

THE **MANY** FACETS OF BRAIN AGING AS ASSESSED BY MRI (AND FREESURFER)

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AGING

- US has added >20 years to normal life expectancy in the last century
 - Advancing age is a risk for several diseases (e.g. AD, CVD, cancer)
 - Which of these changes are most detrimental to cognitive function, and what are the biological conditions that contribute to these detrimental processes?
-

THE US BABY BOOM

- Baby booms (increased rate of births) signify good times and periods of general economic growth and stability
- The number of births per thousand people in the United States
- The blue segment is the Post World War II period; and is defined as the Baby Boom by the United States government.
- ~78 million Americans were born during this period

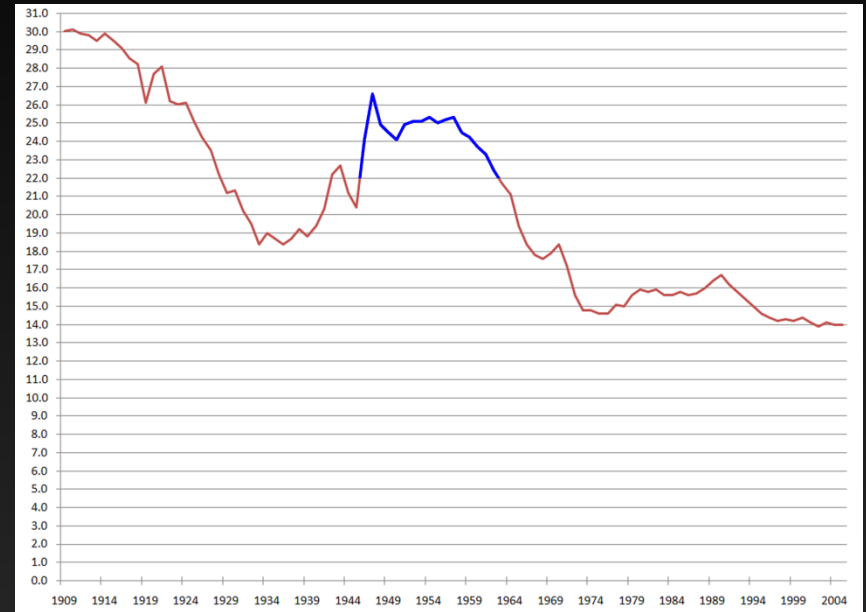


Image: Nicholas W. Beeson, University of Michigan

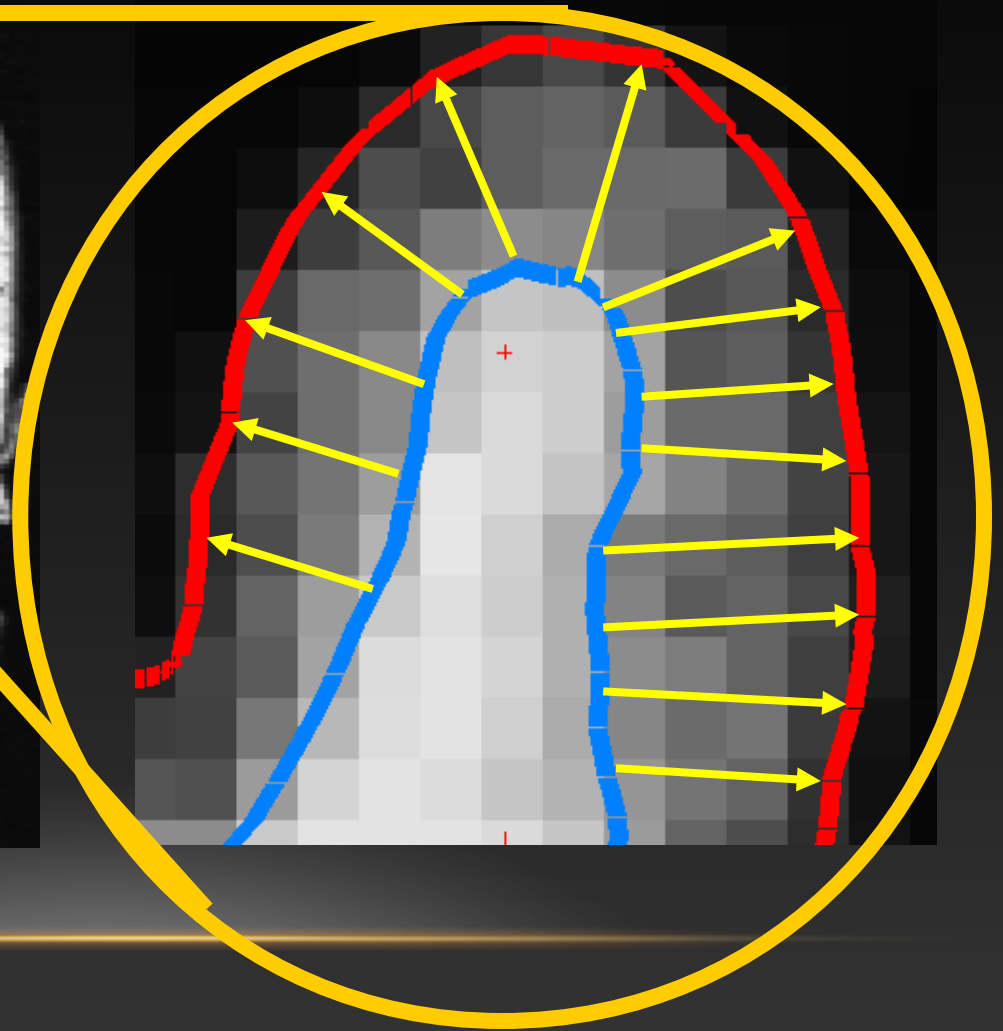
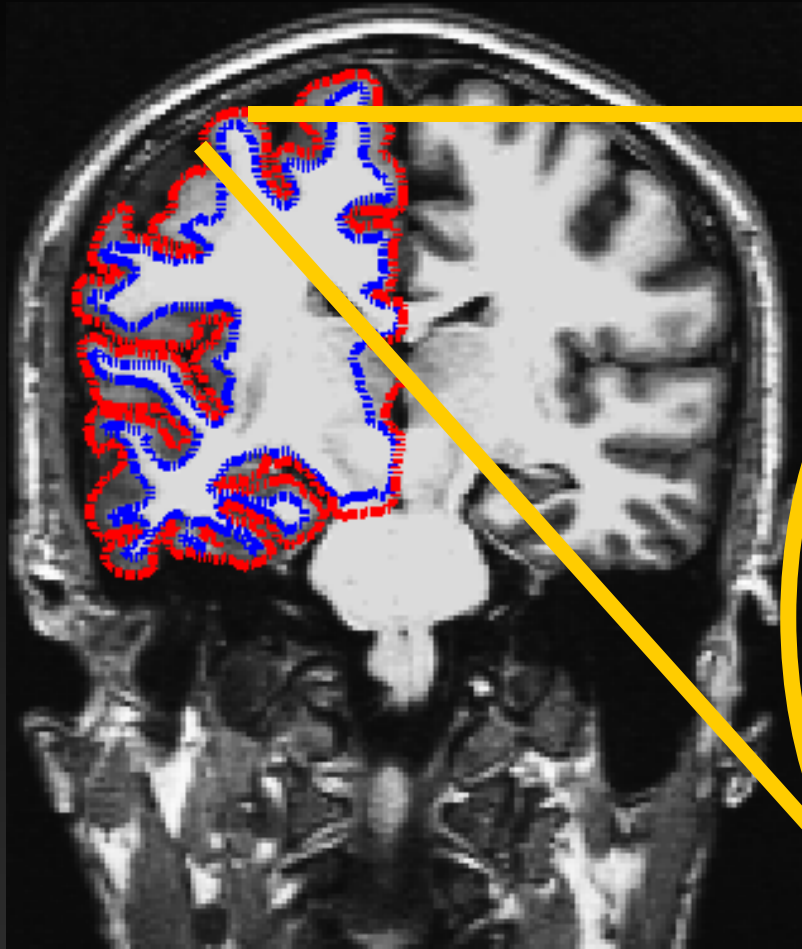
OVERVIEW OF MRI STUDIES OF AGING

