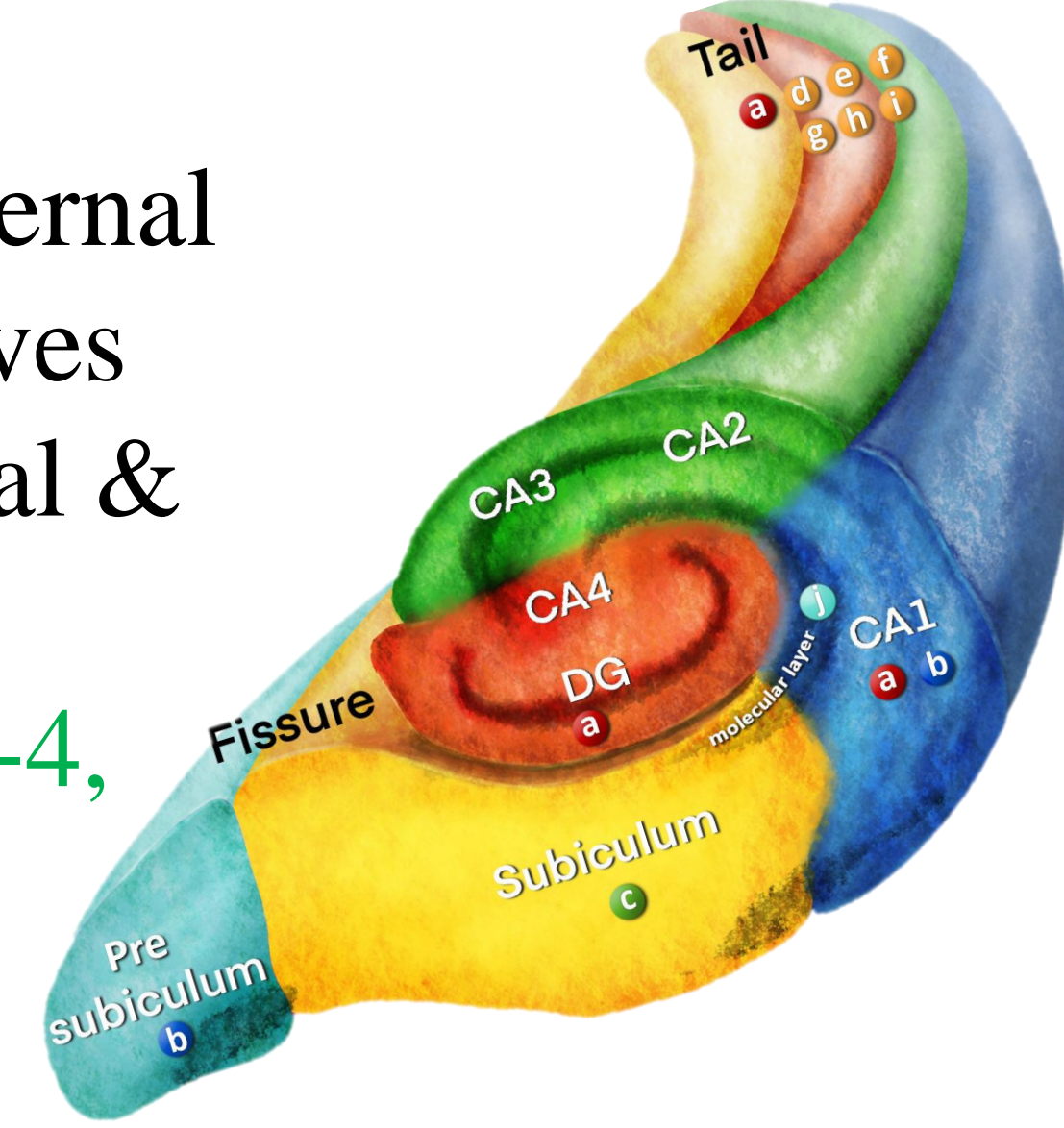# A Comparison of FreeSurfer and Automatic Segmentation of Hippocampal Subfields for Estimating Hippocampal Volumes among Preschoolers

Cui, Z, Ph.D., Dunstan, J., Riggins, T, Ph.D.

University of Maryland

Neurocognitive Development Lab

INTRODUCTION

- The hippocampus is a complex structure comprised of multiple internal circuits (i.e., subfields) that subserves memory across the lifespan (Amaral & Lavenex, 2007), including
  - Cornu Ammonis (CA) fields 1-4,
  - Dentate Gyrus (DG)
  - Subiculum

- Hippocampal subfields are thought to undergo extended postnatal development (Lavenex & Lavenex, 2013), however studies with human children are limited, partially due to methodological limitations.

- **AIM:** To compare hippocampal subfield volumes derived from two automated software packages, Freesurfer and Automatic Segmentation of Hippocampal Subfields (ASHS), among a sample of 3- to 5-year-old children.

