



# 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.<sup>1-5</sup>
- 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
- 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 based thresholding (5000 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

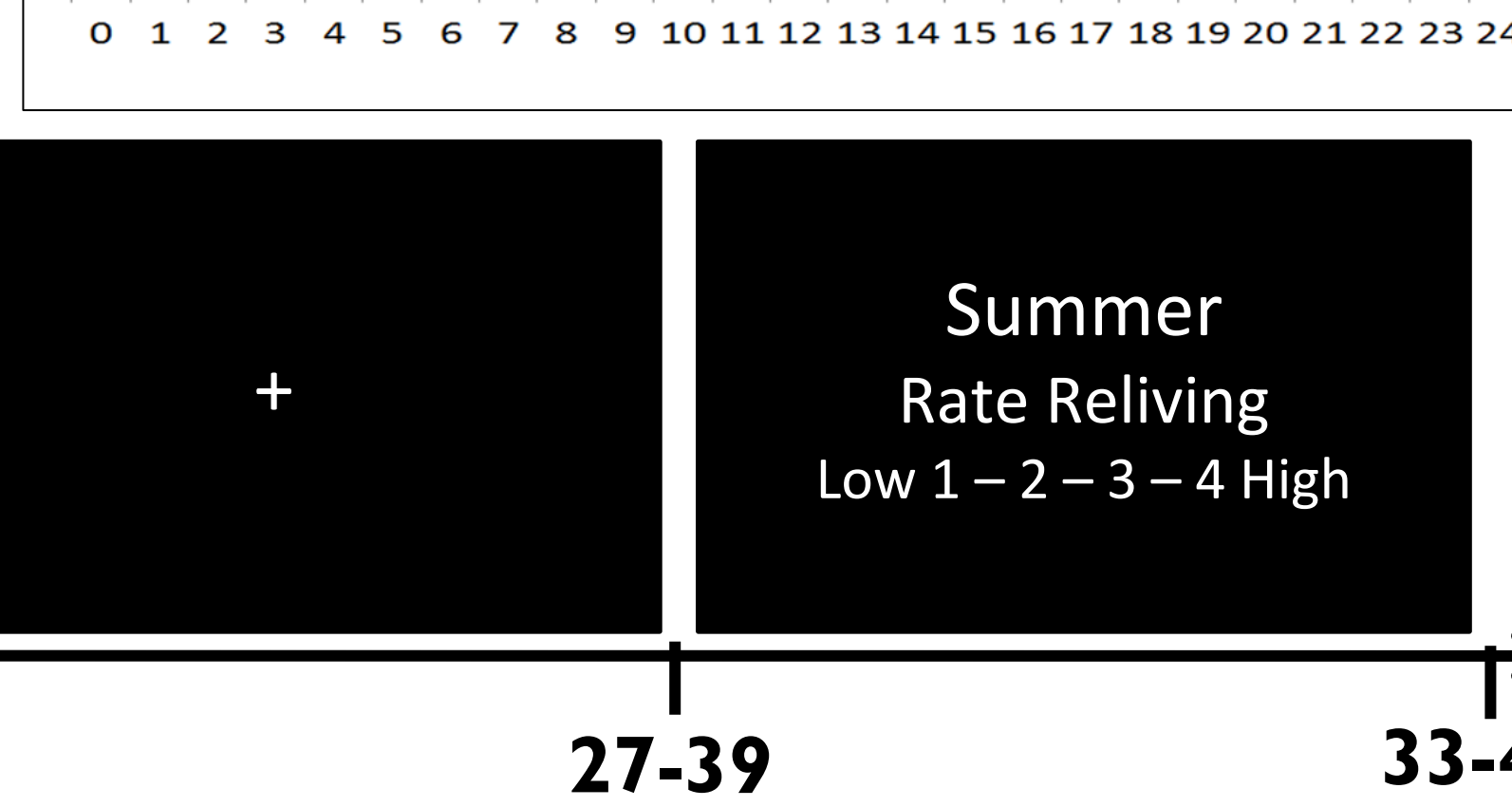
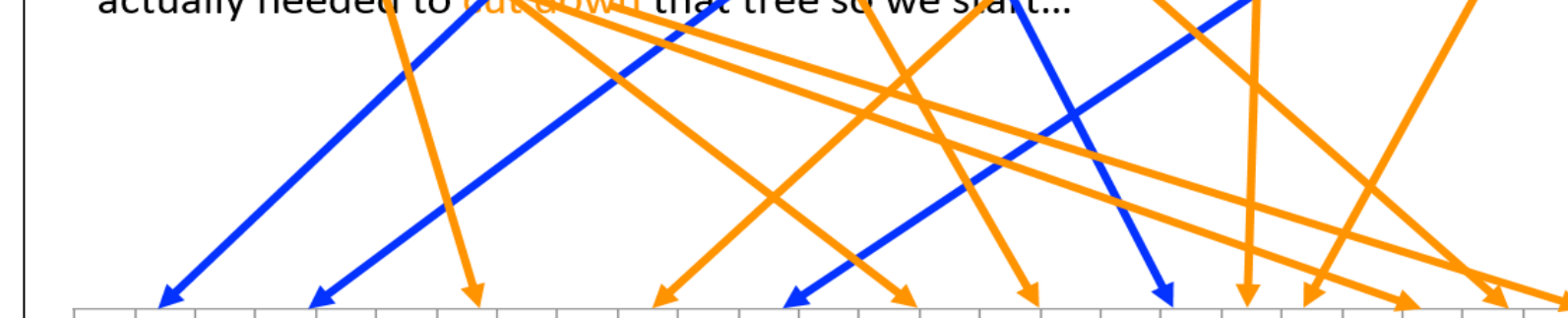
### Amount of Content Analysis

