Consistency of Inter-database Cortical Thinning with Age

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Declaration of Financial Interests or Relationships

Speaker Name: Ethan MacDonald

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

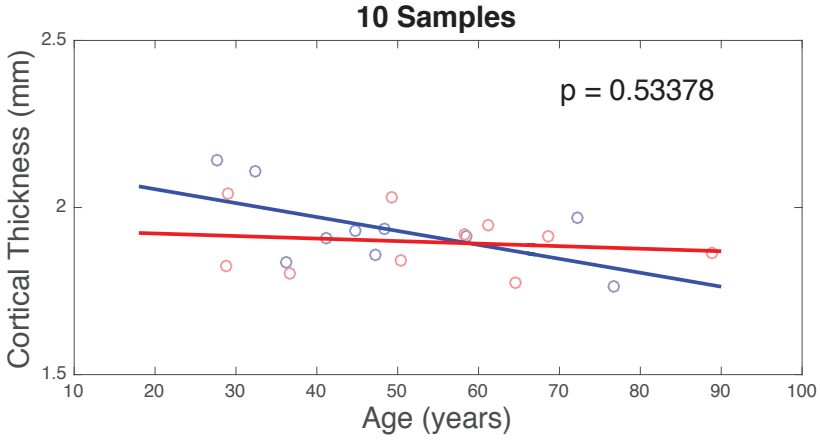
Motivation

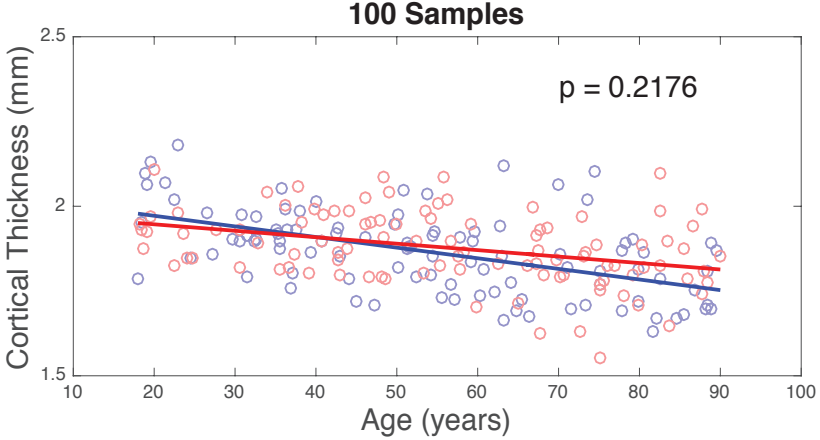
- Many studies consolidate large lifespan databases without testing for differences between the databases
- Some lifespan databases, such as FCN, make lifespan databases from many smaller databases
- Previous studies suggest that there will be differences between databases when parameters differ[1,2]
- Answer the question:

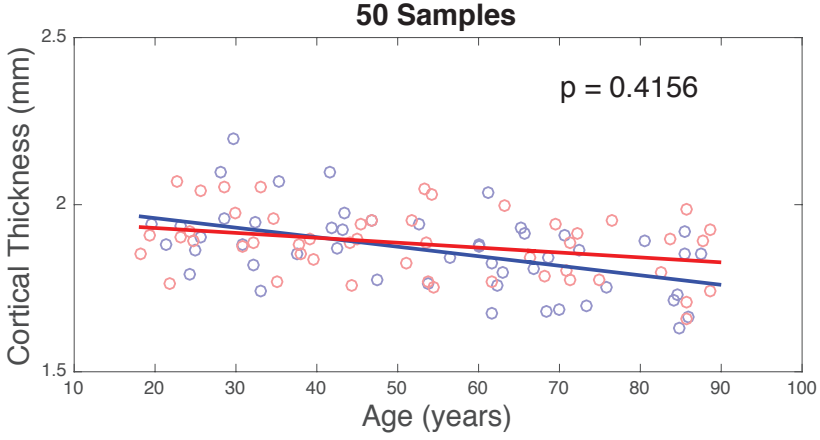
  What are the differences in cortical thinning between lifespan databases?