METHODS

Sample: We utilized a cross-sectional sample of 33 subjects from a larger longitudinal study (Mage = 4.14 ± 0.56 years; 60.6% female).
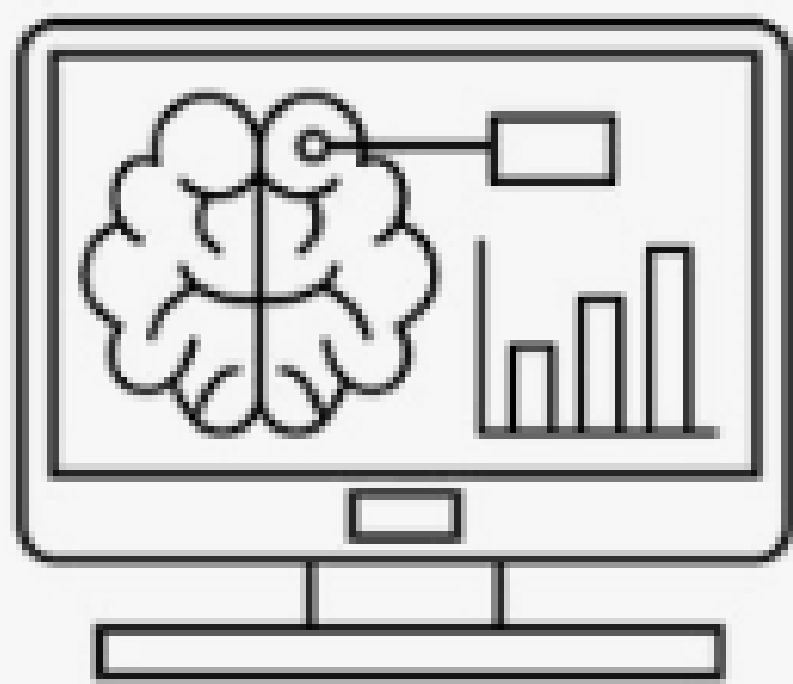
Image Acquisition and Processing

- 3.0T Trio scanner with a 12-channel head coil (Siemens AG, Erlangen, Germany).

- Whole-brain T1-weighted .9mm isotropic scans were acquired for processing in FreeSurfer 7.1.1 (Fischl, 2012).

