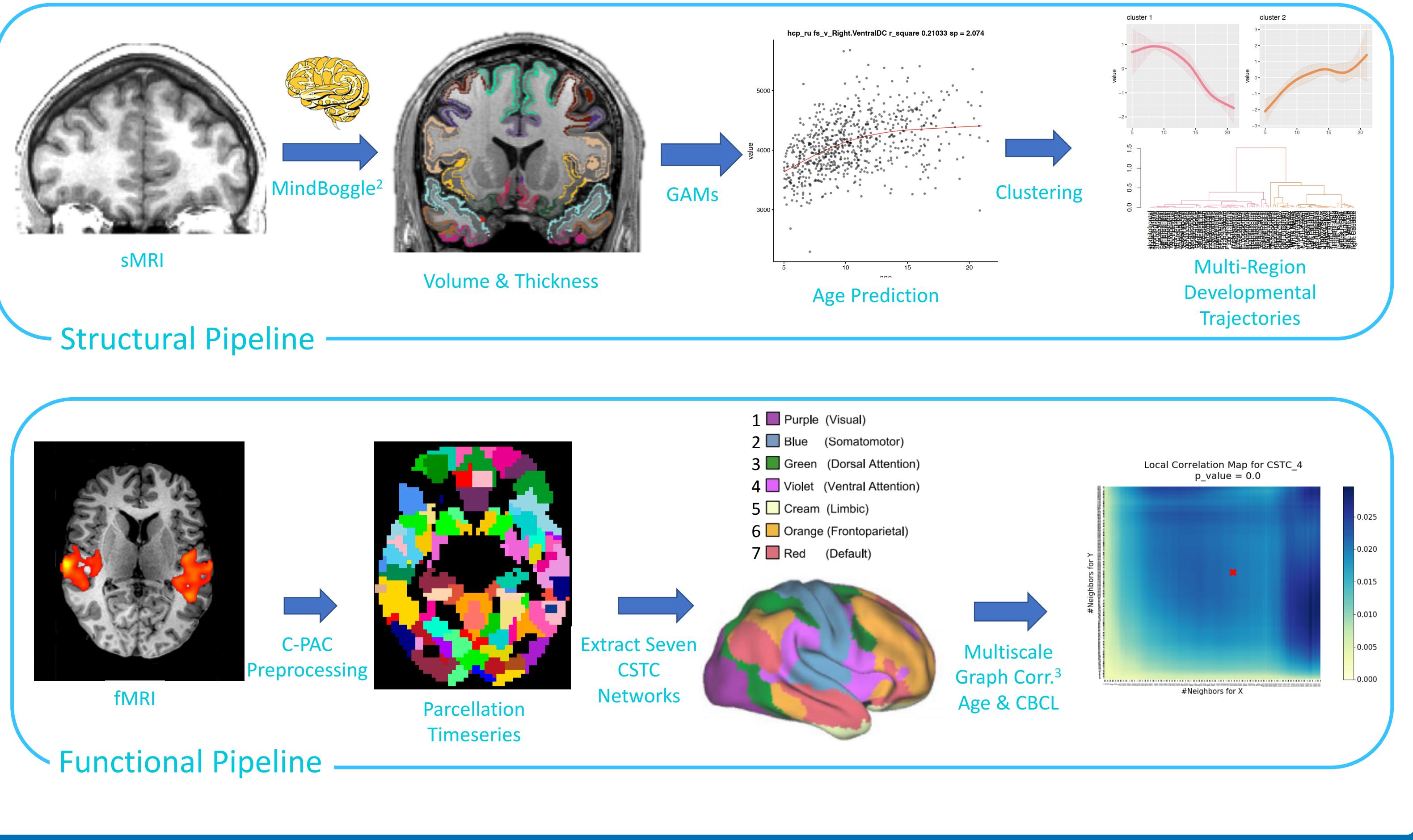
Results: We find highly reproducible developmental trajectories of structural volumes and structural thickness across analysis methods, sites and MRI scanners (100%-87%). We find robust prediction of age with all CSTC structural feature sets. We see functional CSTC circuits are most robustly predictive of age in the motor, dorsal attention, limbic, fronto-parietal, and default networks. The default CSTC network is most robustly predictive of CBCL scores. We find differences in the linear/nonlinear scale of the relationships between functional networks and age versus CBCL.

