

# The Effects of Age on Neural Differentiation are moderated by Global Cortical Thickness

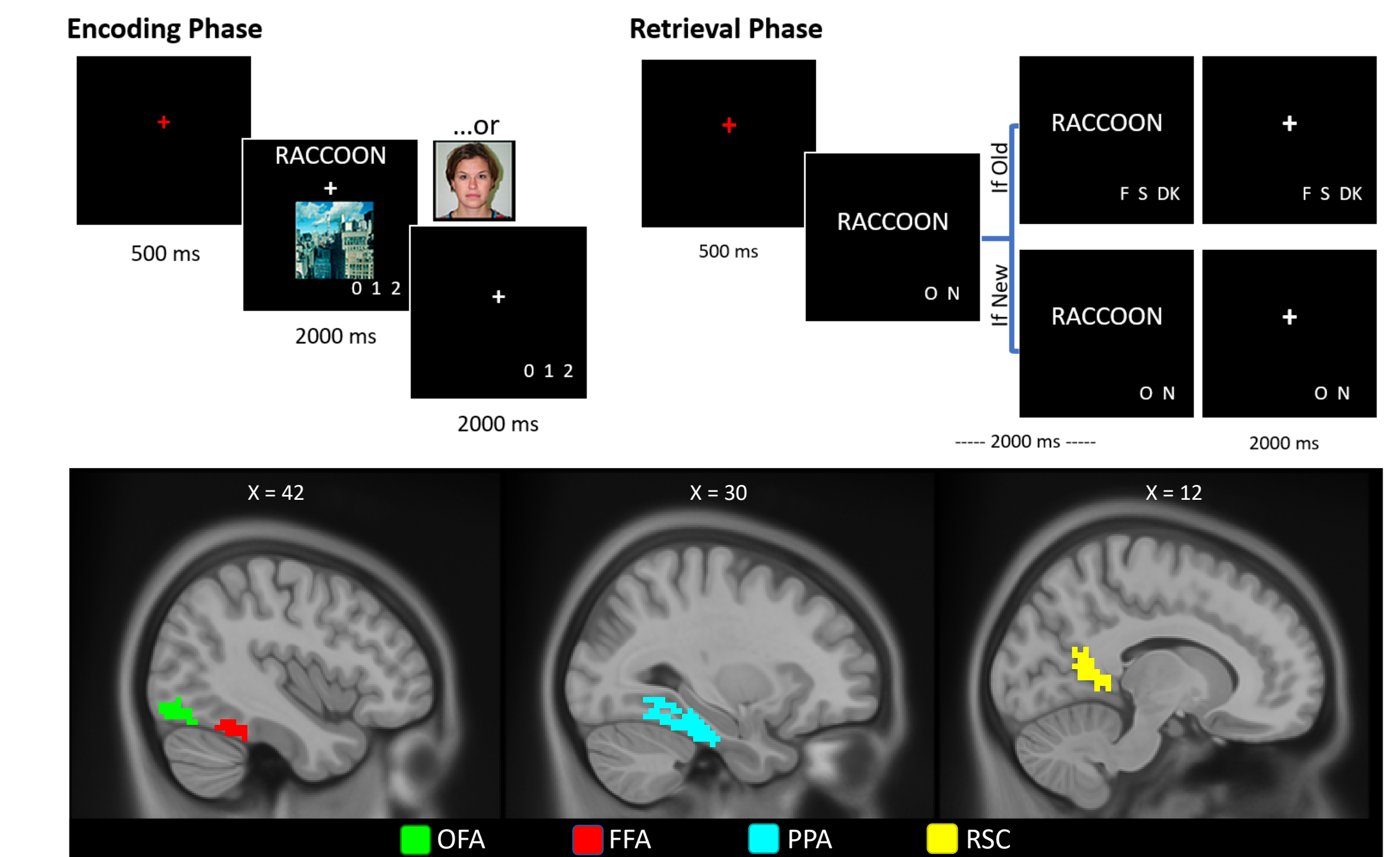
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## Background

