



Functional activation during a novel passive viewing paradigm is associated with out-of-scanner episodic memory performance in preschoolers

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Introduction

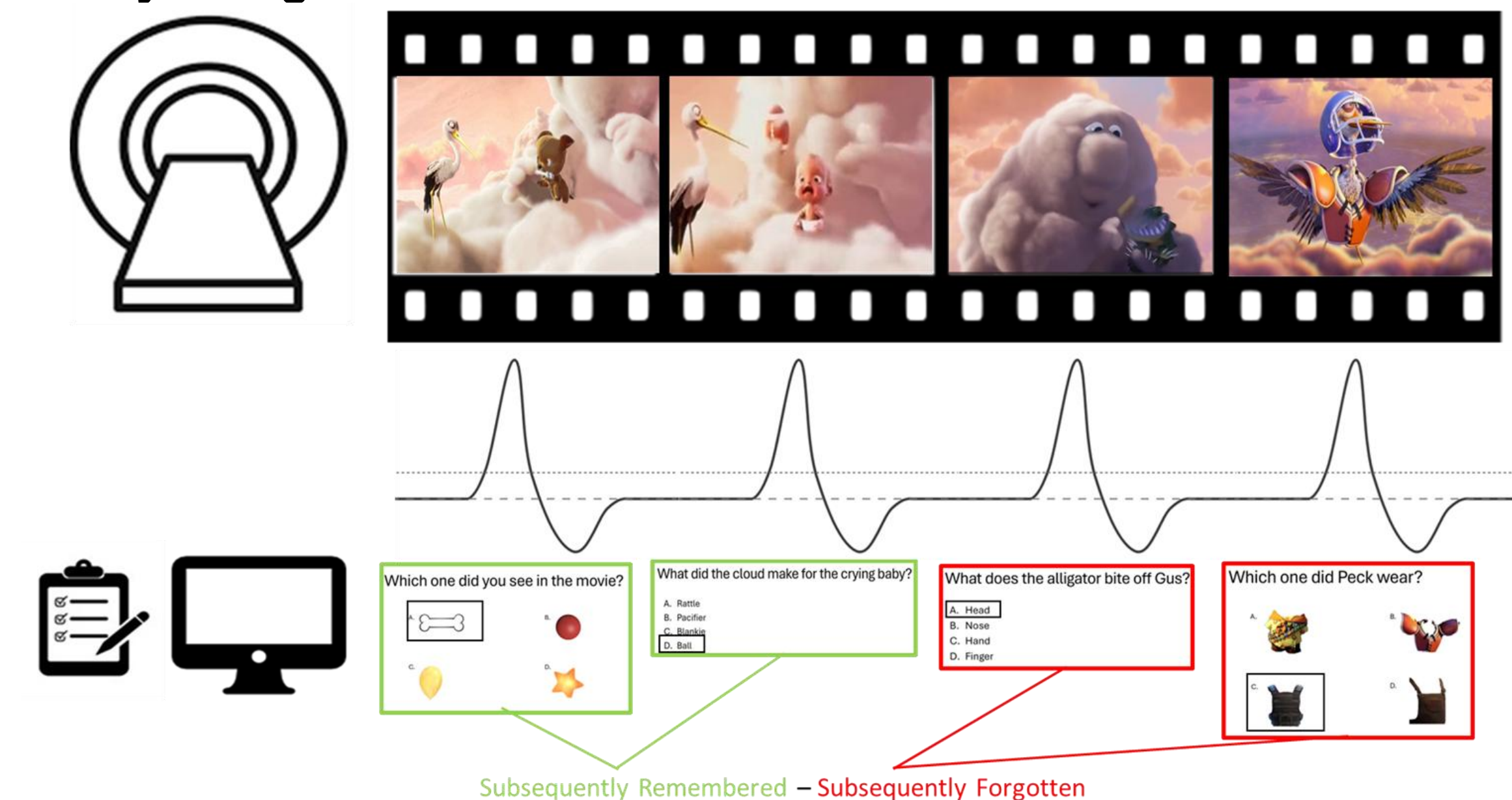
- Early childhood (3-5 years) is marked by significant improvements in episodic memory¹.
- Work in infants² and adolescents³ demonstrate relations among hippocampal function and successful memory encoding.
- In older children and adults, successful encoding involves a broader network of cortical and subcortical regions^{4,5}, including deactivation of regions within the default mode network (DMN)⁶.
- However, the neural mechanisms underlying encoding during early childhood remain under-explored due to the methodological challenges associated with acquiring task-based data from awake young children.
- To address this gap, we developed a passive viewing fMRI encoding paradigm using two animated clips – *Partly Cloudy* and *Pip*.