- Age-associated alteration in:
 - Brain macrostructure
 - Structural MRI (sMRI)
 - Brain microstructure
 - Diffusion tensor imaging (DTI); Gray/white tissue
 - Brain Vasculature: Cerebral blood flow
 - Arterial spin labeling MRI (ASL)

BRAIN ATROPHY WITH AGING

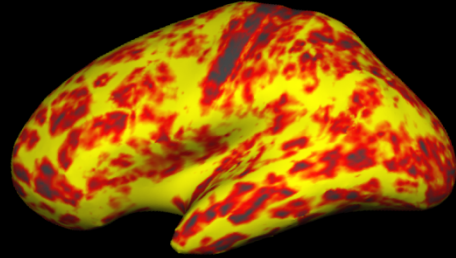
- Postmortem studies have demonstrated substantial reduction in brain weight across the adult lifespan (5-10%)
- MRI can quantify the regional basis of these changes to determine whether certain regions are particularly vulnerable
- Prior studies suggested vulnerability of prefrontal and association cortex with relative sparing of primary cortices

CORTICAL THICKNESS (RECON-ALL)

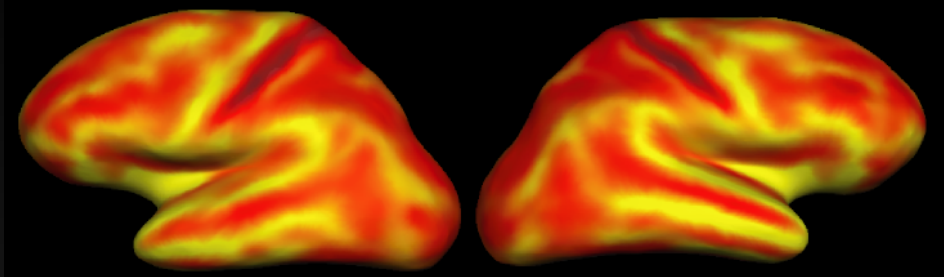


Group Mean Thickness

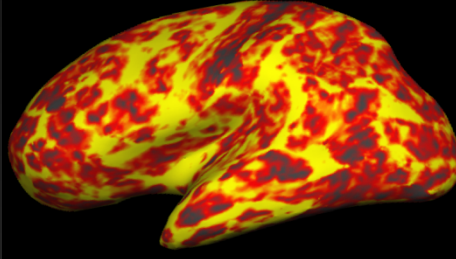
18M



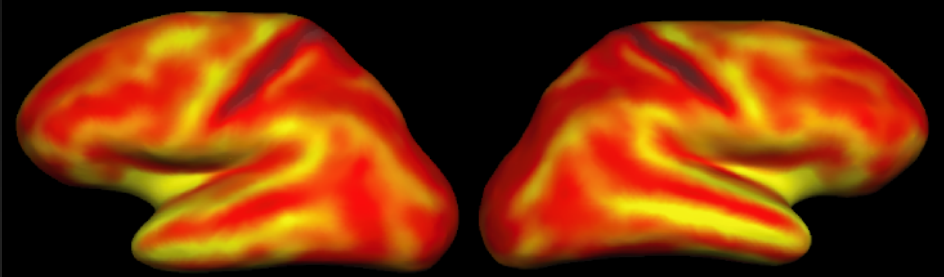
Young



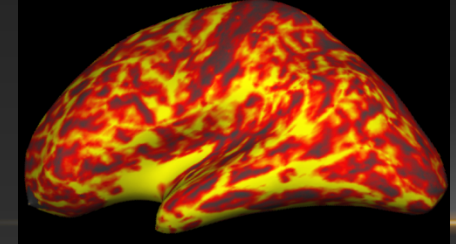
48M



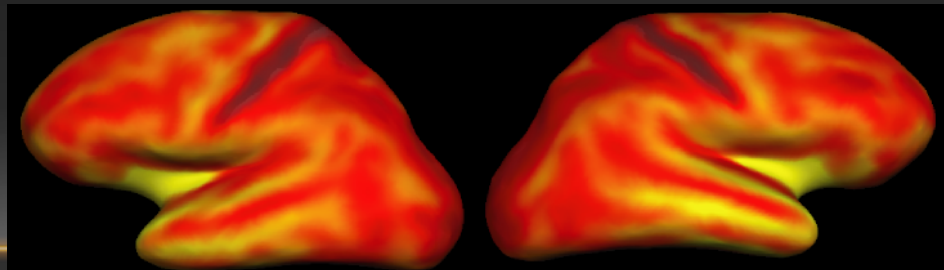
Middle Aged



88M



Old



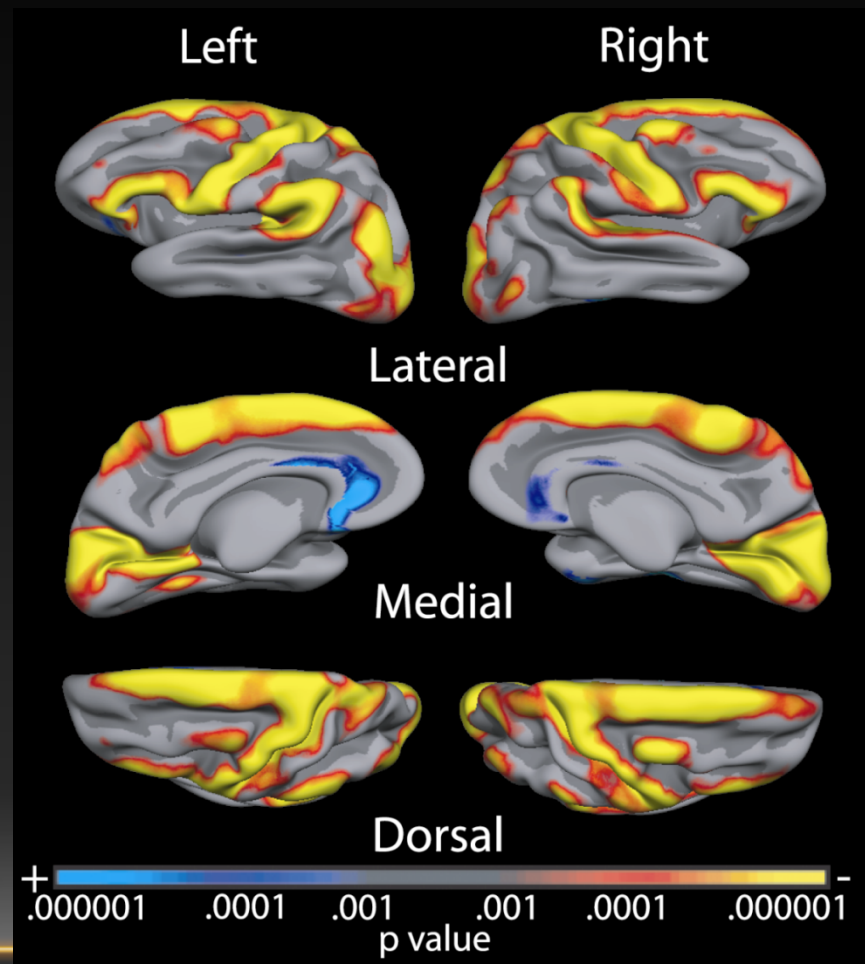
1mm

2mm

3mm

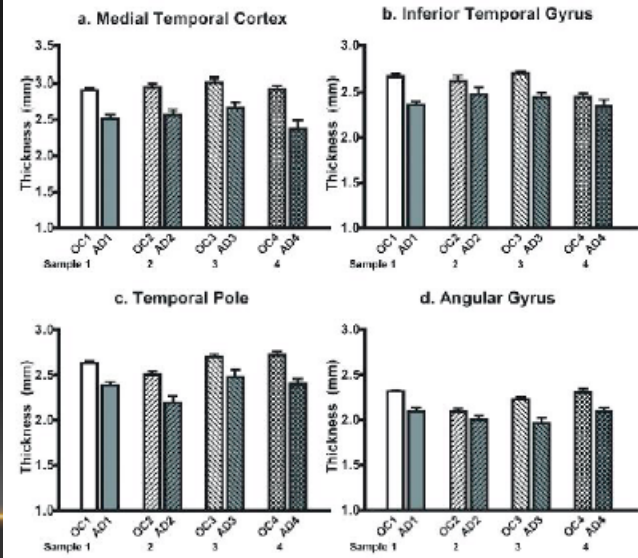
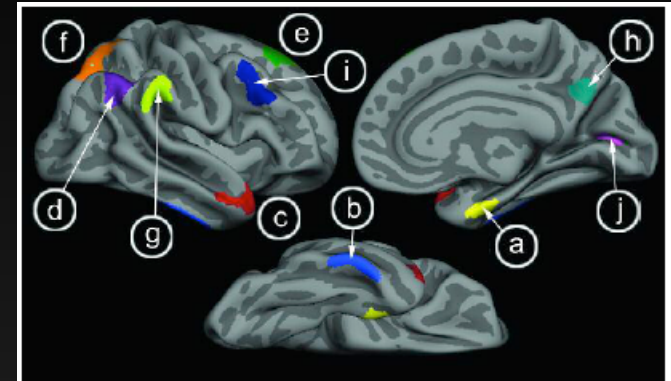
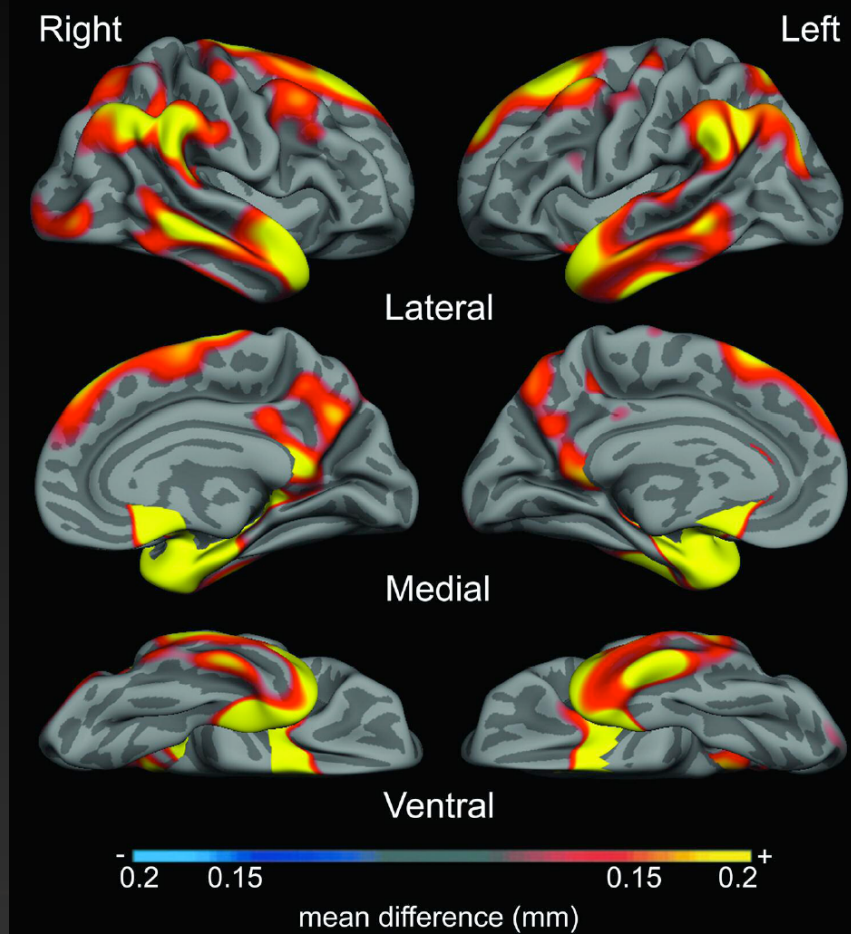
AGE-ASSOCIATED CORTICAL THINNING (MRI_GLMFIT)

