

Age-related differences in neural activity for novelty and relational encoding of scenes

Leow, Wei Yang Dayton

2015

Leow, W. Y. D. (2015, March). Age-related differences in neural activity for novelty and relational encoding of scenes. Presented at Discover URECA @ NTU poster exhibition and competition, Nanyang Technological University, Singapore.

<https://hdl.handle.net/10356/84880>

© 2015 The Author(s).

Downloaded on 13 Mar 2024 18:57:19 SGT

Age-related Differences in Neural Activity for Novelty and Relational Encoding of Scenes

Introduction

Episodic memory decline is a hallmark of the aging brain¹. Episodic encoding can be delineated into **novelty** (processing the unfamiliarity) and **relational** (processing the meaningfulness) encoding². Present literature has shown the fusiform gyrus (FG), hippocampus, parahippocampus and inferior frontal gyrus (IFG) are involved in relational encoding of scenes²⁻⁵; while the inferior occipital gyrus (IOG) is additionally involved in novelty encoding of scenes^{2,4,6}, serving as viable regions of interest (ROIs) when examining the neural correlates of novelty and relational encoding of scenes.

Age-related fMRI studies have reported that older adults show contralateral prefrontal recruitment during episodic encoding – presented as the **hemispheric asymmetry reduction in older adults (HAROLD) model**⁷. A contralateral prefrontal recruitment may suggest an increased functional connectivity (FC) between the left and right prefrontal regions. However, the use of FC analysis to support the HAROLD model is currently lacking in present literature. Furthermore, age-related studies on episodic encoding have not examined if novelty and relational encoding are differentially affected by age.⁸ Hence, it will be informative to evaluate if the HAROLD effect is evident for novelty and relational encoding. This study utilized a fMRI task sensitive to both **novelty** and **relational** encoding of scenes to investigate age-related differences in the functional connectivity (FC), focusing on a priori ROIs, with the **HAROLD effect** being predicted.

Aims & Hypotheses

Aims

1. To examine age-related differences in the functional connectivity for **novelty** and **relational** encoding of scenes.

2. To examine if the findings for novelty and relational encoding of scenes support the **HAROLD model**.

Hypotheses

- Both young and older adults are expected to show activation in the respective ROIs for **novelty** and **relational** encoding of scenes.
- Both young and older adults are expected to show significant FC between the left and right IFG for **novelty** and **relational** encoding of scenes.
- Older adults are predicted to show a **greater FC** between left and right IFG compared to young adults for **novelty** and **relational** encoding of scenes.

Method

Participants

- 16 older adults (9 female, 2 left-handed) mean age = 66.2 (SD = 6.5); MMSE = 29.3 (SD = 0.7)
- 23 young adults (12 female, 2 left-handed) mean age = 23.3 (SD = 2.2); MMSE = 29.9 (SD = 0.3)

Task

- Novelty encoding:** Non-scrambled **novel (N)** vs Non-scrambled **repeating (R)** contrast².
- Relational encoding:** Non-scrambled **novel (N)** vs scrambled **novel (S)** contrast².
- Accuracy (ACC) and reaction time (RT) during scan were recorded; post-scan recall was tested for unintentional encoding.

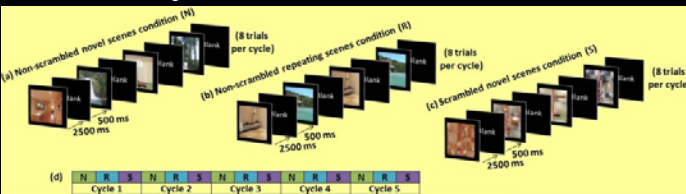


Figure 1. Stimulus presentation to each participant was blocked by condition in the order of (a) non-scrambled novel scenes condition, (b) non-scrambled repeating scenes condition and (c) scrambled novel scenes condition for 5 cycles. Each block lasted 24 s and one run took 360 s in total.

Image acquisition & preprocessing

- Images were acquired in a 3.0 T MRI scanner (EPI 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) pipeline⁸.

Data analyses

Behavioral data: 2 (Age) x 3 (Condition) analysis of variances (ANOVAs) were performed on ACC and RT recorded during scan, and on post-scan ACC. Post-hoc multiple pair-wise comparisons were performed for significant interaction or main effects, with $p < .05$.

Imaging data: Subject-level general linear model analyses were conducted for both N>R and N>S contrasts using SPM8, before submitting for **group-level random effects ROI analyses**, adjusting for gray matter probability and RTs using biological parametric mapping (BPM)⁹, with $p < .001$ (uncorrected), $k > 20$. Later, **subject-level and group-level ROI-to-ROI functional connectivity analyses** were conducted for both N>R and N>S contrasts via CONN toolbox v.13^{10,11}, with $p < .05$ (FDR corrected). Left and right FG, hippocampus, parahippocampus and IFG ROI masks were created for relational encoding of scenes via WFU PickAtlas 2.4; while left and right IOG ROI masks were added for novelty encoding of scenes.