Methods

Participants

- Cross-sectional sample of 73 3-5-year-old children (Mage = 50.02 mos ± 8.66 mos, 38 F) recruited from College Park, MD and Amherst, MA communities.

Study Design



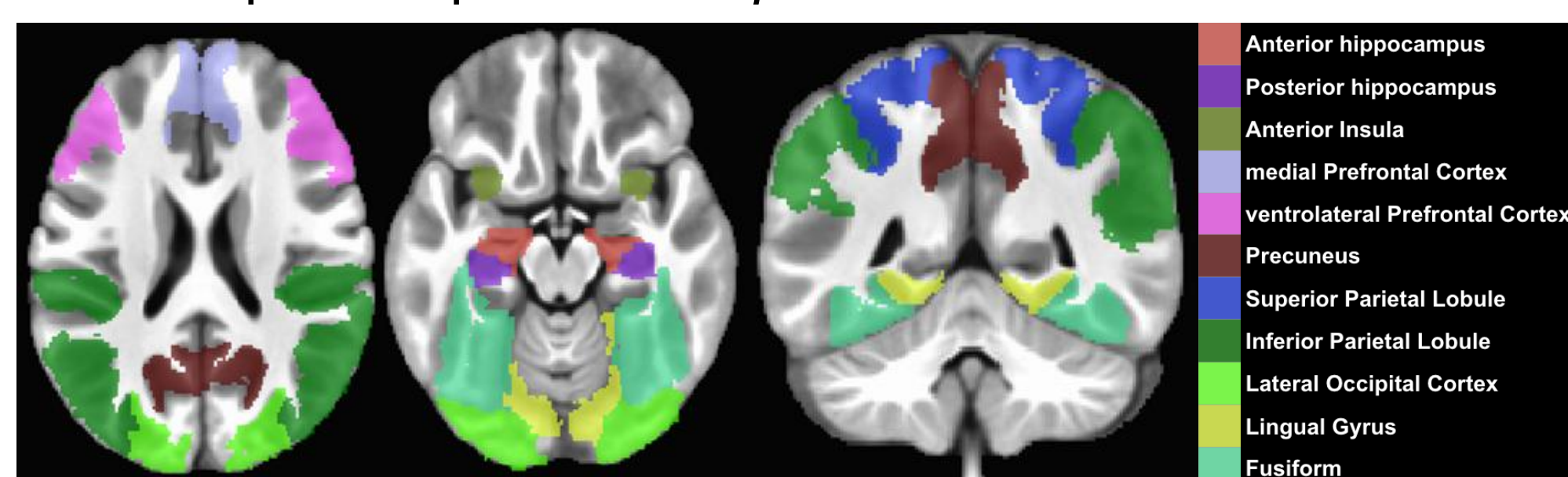
- Participants watched the Pixar short, *Partly Cloudy*, and the short film *Pip*, while undergoing a 10-minute functional MRI.
- Following the scan, participants answered 40 episodic memory questions about the movie – 21 “auditory” questions that probed recollection of specific details (e.g., “What does the alligator bite off Gus?”) and 19 “visual” questions probing recognition of movie-specific scenes (e.g., “Which baby animal bites Peck?”).

fMRI Data

- Functional scan acquired during passive viewing of *Partly Cloudy* and *Pip* was time-locked to start of scan.
- fMRI scan parameters: 666 EPI volumes, voxel size=2.4mm³ isotropic, 60 axial slices, TR/TE=900/35 ms.
- All functional imaging data were analyzed using AFNI.