- T2-weighted scan (.4mm x.4mm x 2mm) of the medial temporal lobe for ASHS processing (Yushkevich et al, 2014).
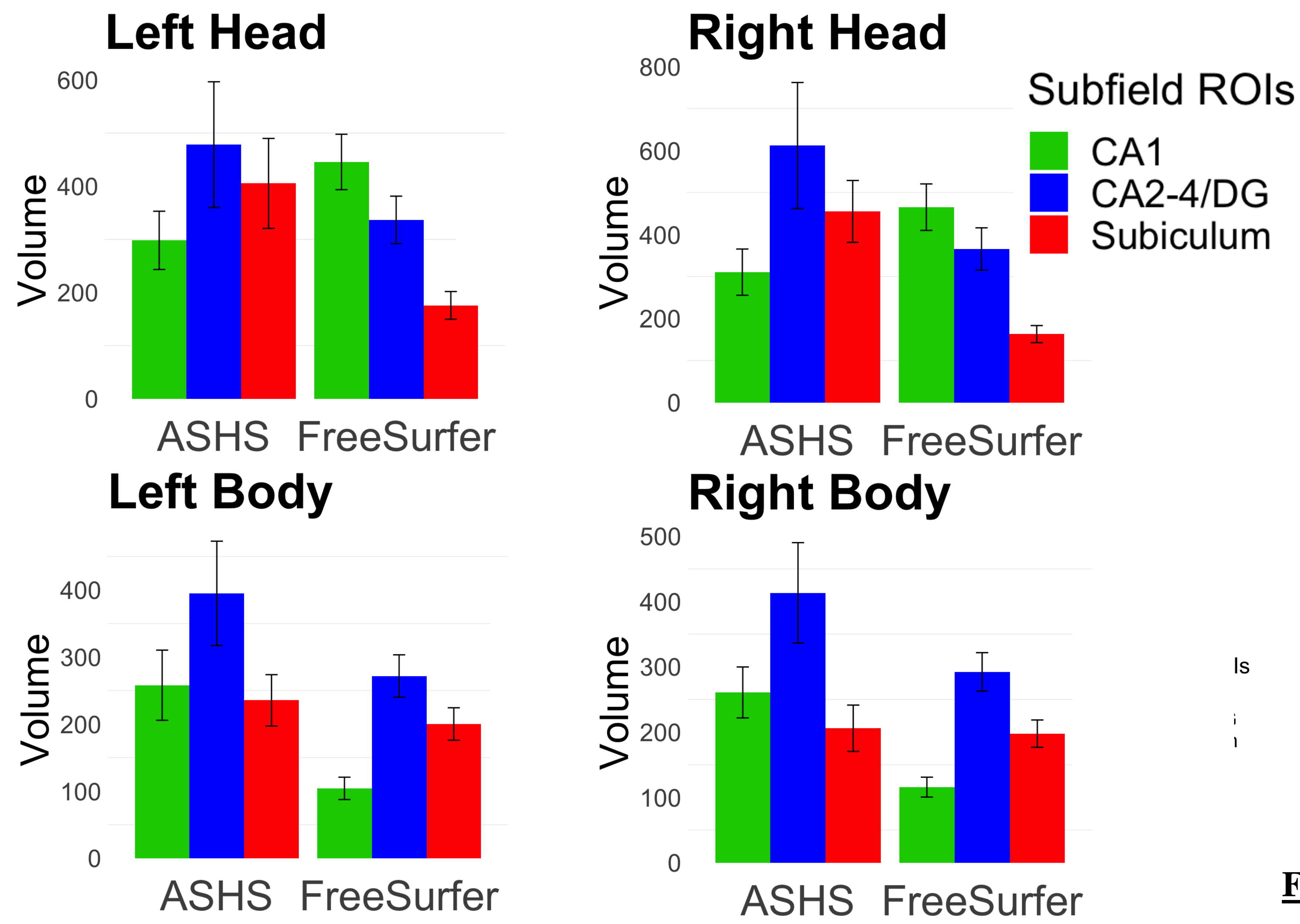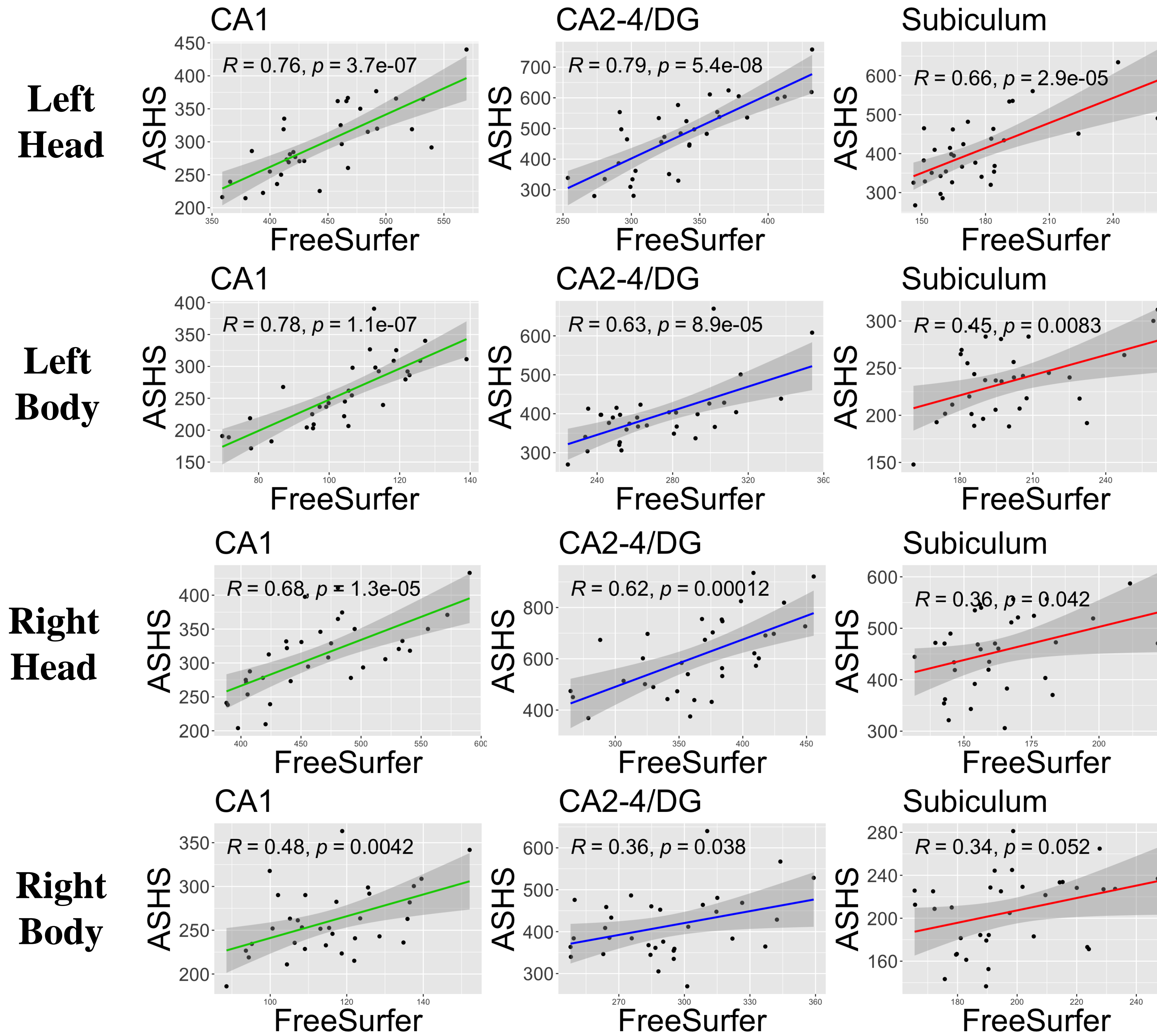
Analysis

- Pearson correlation analysis and paired sample t-tests were run to investigate if similarities and differences in subfield volumes extracted using the two methods.

RESULTS

RESULTS (continued)

- ⭐ *Pearson Correlation* showed that volumes derived from the two methods were robustly correlated across each bilateral subregion and subfield (subiculum, CA1, and CA2-4/DG), average $r(31) = 0.58$ ($r_{left} = 0.68$, $r_{right} = 0.47$).

- ⭐ *Paired sample t-tests* showed significantly smaller FreeSurfer segmentation volumes in all subfields except bilateral CA1-head ($\Delta = 151.11mm^3$, $p < .001$) and right subiculum-body ($\Delta = -8.28mm^3$, $p = .18$).

DISCUSSION AND NEXT STEPS

- Our findings revealed correlations and differences in hippocampal volumes derived from FreeSurfer and ASHS.

- Our future steps include 1) comparing both methods to manual tracing; 2) examining potential divergences in group comparisons based on children's sex, socioeconomic and nap status, and 3) investigating differences in estimates of developmental changes in subfields between the two methods.

