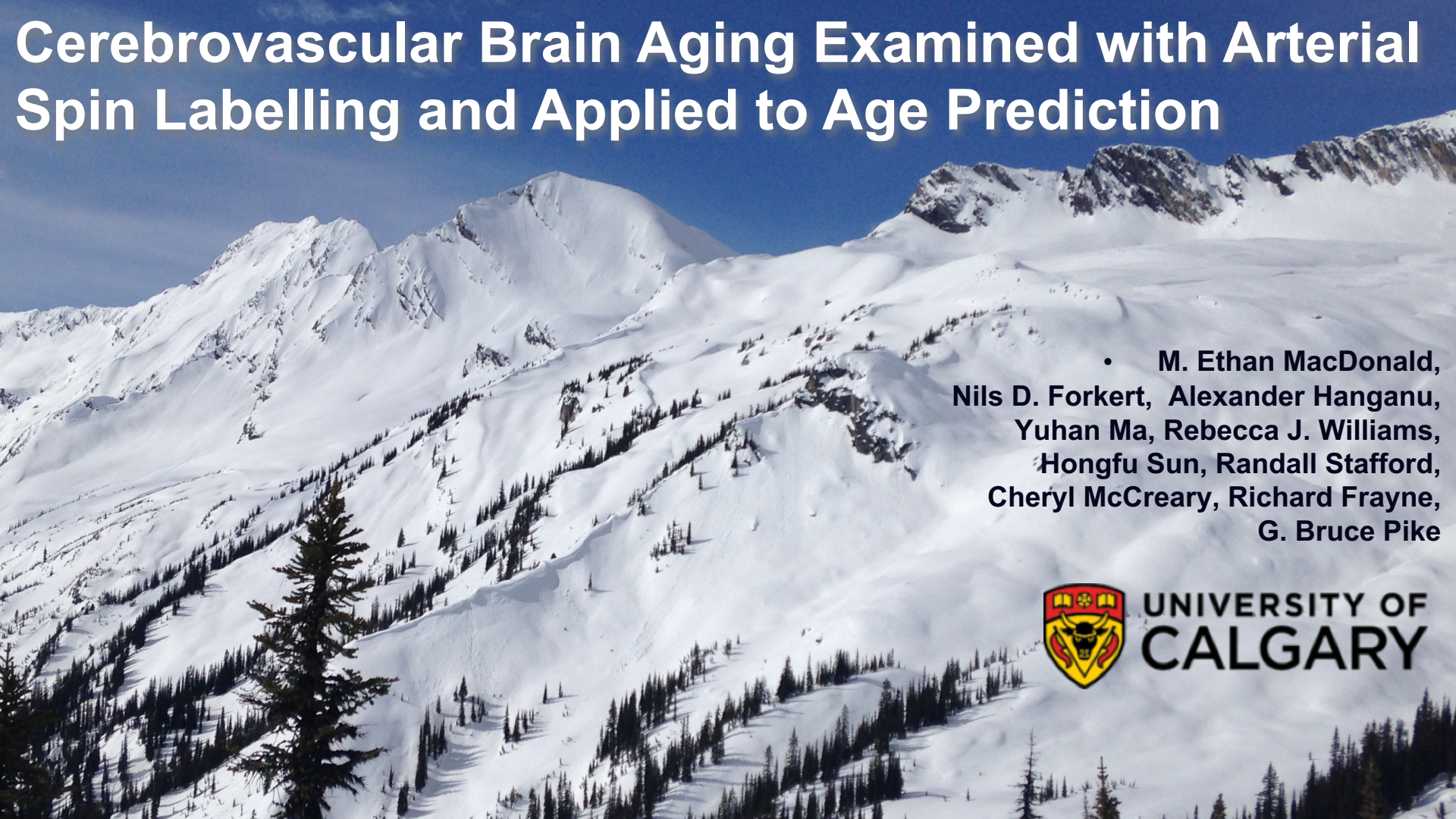
Cerebrovascular Brain Aging Examined with Arterial Spin Labelling and Applied to Age Prediction