[1) Han *et al.*, 2006. NeuroImage, 2) Dickerson, *et al.*, 2008. NeuroImage]

BLUE: y = -0.0024 t + 2
RED: y = -0.0020 t + 2







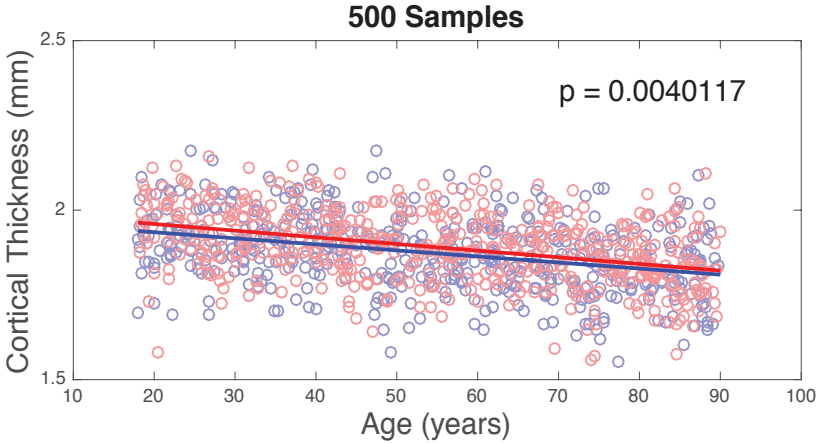


Image Data

- 4 Databases:
  - Calgary Normative Database
  - Open Access Series of Imaging Studies (OASIS) database
  - Information eXctraction of Images (IXI) database
  - Dallas Lifespan Brain Study (DLBS) database

- Total 1,382 Subjects
- T_1-weighted Anatomical Scans

Database Breakdown

Calgary Normative Database

- Montreal Cognitive Assessment score >26
- 3T GE Scanner
- 1 mm^3

OASIS database

- Tested normal on Mini-Mental State Exam
- 1.5T Siemens scanner
- 1 mm × 1 mm × 1.25 mm

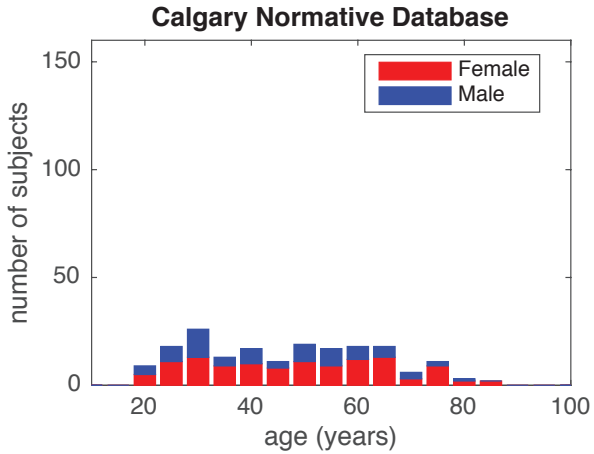
IXI database

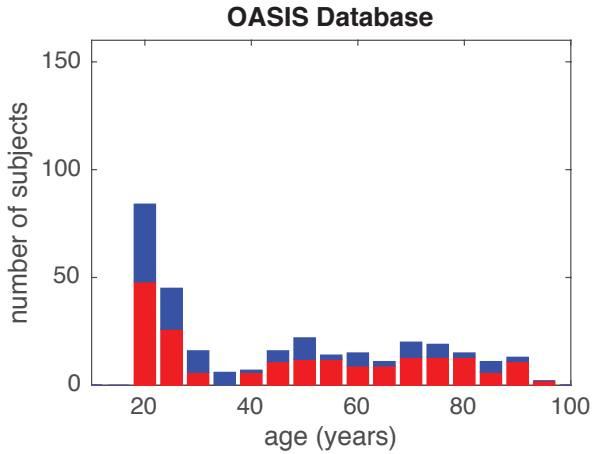
- Philips 3T, Philips 1.5T, or GE 1.5T
- 0.94 mm × 0.94 mm × 1.2 mm