- Thinning in primary and association cortices
- Regional thinning relates to neuropsychological performance
- Mechanisms of thinning are unknown



Salat et al., Cerebral Cortex, 2004

CORTICAL SIGNATURE OF AD



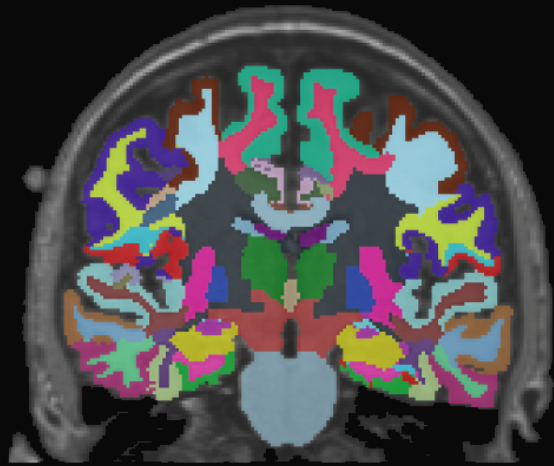
Dickerson et al., Cerebral Cortex, 2008

GRAY MATTER MACROSTRUCTURE SUMMARY

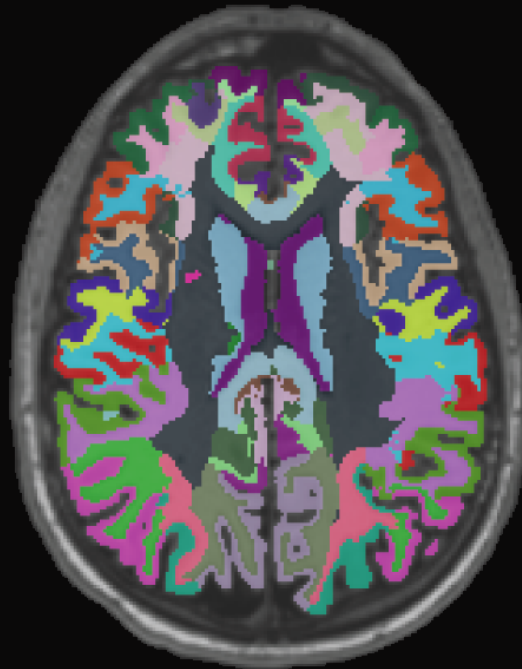
- There are substantial volumetric changes in cortical and subcortical gray matter with nondemented aging
 - AD may accelerate, yet also presents with distinct structural abnormalities compared to aging
-

WMPARC: VOLUMETRIC ANALYSIS/DTI ROI ANALYSIS (WMPARC.MGZ)

