Representation of temporal memory retrieval in the human precuneus

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Introduction

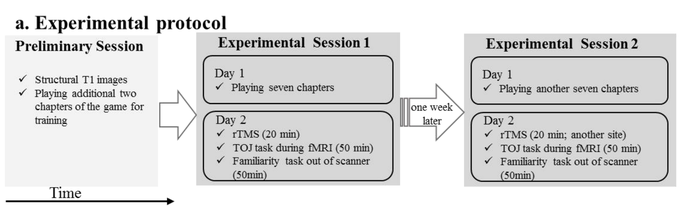
- Shared neural ensembles link distinct memories encoded close in time[1], thus events encoded within close temporal distance (TD) are more likely to be co-recalled than events encoded across more distant TD: here we identified the multivoxel response pattern reflecting this effect in human parietal cortex.
- This pattern is further influenced by whether two events happened under a similar context or not[2,3].
- Precuneus is instrumental for retrieval of temporal order[4]: we examined the causality of precuneus-inhibition on this process.

Materials & Methods

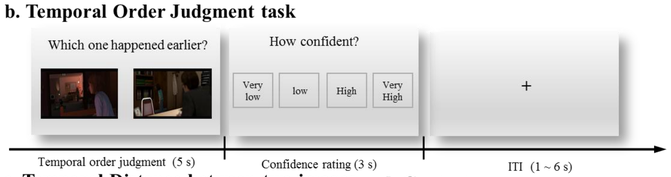
- 20 participants took part in an interactive video game containing seven distinct yet related chapters on day 1, and 24 hours later, completed 240 trials of temporal order judgment (TOJ) during fMRI.
- Three within-subjects factors regarding TOJ task were manipulated:

1. **T**emporal **D**istance between two images (60 TDs, power function distributed, permitting scale-invariance across subjects)
2. **Context** (whether two images extracted from same chapters or adjacent chapters: Within-chapter vs. Across-chapter)
3. **TMS** session before performing TOJ task (rTMS stimulated precuneus as target region or stimulated vertex as control: TMS-vertex vs. TMS-precuneus MNI: x= 6, y= -70, z= 44, 1 Hz for 20 min)

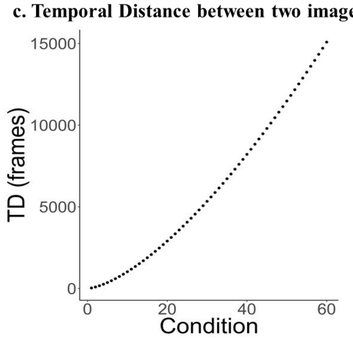
a. Experimental protocol



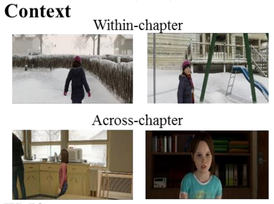
b. Temporal Order Judgment task



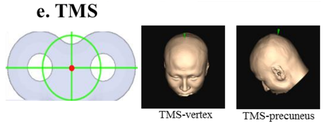
c. Temporal Distance between two images



d. Context



e. TMS

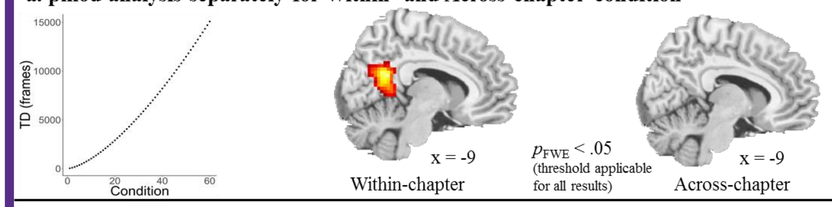


Goals

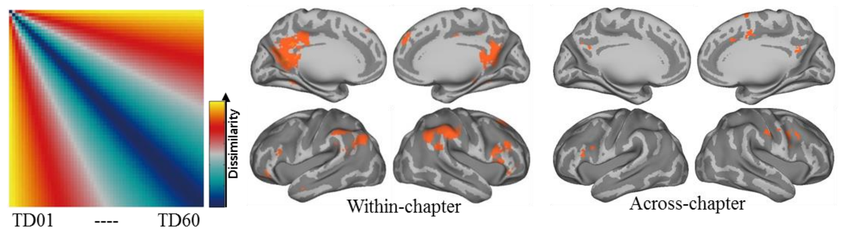
- To test whether predictions generated by "memory allocation hypothesis"[1] might be held valid during retrieval stage.
- To reveal how memory of TD between two events at encoding is held at retrieval using multivoxel representational similarity analysis (RSA)[5].
- To test whether the neural similarity pattern of TDs is dependent on the normal functioning of the precuneus.

