FMRI correlates of spoken autobiographical memory retrieval associated with spatial, temporal, and self-referential processing

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Introduction

- Autobiographical memory (AM) retrieval is a complex process that recruits dynamically changing networks of brain regions.[1-5]
- Prior studies primarily focused on neural activation that persists throughout memory retrieval, or that occurs throughout an earlier "search" phase compared to a later "elaboration" phase.
- This study uses narrated memories retrieved during scanning to examine the neural correlates of memory content.
- We examine the brain areas positively correlated with the amount of spoken memory content retrieved.
- Additionally, we examine the neural correlates of 4 different categories of memory content assessed by coding "words" produced during narrated AM into:
  - **Spatial-Relationship:** Words reflecting relationships between items in space
    - Examples: above, under, between, "three feet long", "over there"
  - **Time-Referential:** Words reflecting durations or perceived time of an event
    - Examples: "2 hour", "forever", "going slowly", "That afternoon"
  - **Self-Referential:** Words referring to the individual alone
    - Examples: "Me", "I"
  - **Other Person-Referential:** Words referencing anyone other than oneself
    - Example: He, She, They, Jack, Tina, My Boss, Grandma

Aims

- Identify brain regions that activate more when people retrieve memories with a larger amount of content.
- Examine whether retrieval of four different types of AM content selectively activate corresponding brain areas which support processing of these categories in related contexts.

Hypotheses

- A subset of brain regions supporting AM retrieval will demonstrate a parametric relationship to the amount of content retrieved.
- Retrieval of **Spatial-Relationship, Time-Referential**, **Self-Referential**, and **Other Person-Referential** AMs will selectively activate corresponding brain areas that support processing of these content categories in related contexts.

Method

- Realignment, unified segment normalization, smooth= 6 mm
- 18 participants: 9 female, Mage=27

Data Analysis

- Realignment, unified segment normalization, smooth= 6 mm
- ICA-AROMA to remove movement artifacts
- Mean motion by run and Max scan-to-scan motion for all participants < 1.5mm
- 12.5% of runs had over 2mm total cumulative movement
- All results corrected for multiple comparisons, $p < .05$ (FWE)
  - SNPM non-parametric cluster thresholding (5k permutations)

Cue word AM retrieval

- 24 novel cue words (24-36 sec total) (3s ITI)
- 2 overt AM retrieval runs
- Unrehearsed Autobiographical Memory retrieval
  - Low-level baseline arrow detection (7 sec)
  - Cue word presentation, button press when memory "firmly in mind"
  - Narrated autobiographical memory retrieval (12-18s)
- Rated Valence and Reliving of memory (Low 1- 4 High)

Transcription

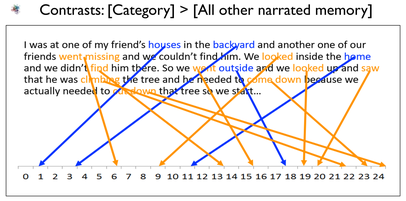
- Memories transcribed by 3 raters

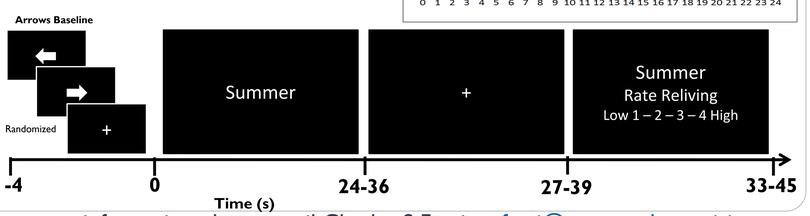
Amount of Content Analysis

- Parametric modulator: # of words per second during memory narration, normalized by run
- Contrast: [PMod Memory] > [Arrows + Fixation + Ratings]

Content Analysis

- Words in memories coded by 3 raters based on operational definitions
- **Spatial-Relationship, Time-Referential, Self-Referential, and Other Person-Referential** words
- Contrasts: [Category] > [All other narrated memory]





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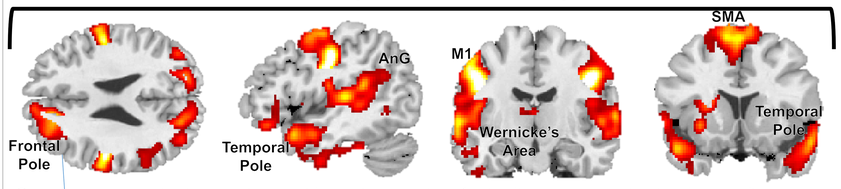
Results

Overall Memory

Narrated Memory > Non-Memory Baseline



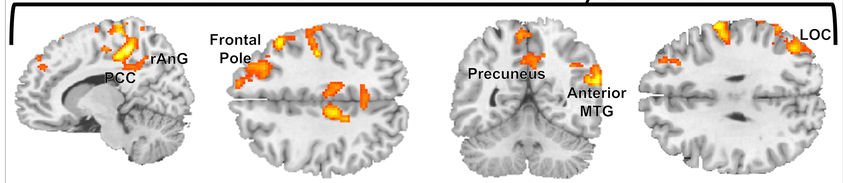
Overall memory activation consistent with previous studies of episodic memory retrieval and speech/language.