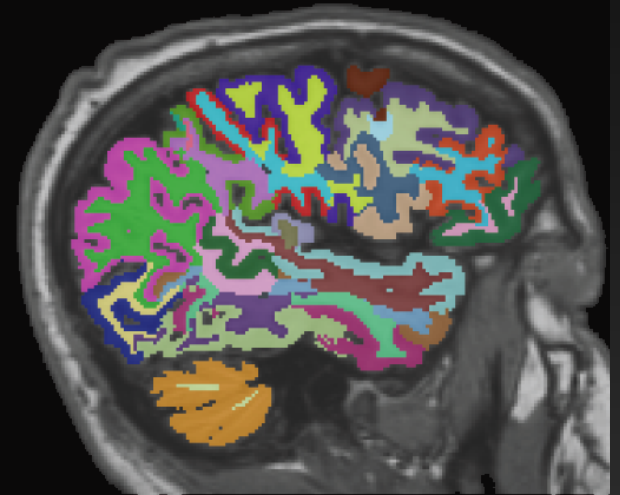
Coronal



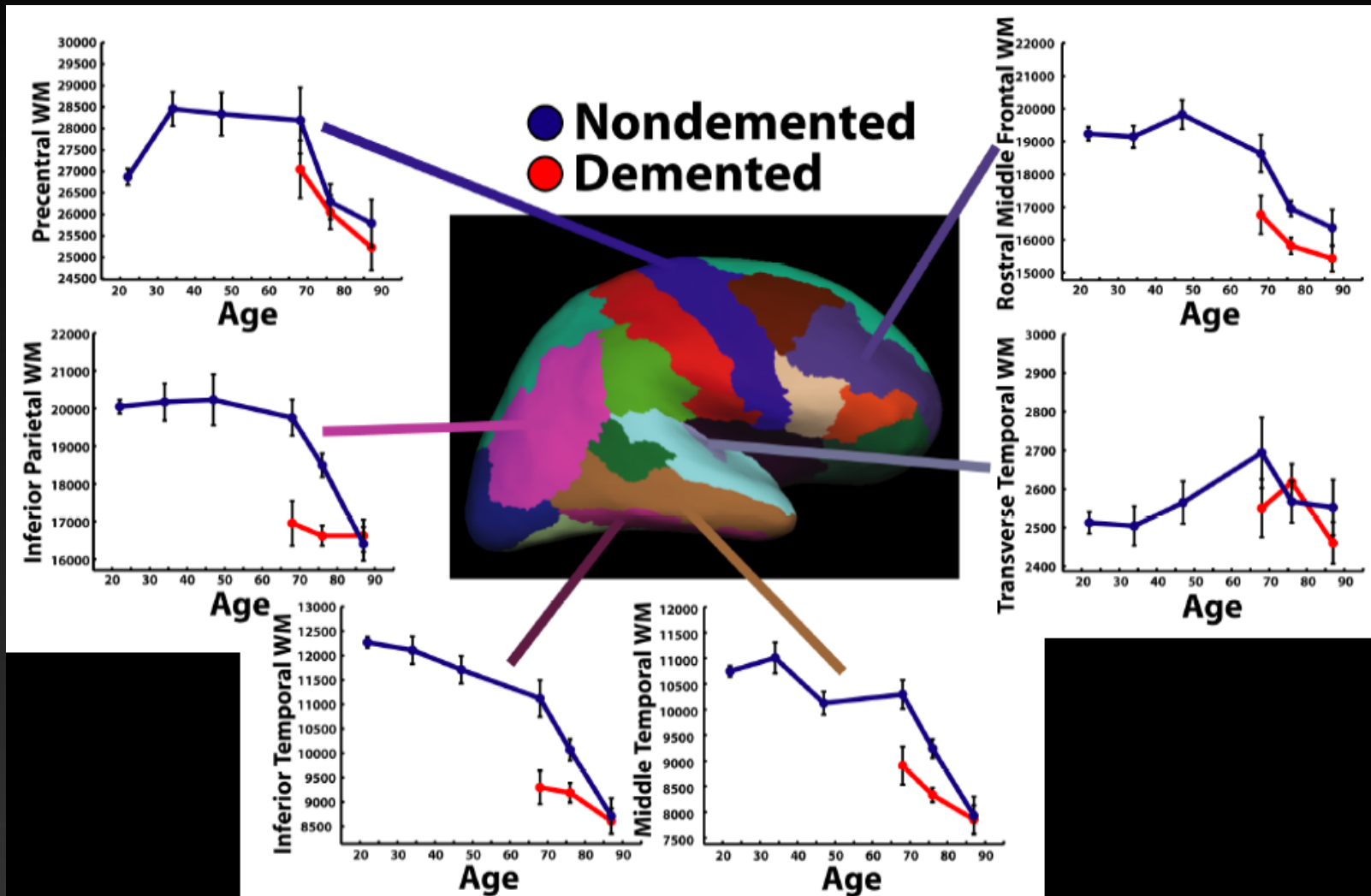
Axial



Sagittal



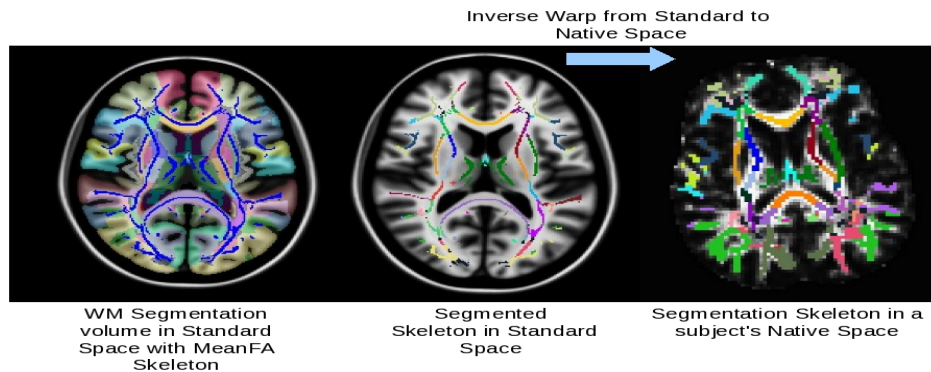
EFFECTS OF AGE AND AD ON REGIONAL WHITE MATTER



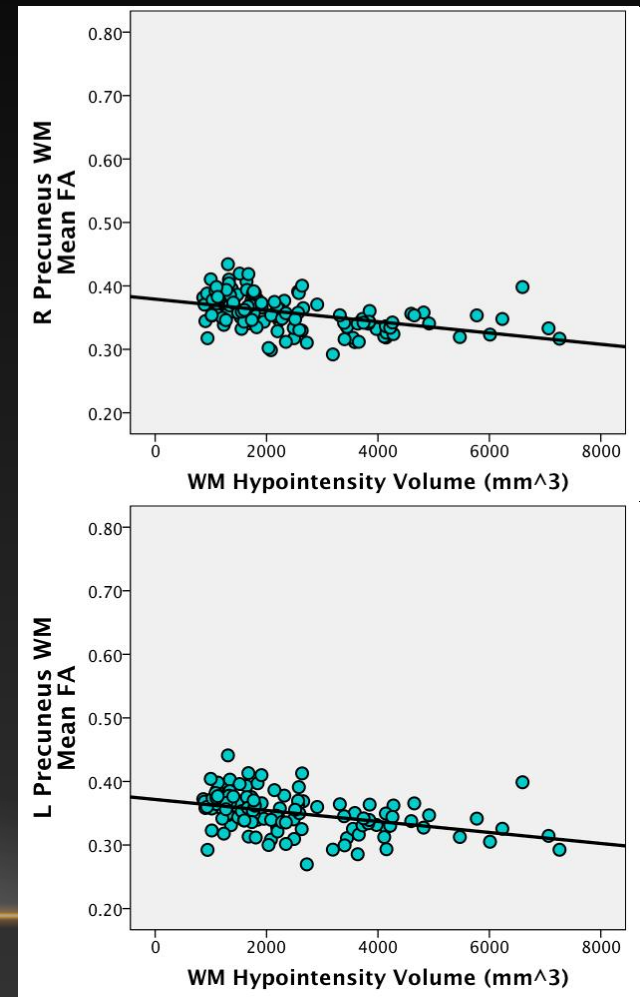
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FSL INTEGRATION: COMBINED TBSS/WM PARCELLATION ROI ANALYSIS