Result 1: Representation of TD is highly context-dependent in the TMS-vertex session

a. pmod analysis separately for Within- and Across-chapter condition

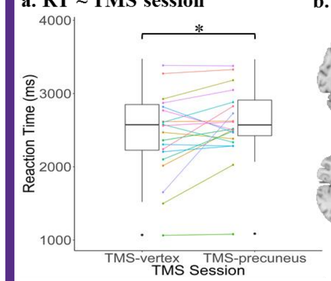


b. RSA searchlight with TD RDM separately for Within- and Across-chapter condition

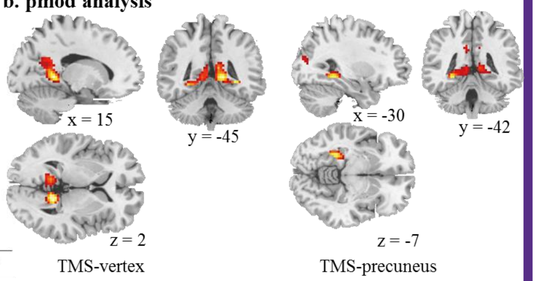


Result 2: Representation of TD & Context disappeared after stimulating precuneus

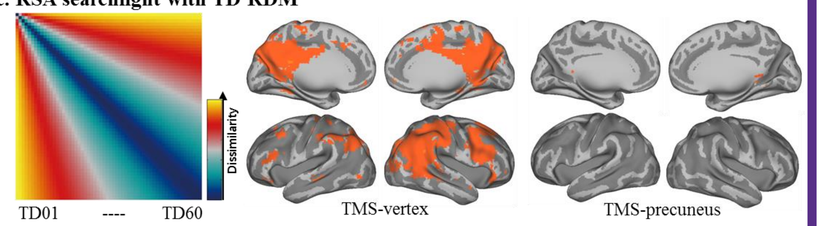
a. RT ~ TMS session



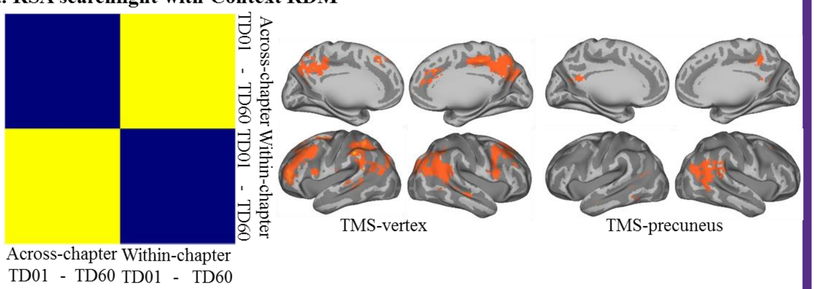
b. pmod analysis



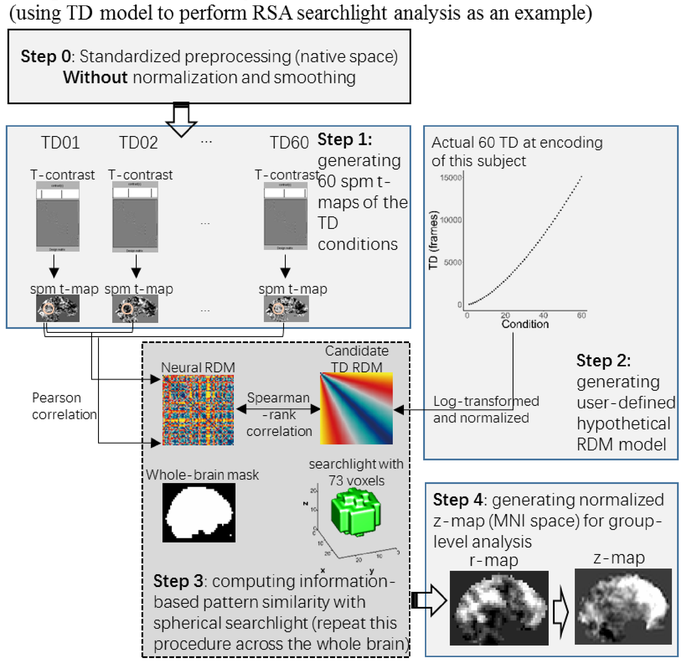
c. RSA searchlight with TD RDM



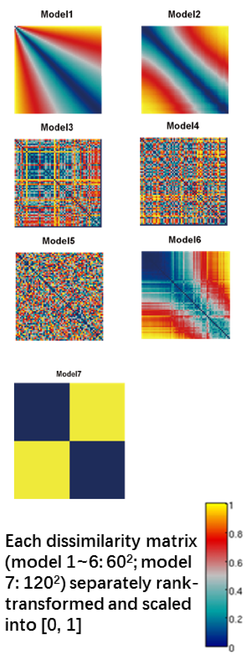
d. RSA searchlight with Context RDM



f. Pipeline of RSA analysis with one subject's fMRI data
(using TD model to perform RSA searchlight analysis as an example)



g. Candidate RDMs



Each dissimilarity matrix (model 1~6: 60^2; model 7: 120^2) separately rank-transformed and scaled into [0, 1]

Discussion & Next step

- Discovery of mnemonic representation of TD in the parietal cortex.
- To investigate how representation of objective TD would be influenced by *subjective* TD (internal world); and how such neural patterns would be dynamically changed as time passes.

References & Funding

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