- 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]

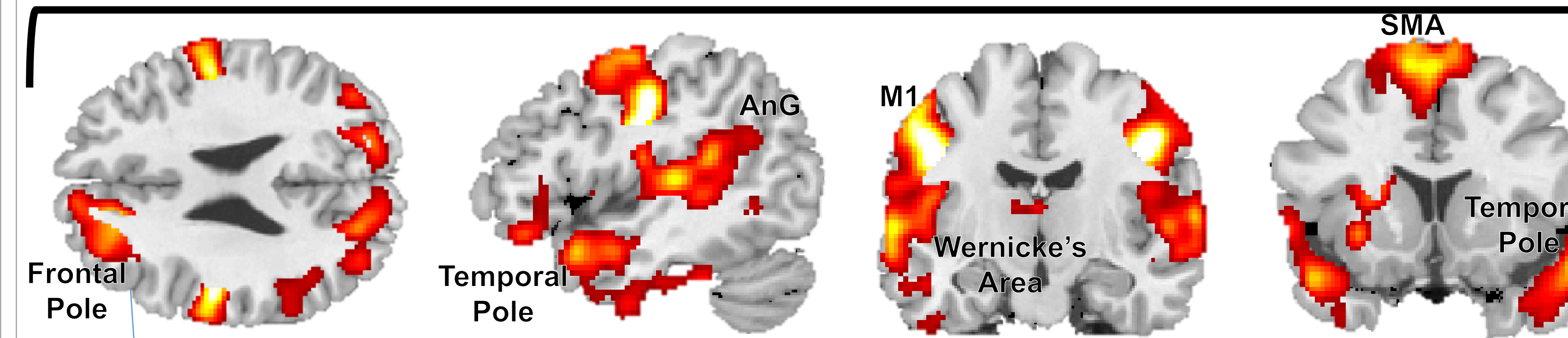
I was at one of my friend's houses in the backyard and another one of our friends went missing and we couldn't find him. We looked inside the home and we didn't find him there. So we went outside and we looked up and that he was climbing the tree and he jumped by falling down because we actually needed to know that tree so we start...



## Results

### Overall Memory

#### Narrated Memory > Non-Memory Baseline



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

#### Memory

- Frontal Pole
- Inferior Frontal Gyrus
- Left Angular Gyrus
- Ant Middle Temporal Gyrus
- Precuneus
- Lateral Occipital Cortex

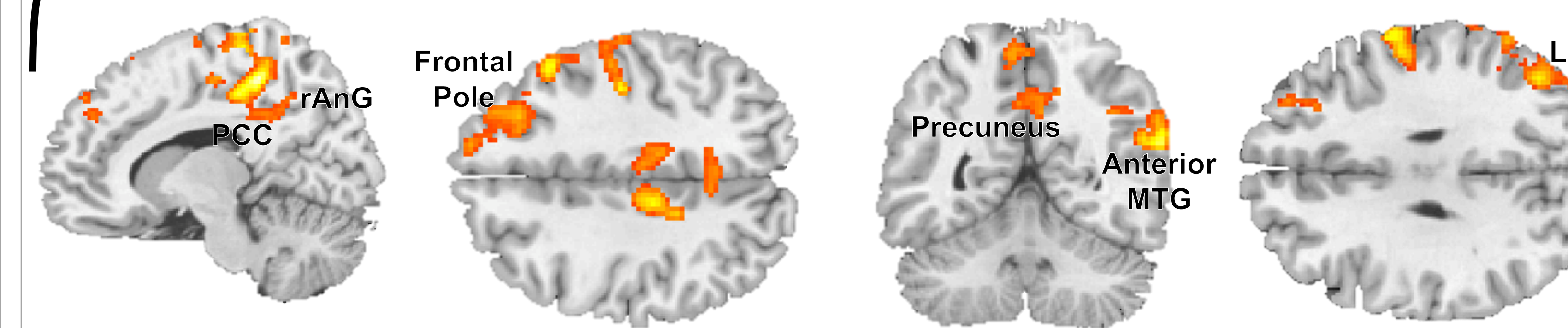
#### Speech / Language

- Planum Temporale (Wernicke's Area)
- Superior Temporal Gyrus (Primary Auditory)
- Heschl's Gyrus
- Precentral Gyrus (Motor Strip)
- Postcentral Gyrus (Somatosensory)
- 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