- Increasing age is associated with:
  - Lower memory performance<sup>1</sup>
  - Progressive gray matter atrophy<sup>2</sup>
  - Age-related neural dedifferentiation (lower neural differentiation / selectivity)<sup>3</sup>
- Neural differentiation in the Parahippocampal Place Area (PPA) at encoding<sup>4,5</sup>, as well as at retrieval<sup>6,7</sup>, is functionally significant: PPA selectivity for scene stimuli has been reported to predict memory performance.
- Likewise, cortical thickness has been reported to be associated with cognitive performance, demonstrating a negative relationship in young and a positive relationship in older adults<sup>8</sup>
- Here, we addressed the following questions:
  - Is global cortical thickness associated with neural differentiation at encoding?
  - Do age differences in cortical thickness relate to the age differences observed for neural differentiation?
  - Are neural differentiation and cortical thickness independently predictive of memory performance?

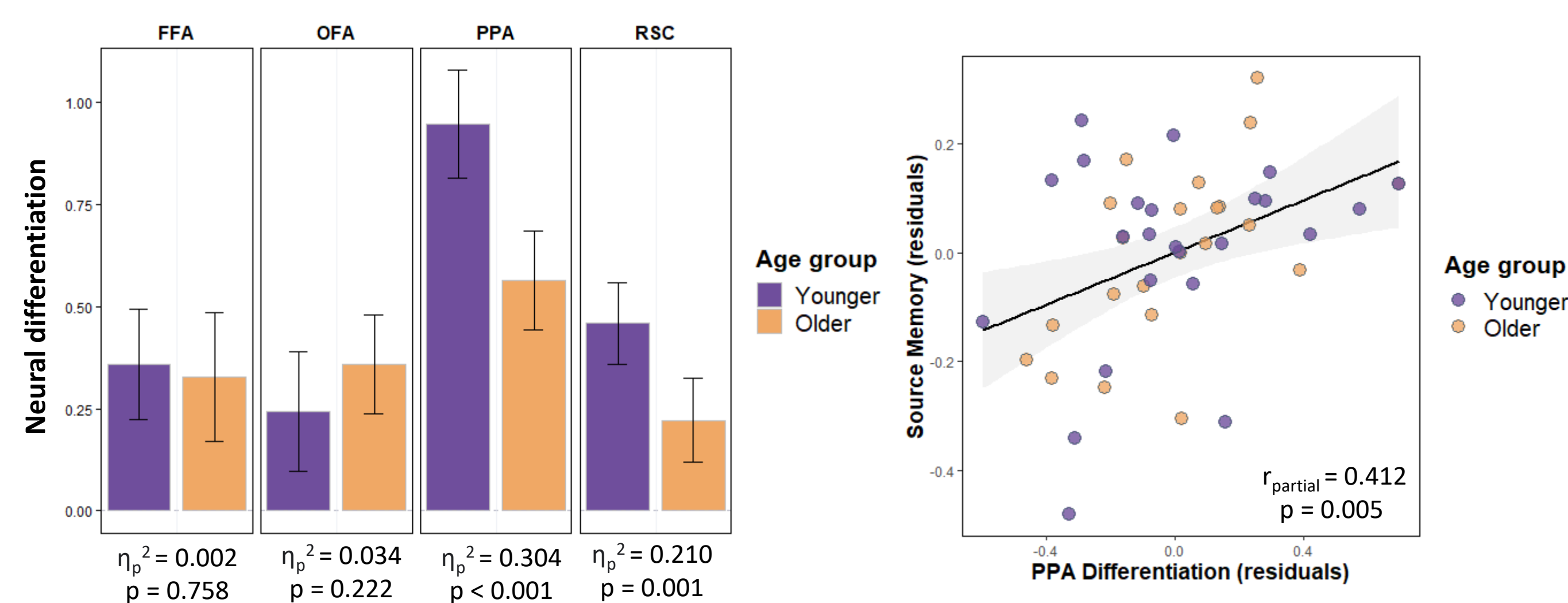
## Methods

- 24 Younger (18 – 28 yrs) and 24 Older (65 – 75 yrs) adults: fMRI during encoding and retrieval tasks.
- Encoding Task:** Words paired with an image of a face or a scene; participants imagined scenarios where the object (word) is interacting with the face or scene.
