The role of autobiographical memory processes in planning and problem solving

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Background and Objectives

- Future-oriented cognitive tasks that involve thinking about hypothetical scenarios recruit similar neural regions to autobiographical remembering (AM) retrieval [1,2]
- Like AM, future-oriented cognitive tasks requires both accessing and constructing mental scenarios in response to a cue [1], but future-oriented cognitive tasks can take on different forms:
  - **Planning** require constructing a hypothetical mental event based on established scripts or schemas
  - **Problem solving** require constructing a hypothetical mental event that is specific to a given cue (problem scenario)
- **The main objective of the current study was to examine how these two forms of future-oriented tasks overlap with AM retrieval.**
- AM retrieval, planning and problem solving require distinct phases of processing. These are **accessing** potential mental events (memories, plans, solutions) and **simulating** one mental event in detail [3].
- **A second objective of the current study was to test whether the overlap between memory and future-oriented tasks shifts as a function of these different phases of processing.**
- These objectives were met with an fMRI study in young healthy adults.

Materials and Methods

Participants: 25 healthy young adults (10 male; mean age = 20.4 ± 0.45 years)

Stimuli: : 24 Memory, 12 Planning and 12 Problem Solving scenario cues

- **Memory** cues reflected categories of experienced events; *"Times you were celebrating"*
- **Planning** cues* reflected well-defined scenarios that require scripted actions; *"You want to learn a new instrument"*
- **Problem solving*** cues are open-ended scenarios with no single prescribed solution; "Your *friend is angry with you and you don't know why"*

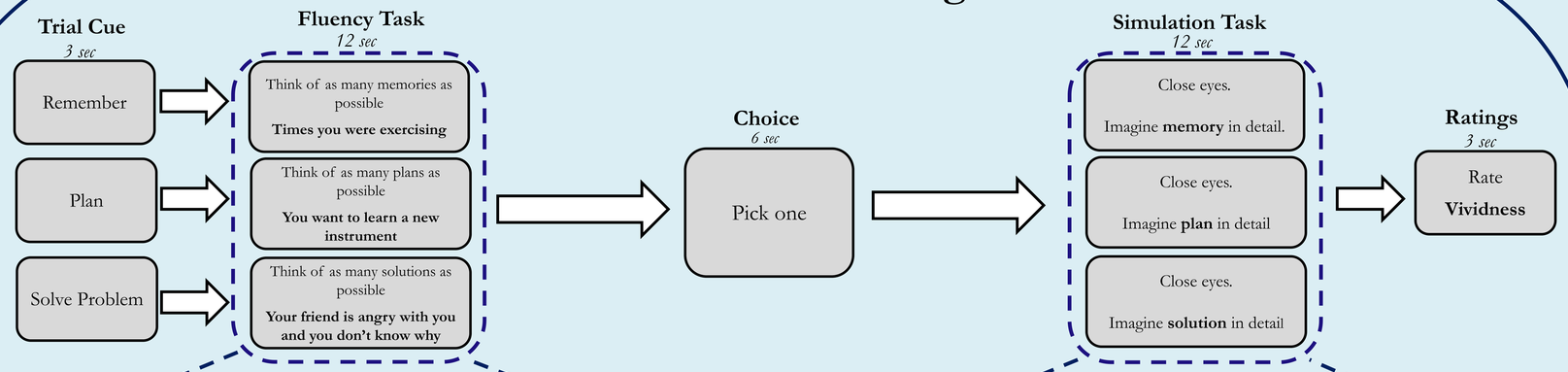
Procedure: In a 3T MRI scanner, participants were presented with cue stimuli randomized across 6 functional runs. To each cue, participants performed a fluency and a simulation task, corresponding to the access and simulation phases of processing, respectively.

Analysis: After pre-processing, Mean-Centered partial least squares (PLS) analysis [4] was used to determine similarities and differences in neural activity across the trial types separately for each task.

- Reliable latent variables (LV) that reflect neural patterns that dissociate between trial types are determined by permutation tests.
- For each reliable LV, brains scores reflect the degree each trial type was reflected in associated neural patterns. Results presented at p<.005 (bootstrap ratio score +/- 2.8) with cluster size > 15 voxels.

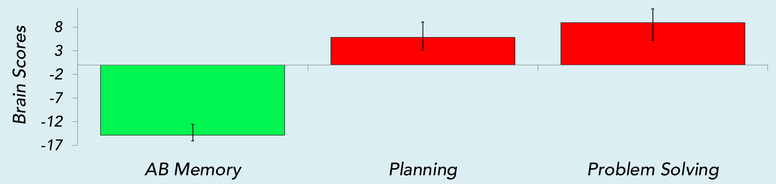
**Cue categorization was confirmed via an online behavioral experiment.*

