

# 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?
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# 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

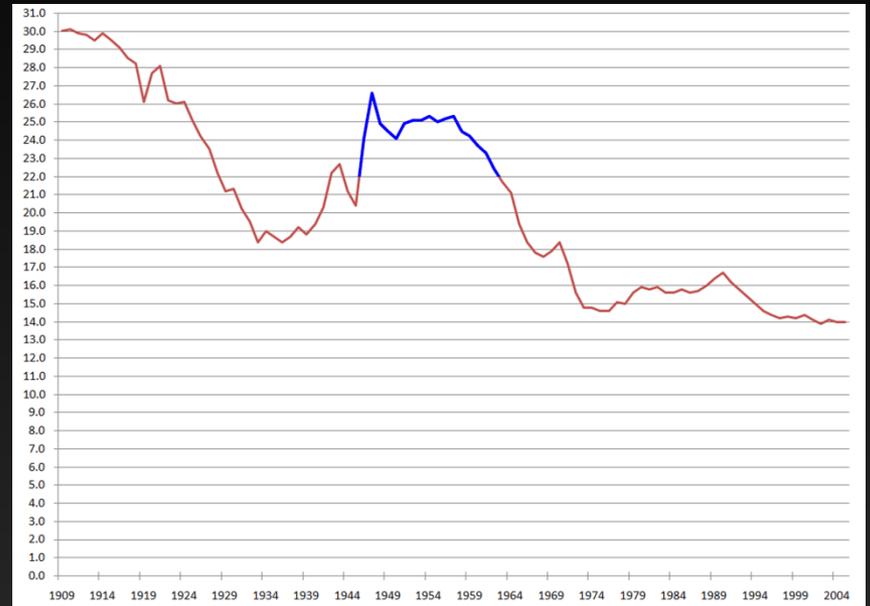


Image: Nicholas W. Beeson, University of Michigan

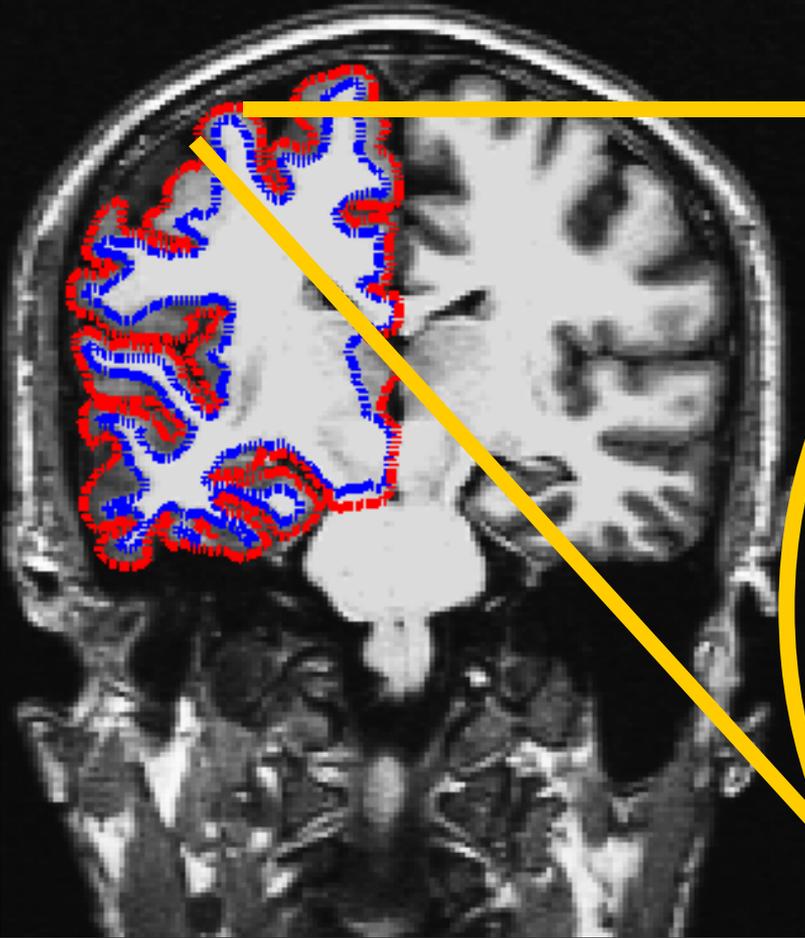
# OVERVIEW OF MRI STUDIES OF AGING

- 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

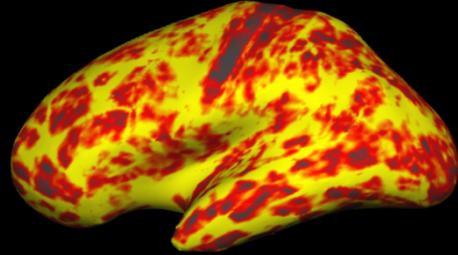
- Postmortem studies have demonstrated substantial reduction in brain weight across the adult lifespan (5-10%)
  - MRI can quantify the regional basis of these changes to determine whether certain regions are particularly vulnerable
  - Prior studies suggested vulnerability of prefrontal and association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