Conclusions: Structural and functional CSTC circuits are sensitive to both age and psychopathology. The Linear/nonlinear scale of these relationships differ between age and CBCL.

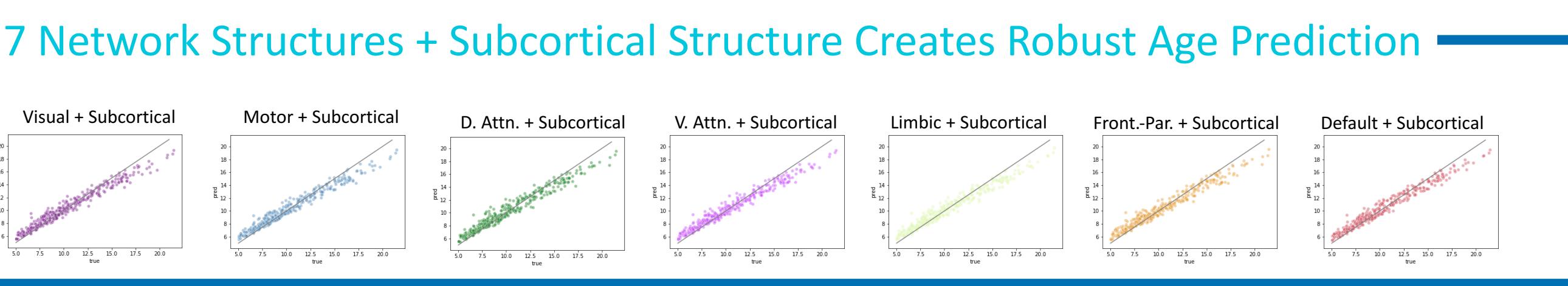