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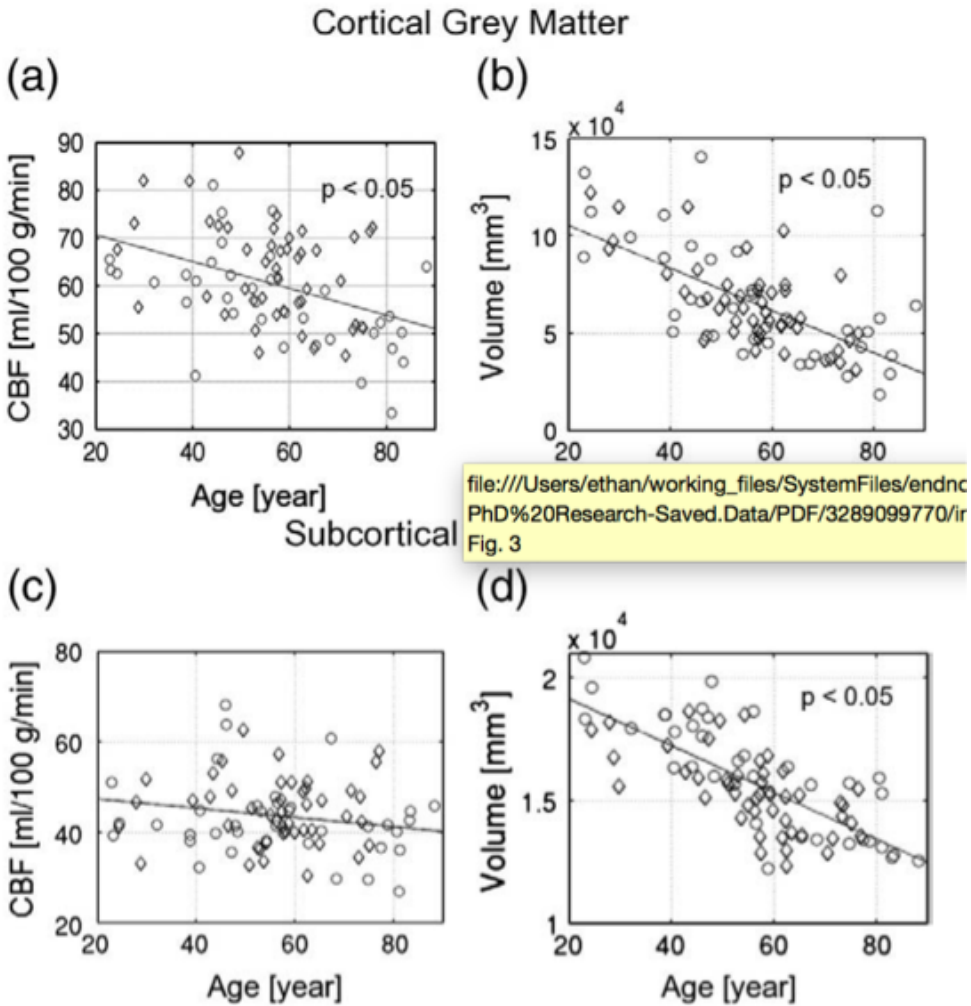
Declaration of Financial Interests or Relationships

Speaker Name: M. Ethan MacDonald

I have no financial interests or relationships to disclose with regard to the subject matter of this presentation.

Motivation

- Both cortical thickness and cerebral blood flow (CBF) are known to reduce with age[1]
- To understand how cortical thickness and CBF reduce together from finely selected cortical ROIs
- Age predication is often done with T1 weighted images
- Adding CBF information may improve age prediction modelling