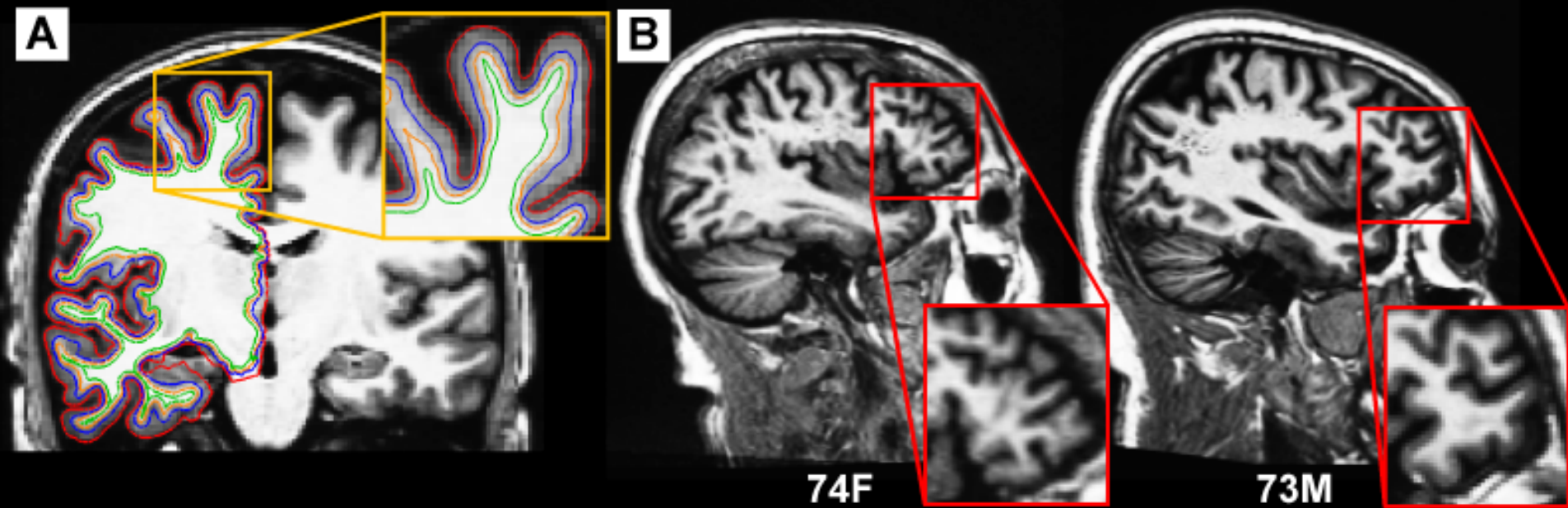
Leritz et al., *under review*



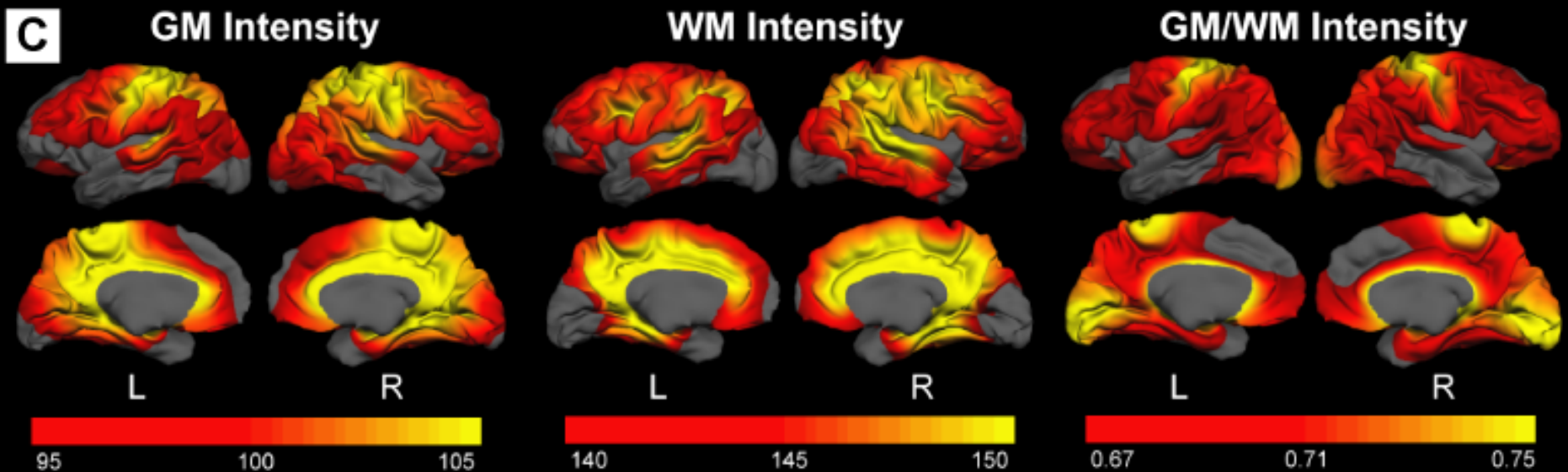
DIFFUSION MEASURES DEEP WHITE MATTER: WHAT ABOUT SUPERFICIAL MICROSTRUCTURE?

Low Contrast

High Contrast

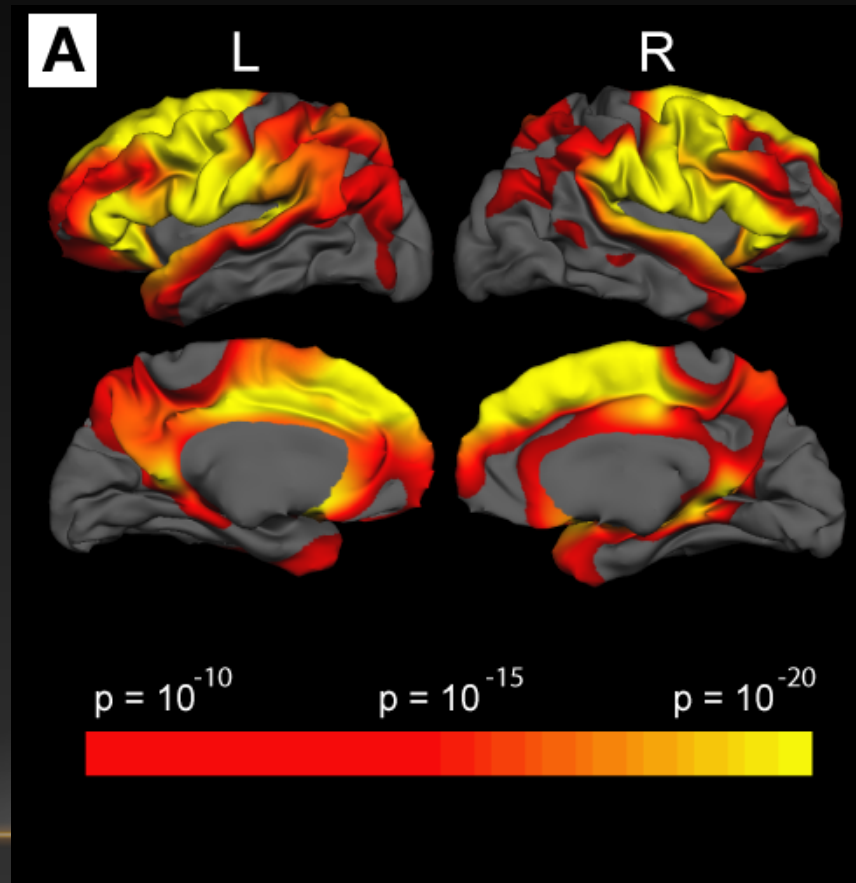


VARIATION IN SIGNAL INTENSITY ACROSS THE CORTICAL MANTLE (PCTSURFCON)



