Scene-selective Increases in the Functional Connectivity of the Parahippocampal Place Area are Greater in Young than Older Adults During Encoding but are Age-invariant at Retrieval

Sabina Srokova, Paul F. Hill, Michael D. Rugg
Center for Vital Longevity, University of Texas at Dallas

Background

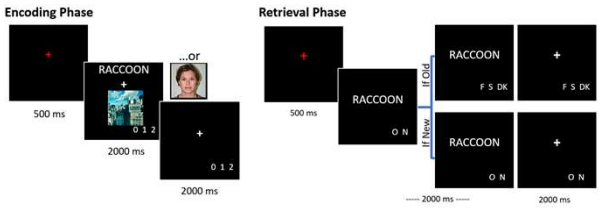
- Increasing age is associated with **age-related neural dedifferentiation** (reduced neural selectivity). These reductions in selectivity appear particularly robust in the scene-selective cortical regions during scene perception.[1,2]
- **Cortical reinstatement** for scene stimuli (retrieval-related reactivation of neural patterns originally observed at encoding) also appears weaker in older age. These age differences in reinstatement appear to be attributable to age differences in scene-related selectivity at encoding.[3]
- Scene-selective activity in the Parahippocampal Place Area (PPA) at encoding[4,5] as well as at retrieval[6,7] are functionally significant: PPA selectivity for scene stimuli has been shown to predict memory performance.

- Here, we examined age differences in the scene-related functional connectivity of the PPA. **Our two primary questions are:**
  - How does scene-related functional connectivity of the PPA differ when scenes are directly perceived (encoding) vs. when scenes are successfully retrieved?
  - Are there any age differences in PPA connectivity at encoding or at retrieval?

Methods

24 Younger (18 – 28 years) and 24 Older (65 – 75 years) adults underwent fMRI during encoding and retrieval tasks.

- **Encoding (study) Task:** Words paired with an image of a face or a scene; imagine a scenario where the object (word) is interacting with the face or scene.
- **Retrieval (test) Task:** Presented with studied and new words; if word is judged old, indicate whether the word had been studied with a face or a scene



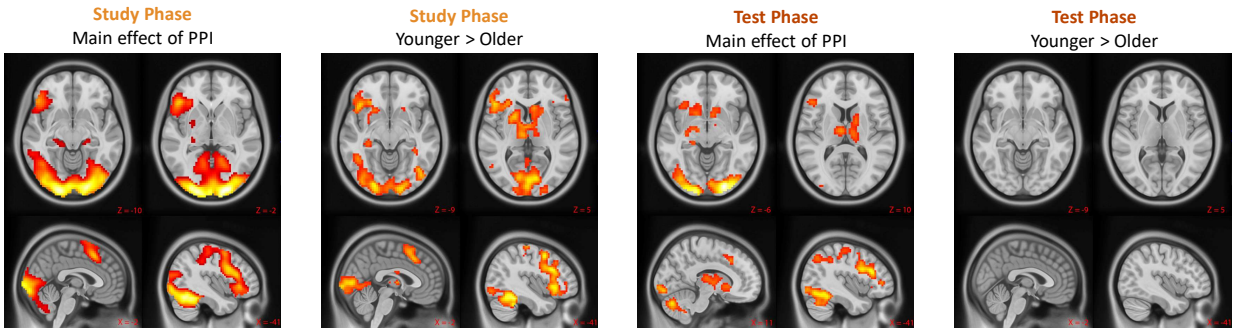
Analysis Approach:

- Functional connectivity with **Psychophysiological interaction (PPI) analysis**
- **PPI seeds** (3 mm radius) defined by selecting the peak voxel of the age-unbiased group-level scene > face contrast of the data from the study phase and scene source correct > face source correct at test.
  - **Left PPA:** Study: -27 -46 -16 Test: -30 -37 -22
  - **Right PPA:** Study: 30 -40 -19 Test: 27 -34 -25
- **PPI regressors** for each subject (1st level analysis):
  - **Physiological regressor:** Representative time course in a seed region
  - **Psychological regressor**: Scene > Face (Study)
    Scene source correct > Face source correct (Test)
  - **PPI regressor: P**hysiological x psychological interaction