Results

Behavioral results:

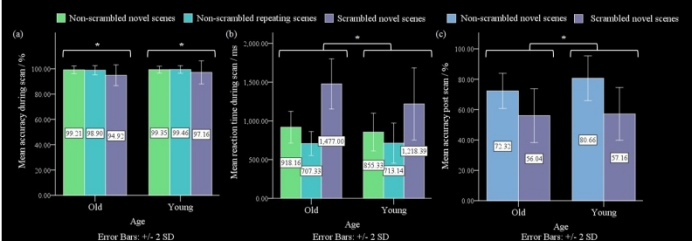


Figure 2. 2 x 2 mixed design ANOVAs revealed only significant main effect of condition for (a) ACC during scan; while condition x age interactions were found for (b) RT during scan and (c) post scan ACC, at $p < .05$. RTs for all conditions were submitted as covariates for group analyses.

Imaging results:

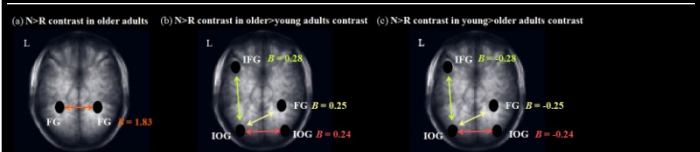
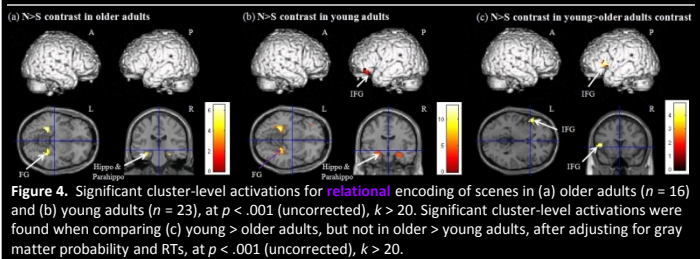
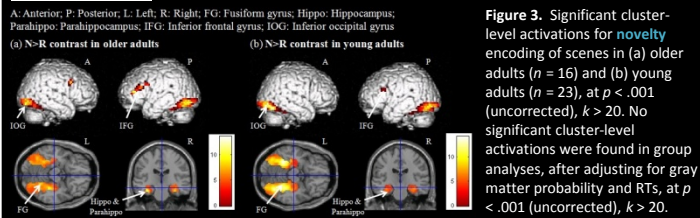


Figure 5. Shows FCs significant for **novelty** encoding of scenes in (a) older adults, (b) older > young adults, and (c) young > older adults, after adjusting for intra-cranial brain volume and RTs, at $p < .05$ (FDR corrected).

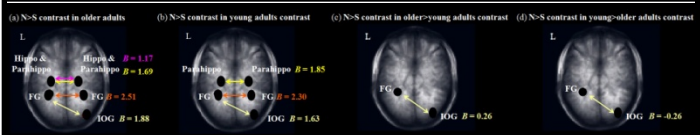


Figure 6. Shows FCs significant for **relational** encoding of scenes in (a) older adults, (b) young adults, (c) older > young adults, and (d) young > older adults, after adjusting for intra-cranial brain volume and RTs, at $p < .05$ (FDR corrected).

Conclusion

- Consistent with previous studies²⁻⁶, young adults showed activations in the respective ROIs for **novelty** and **relational** encoding of scenes.
- Although activation analyses lent support for **HAROLD model** for **novelty** encoding of scenes, there was no age-related increase in the functional connectivity between left and right IFG.
- No significant IFG activity was found in older adults for **relational** encoding of scenes. This could be explained by (1) the poor elicitation of relational encoding, as reflected in their lower post-scan ACC performance than young adults; and (2) the absence of significant right hippocampal activity, resulting in a consequential absence of IFG activation¹².

[1] Craik, F. I., & Rose, N. S. (2012). Neuroscience and Biobehavioral Reviews, 36, 1229-39. [2] Binder, J. R., et al. (2005). Epilepsia, 46, 1061-1070. [3] Kirchhoff, B. A., et al. (2000). The Journal of Neuroscience, 20, 6173-6180. [4] Gutchess, A. H., et al. (2005). J. Cognit. Neurosci., 17, 84-96. [5] Addis, D. R., & McAndrews, M. P. (2006). NeuroImage, 33, 1194-1206. [6] Miyakoshi, M., et al. (2012). Brain Imaging and Behavior, 6, 357-365. [7] Cabeza, R. (2002). Psychology and Aging, 17, 85-100. [8] Ashburner, J. (2007). NeuroImage, 38, 95-113. [9] Casanova, R., et al. (2007). NeuroImage, 34, 137-143. [10] Whitfield-Gabrieli, S., & Nieto-Castanon, A. (2012). Brain Connectivity, 2, 125-141. [11] Chai, X. J., et al. (2012). NeuroImage, 59, 1420-1428. [12] Simons, J. S., & Spiers, H. J. (2003). Nature Reviews Neuroscience, 4, 637-648.