- Frontal Pole
- Right Angular Gyrus
- Ant Middle Temporal Gyrus
- Superior Parietal Lobule
- Precuneus
- Lateral Occipital Cortex
- Posterior Cingulate Cortex

#### Speech / Language

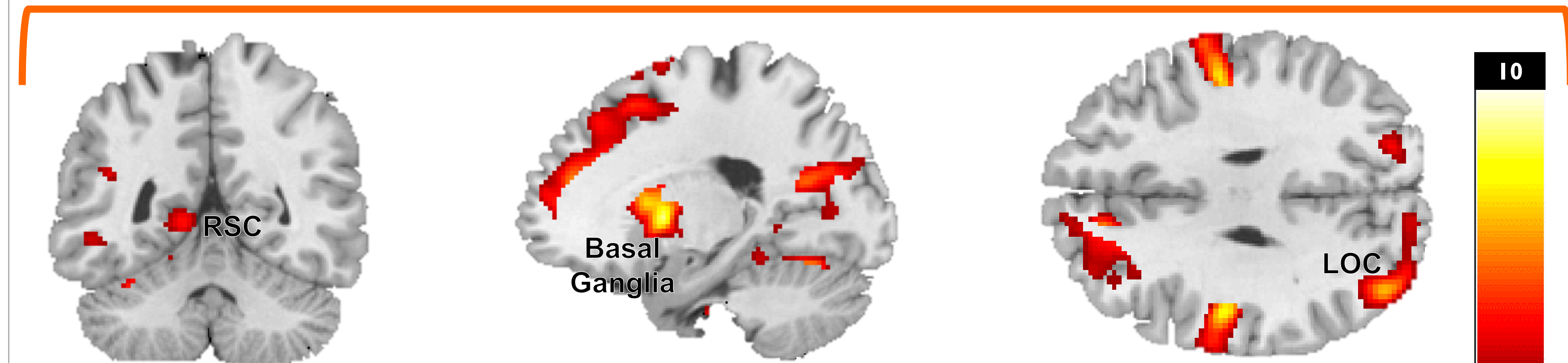
- Planum Temporale (Wernicke's Area)
- Superior Temporal Gyrus (Primary Auditory)
- Heschl's Gyrus
- Precentral Gyrus (Motor Strip)
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### Content Analysis

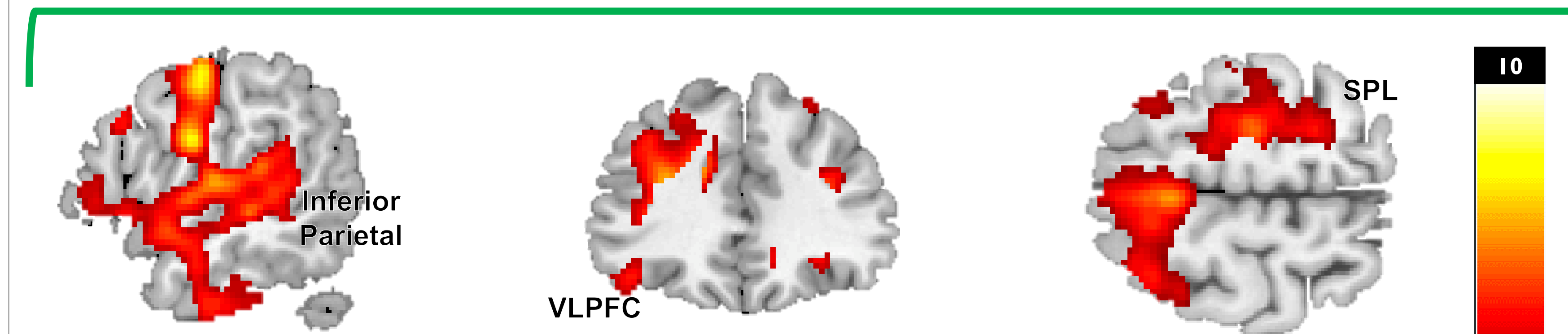
- Hypothesized activation
- \*Unique activation (only present in this condition)