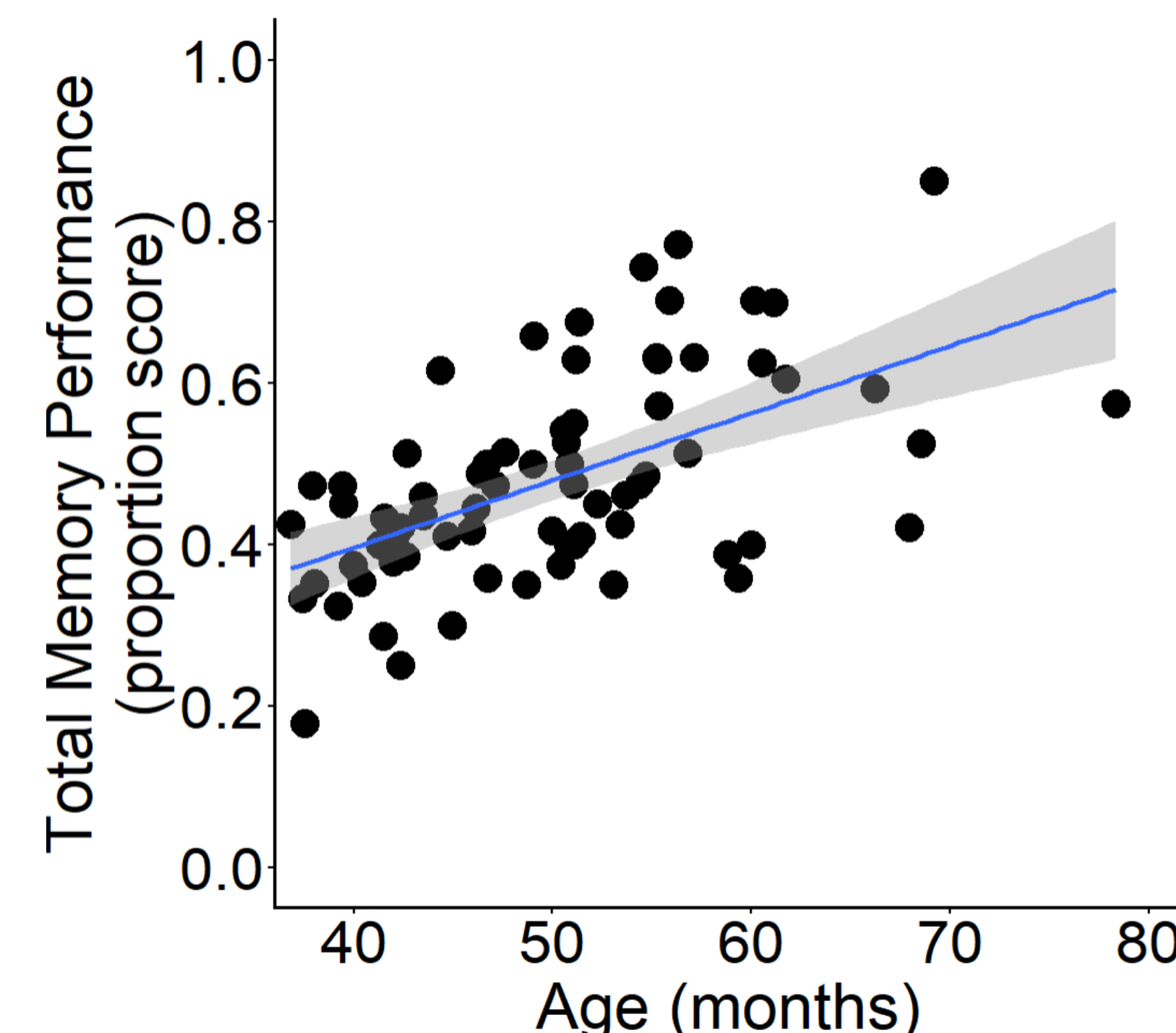
Statistical Analyses

- Each memory-question onset was classified according to the participant's later **correct (subsequent remembered) vs. incorrect (subsequent forgotten)** response.
- All events were modeled with a fixed 6-second duration, producing correct and incorrect beta estimates for each participant.
- ROI analysis:
 - Cortical and medial temporal ROIs, shown below, were selected *a priori* based on their role in memory encoding⁷.
 - AFNI's paired 3dttest++ was used to test correct vs. incorrect within each ROI. Age and sex were included as covariates.
 - A voxelwise threshold of $p < 0.001$ with a cluster size correction for multiple comparisons at $p < 0.05$ was used.