1. JJ Chen, *et al.*, Neuroimage, 2011

Image Data

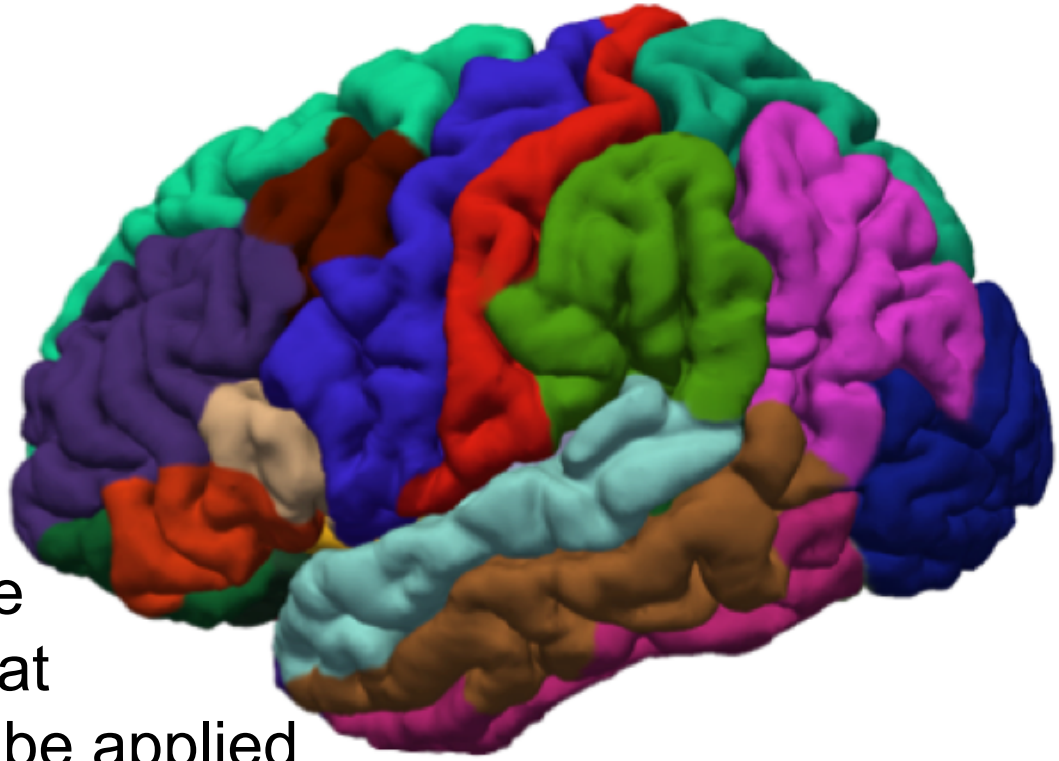
- Calgary Normative Database
- 146 subjects (58-M, 88-F; 18 to 87 years)
- Montreal Cognitive Assessment score >25
- Imaging performed with a 3T GE Discovery 750
- T_1-weighted Anatomical Scans

  MPRAGE isotropic 1 mm, TI/TR/TE/α of 650/5.84/2.36 ms/8°
- Arterial Spin Labelling (ASL)

  pseudo-continuous ASL, 5-mm thick, spiral trajectory, effective in-plane resolution of 2.33 mm, label duration 1.0 s, post label duration 2.0 s

