



Neural Correlates of Emotional Episodic Memory Encoding and Retrieval: Neuroimaging Meta-analyses using Seed-based *d* Mapping

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Introduction

- Emotional episodic memories are typically more accurate, vivid, and persistent than neutral memories¹.
- Neuroimaging meta-analysis methods such as Seed-based *d* Mapping (SDM) and Activation Likelihood Estimation (ALE) summarize brain regions consistently activated across many studies².
- A previous (ALE) meta-analysis of **successful encoding** of emotional episodic memory in 2010 identified the amygdala, hippocampus, and a small set of neocortical regions³.
- Here we revisited **successful encoding** of emotional episodic memory using a substantially **improved SDM method**⁴ and a substantially **larger set of papers**.
- We report for the first time, an **SDM meta-analysis** characterizing activations associated with the **successful retrieval** of emotional memory, and the overlap between encoding and retrieval activations.
- In summary, our goals were to determine the brain regions consistently activated during
 - Successful encoding** of emotional episodic memory
 - Successful retrieval** of emotional episodic memory

Predictions

- Some of the major previous findings would be replicated.
- Novel regions may be detected with additional studies and the use of the SDM meta-analysis method.
- Smaller regions based on fewer studies may not be robust to these changes and may disappear

Methods

Study Identification

- PubMed, Review Articles, Reverse Citation Search, Google Scholar
- Encoding:** (emotion OR emotional OR affective OR arousal OR valence) AND (memory OR recognition) AND (encoding OR encode OR encoded) AND fMRI.
 - (526 results)
- Retrieval:** (emotion OR emotional OR affective OR arousal OR valence) AND (memory OR recognition) AND (retrieve OR retrieval OR retrieved) AND fMRI.
 - (419 results)

Inclusion Criteria

- Event related fMRI
- Emotional (positive or negative) stimuli included any of the following:
 - Pictures, words, or sounds
 - Neutral objects encoded in emotional contexts
- Emotional successful memory contrast
- Recognition or free recall tasks
- Healthy young adult population
- Report voxel-wise whole brain coordinates

Included studies of successful emotional memory encoding:

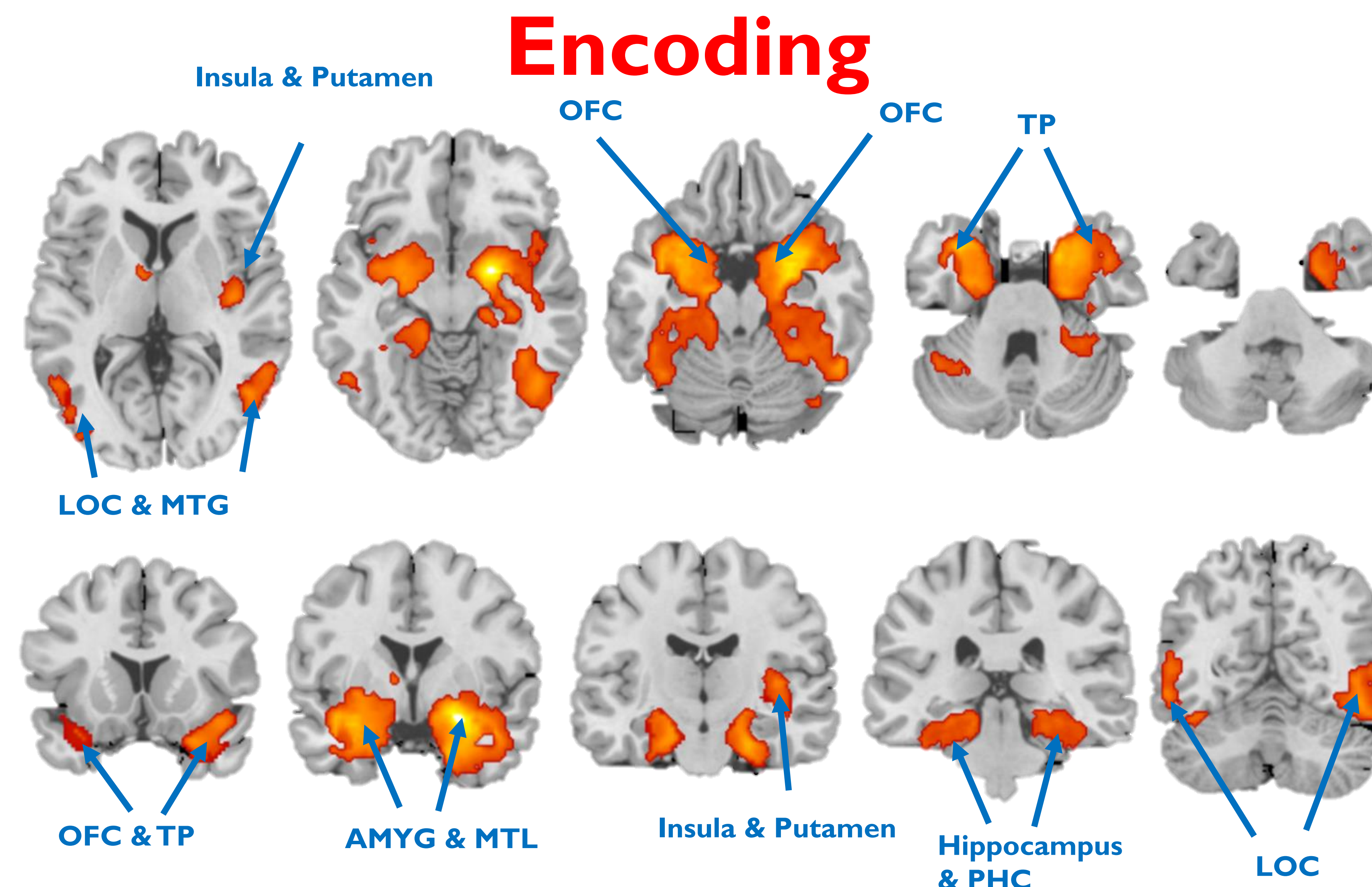
- 25 studies, 285 foci, 516 participants