  - Retrieval Task:** Presented with studied and new words; if word is judged old, participants indicate whether the word had been studied with a face or a scene.
  - ROIs selection (encoding data):**
    - Scene > Face: Parahippocampal Place area (PPA), Retrosplenial Cortex (RSC)
    - Face > Scene: Fusiform Face area (FFA), Occipital Face area (OFA)
  - Functional Analyses - Differentiation Index:**
    - fMRI data at encoding were subjected to trial-wise least-squares-all GLM
    - Differentiation index: for a given ROI, the difference in across-trial response to the ROI's preferred versus non-preferred image class, divided by the pooled standard deviation.
  - Structural Analyses:**
    - T1-weighted images (MPRAGE) processed in Freesurfer v6.0.0 with manual corrections
    - 2 OA excluded from analyses because of poor quality T1s, resulting in Ns of 22 (OA) and 24 (YA)



$$\text{Differentiation Index} = \frac{\mu_{\text{pref}} - \mu_{\text{non pref}}}{\sqrt{\frac{\sigma_{\text{pref}}^2 + \sigma_{\text{non pref}}^2}{2}}}$$

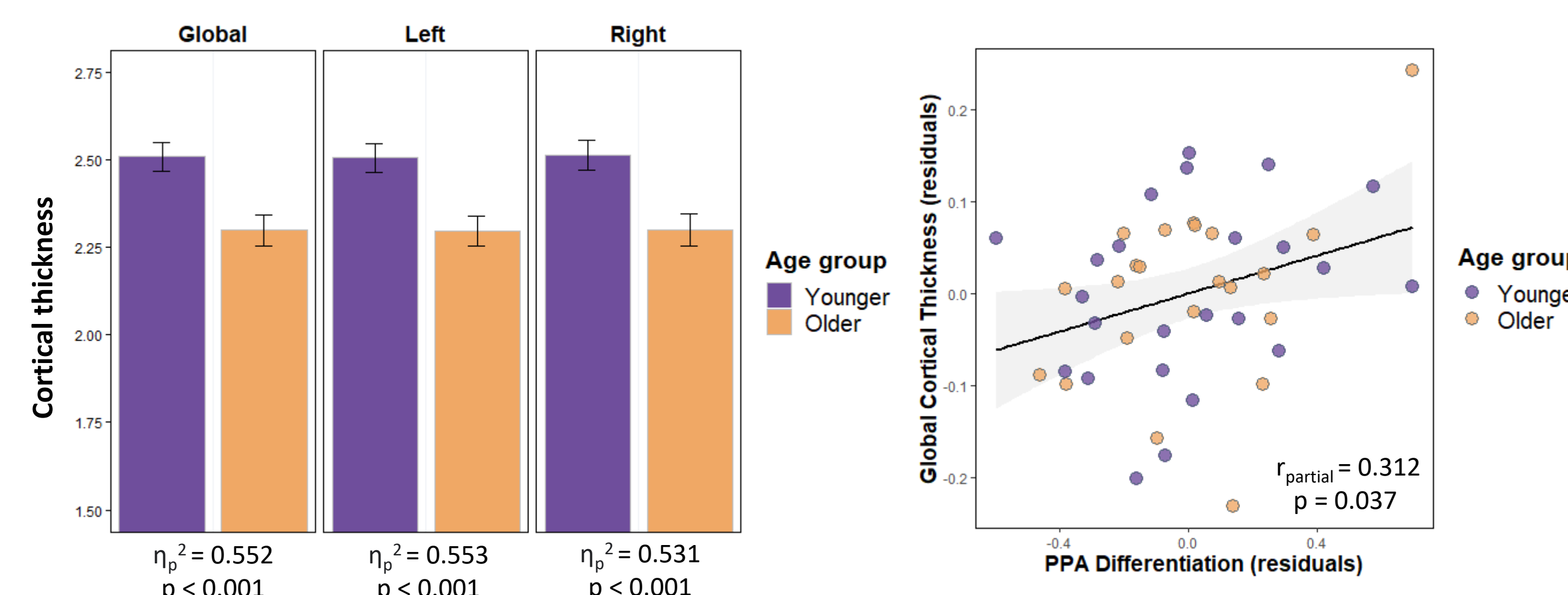
## Neural Differentiation



Age-related neural dedifferentiation was observed in the scene-selective PPA and RSC, but not in the face-selective FFA and OFA.