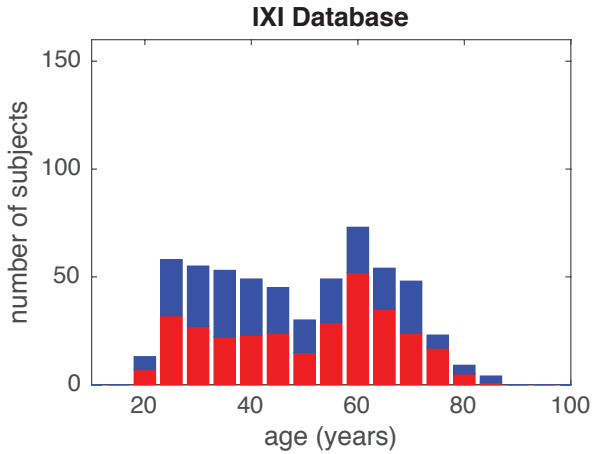
DLBS database

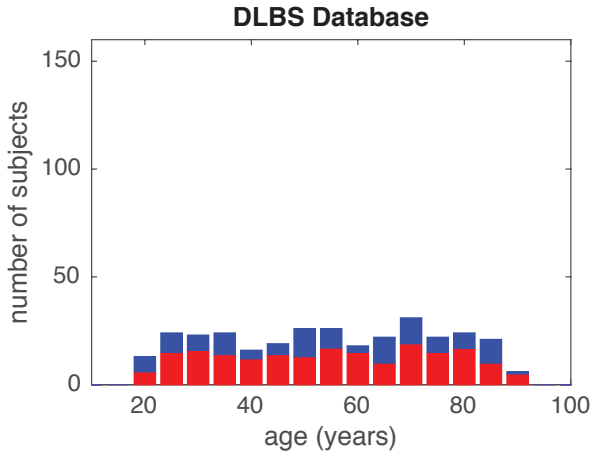
- Philips 3T
- 1 mm^3

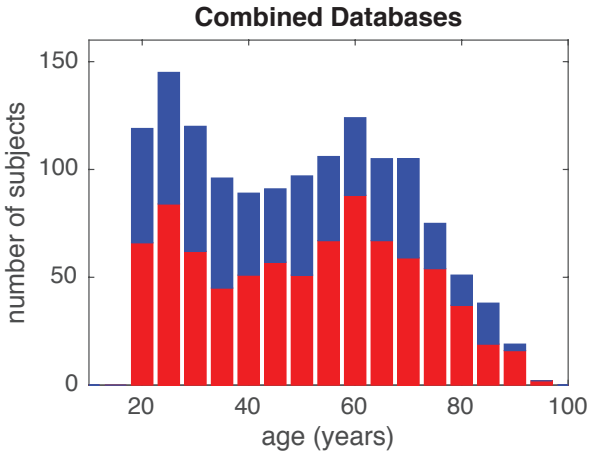
Database Age and Sex Distribution