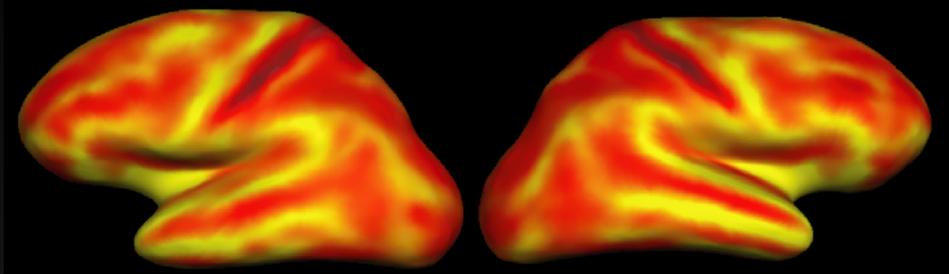


# Group Mean Thickness

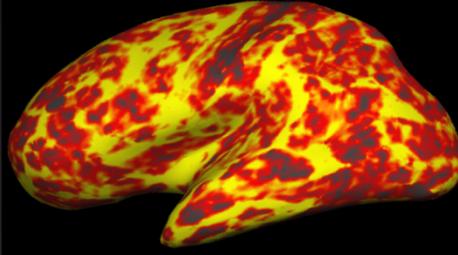
18M



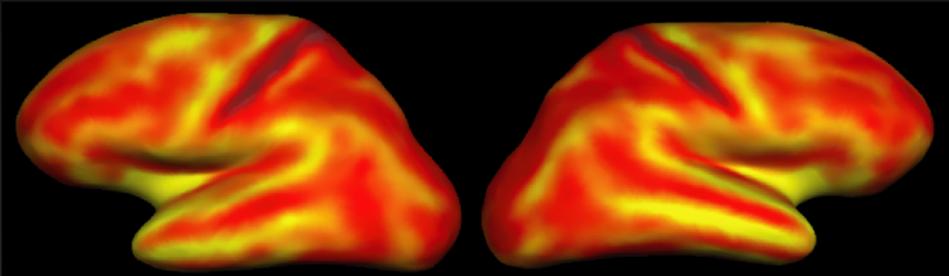
Young



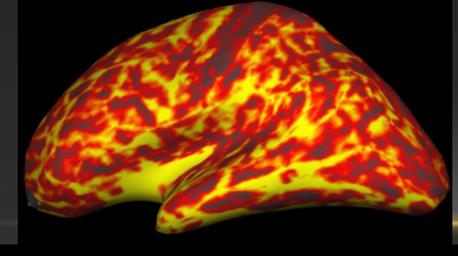
48M



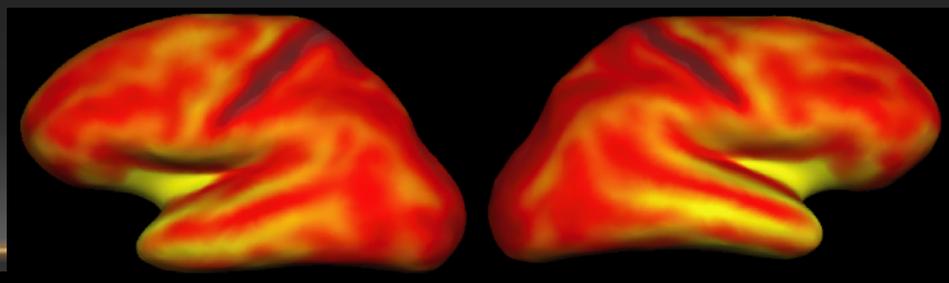
Middle Aged



88M



Old



1mm

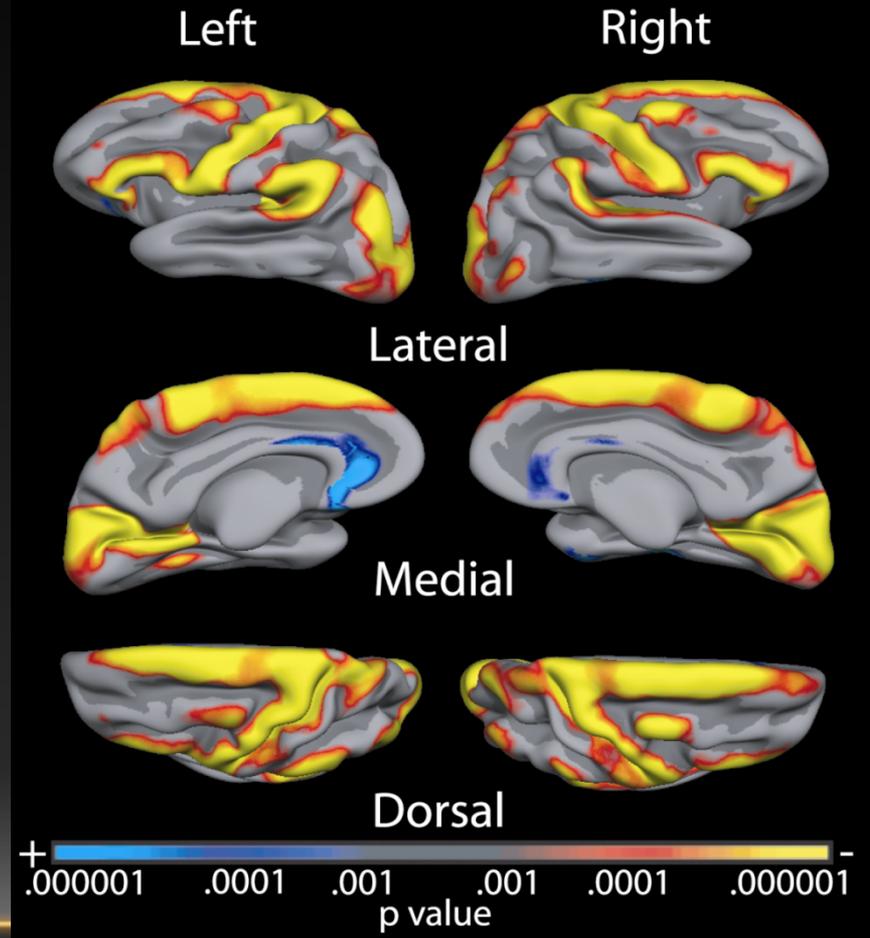
2mm

3mm

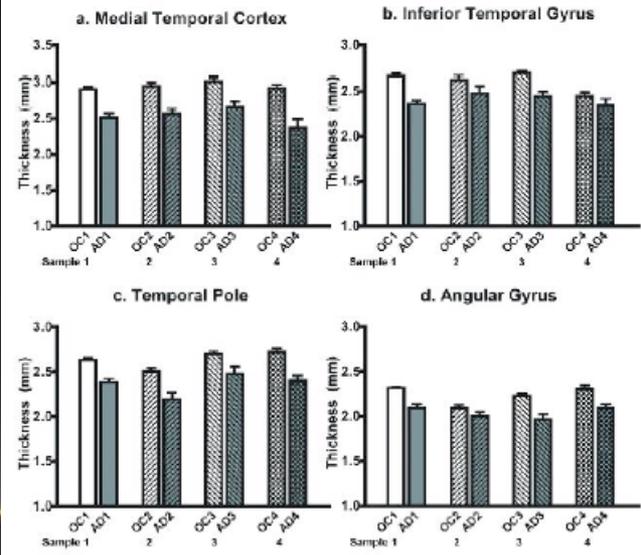
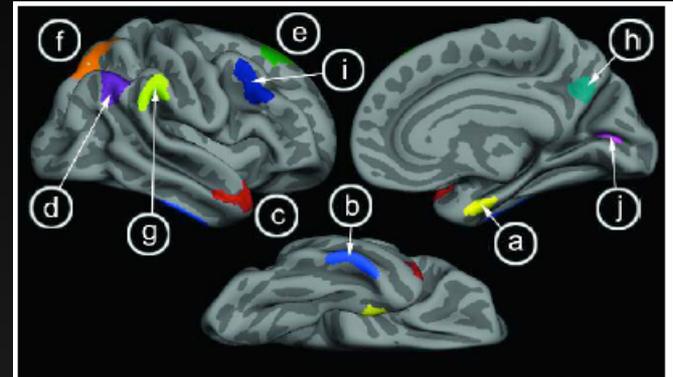
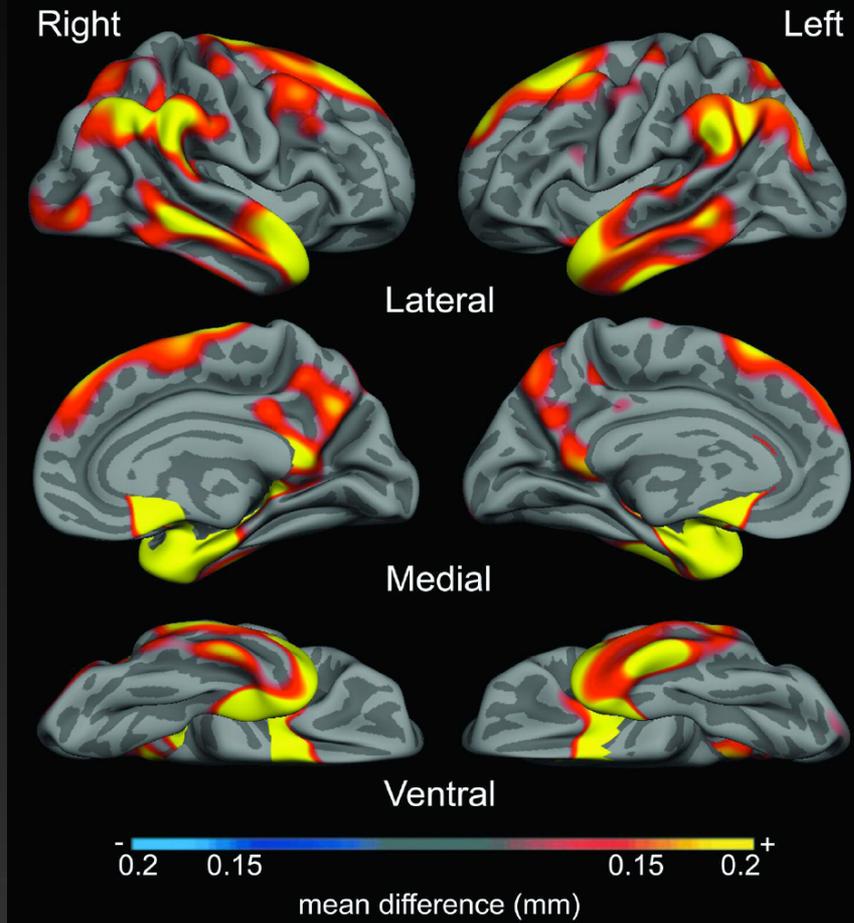


# AGE-ASSOCIATED CORTICAL THINNING (MRI\_GLMFIT)

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