#### Spatial-Relationships > Baseline



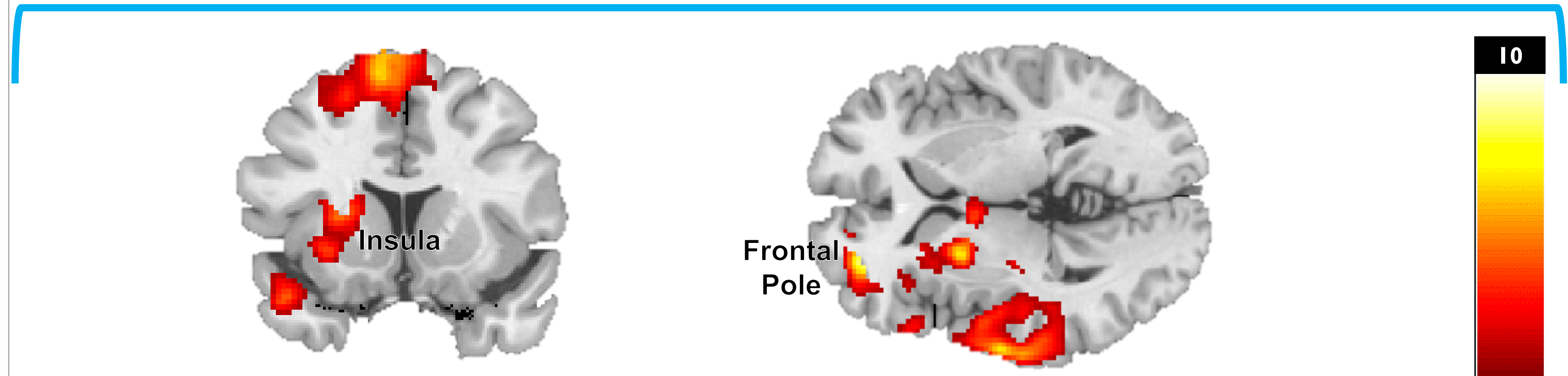
\*Retrosplenial Cortex, Basal Ganglia, Lateral Occipital Cortex

#### Time-Referential > Baseline



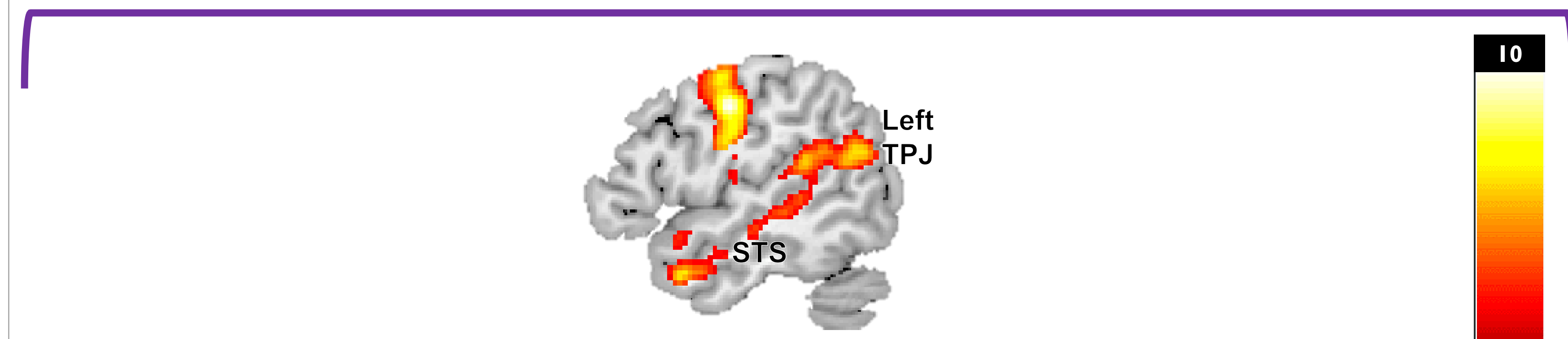
Inferior Parietal, \*VLPFC (Left), \*Superior Parietal Lobule

#### 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

- <sup>1</sup>Cabeza, R., & St Jacques, P. (2007). Functional neuroimaging of autobiographical memory. *Trends in Cognitive Sciences*, 11(5), 219-227.  
<sup>2</sup>Svoboda, E., McKinnon, M., & Levine, B. (2006). The functional neuroanatomy of autobiographical memory: a meta-analysis. *Neuropsychologia*, 44, 2189-2208.  
<sup>3</sup>Daselaar, S. M. et al. (2008). The spatiotemporal dynamics of autobiographical memory: ... *Cerebral Cortex*, 18(1), 217-229.  
<sup>4</sup>St. Jacques, P., Kragel, P., & Rubin, D. (2011). Dynamic neural networks supporting memory retrieval. *NeuroImage*, (57), 608-616.