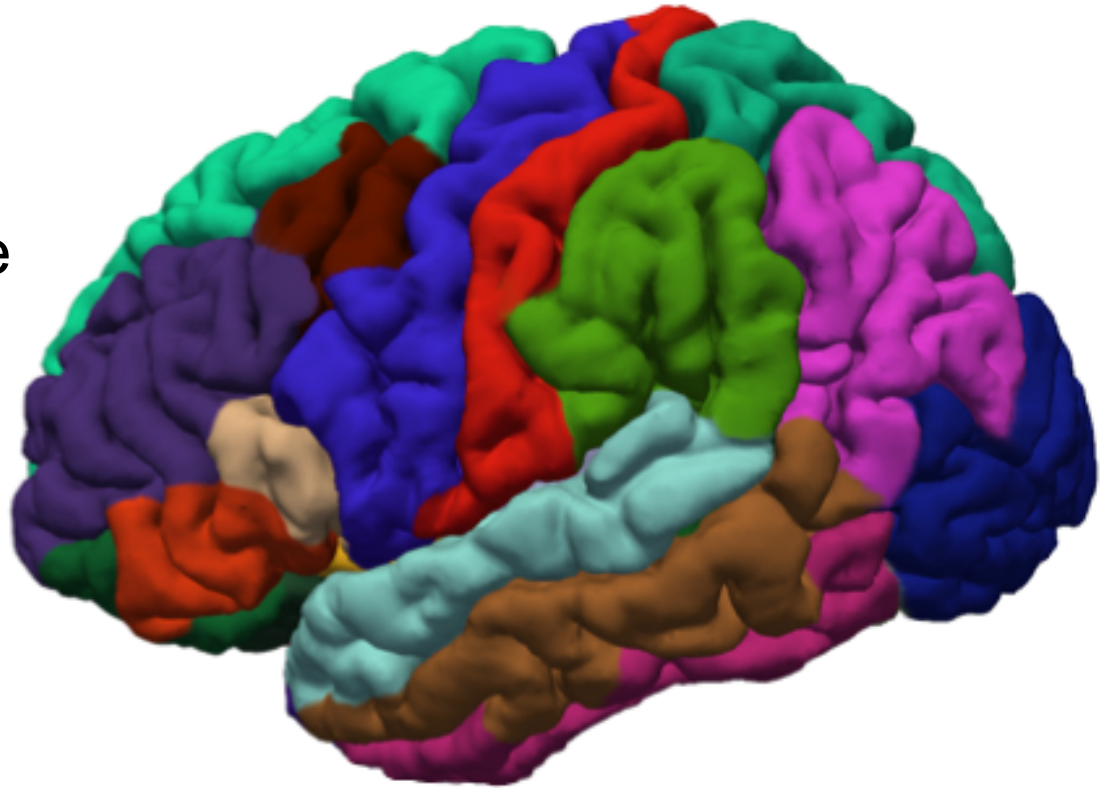




Cortical Parcellation

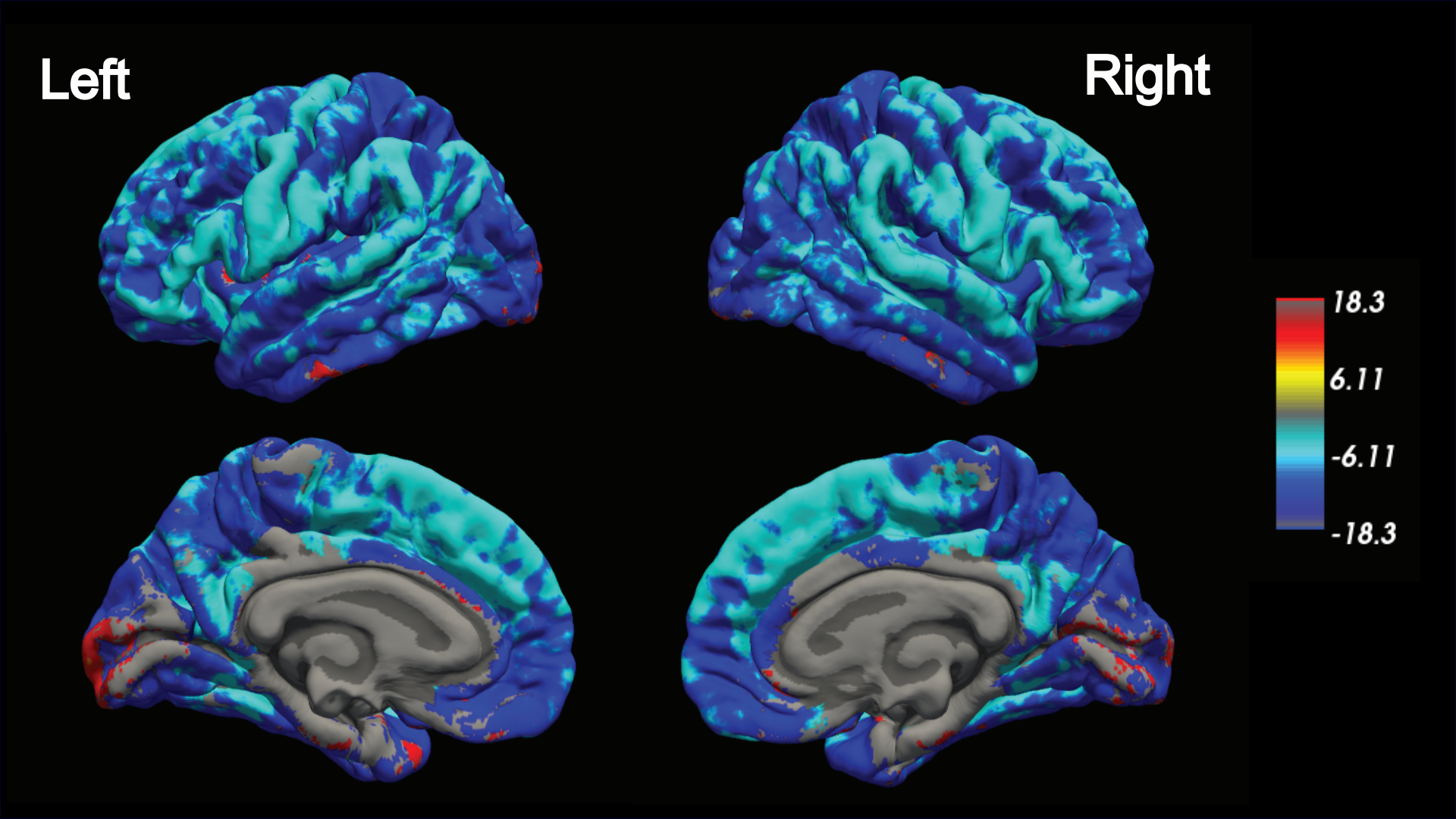
- Freesurfer (v5.3.0), DK Atlas – 34 parcellations per hemisphere