# CORTICAL SIGNATURE OF AD



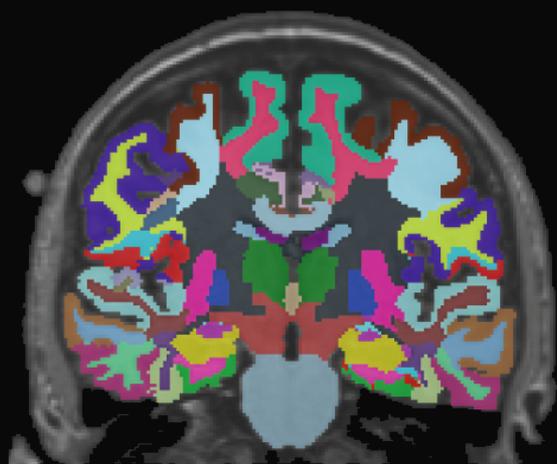
Dickerson et al., Cerebral Cortex, 2008

# GRAY MATTER MACROSTRUCTURE SUMMARY

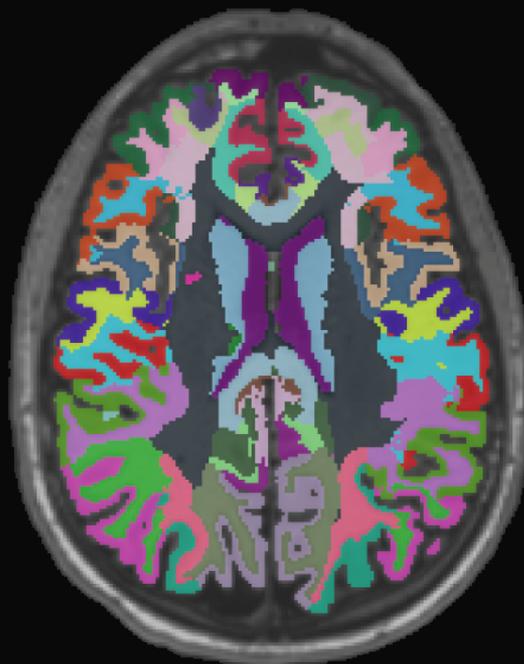
- There are substantial volumetric changes in cortical and subcortical gray matter with nondemented aging
  - AD may accelerate, yet also presents with distinct structural abnormalities compared to aging
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# WMPARC: VOLUMETRIC ANALYSIS/DTI ROI ANALYSIS (WMPARC.MGZ)