FreeSurfer Segmentation

Subiculum
CA1
CA2/3
CA4
GC-DG

ASHS Segmentation

CA1
CA2-4/DG
Subiculum
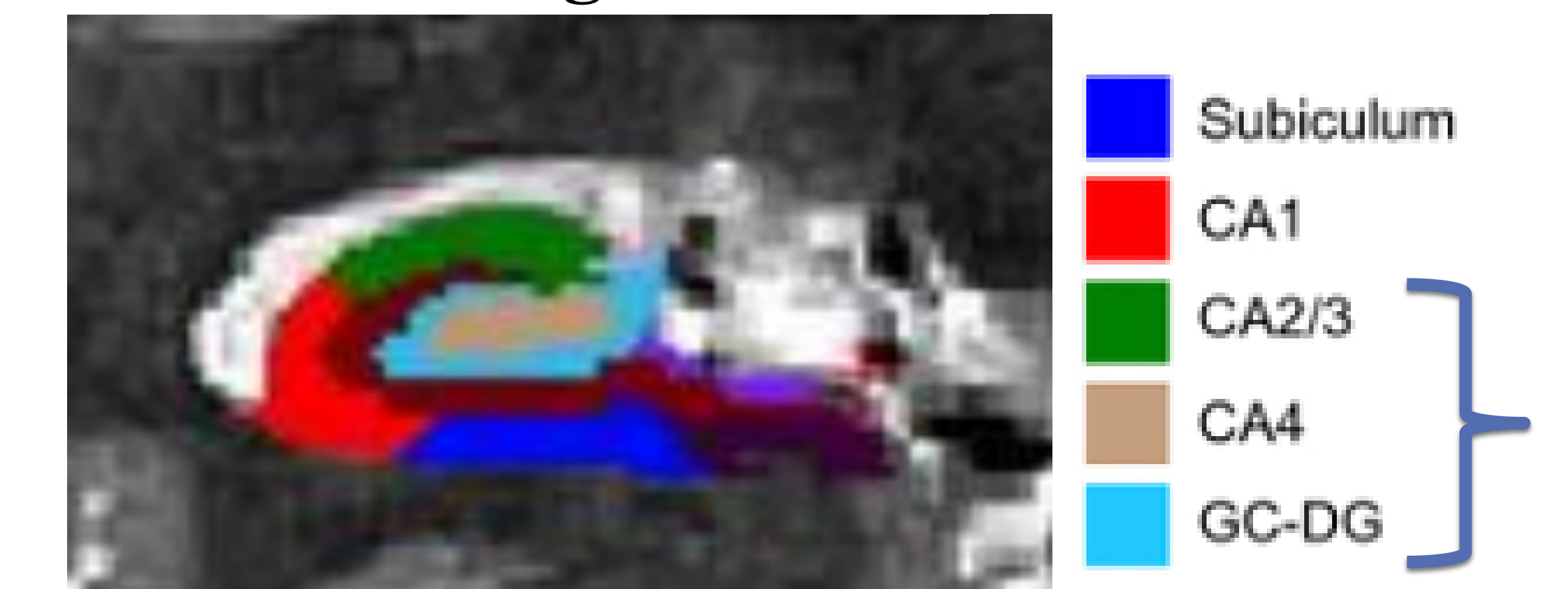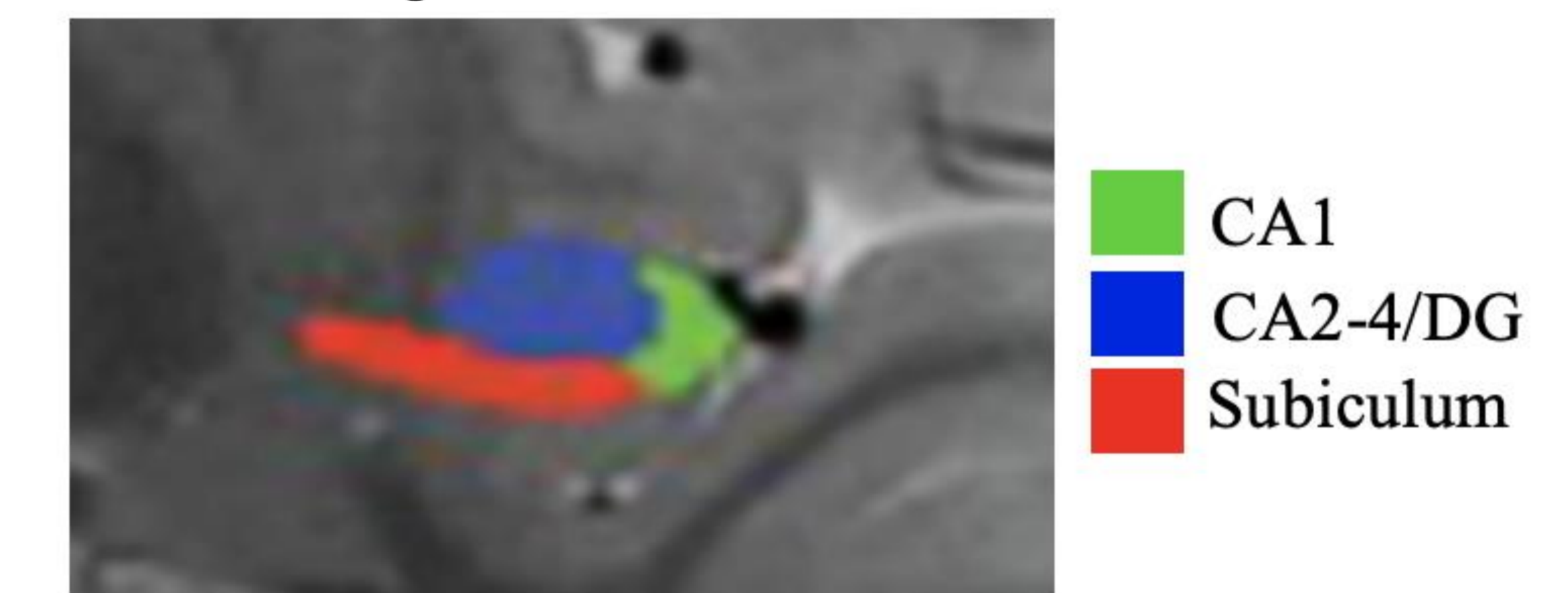
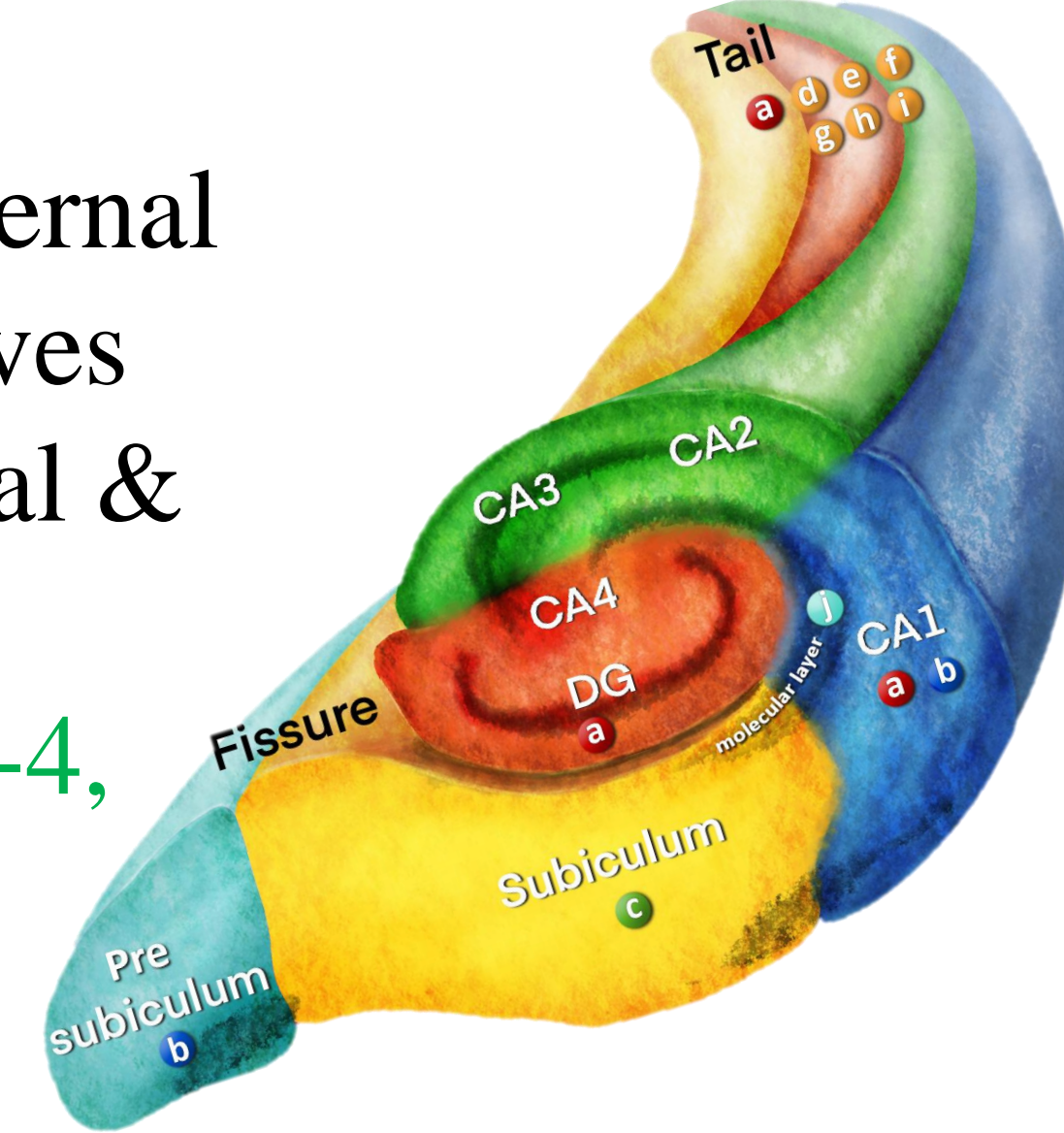**For questions or comments, please contact: zcui12@umd.edu**