PPA neural differentiation was predictive of subsequent source memory after controlling for age group.

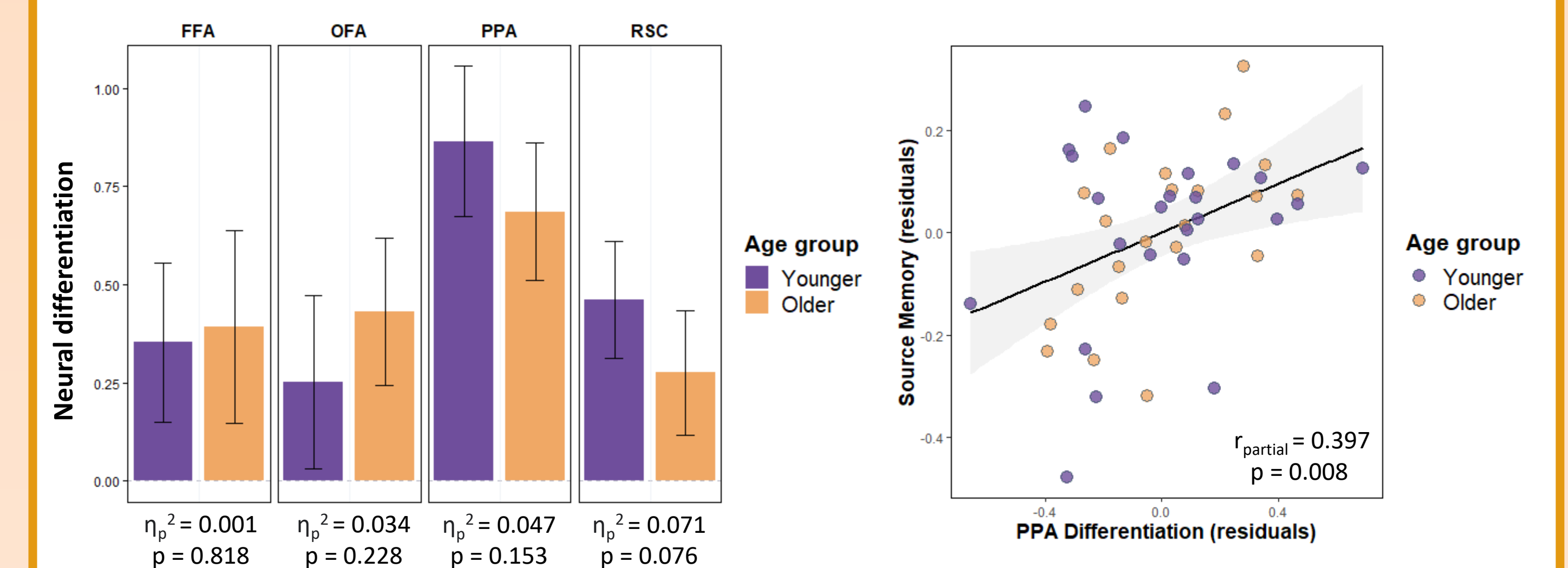
## Cortical Thickness



Cortical thickness was lower in older relative to young adults.

Cortical thickness was positively correlated with PPA neural differentiation when controlling for age group.