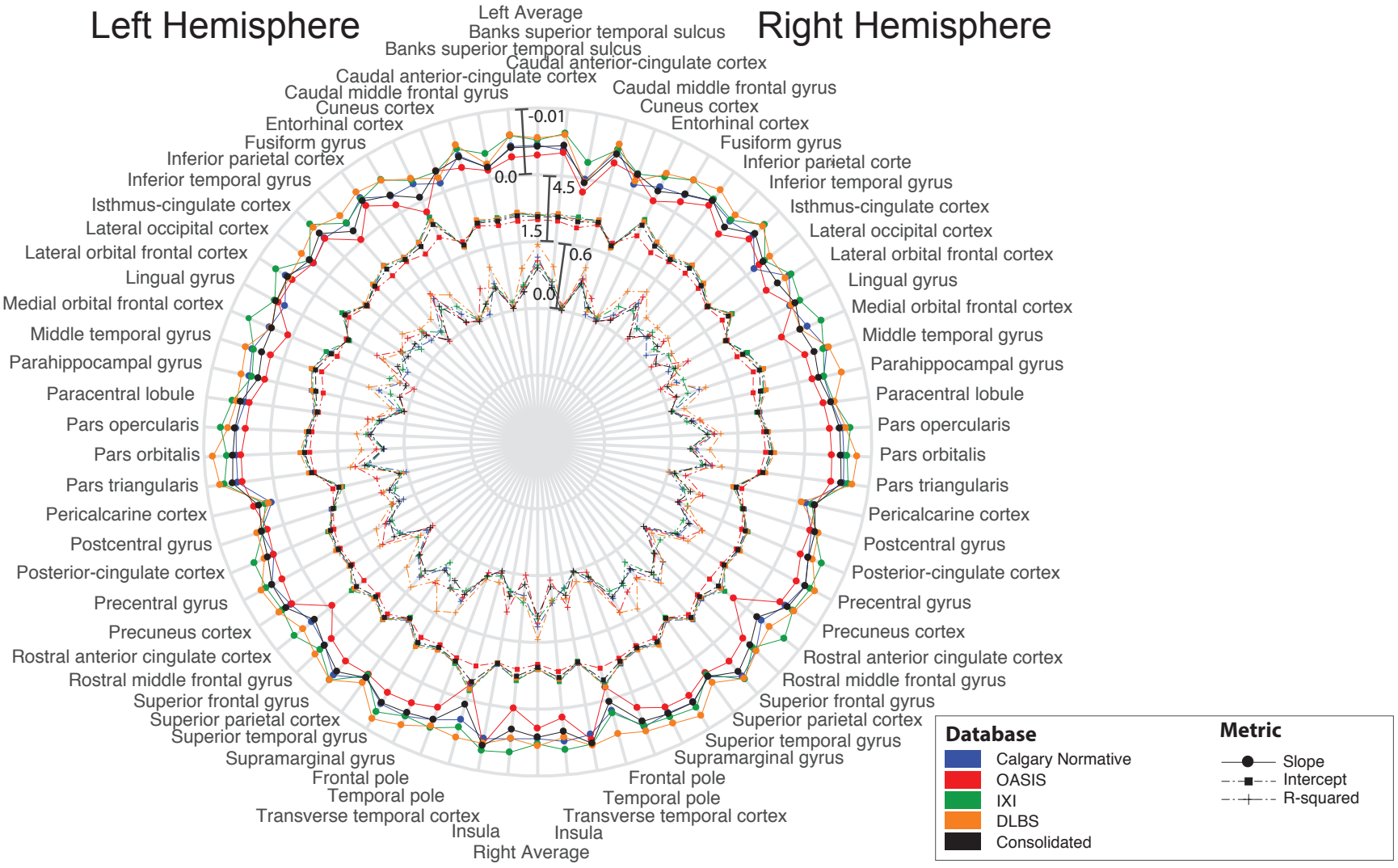
- Cortical thickness measurements were exported to Matlab for statistics and plotting