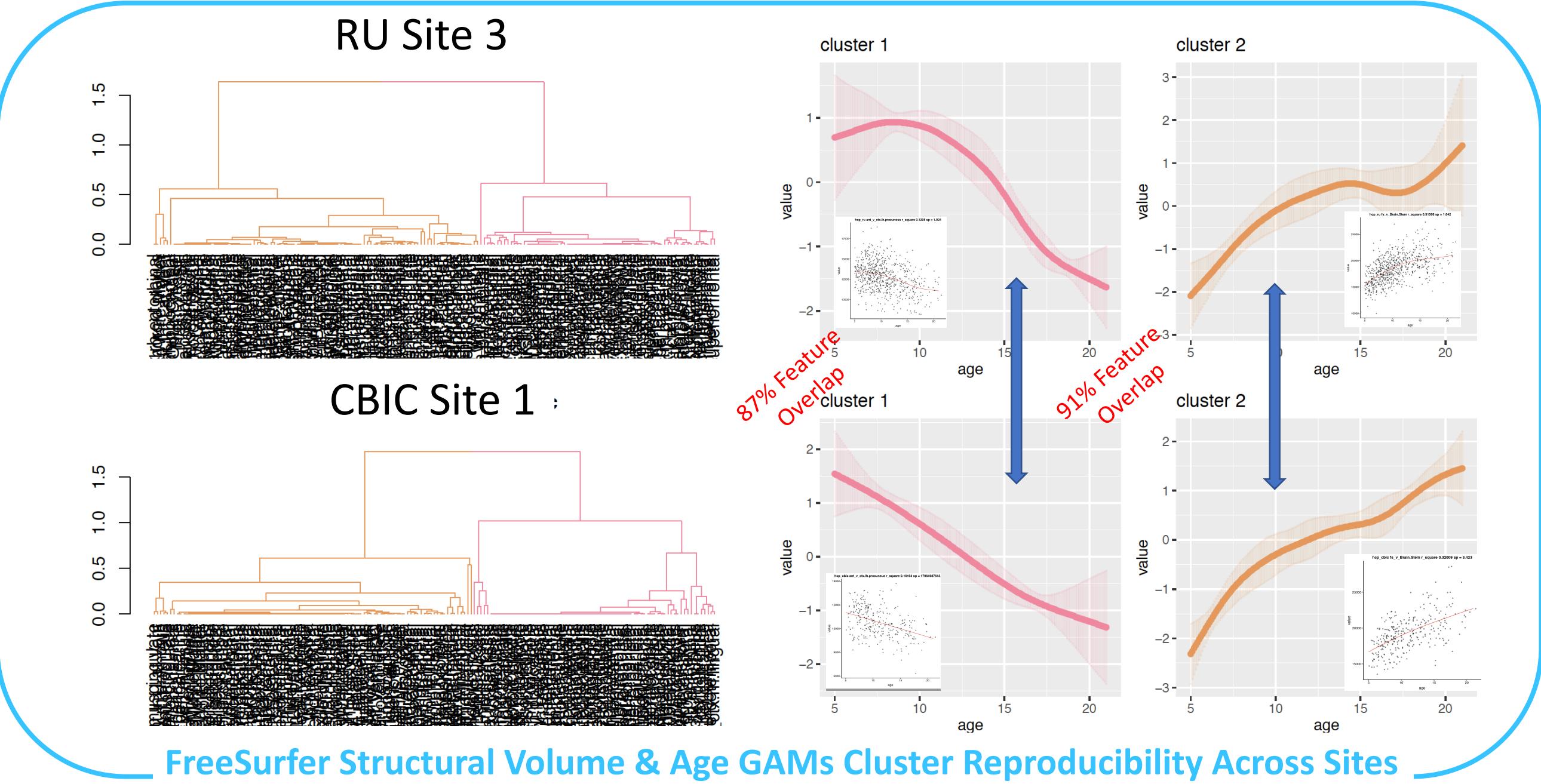
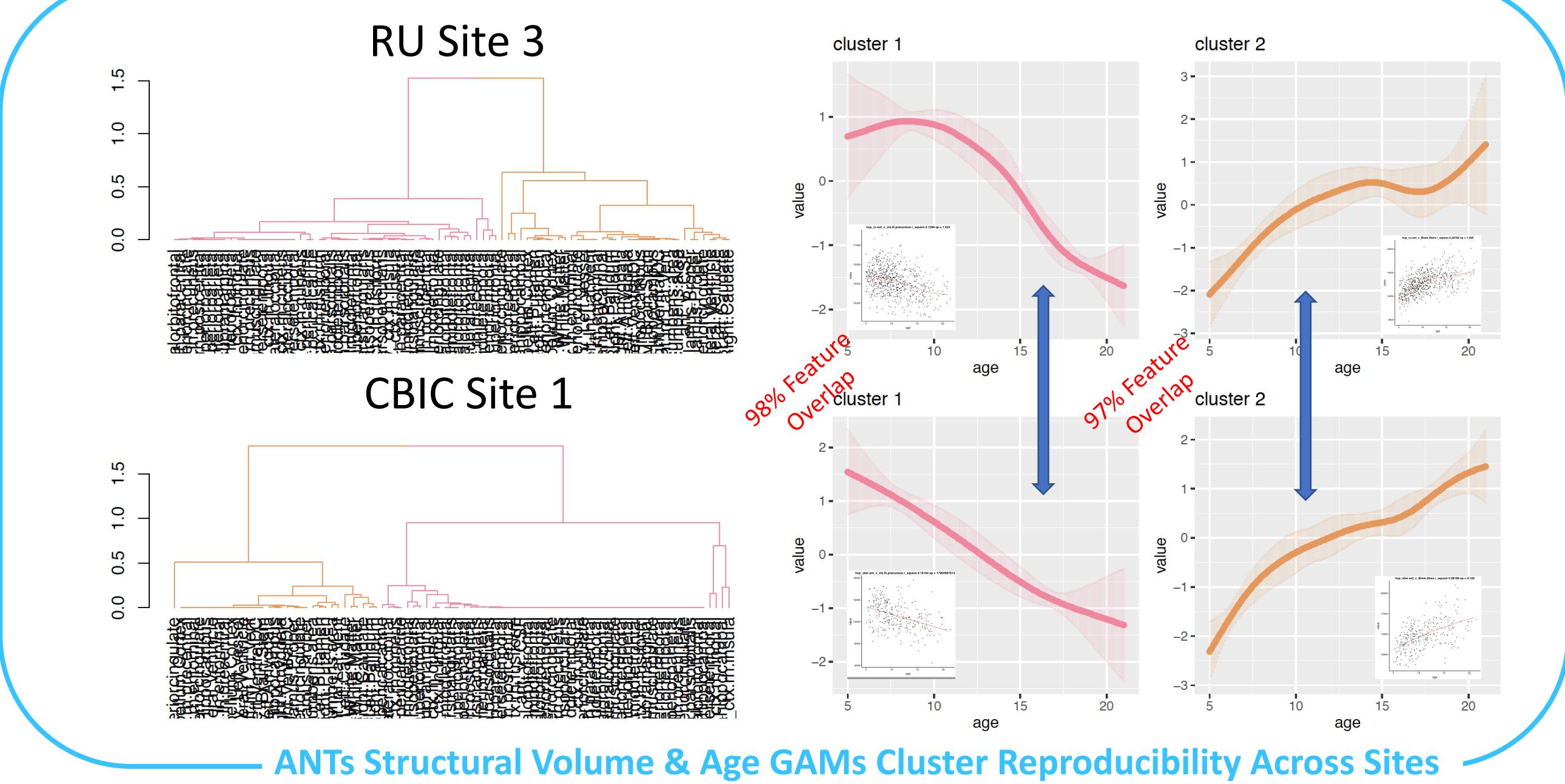
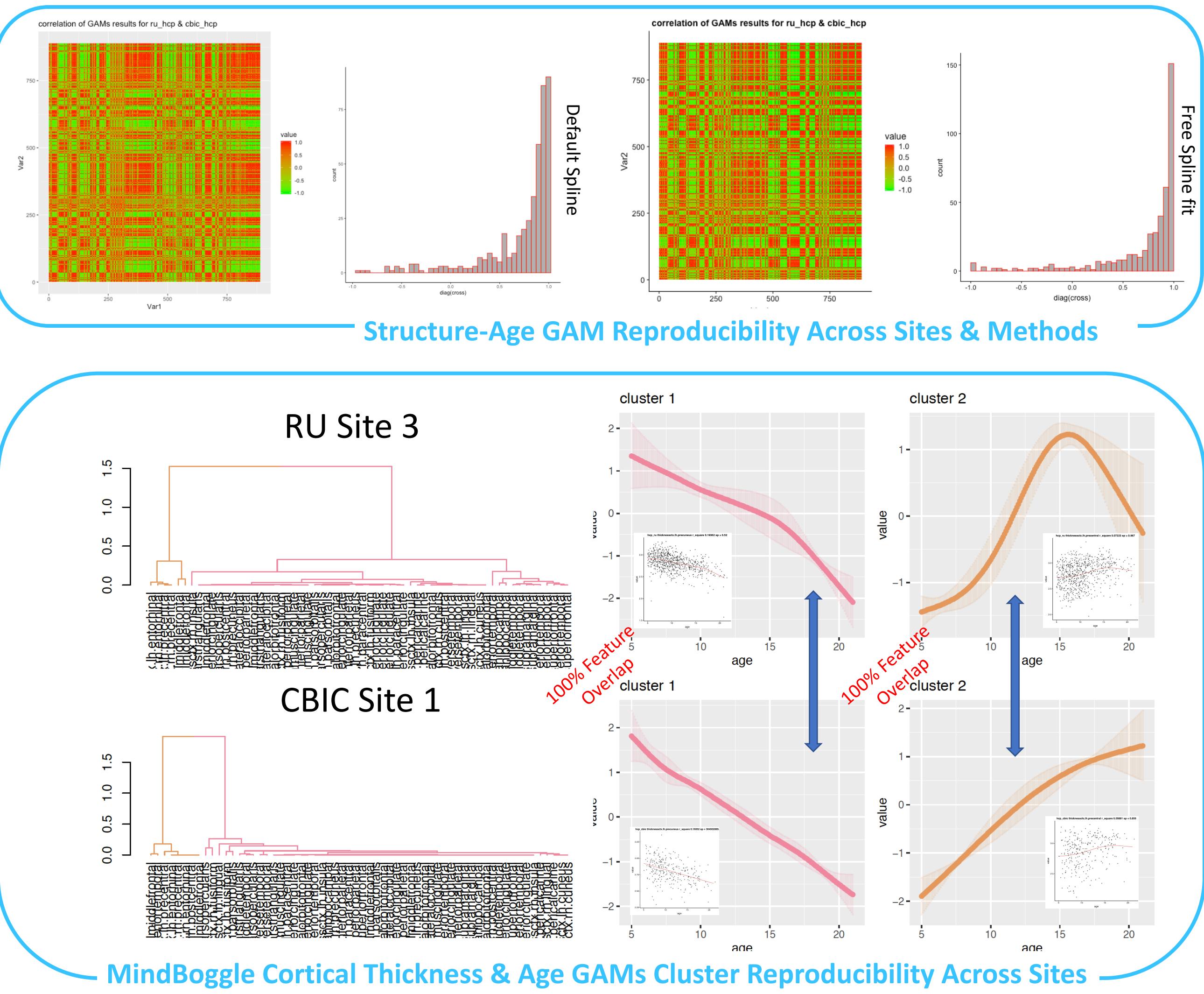
Healthy Brain Network MRI Data

MRI DATA	Sample Size sMRI /fMRI	MRI Scanner	sMRI /fMRI Voxel Res	sMRI /fMRI TR	sMRI /fMRI TE	MRI Preprocessing C-PAC:
Site 1 (CBIC)	828/820	Siemens 3T Prisma	0.8/2.4mm	2500/800ms	3.15/40ms	Structural skull stripping with AFNI. Anatomical registration to study template with ANTs. Functional preprocessed to 2mm, White matter and CSF regression. No GSR, bandpass filtering 0.01-0.1, CompCor- 5 component. White matter and CSF regression, Spike regression.