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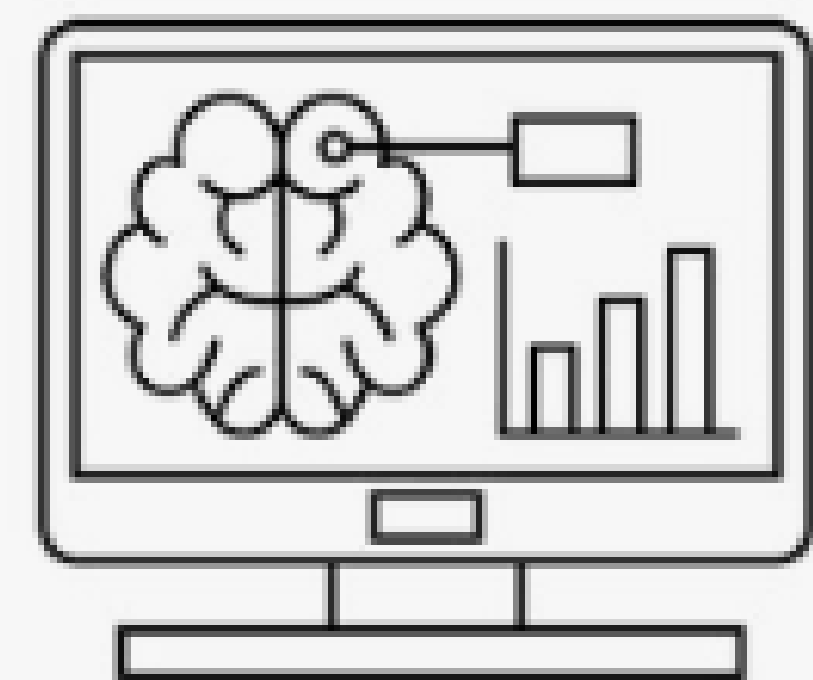
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