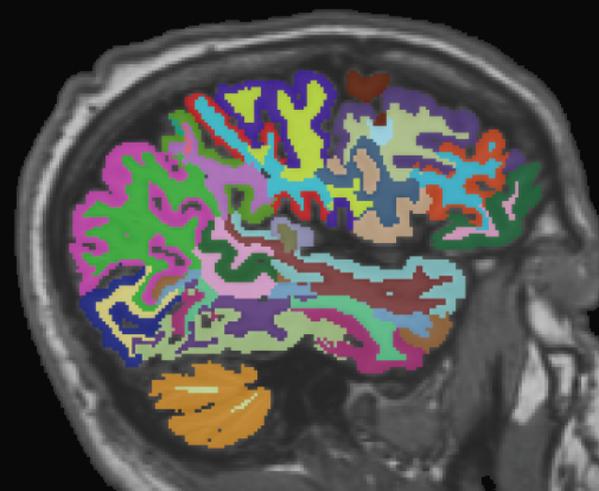
**Coronal**



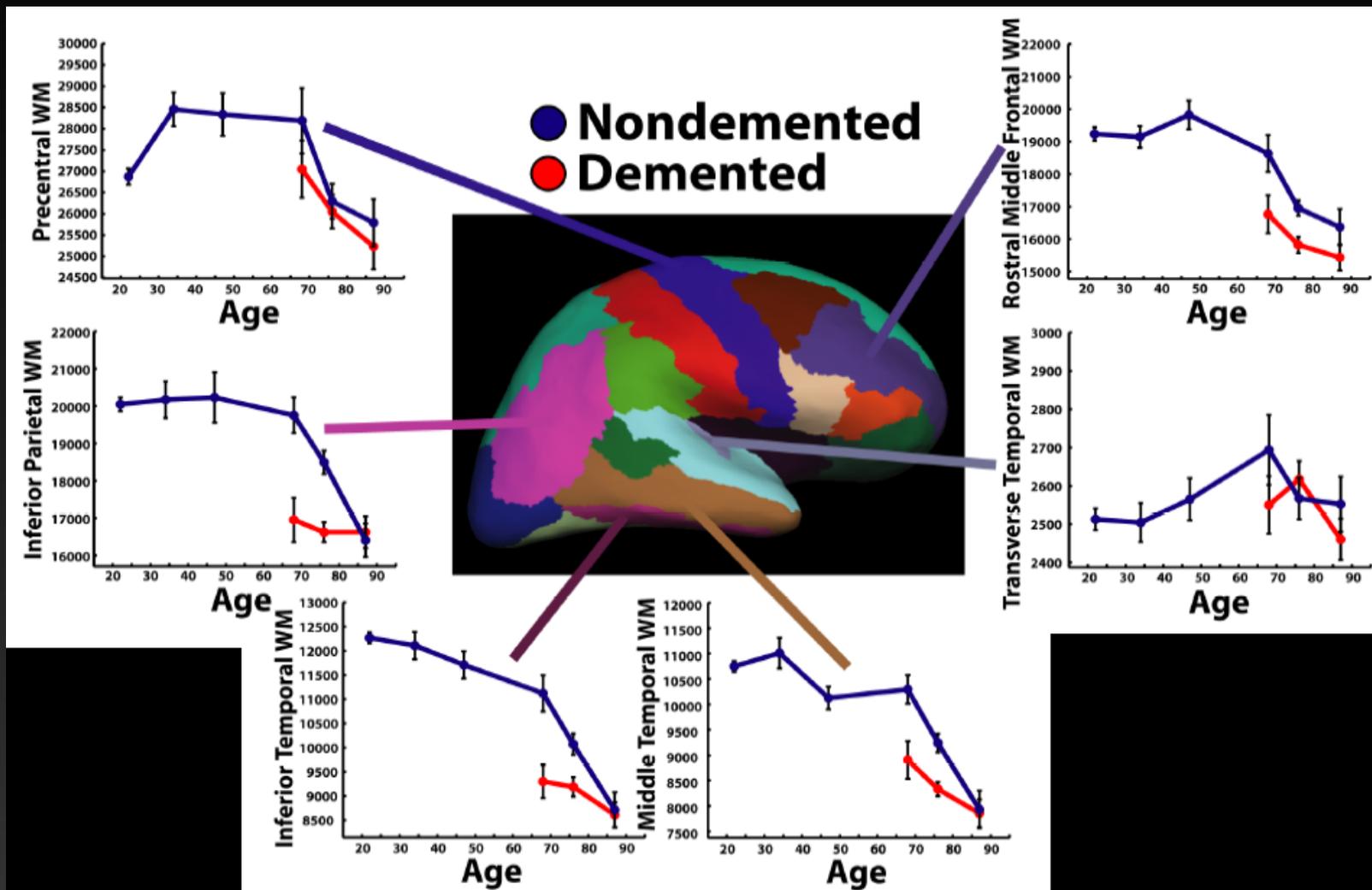
**Axial**



**Sagittal**



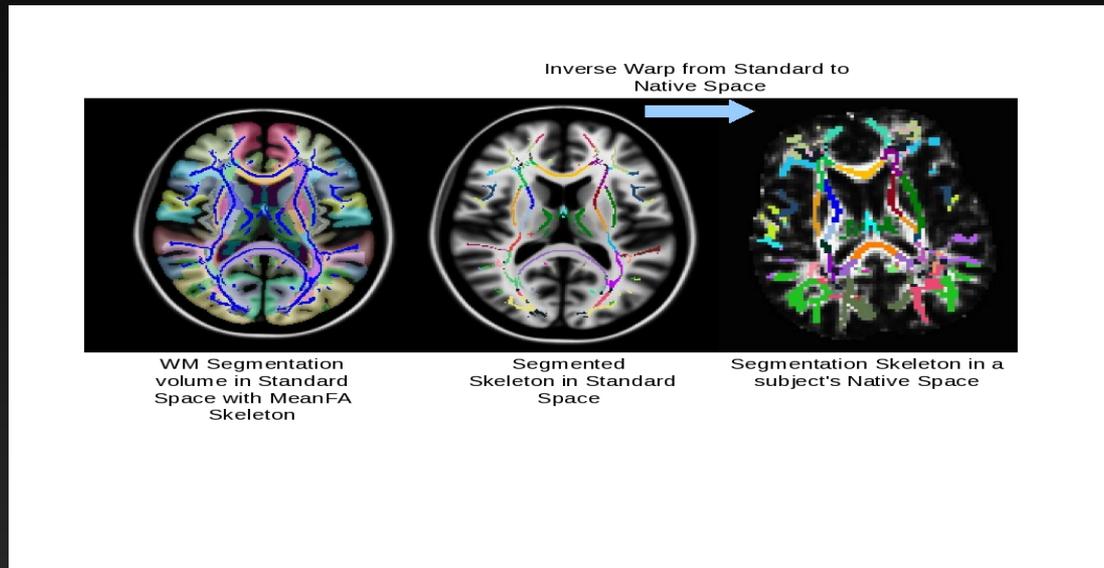