Memory	Speech / Language
• Frontal Pole	• Planum Temporale (Wernicke's Area)
• Inferior Frontal Gyrus	• Superior Temporal Gyrus (Primary Auditory)
• Left Angular Gyrus	• Heschl's Gyrus
• Ant Middle Temporal Gyrus	• Precentral Gyrus (Motor Strip)
• Precuneus	• Postcentral Gyrus (Somatosensory)
• Lateral Occipital Cortex	• Supplementary Motor Area

All whole brain results are corrected for multiple comparisons $p < .05$ FWE SNPM

Amount of Content

Amount of Content > Non-Memory Baseline



Subset of regions active during memory retrieval are more active during memories with more retrieved content.

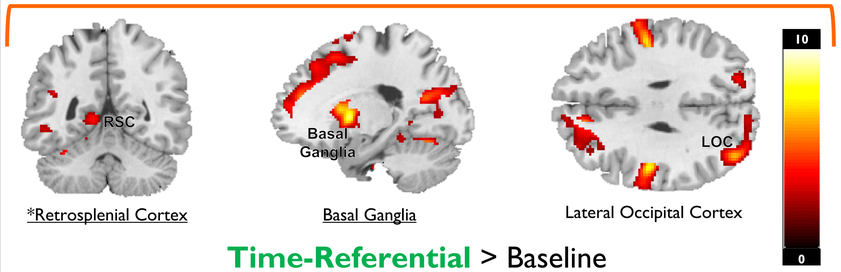
Memory	Speech / Language
• Frontal Pole	• Planum Temporale (Wernicke's Area)
• Right Angular Gyrus	• Superior Temporal Gyrus (Primary Auditory)
• Ant Middle Temporal Gyrus	• Heschl's Gyrus
• Superior Parietal Lobule	• Precentral Gyrus (Motor Strip)
• Precuneus	• Postcentral Gyrus (Somatosensory)
• Lateral Occipital Cortex	
• Posterior Cingulate Cortex	

All whole brain results are corrected for multiple comparisons $p < .05$ FWE SNPM

Content Analysis

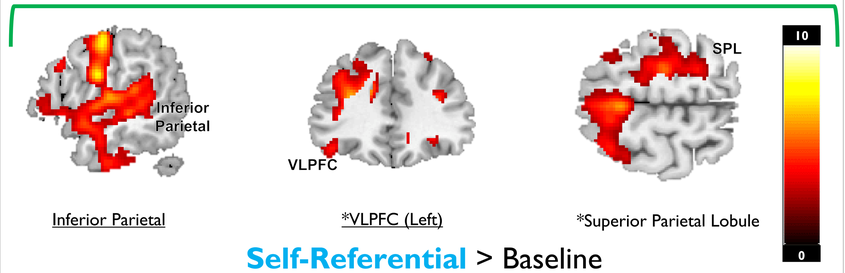
• Hypothesized activation • *Unique activation (only present in this condition)

Spatial-Relationships > Baseline



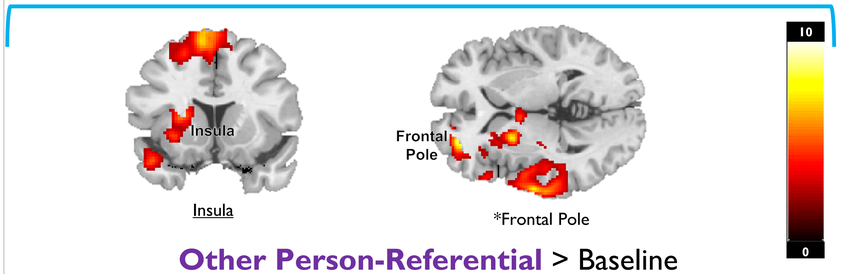
*Retrosplenial Cortex | Basal Ganglia | Lateral Occipital Cortex

Time-Referential > Baseline



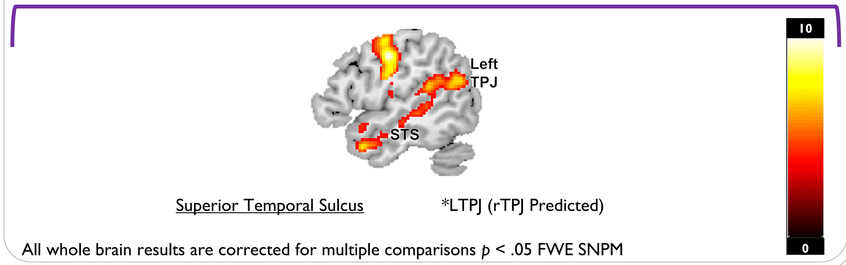
Inferior Parietal | *VLPFC (Left) | *Superior Parietal Lobule

Self-Referential > Baseline



Insula | *Frontal Pole

Other Person-Referential > Baseline



Superior Temporal Sulcus | *LTPJ (rTPJ Predicted)

All whole brain results are corrected for multiple comparisons $p < .05$ FWE SNPM

Conclusions

- Main effect of memory activated regions which support AM retrieval.
- Memory and speech production/language processing regions were observed to vary parametrically with the amount of memory content which was retrieved.
- **Spatial-Relationship** content activated the retrosplenial cortex, lateral occipital cortex, and basal ganglia
- **Time-Referential** content activated inferior parietal cortex, ventrolateral PFC, the superior parietal lobule (as well as broad areas of the right PFC)
- **Self-Referential** content activated the Insula and frontal pole, but not the medial PFC as predicted.
- **Other Person-Referential** content activated the superior temporal sulcus, and the left temporoparietal junction (but not the right as predicted).
- Real time narration of memory content is both feasible and offers a rich opportunity to examine the content of memories.

References

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