## Cortical Thickness as a Covariate

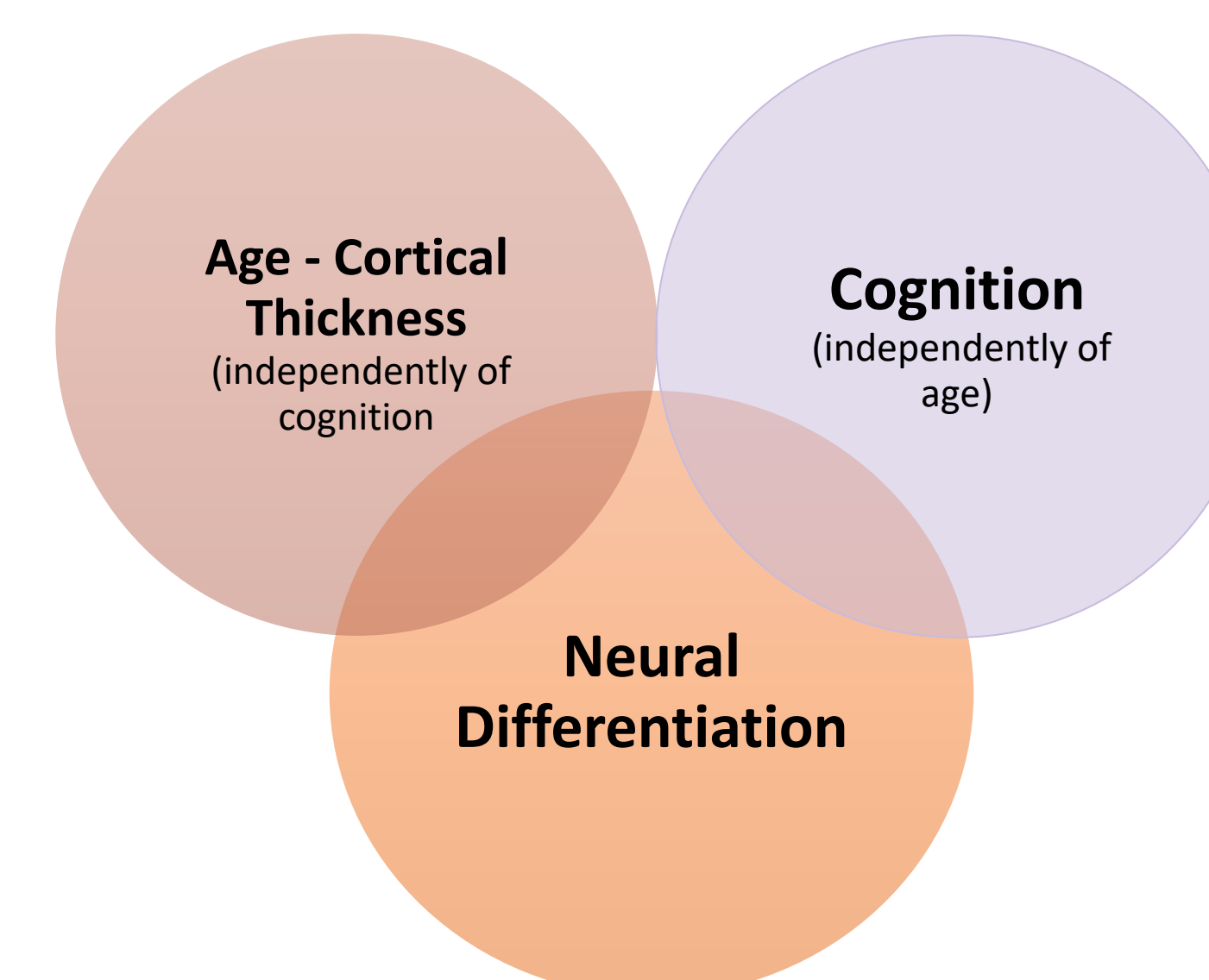


Age effects on neural differentiation were no longer present when covarying out cortical thickness.

PPA neural differentiation remained positively correlated with source memory when controlling for both age group and cortical thickness.

## Summary & Discussion

- Older adults demonstrated **reduced neural differentiation** (for scenes only) and **lower cortical thickness** relative to their younger counterparts.
- PPA neural differentiation demonstrated age-invariant (controlling for age) positive correlations with **source memory** and with **cortical thickness**.
- When controlling for cortical thickness:**
  - Age effects on neural differentiation for scenes are absent.
  - The age-invariant relationship between PPA differentiation and source memory remains.
- These findings suggest that neural differentiation (at least in the PPA) is associated with two sources of variance:**
  - Effects of age (moderated by age-related reductions in cortical thickness)
  - Effects of cognition (independent of age)



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