# EFFECTS OF AGE AND AD ON REGIONAL WHITE MATTER



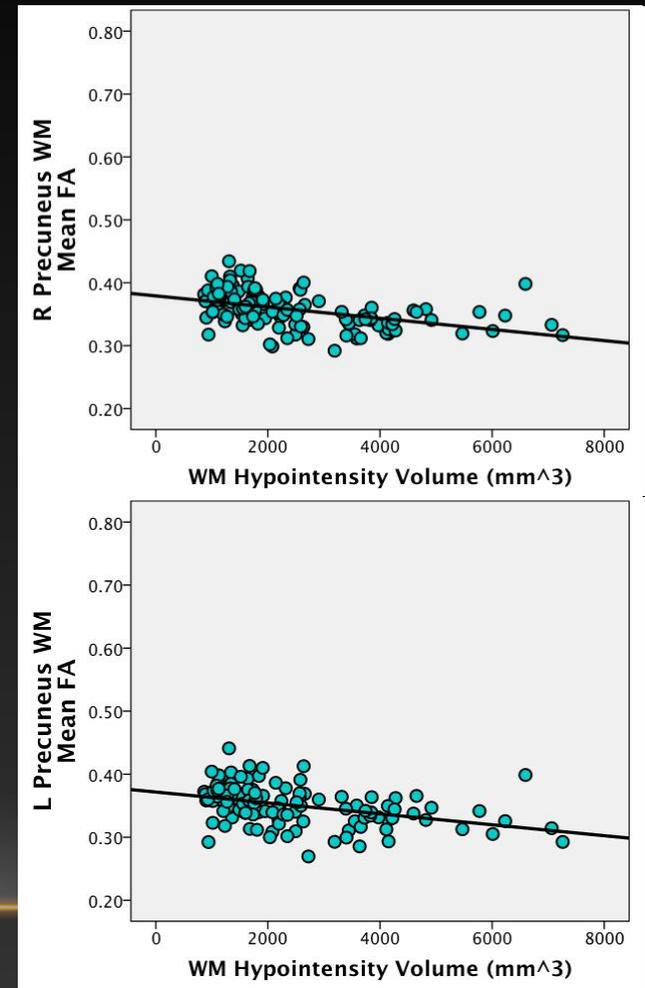
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# FSL INTEGRATION: COMBINED TBSS/WM PARCELLATION ROI ANALYSIS