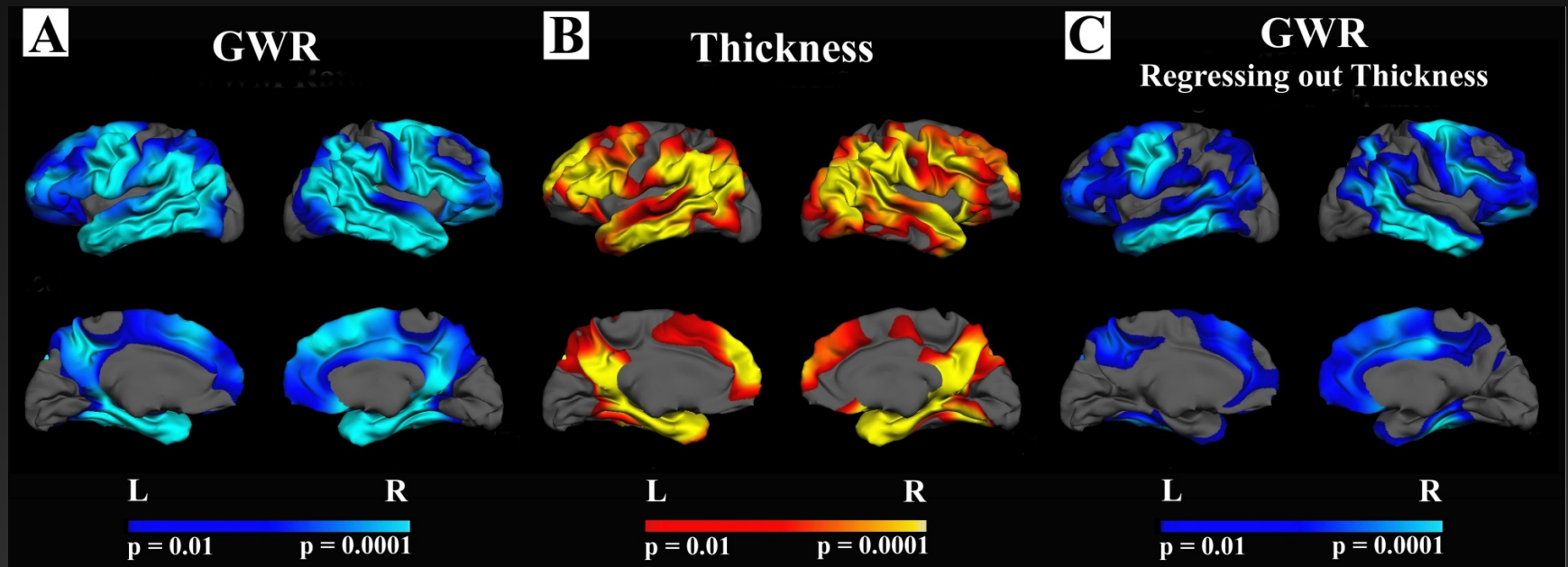
STRONG ASSOCIATIONS BETWEEN REGIONAL GWR AND AGE (MRI_GLMFIT)

Changes in Contrast (GWR) with Age



Salat et al., 2009

EFFECTS OF AD ON GWR REMAIN STRONG WHEN CONTROLLING FOR CORTICAL THICKNESS (MRI_GLMFIT W/-PVR)



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ARTERIAL SPIN LABELING (ASL) QUANTITATIVE CBF MAPS IN YOUNG, MIDDLE-AGED, AND OLDER ADULTS

<40 years

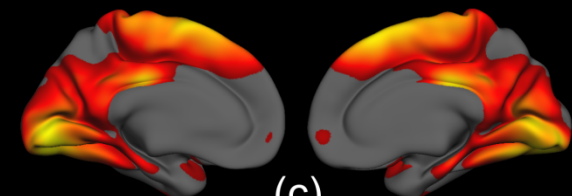
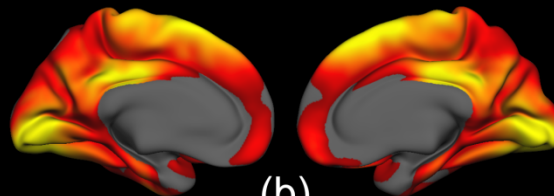
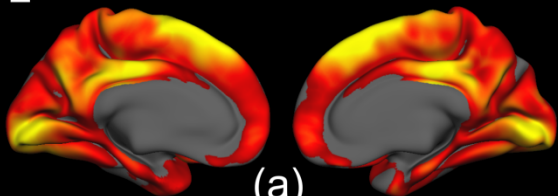
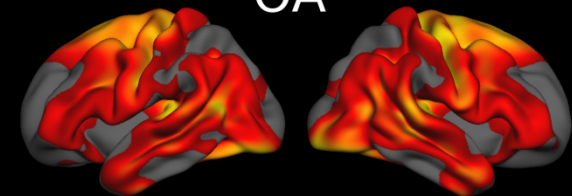
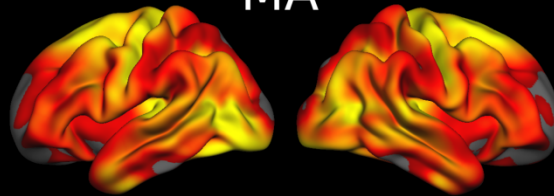
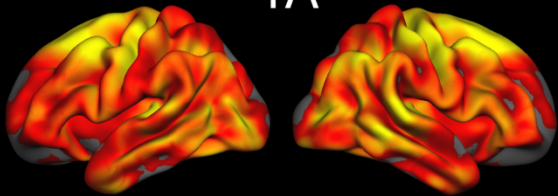
40-60 years

>60 years

YA

MA

OA



(a)