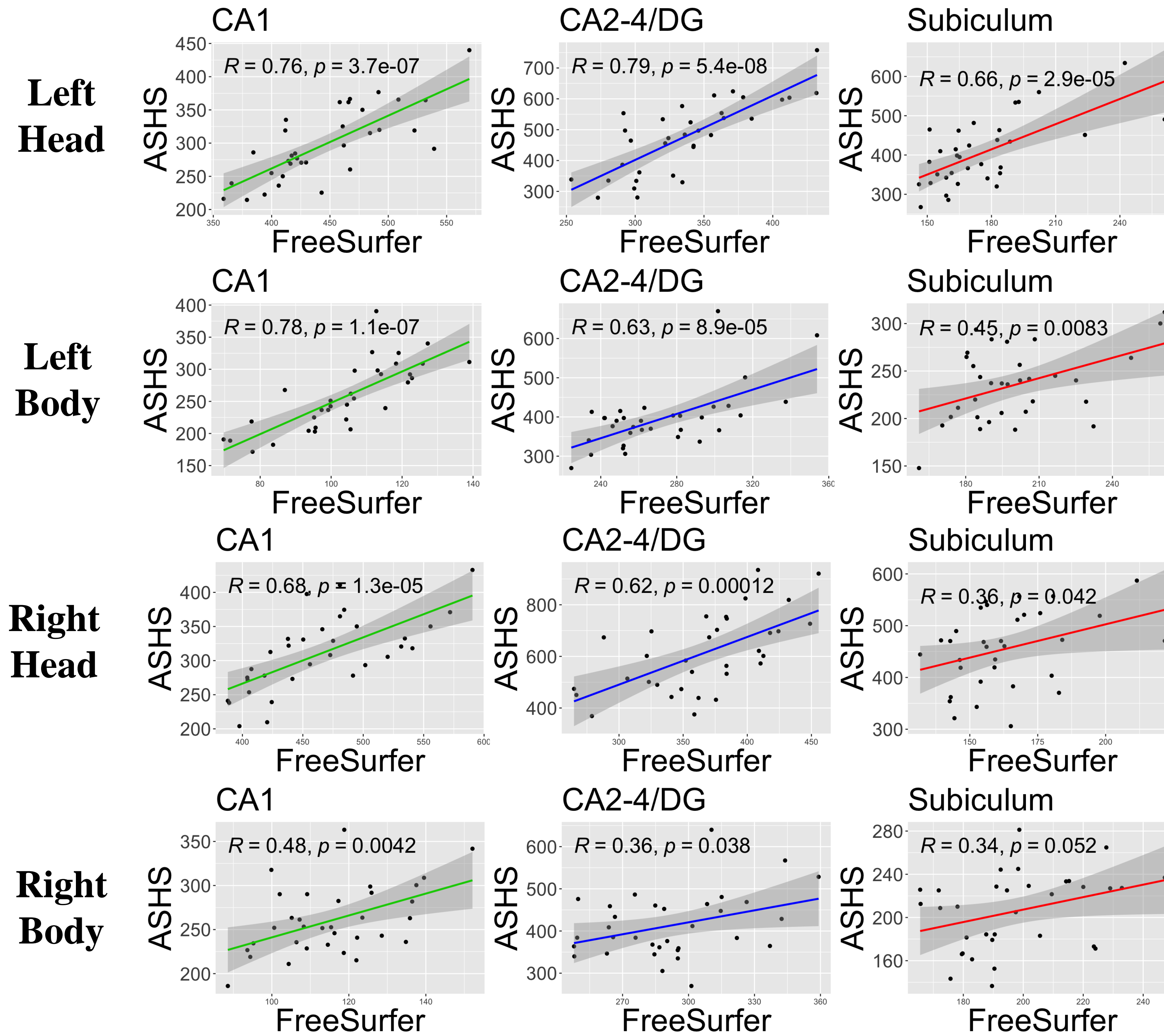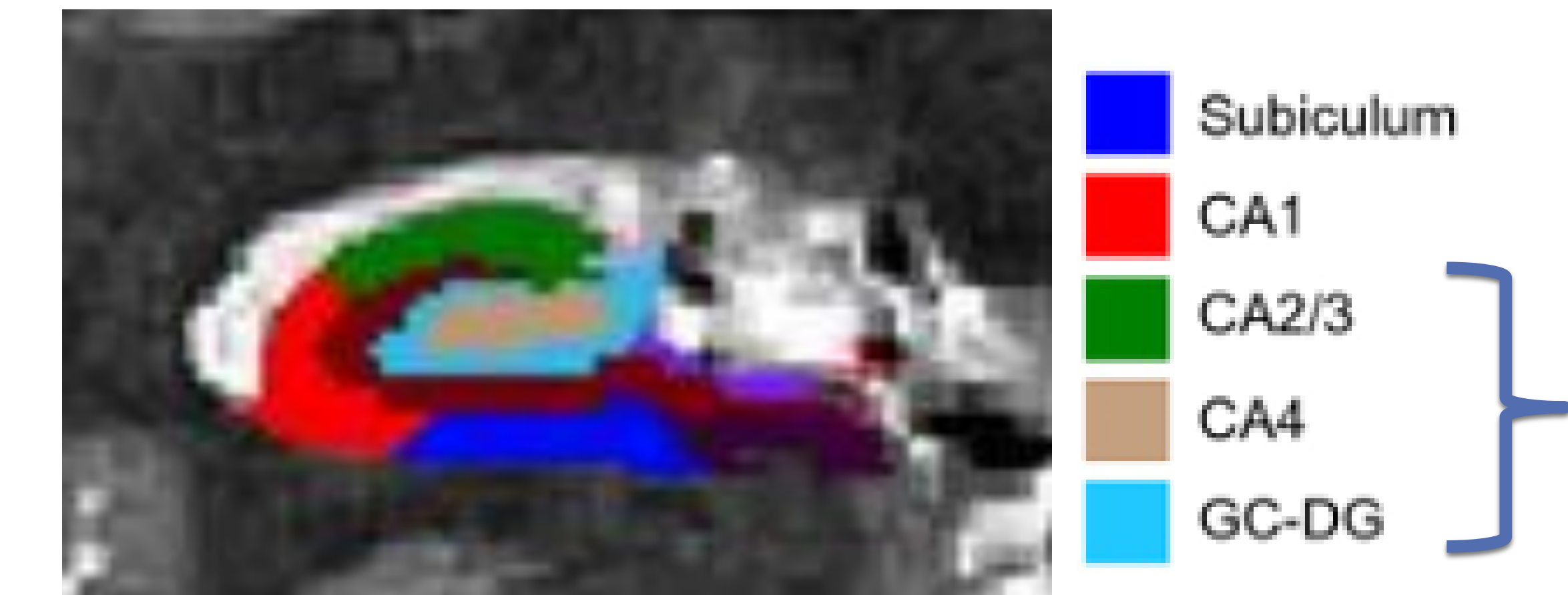