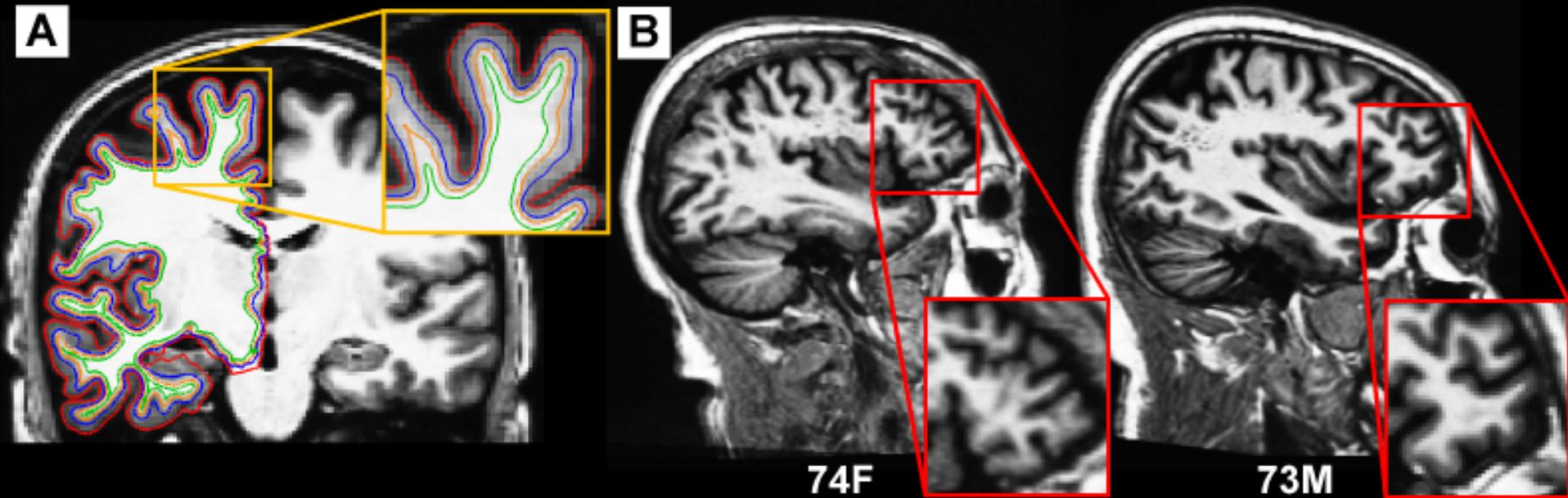
Leritz et al., *under review*



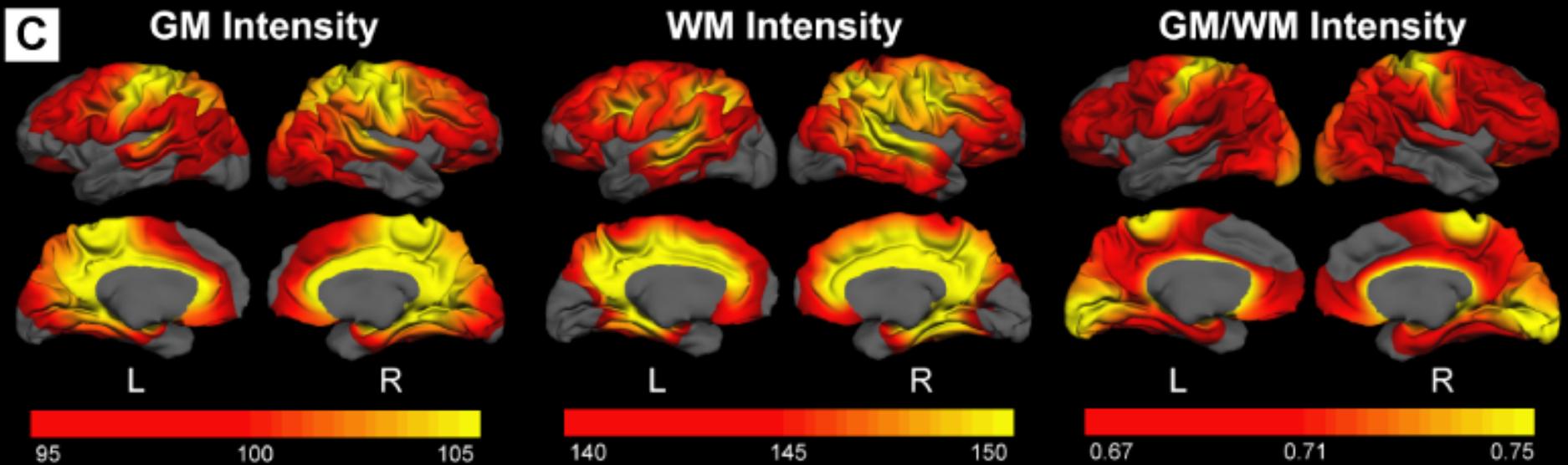
# DIFFUSION MEASURES DEEP WHITE MATTER: WHAT ABOUT SUPERFICIAL MICROSTRUCTURE?