Site 2 (SI)	353/358	Siemens 1.5T Avanto	1.0/2.5mm	2730/1450ms	1.64/40ms	
Site 3 (RU)	1135/1170	Siemens 3T Tim Trio	0.8/2.4mm	2500/800ms	3.15/40ms	

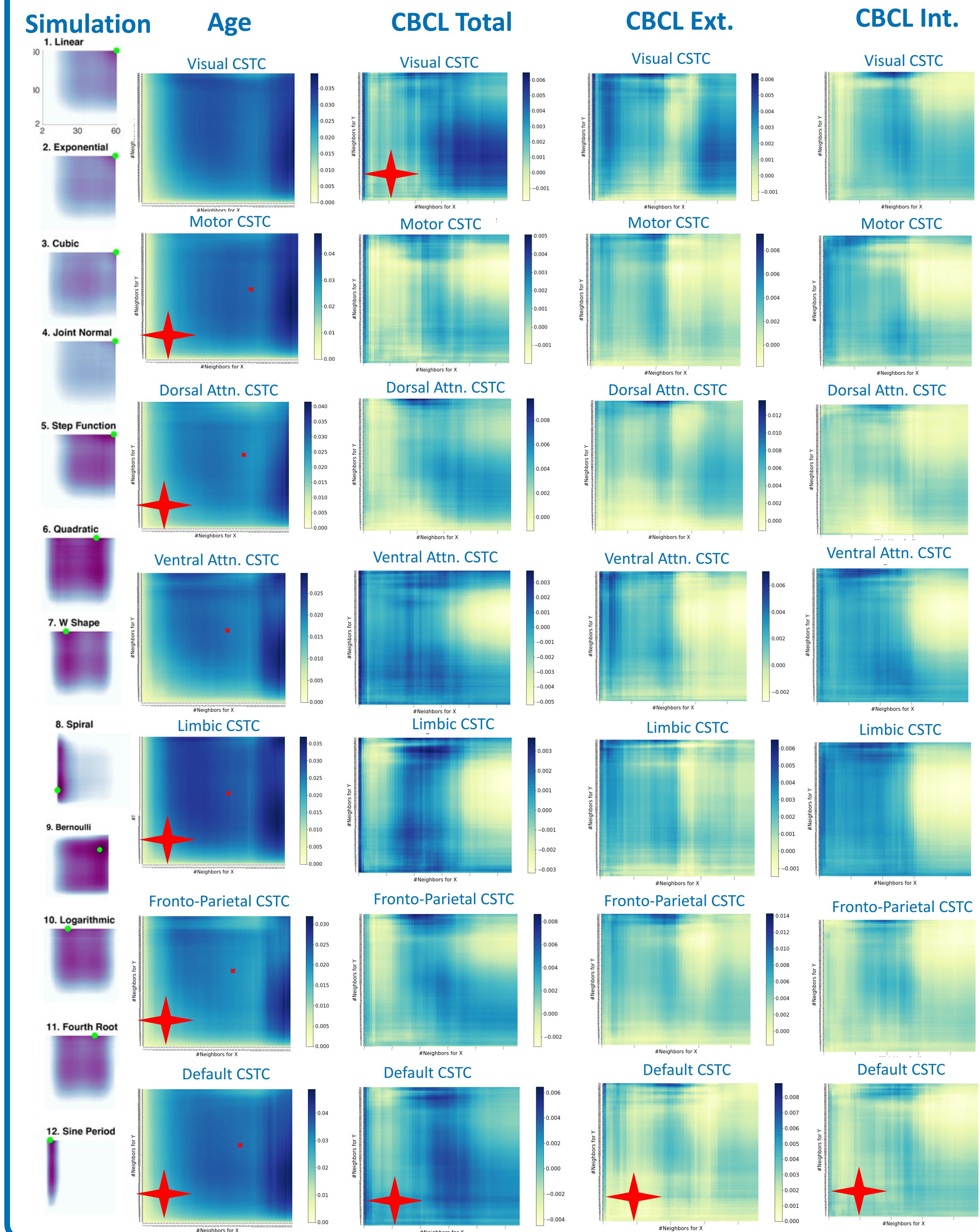
sMRI/fMRI Analysis Pipelines



Cross-Site Reproducibility of Structure-Age Prediction



CSTC Resting State Networks & Age Associations



Conclusions

- Structural results demonstrate developmental trajectory clusters are robust to site, scanner, analysis method, and structural feature type.
- The largest cluster shows decreases in volume and thickness from 5-20, and a smaller cluster showing increases.
- Structural features are robustly predictive of age across all CSTC structural feature sets.
- Functional CSTC circuits seem to have a mix of linear and quadratic effects in their association with age across a range of CSTC circuits.
- Default CSTC circuit more sensitive to individual differences in CBCL
- CBCL-CSTC circuit relationships seem to have a more complicated nonlinear relationship than the Age-CSTC associations.

References

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