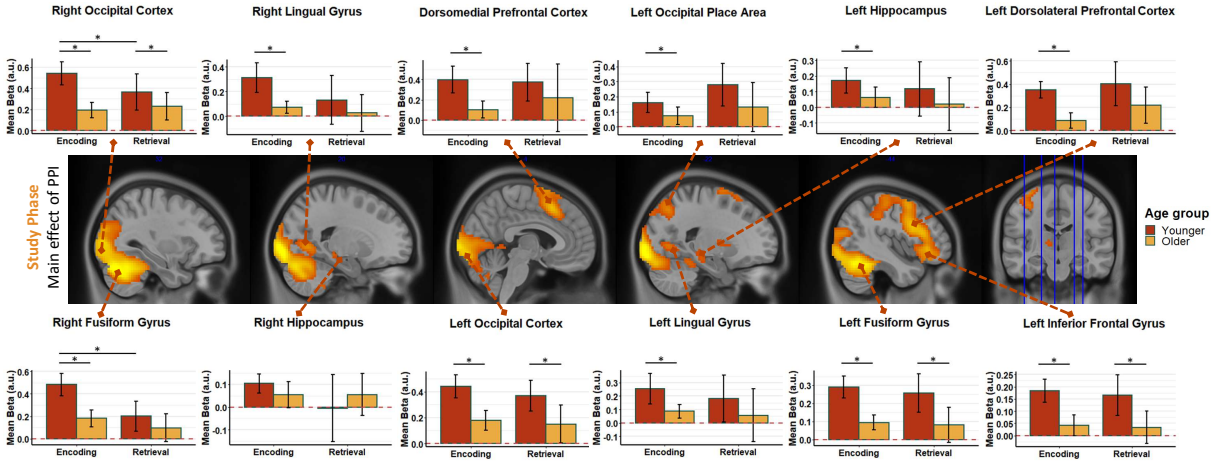
- Parameter estimates then carried over to a 2nd level analysis separately for study and test phases: **2 (younger / older adults) x 2 (left / right PPA) ANOVAs**

- **Results (I.)** reflect the whole brain outcome of the 2nd level analyses
- **Results (II.)** reflect parameter estimates which were extracted for each individual subject from a 5 mm radius sphere centered on the peak voxels of the effects which were identified in the main effect of PPI of the study phase.

Results (I.)



Results (II.)



Summary and Conclusions

- **Encoding:** Increases in scene-related functional connectivity between the PPA and the bilateral hippocampus, occipital cortex, fusiform gyri, dorsomedial prefrontal cortex, left dorsolateral prefrontal cortex, and left inferior frontal gyrus.
- **Retrieval**: PPA functional connectivity overlapped with the effects identified at encoding, demonstrating **reinstatement of functional connectivity at retrieval.**
- **Weaker functional connectivity in older than younger adults at encoding** in all aforementioned regions + the caudate/putamen and thalamus.
- **No age differences at retrieval** at the whole-brain level, but subject-wise mean parameter estimates suggest reduced functional connectivity in the occipital areas.

- **Scene-related functional connectivity is reinstated at retrieval; however, age differences are not recapitulated and are instead confined to scene perception.**

References and Other Info

1. Koen, J. D., Srokova, S., & Rugg, M. D. (2020). *Curr. Opin. Behav. Sci.*
2. Koen, J. D., & Rugg, M. D. (2019). *TICS.*
3. Hill, P. F., King, D. R., & Rugg, M. D. (2021). *Cerebral Cortex.*
4. Koen, J. D., Hauck, N., & Rugg, M. D. (2019). *Jneuro.*
5. Srokova, S., Hill, P. F., Koen, J. D., King, D. R., & Rugg, M. D. (2020). *Eneuro.*
6. Srokova, S., Hill, P. F., Elward, R. L., & Rugg, M. D. (2021). *Neurobiol. of aging.*
7. Srokova, S., Hill, P. F., & Rugg, M. D. (2022). *JNeuro*

Scan to Download PDF

Contact
sabina.srokova@utdallas.edu
sabinasrokova.com

Funding
NSF Grant 1633873

THE UNIVERSITY OF TEXAS AT DALLAS · CENTER FOR VITAL LONGEVITY · fNIM laboratory functional Neuroimaging of Memory