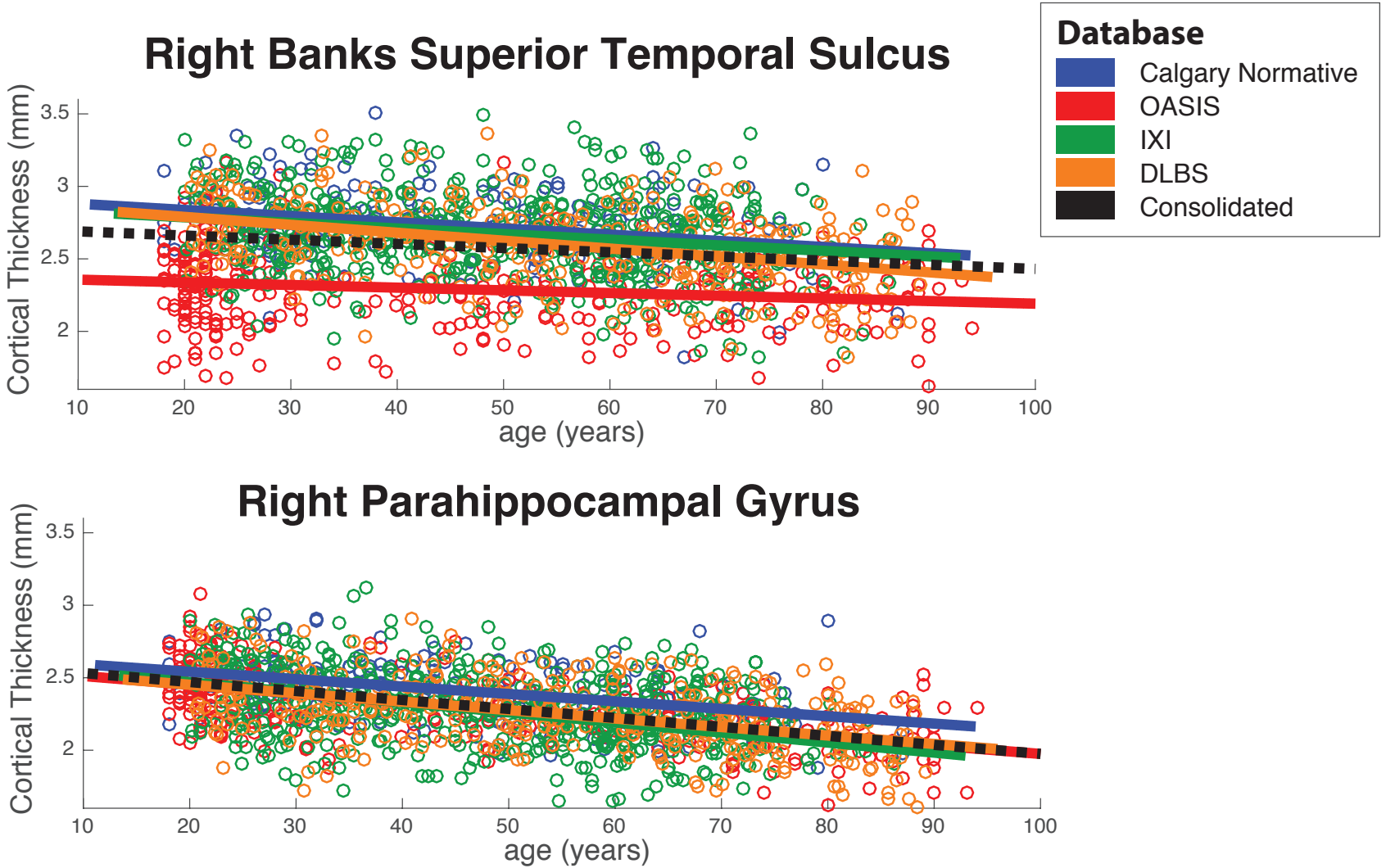


Statistical Analysis

- General Linear Model (GLM) of surface differences between databases
- For each region:
  - Calculated the linear regression line
  - Tested for Correlation with age using Pearson test
  - Tested the residuals for normality and homogeneity of variance between databases
  - ANCOVA test, 4-level factor of database and age as a covariate
- Calculated the Correlation Matrix and Regression Bootstrapping of each database