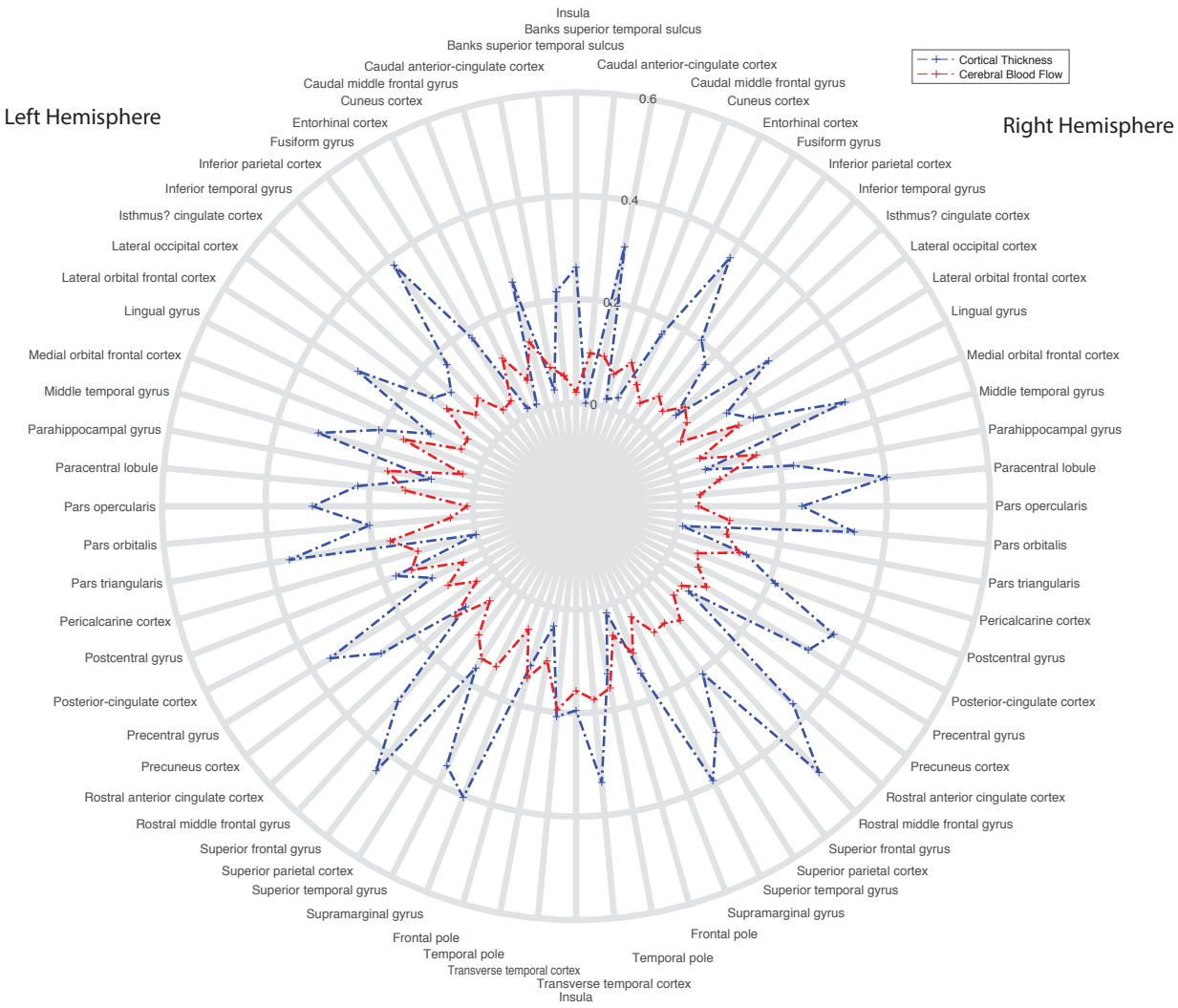
Cortical Parcellation

- Freesurfer (v5.3.0), DK Atlas – 34 parcellations per hemisphere
- Cortical thickness measurements were exported to Matlab for statistics and plotting
- ASL data was registered to the same anatomical data so that the same ROIs could be applied



Analysis

- For each ROI in each datatype, we calculated: Regression & Laterality Index
- Correlation matrix was calculated for each datatype
- All the CBF data was then registered to a template and a regression was calculated for each voxel.
- Multiple Linear Regression with recursive feature selection was then performed for three cases:
  - Cortical thickness data
  - CBF data
  - Both