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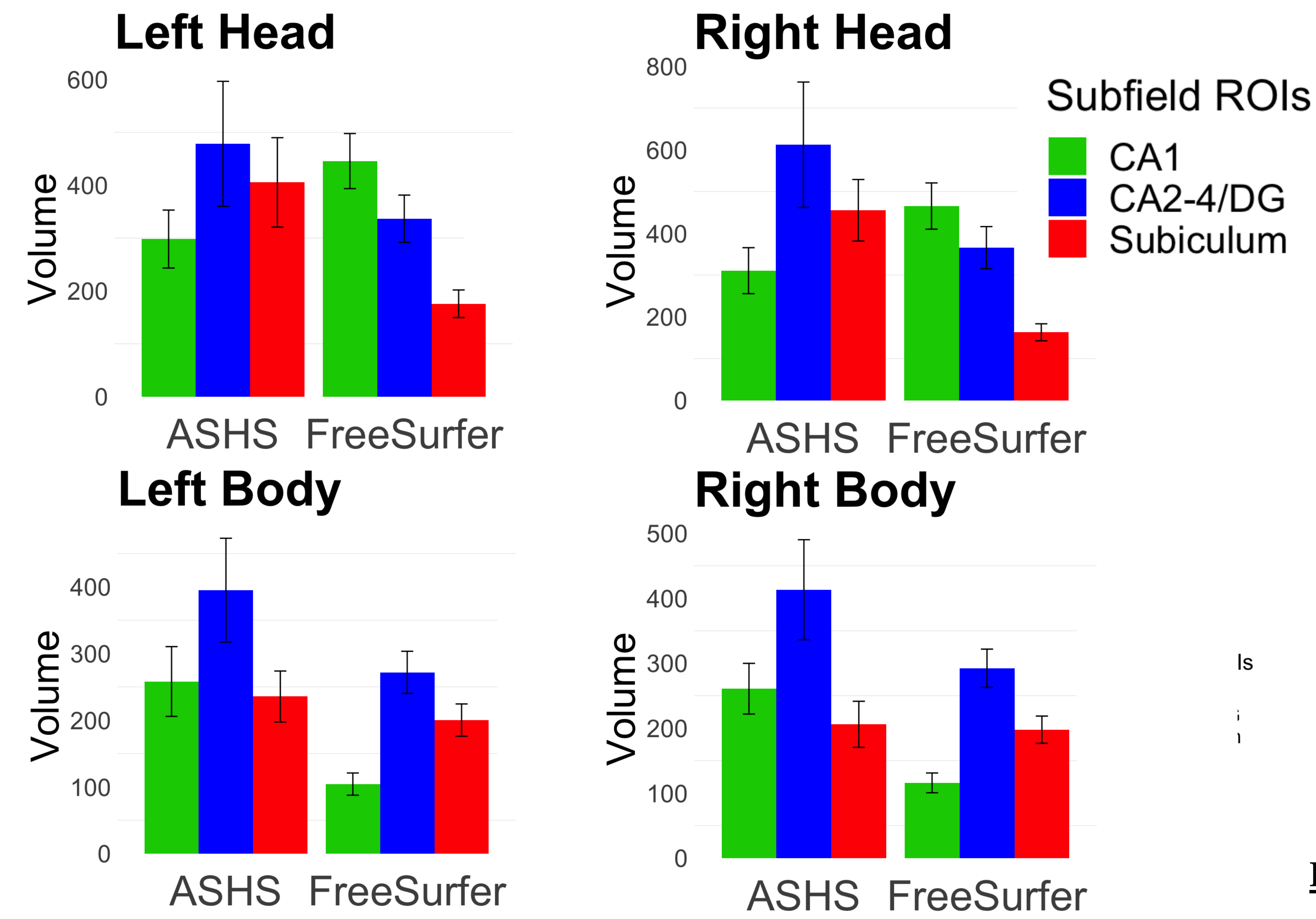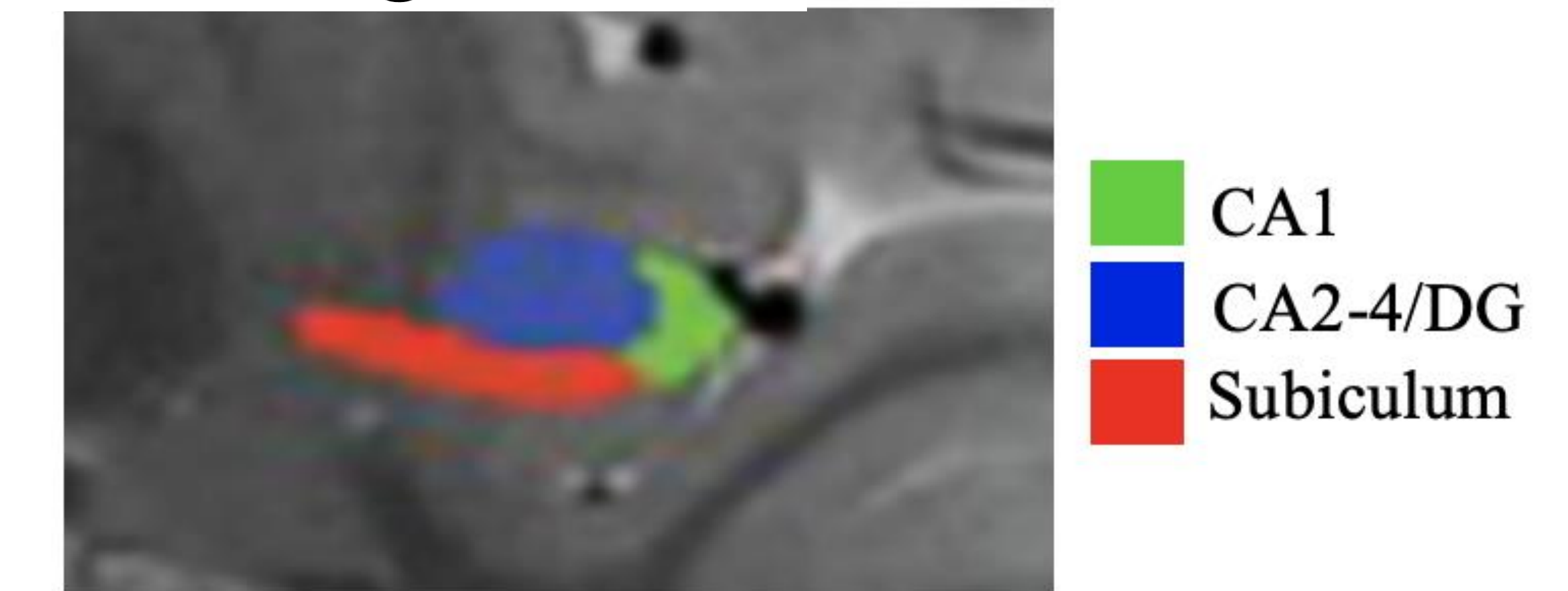
RESULTS