Left
Right
18.3
6.11
-6.11
-18.3

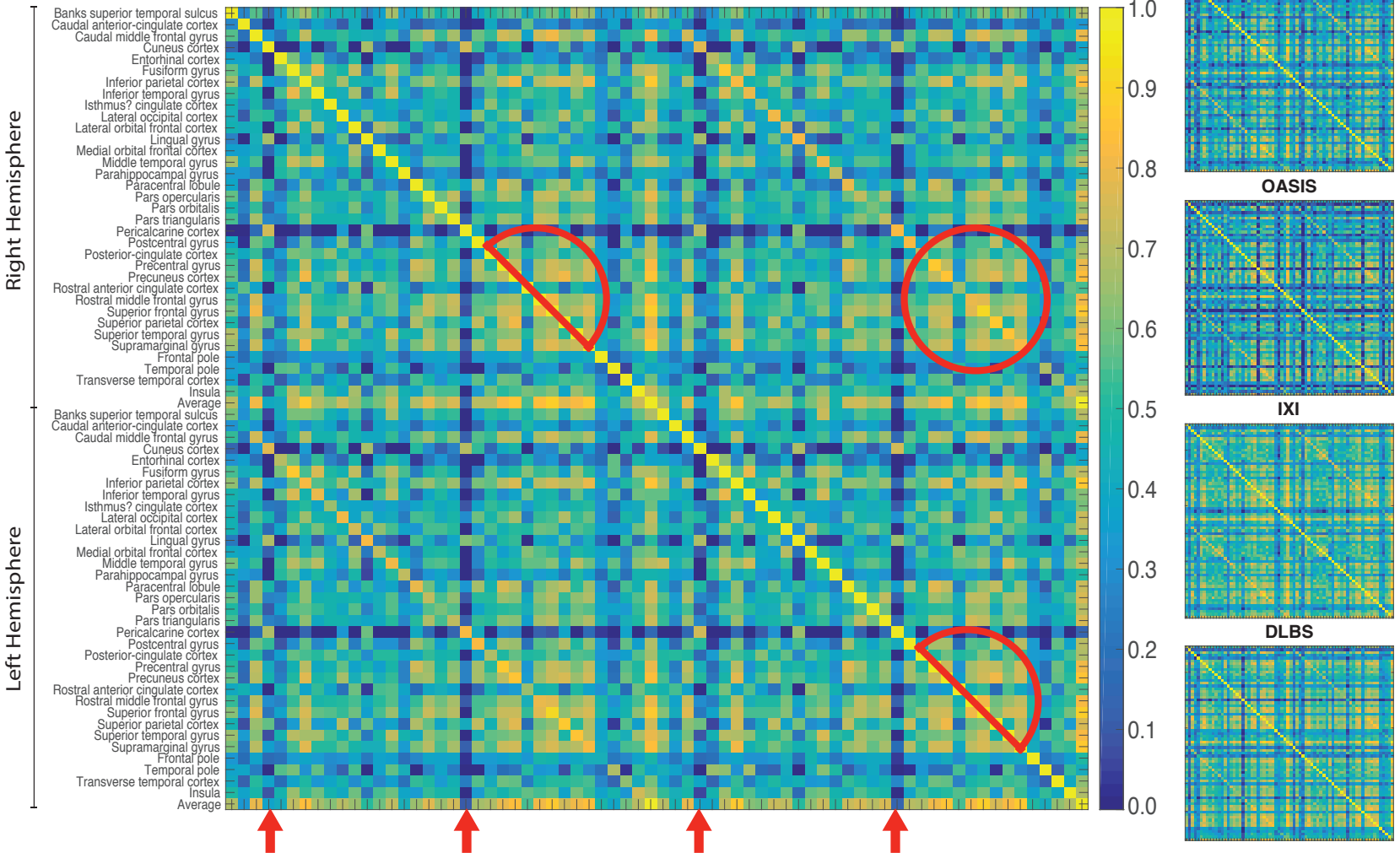

Left Hemisphere
Right Hemisphere
Left Average
Banks superior temporal sulcus
Caudal anterior-cingulate cortex
Caudal middle frontal gyrus
Cuneus cortex
Entorhinal cortex
Fusiform gyrus
Inferior parietal cortex
Inferior temporal gyrus
Isthmus-cingulate cortex
Lateral occipital cortex
Lateral orbital frontal 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
Insula
Right Average
-0.01
0.0
4.5
1.5
0.6
0.0
Database
Calgary Normative
OASIS
IXI
DLBS
Consolidated
Metric
Slope
Intercept
R-squared