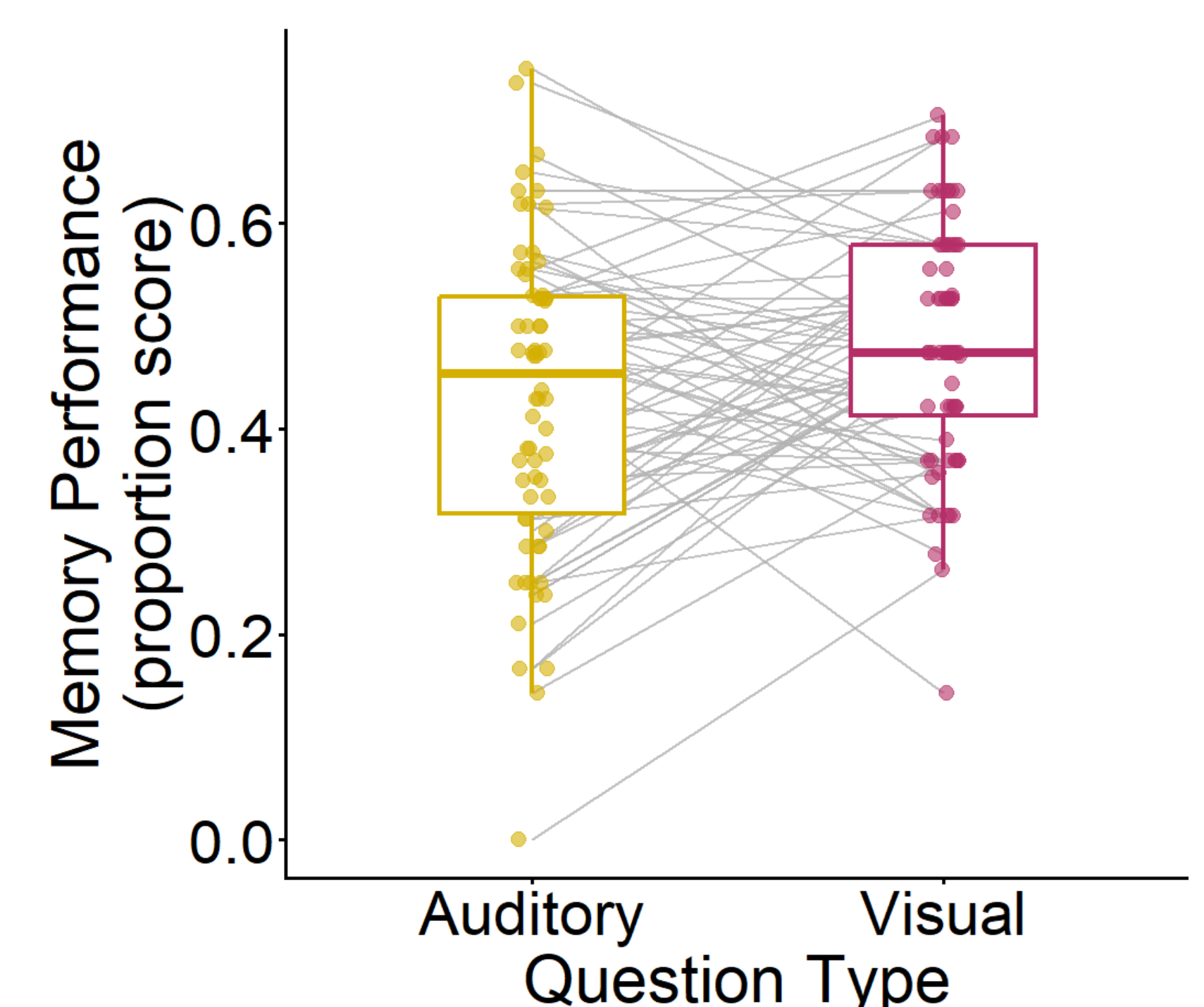


Results

Behavioral Results



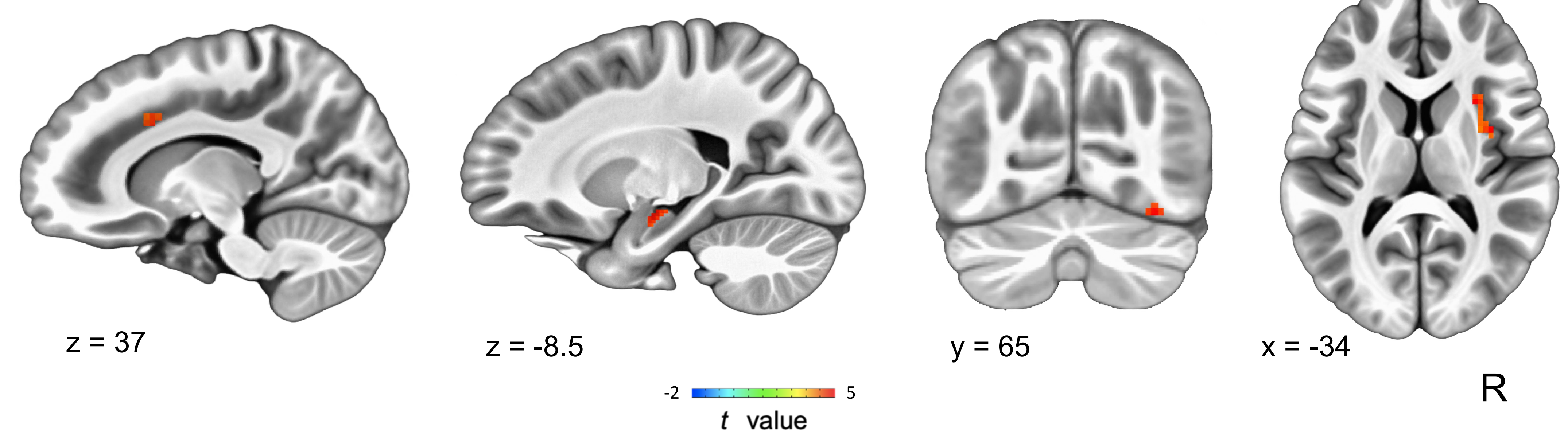
- Age was associated with total memory performance ($\beta = 0.008$, $p < .001$)