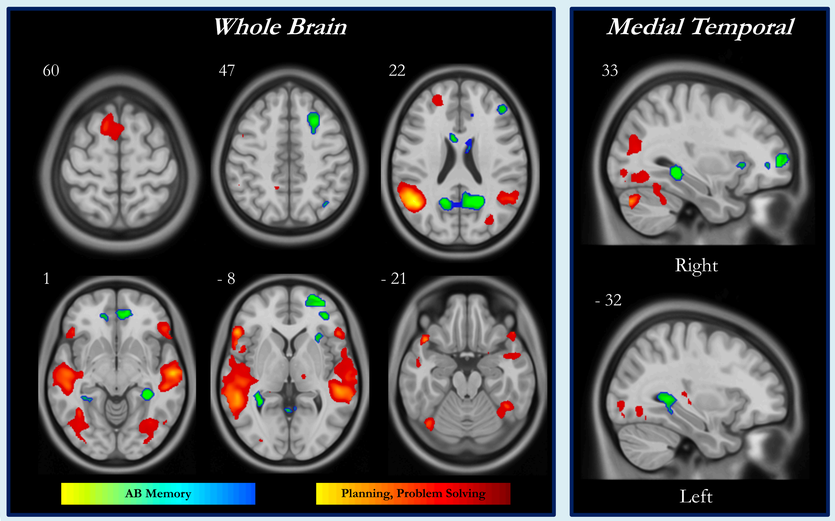
In-Scanner Trial Design



ACCESS

Mean-Centered PLS: LV1 (p < .0001, 73.54% cross-block variance)

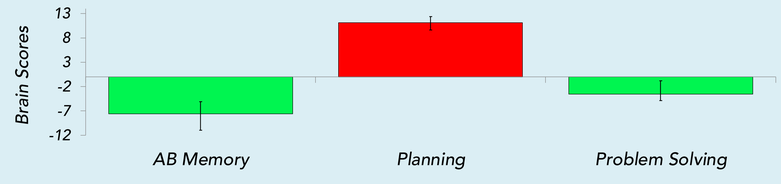


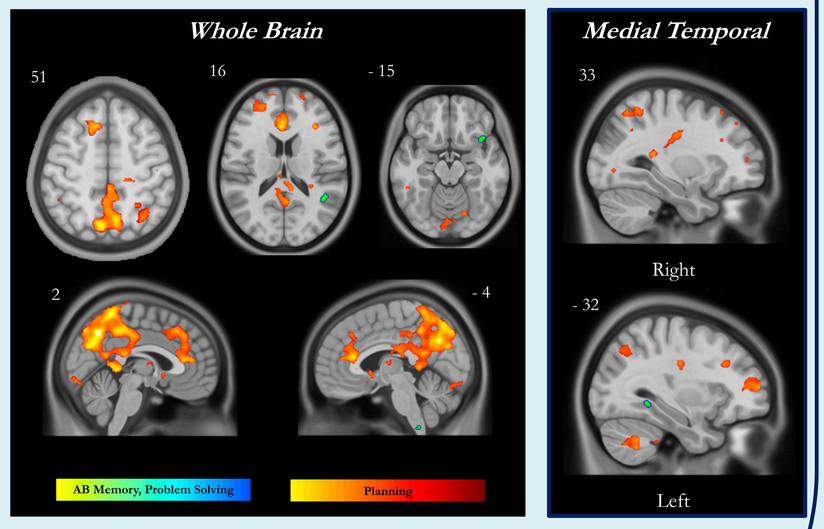


- Significant neural overlap between planning and problem solving distinct from autobiographical memory when fluently accessing memories/outcomes
- The neural overlap between the **planning** and **problem solving trials** includes lateral temporal lobes, superior and inferior and medial frontal gyrus, precuneus, cuneus, caudate and thalamus.
- Regions preferentially recruited during **autobiographical memory trials** include PCC, ACC, superior and middle frontal gyri, inferior parietal lobule, precuneus and bilateral hippocampi

SIMULATION

Mean-Centered PLS: LV1 (p < .0001, 76.38% cross-block variance)





- Significant neural overlap between autobiographical memory and problem solving that is distinct from planning when simulating one scenario in detail.
- Overlap during **autobiographical memory** and **problem solving trials** includes right inferior frontal gyrus, right middle temporal lobe, and left parahippocampus.
- Regions preferentially recruited during **planning trials** include bilateral medial PFC, PCC, precuneus, right inferior parietal lobule and left superior frontal gyri.

Discussion and Conclusion

- The dissociation between autobiographical memory and the future-oriented cognitive tasks during the fluency phase suggests disparate mechanisms are needed to access stored memories versus consider potential outcomes
  - AM access recruiting regions typically assigned to memory retrieval and future-oriented cognition with regions involved in schematic and executive processing
- The overlap between autobiographical memory and the problem solving but not planning task during the simulation phase suggests disparate neural demands when elaborating on mental scenarios
  - Planning recruits frontal-parietal and default mode network regions. Whereas AM and problems solving overlap in regions implicated in contextual processing.
- Together, these data suggest distinctions in how neural mechanisms traditionally assigned to remembering past personal experiences aid goal-directed prospective thinking.

[1] Schacter, D. L., & Addis, D. R. (2007). Phill Trans of the Royal Society B, 362(1481), 773-786. [2] Sheldon, S., Fenerci, C., & Gurguryan, L. (2019). Front. Syst. Neurosci, https://doi.org/10.3389/fnsys.2019.00004; [3] McCormick, C., et al. (2013). Cerebral cortex, 25(5), 1297-1305; [4] McIntosh, A. R., Bookstein, F. L., Haxby, J. V, & Grady, C. L. (1996). NeuroImage, 3(3), 143–157