Left Hemisphere
Right Hemisphere
Cortical Thickness
Cerebral Blood Flow
0
0.2
0.4
0.6
Insula
Banks superior temporal sulcus
Banks superior temporal sulcus
Caudal anterior-cingulate cortex
Caudal middle frontal gyrus
Cuneus cortex
Entorhinal cortex
Fusiform gyrus
Inferior parietal cortex
Inferior temporal gyrus
Isthmus? cingulate cortex
Lateral occipital cortex
Lateral orbital frontal cortex
Lingual gyrus
Medial orbital frontal cortex
Middle temporal gyrus
Parahippocampal gyrus
Paracentral lobule
Pars opercularis
Pars orbitalis
Pars triangularis
Pericalcarine cortex
Postcentral gyrus
Posterior-cingulate cortex
Precentral gyrus
Precuneus cortex
Rostral anterior cingulate cortex
Rostral middle frontal gyrus
Superior frontal gyrus
Superior parietal cortex
Superior temporal gyrus
Supramarginal gyrus
Frontal pole
Temporal pole
Transverse temporal cortex
Caudal anterior-cingulate cortex
Caudal middle frontal gyrus
Cuneus cortex
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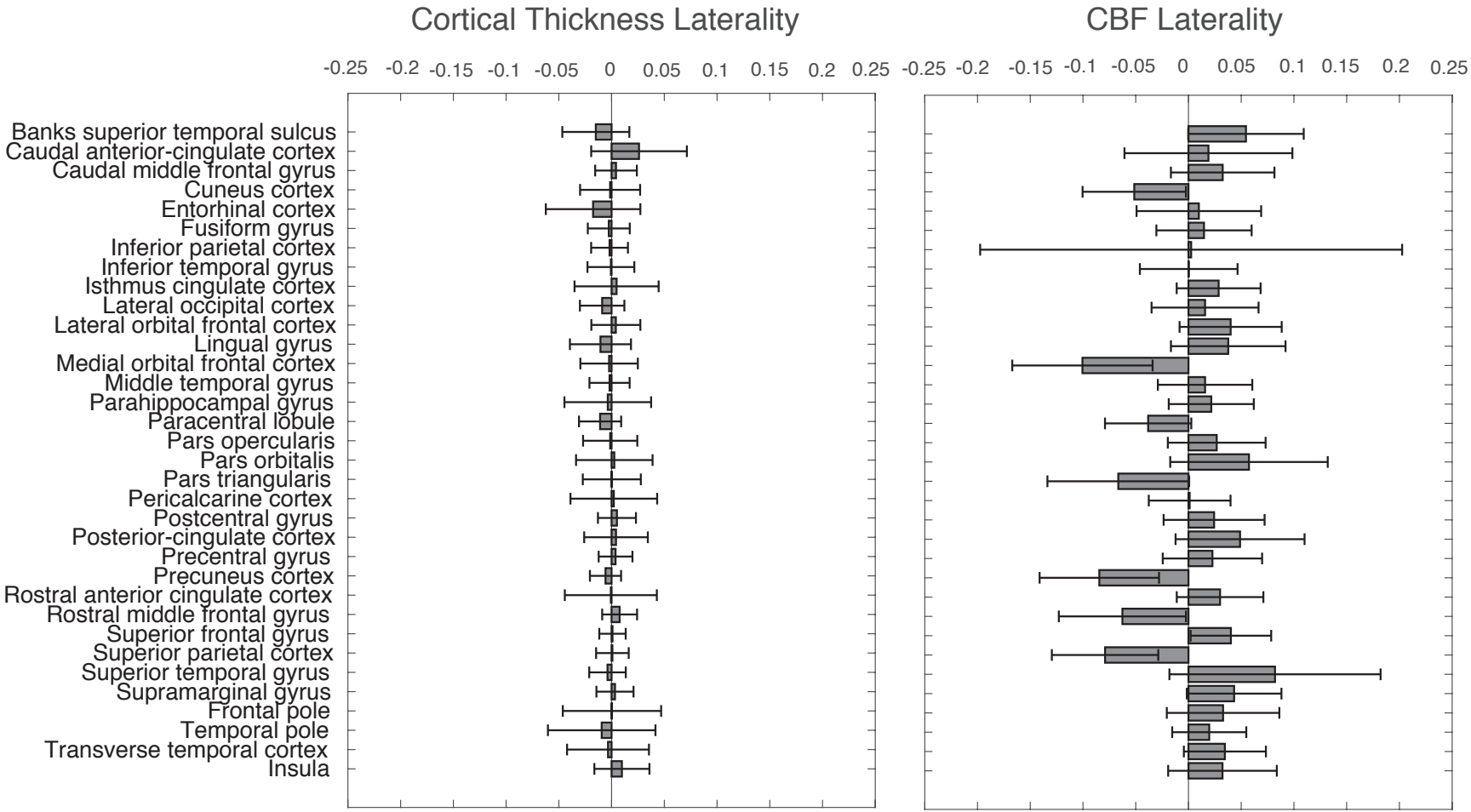
Superior temporal gyrus
Supramarginal gyrus
Frontal pole
Temporal pole
Transverse temporal cortex
Insula