Low Contrast

High Contrast

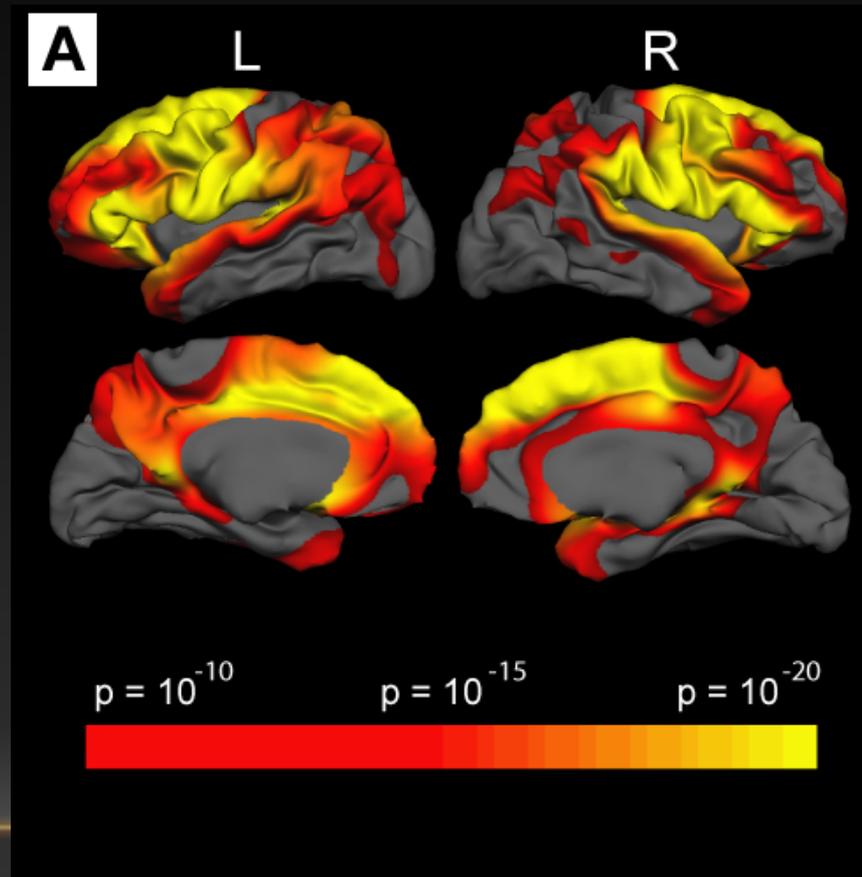


# VARIATION IN SIGNAL INTENSITY ACROSS THE CORTICAL MANTLE (PCTSURFCON)



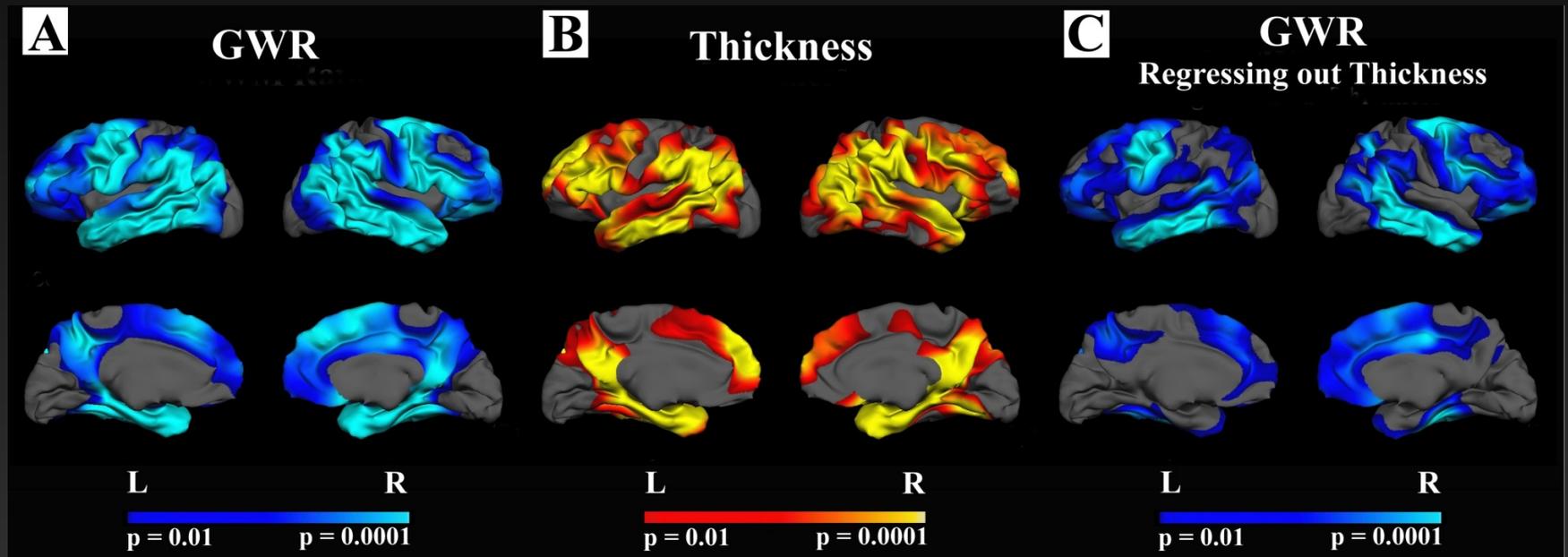
# STRONG ASSOCIATIONS BETWEEN REGIONAL GWR AND AGE (MRI\_GLMFIT)

Changes in Contrast (GWR) with Age



Salat et al., 2009

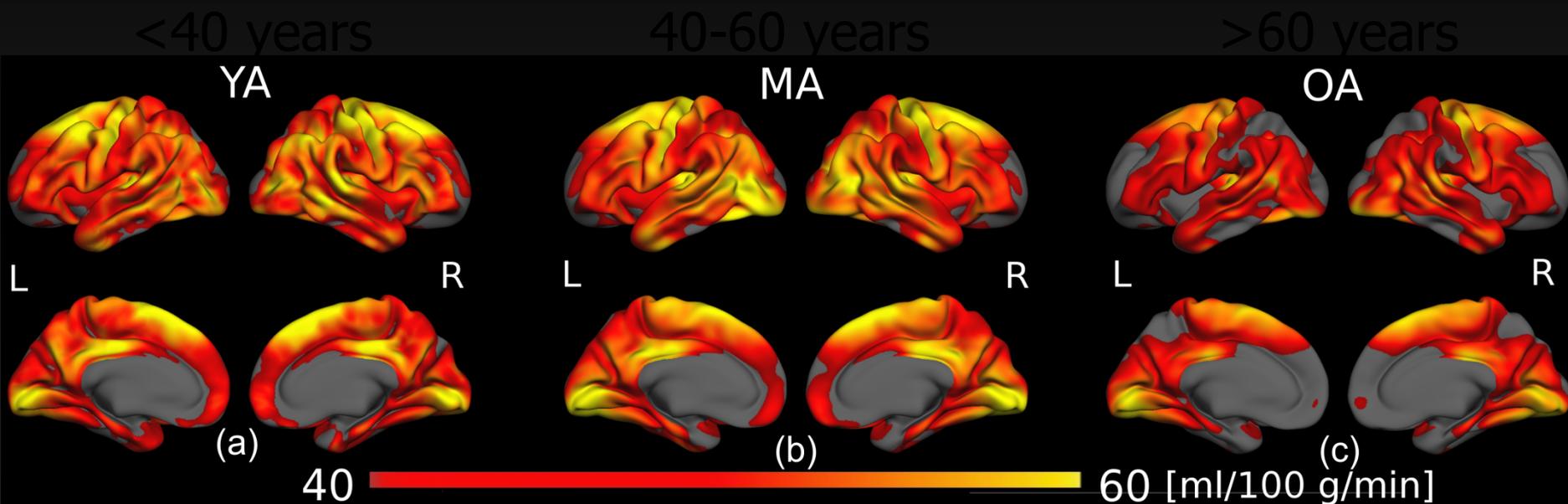
# EFFECTS OF AD ON GWR REMAIN STRONG WHEN CONTROLLING FOR CORTICAL THICKNESS (MRI\_GLMFIT W/-PVR)