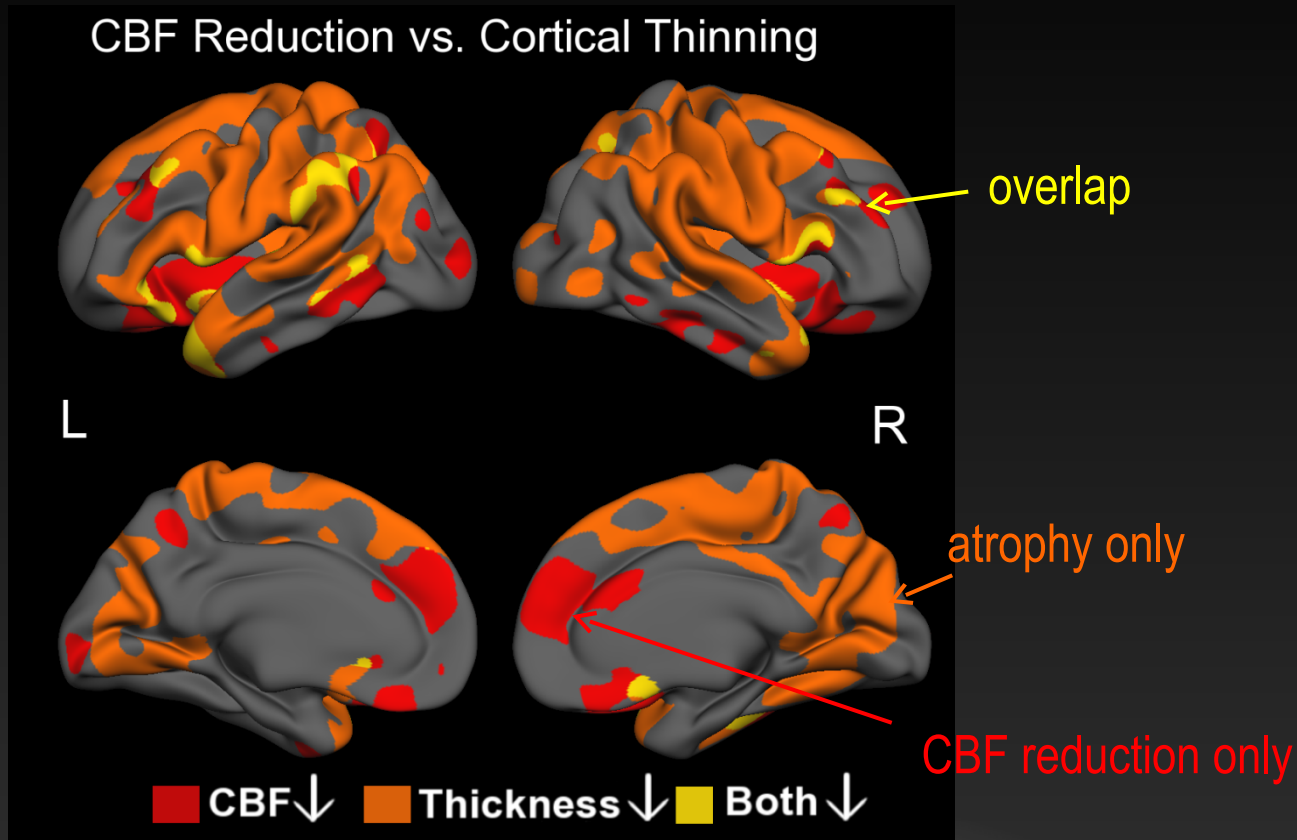
(b)

(c)

40

60 [ml/100 g/min]

MINIMAL OVERLAP: CBF↓ & ATROPHY



CBF SUMMARY

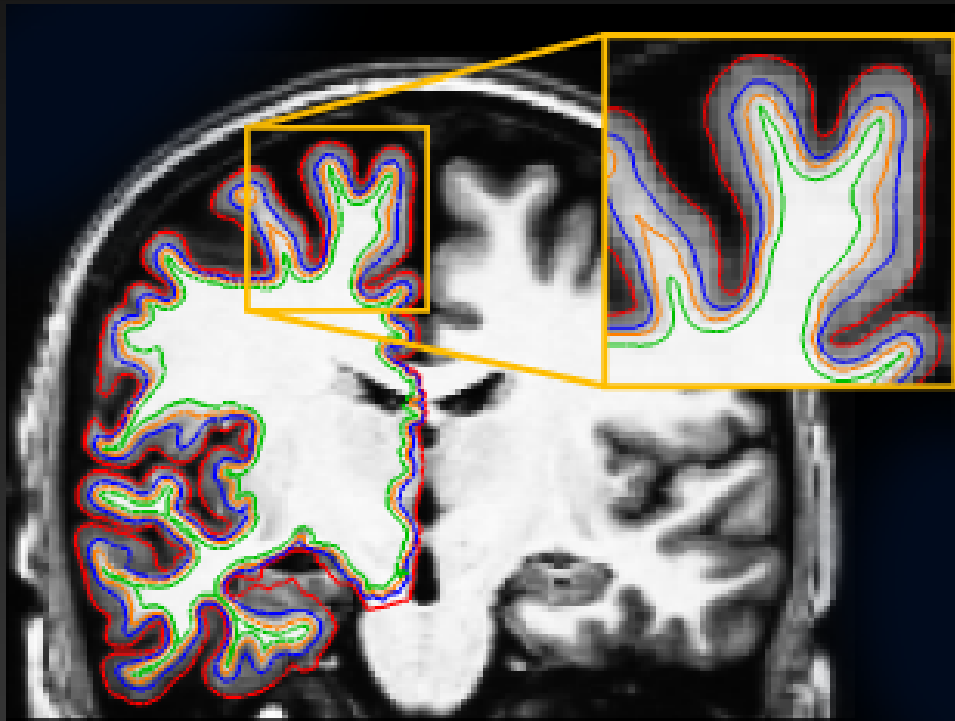
- There is a regional decline in cerebral blood flow with advancing age
 - Changes in blood flow are regionally distinct from those of atrophy
-

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ACKNOWLEDGEMENTS

- H. Diana Rosas
- Bruce Fischl
- Randy Buckner
- Andre van der Kouwe
- Doug Greve
- Stephanie Lee
- Bill Milberg
- Betsy Leritz
- Gina McGlinchey
- Jean Chen
- Tyler Triggs



- **National Institutes of Health:**
 - **NIA K01AG024898**
 - **NINR R01NR10827**
- **Athinoula A. Martinos Center for Biomedical Imaging:**
 - **National Center for Research Resources: P41RR14075**
 - **National Alliance for Medical Image Computing: NIBIB U54 EB005149**
- **Freesurfer Team:**
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