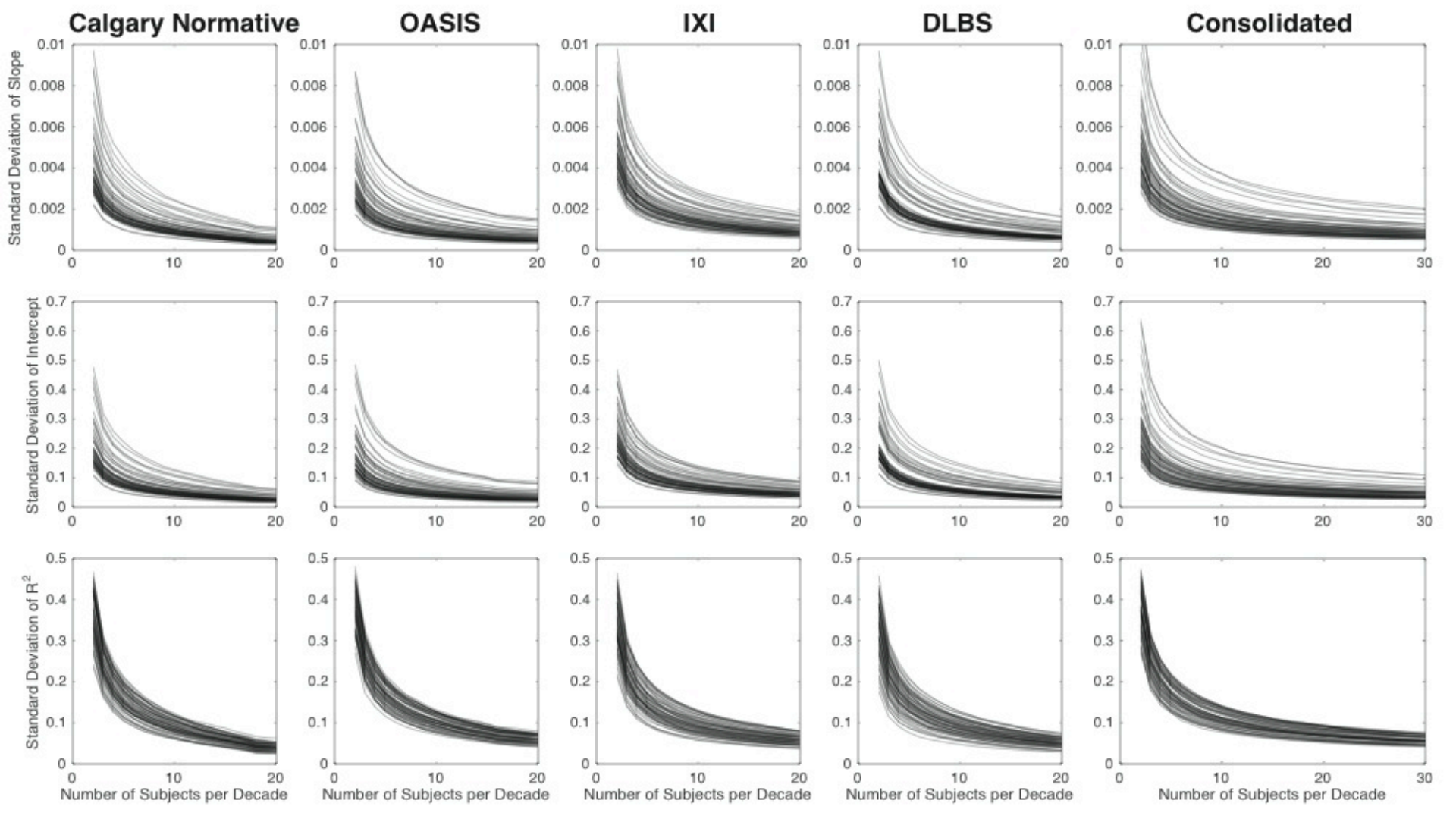

Right Banks Superior Temporal Sulcus
Cortical Thickness (mm)
3.5
3
2.5
2
10
20
30
40
50
60
70
80
90
100
age (years)
Database
Calgary Normative
OASIS
IXI
DLBS
Consolidated
Right Parahippocampal Gyrus
Cortical Thickness (mm)
3.5
3
2.5
2
10
20
30
40
50
60
70
80
90
100
age (years)

Statistical Analysis Results

- Pearson correlation test
  (258/280 at $p < 0.01$; 263/280 at $p < 0.05$)
- The Jarque–Bera tests of normality
  (261/280 at $p < 0.01$; 272/280 at $p < 0.05$)
- The Levene's test for homogeneity of variance
  (57/70 at $p < 0.01$; 64/70 at $p < 0.05$)
- ANCOVA test was significant in all 70 regions
  ($p < 0.001$;
  and after Bonferroni Correction $p < 1.43(10^{-5})$)

Combined Databases




Calgary Normative
OASIS
IXI
DLBS
Consolidated
Standard Deviation of Slope
Standard Deviation of Intercept
Standard Deviation of R^2
Number of Subjects per Decade
Number of Subjects per Decade
Number of Subjects per Decade
Number of Subjects per Decade
Number of Subjects per Decade

Age Prediction

- Multiple regression model

			Test Database							
	Leave One Out		Calgary Normative		OASIS		IXI		DLBS	
Calibration Database	R^2	MAD	R^2	MAD	R^2	MAD	R^2	MAD	R^2	MAD
Calgary Normative	0.647	10.95			0.726	13.19	0.660	11.37	0.738	11.80
OASIS	0.815	11.51	0.702	10.24			0.690	13.41	0.752	12.12
IXI	0.746	8.74	0.699	9.81	0.773	14.00			0.749	11.46
DLBS	0.818	9.43	0.695	10.51	0.705	23.17	0.676	11.40		
Consolidated	0.784	9.80								

MAD - Mean Absolute Difference (years)

Discussion

- Cortical thickness had statistically significant differences between databases in all regions
- Correlation matrices and bootstrapping imply the variance is similar between databases
- When calibrating aging models it is best to use data with similar to the data you'll be testing on
- **Large scale databases should be combined with caution**

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