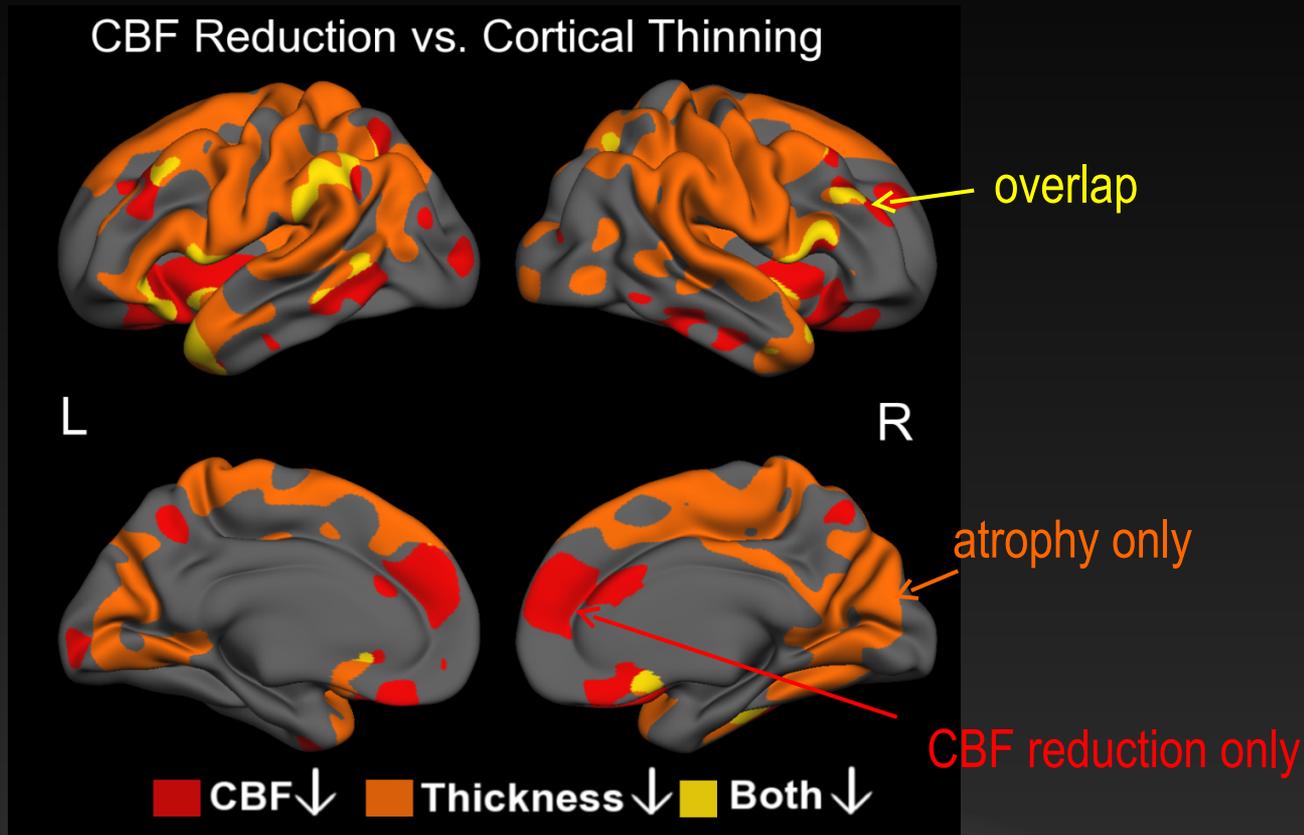
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# ARTERIAL SPIN LABELING (ASL) QUANTITATIVE CBF MAPS IN YOUNG, MIDDLE-AGED, AND OLDER ADULTS



# MINIMAL OVERLAP: CBF↓ & ATROPHY



# CBF SUMMARY

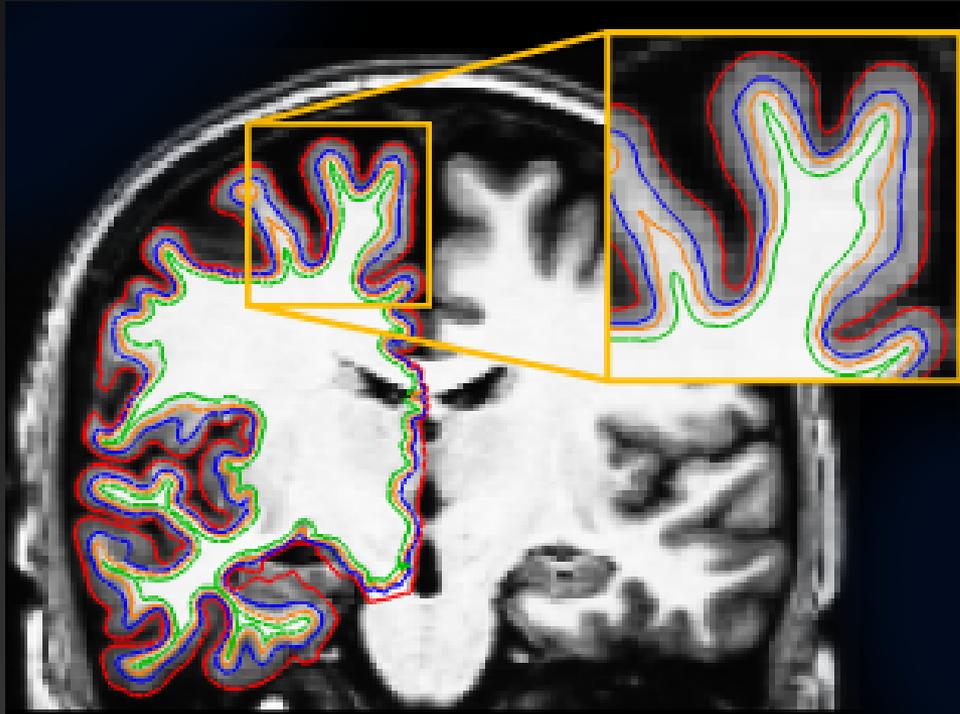
- There is a regional decline in cerebral blood flow with advancing age
  - Changes in blood flow are regionally distinct from those of atrophy
-

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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:**
  - [surfer.nmr.mgh.harvard.edu](http://surfer.nmr.mgh.harvard.edu)
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