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<th>Age-related differences in functional connectivity during scene encoding</th>
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Introduction

- The functional network underlying episodic encoding involves both the prefrontal cortex (PFC) and medial temporal lobes (MTL).¹
- Episodic encoding differs in terms of the stimuli and the types of elements involved.
- Prior neuroimaging studies have found both the parahippocampal cortex in the MTL and inferior frontal gyrus (IFG) in the PFC to be activated for scene encoding.² In addition, when scenes are encoded based on its meaningfulness (i.e. relational encoding), the hippocampus will be activated for relational binding of the stimulus.³
- In general, there is converging support for both the IFG and MTL (hippocampus/parahippocampus) to be functionally connected and work in tandem during relational encoding of scenes.
- Older adults performing relational encoding⁴ and scene encoding⁵ exhibited increased inferior frontal activation than young adults to meet their increased cognitive demand. Specifically, an increased inferior frontal activity was shown to compensate for the decreased medial temporal activity.
- The posterior-to-anterior shift in aging (PASS) model⁶ could potentially be used to account for this medial-temporal-to-inferior frontal compensatory shift in brain activation.
- Although prior studies have non-scrapped novel scene differences in both the IFG and MTL activation during relational encoding of scenes, the IFG-MTL co-activation is not specifically investigated. Hence, this study utilized a functional MRI (fMRI) task sensitive to relational encoding of scenes to evaluate age-related differences in the IFG-MTL functional connectivity (FC).

Aims & Hypotheses

Aims
1. To examine the difference in IFG-MTL functional connectivity between young and older adults while performing relational encoding of scenes.
2. To use the present finding to extend support for the PASS model.

Hypotheses
1. Both young and older adults are expected to show increased functional connectivity between IFG and MTL during relational encoding of scenes.
2. Older adults are expected to show reduced functional connectivity between IFG and MTL during relational encoding of scenes compared to the young.

Method

Participants
16 healthy old adults (9 F, 2 left-handed) mean age = 66.2 (SD = 6.5) MMSE mean score = 29.3 (SD = 0.7)
23 healthy young adults (12 F, 2 left-handed) mean age = 23.3 (SD = 2.2) MMSE mean score = 29.9 (SD = 0.3)

Task
Relational encoding of scenes: Non-scrapped novel (N) vs scrambled novel scenes (S) task contrast.⁷
Accuracy (ACC) and reaction time (RT) during scan were recorded; post-scan recall was tested for unintentional encoding.

Image acquisition and preprocessing
All participants’ brain images were acquired in a 3.0T MRI scanner (EP parameters: TE 30 ms, TR 3000 ms, FOV 192 mm, matrix 64x64, slice thickness 3 mm, 39 axial slices with 0.75 mm gap).
Preprocessing was carried out using statistical parametric mapping 8 (SPM 8) on MATLAB 7.9, following the diffeomorphic anatomic registration through exponentiated lie algebra (DARTEL) pipeline.⁷

Data analyses
- Behavioral data: 2 (Age) x 2 (Task) analysis of variances (ANOVAs) were performed on ACC and RT recorded during the scans, and on post-test ACC. Post-hoc multiple pairwise comparisons were performed for significant interaction or main effects, with p < .05.
- Imaging data: General Linear Model analyses for N vs S contrast were performed for subject-level brain activation map using SPM8, before submitting for group-level random effects (IFG-MTL ROI) analyses with gray matter probability and RTs adjusted using biological parametric mapping (BPM), with p < .001 (uncorrected), k > 20. Later, ROI-to-ROI (IFG-MTL) functional connectivity analyses for N vs S task contrast were conducted for subject-level and group-level, using CONN toolbox v.11,⁸ with p < .05 (FDR corrected). Left and right IFG and MTL ROI masks were created using WFU PickAtlas 2.4. Intra-cranial brain volumetric decline and RTs for both conditions were adjusted.

Results

Behavioral results
- Figure 2 x 2 mixed design ANOVAs, at p < .05, were performed on (a) ACC during scan, (b) RT during scan and (c) post-test ACC.
- RTs for both conditions were submitted as covariates for between-groups IFG-MTL functional connectivity analyses.

Imaging results
Activation analyses
(a) Old adults
(b) Young adults
(c) Old vs young adults
Figure 3 Old and young adults showed bilateral MTL activation (indicated by arrow). No IFG or MTL activation was found in the old vs young adults comparison.

Connectivity analyses
(a) Old adults
(b) Young adults
(c) Old vs young adults
Figure 4 Both old and young adults had increased FC between right and left MTL. Old adults also showed a marginal increase of FC between right MTL and left IFG at p < .06 (FDR corrected). Older adults had an increased FC between the right and left MTL compared to the young.

Conclusion

- Older adults responded slower than young adults for both conditions, with reaction time being slower for scrambled novel scenes than non-scrapped condition.
- Only older adults showed functional connectivity between IFG and MTL during relational encoding of scenes, while younger adults had connectivity between left and right MTL, partially supporting the first hypothesis.
- Contrary to the second hypothesis, no age-related difference in IFG-MTL functional connectivity was found to suggest a PASA phenomenon. However, the present finding showed increased functional connectivity between left and right MTL in the elderly compared to the young when performance and brain atrophy is controlled. For these results could be generalized to the CRUNCH model⁹ that suggests a functional compensation in aging.

References