Cortical Thickness Laterality
CBF Laterality
-0.25 -0.2 -0.15 -0.1 -0.05 0 0.05 0.1 0.15 0.2 0.25
Banks superior temporal sulcus
Caudal anterior-cingulate cortex
Caudal middle frontal gyrus
Cuneus cortex
Entorhinal cortex
Fusiform gyrus
Inferior parietal cortex
Inferior temporal gyrus
Isthmus cingulate cortex
Lateral occipital cortex
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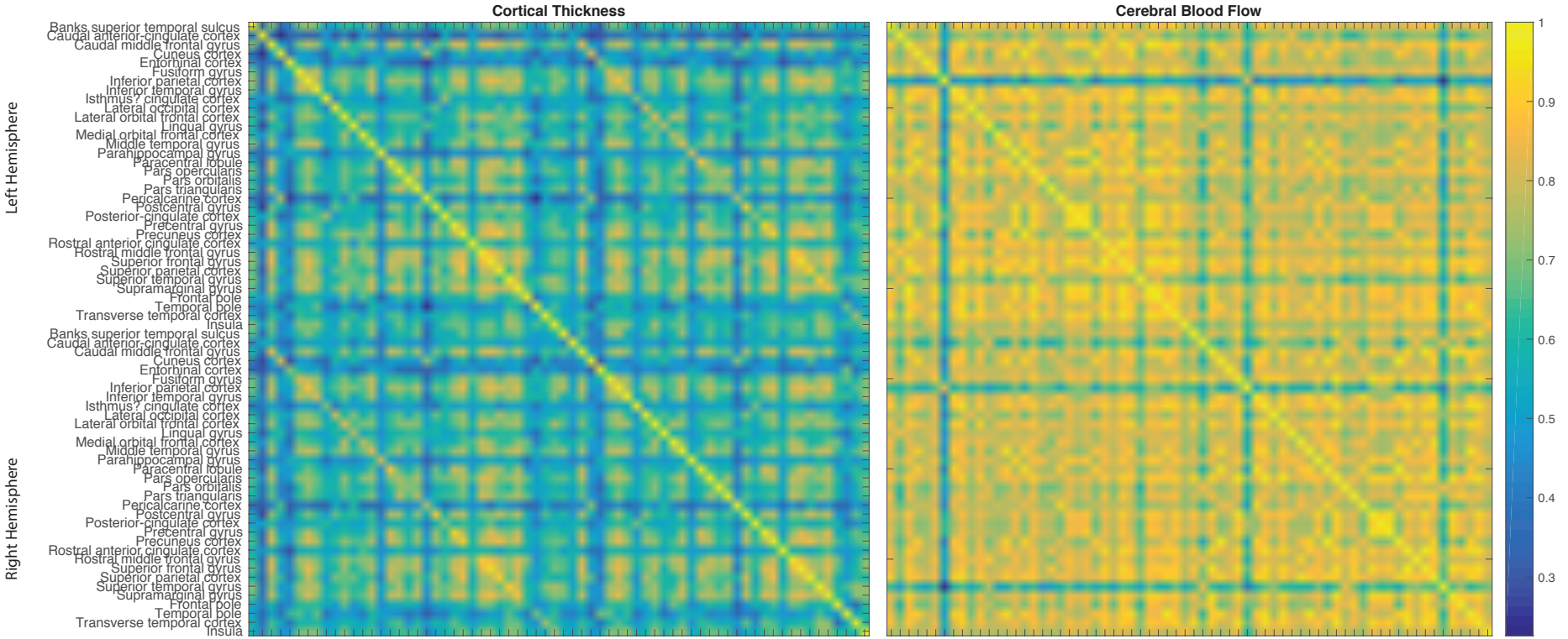
Superior parietal cortex
Superior temporal gyrus
Supramarginal gyrus
Frontal pole
Temporal pole
Transverse temporal cortex
Insula