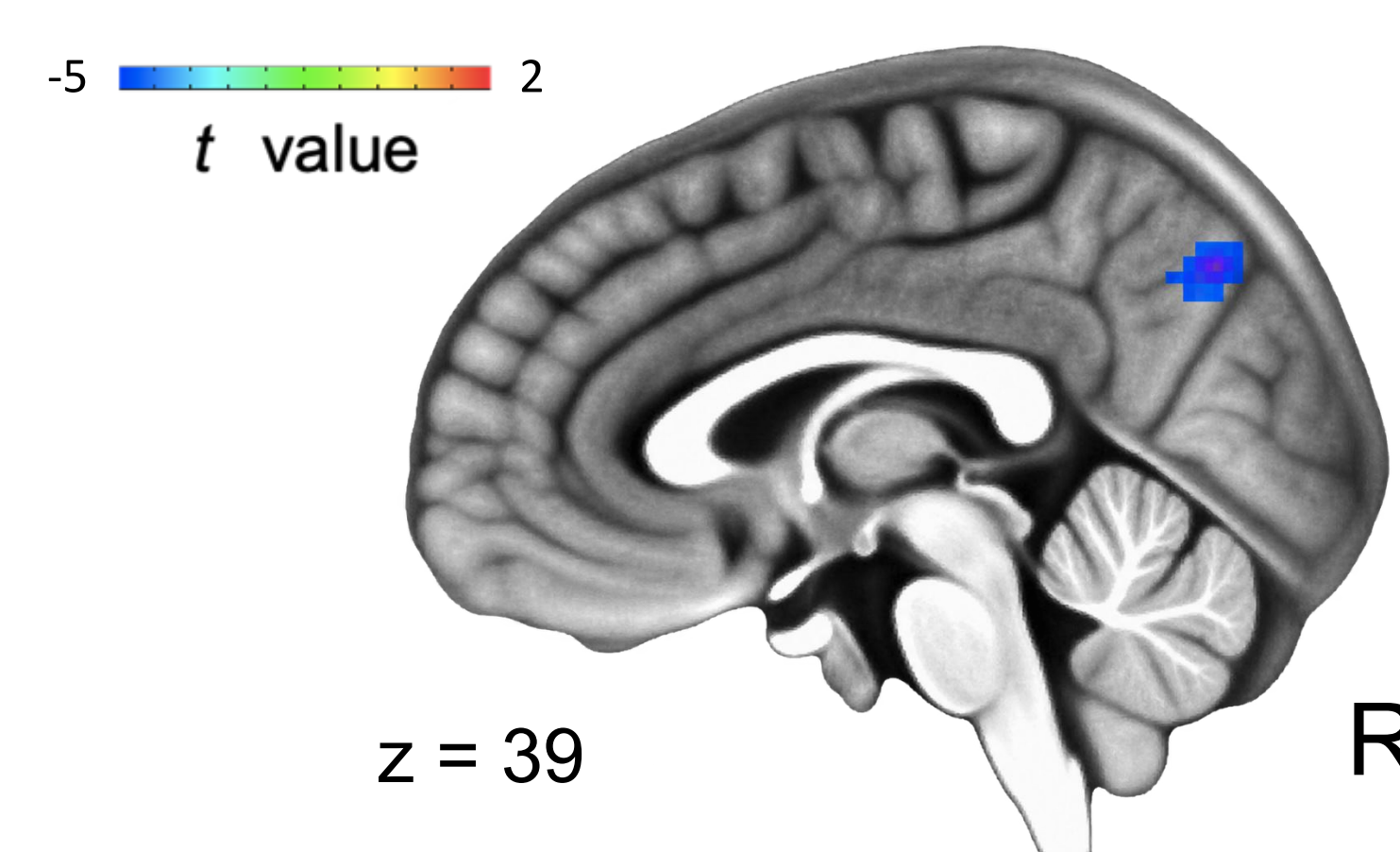
- A paired sample t-test revealed no significant difference in performance on auditory and visual questions ($p > .05$)

fMRI Results

- *Greater* activation was found for the Subsequent Remembered > Subsequent Forgotten contrast in the R mPFC, R anterior hippocampus, R fusiform and the R anterior insula.



- Additionally, *greater* activation was also found in the R posterior hippocampus, L anterior insula, L/R IPL, L lingual gyrus, and R vIPFC.



- *Lower* activation was found for the Subsequent Remembered > Subsequent Forgotten contrast in the L and R precuneus and the L SPL.

Take-Home Message

Successful naturalistic encoding in children is associated with *greater activation* in frontal, temporal, and occipital regions and *lower activation* in a functional core of the DMN in the parietal lobe

References

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Acknowledgments

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Future Directions

- Data collection is ongoing with the goal of increasing the current sample and to extend analyses to longitudinal investigations of the co-development of hippocampal function and episodic memory
- Assess potential differences in brain regions recruited for successful free recall vs. prompted recall
- Assess differences in activation for “visual” vs. “auditory” performers and high performers vs. low performers
- Explore functional connectivity among these memory-related ROIs