Scatter plots (ASHS vs FreeSurfer) by subregion:

Left Head:
- CA1: $R = 0.76, p = 3.7e\text{-}07$
- CA2-4/DG: $R = 0.79, p = 5.4e\text{-}08$
- Subiculum: $R = 0.66, p = 2.9e\text{-}05$

Left Body:
- CA1: $R = 0.78, p = 1.1e\text{-}07$
- CA2-4/DG: $R = 0.63, p = 8.9e\text{-}05$
- Subiculum: $R = 0.45, p = 0.0083$

Right Head:
- CA1: $R = 0.68, p = 1.3e\text{-}05$
- CA2-4/DG: $R = 0.62, p = 0.00012$
- Subiculum: $R = 0.36, p = 0.042$

Right Body:
- CA1: $R = 0.48, p = 0.0042$
- CA2-4/DG: $R = 0.36, p = 0.038$
- Subiculum: $R = 0.34, p = 0.052$

Bar charts — Left Head, Right Head, Left Body, Right Body (ASHS vs FreeSurfer)

Subfield ROIs:
- CA1
- CA2-4/DG
- Subiculum

FreeSurfer Segmentation

- Subiculum
- CA1
- CA2/3
- CA4
- GC-DG

ASHS Segmentation

- CA1
- CA2-4/DG
- Subiculum

- ⭐ **Pearson Correlation** showed that volumes derived from the two methods were robustly correlated across each bilateral subregion and subfield (subiculum, CA1, and CA2-4/DG), average $r(31) = 0.58$ ($r_{left} = 0.68$, $r_{right} = 0.47$).

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