Cortical Thickness
Cerebral Blood Flow
Left Hemisphere
Right Hemisphere
Banks superior temporal sulcus
Caudal anterior-cingulate cortex
Caudal middle frontal gyrus
Cuneus cortex
Entorhinal cortex
Fusiform gyrus
Inferior parietal cortex
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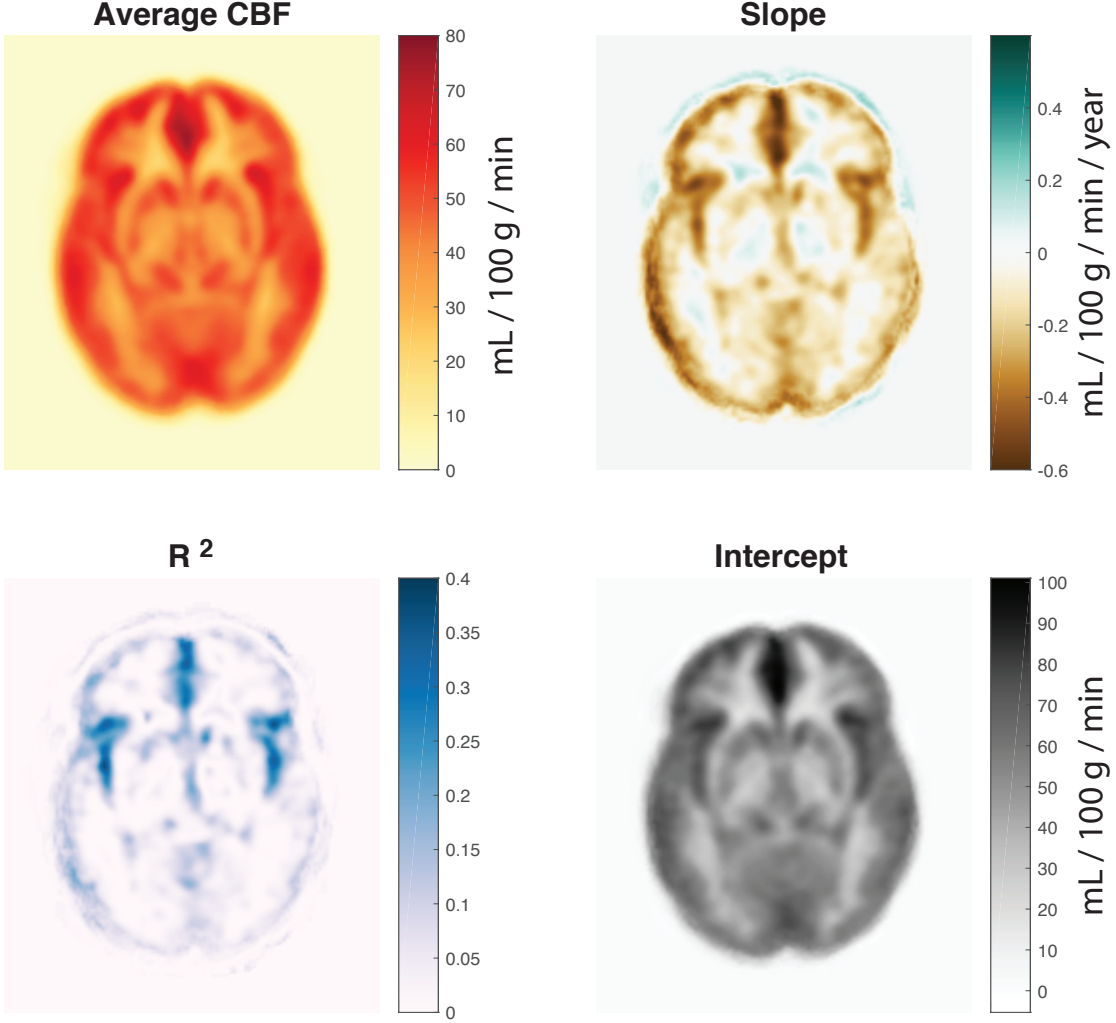
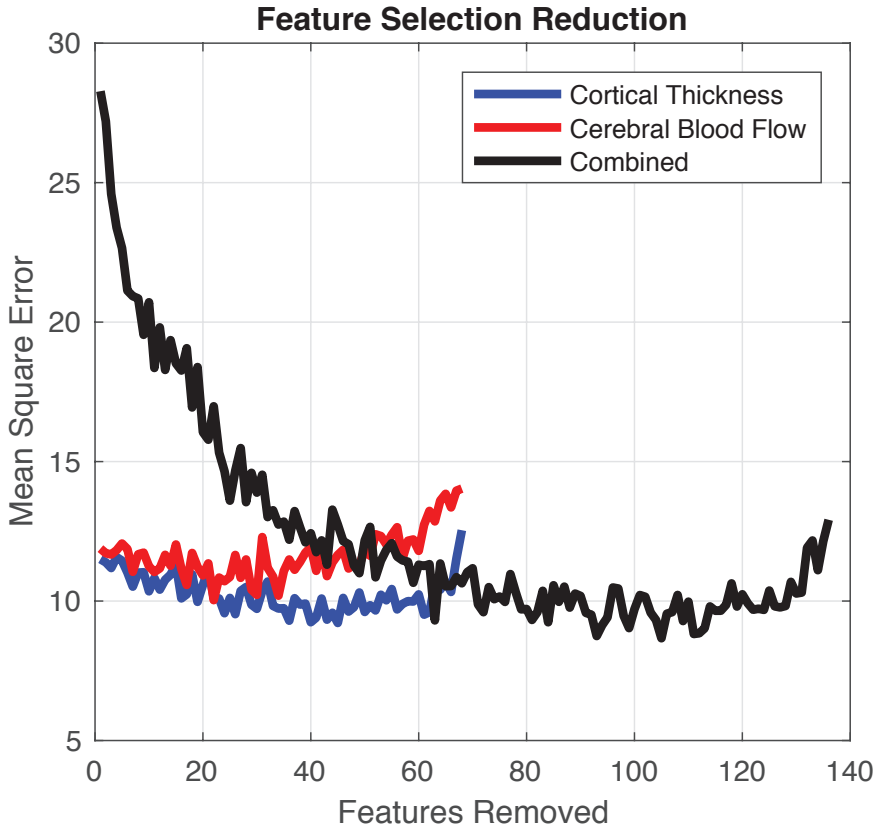
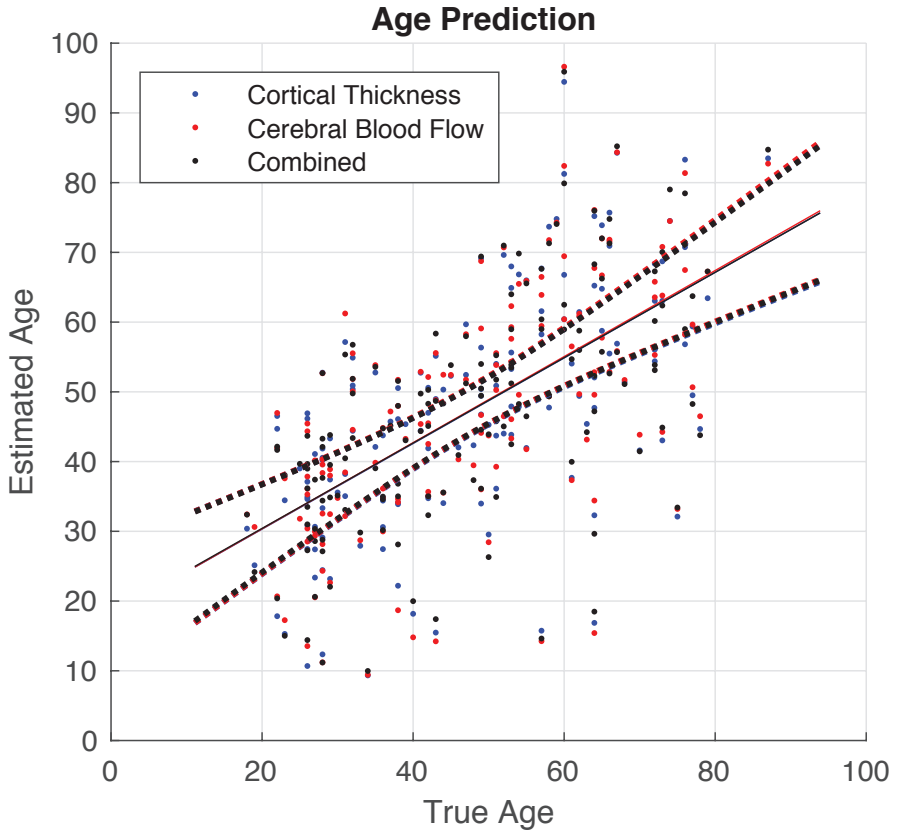
Precentral gyrus
Precuneus cortex
Rostral anterior cingulate cortex
Rostral middle frontal gyrus
Superior frontal gyrus
Superior parietal cortex
Superior temporal gyrus
Supramarginal gyrus
Frontal pole
Temporal pole
Transverse temporal cortex
Insula
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3


Average CBF
80
70
60
50
40
30
20
10
0
mL / 100 g / min
Slope
0.4
0.2
0
-0.2
-0.4
-0.6
mL / 100 g / min / year
R 2
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Intercept
100
90
80
70
60
50
40
30
20
10
0
mL / 100 g / min


Feature Selection Reduction
Cortical Thickness
Cerebral Blood Flow
Combined
Mean Square Error
Features Removed
30
25
20
15
10
5
0
20
40
60
80
100
120
140


Age Prediction
Cortical Thickness
Cerebral Blood Flow
Combined
Estimated Age
True Age
100
90
80
70
60
50
40
30
20
10
0
0
20
40
60
80
100

Conclusions

- CBF data has lower R^2 with age than cortical thickness
- There is more laterality in CBF than cortical thickness
- Cortical thickness is less correlated amongst regions than CBF
- Group average maps indicate that the reduction of CBF with age is constrained primarily to gray matter with similar rates of change across regions
- age prediction was good for either cortical thickness and CBF alone only, and slightly better with the combination.

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