Included studies of successful emotional memory retrieval:

- 17 studies, 210 foci, 310 participants

Statistical Analysis

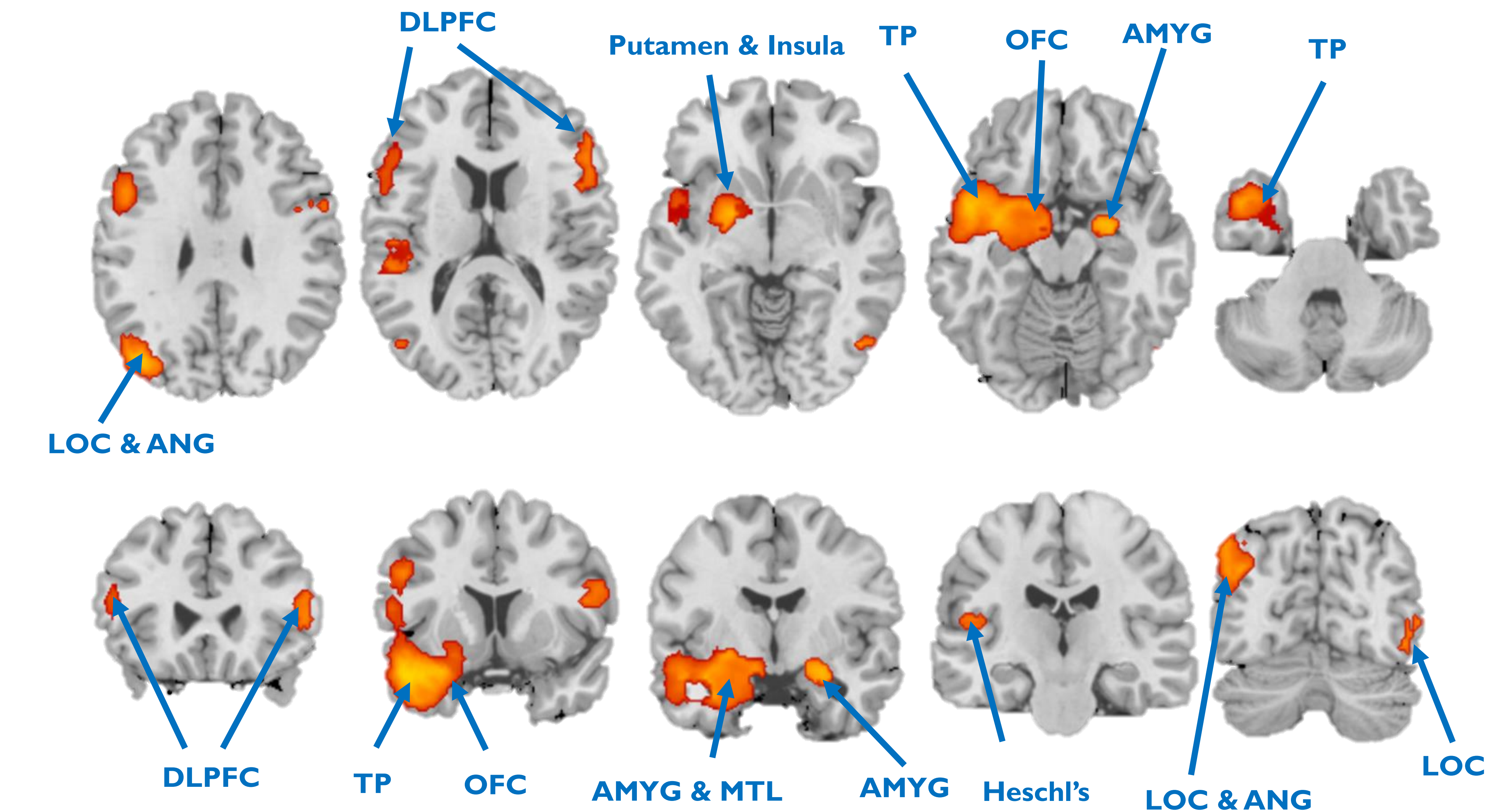
- Seed Based *d* Mapping Permutation of Subject Images⁴ (SDM-PSI) v6.2.1
- Threshold free cluster enhancement family wise error corrected (TFCE-FWE) $p < .05$
- 1000 permutations



Successful **emotional memory encoding** recruits brain regions involved in:

- Episodic memory encoding**⁵: medial temporal lobe (MTL) regions including hippocampus, entorhinal cortex, perirhinal cortex, parahippocampal cortex (PHC)
- Emotion processing**: amygdala⁶ (AMYG), orbitofrontal cortex⁷ (OFC), temporal pole⁸ (TP), putamen⁹, insula¹⁰
- Perceptual processing**: lateral occipital cortex¹¹ (LOC), inferior temporal gyrus¹², middle temporal gyrus¹² (MTG), temporal occipital fusiform cortex¹¹, temporal fusiform cortex¹¹, occipital fusiform gyrus¹¹.

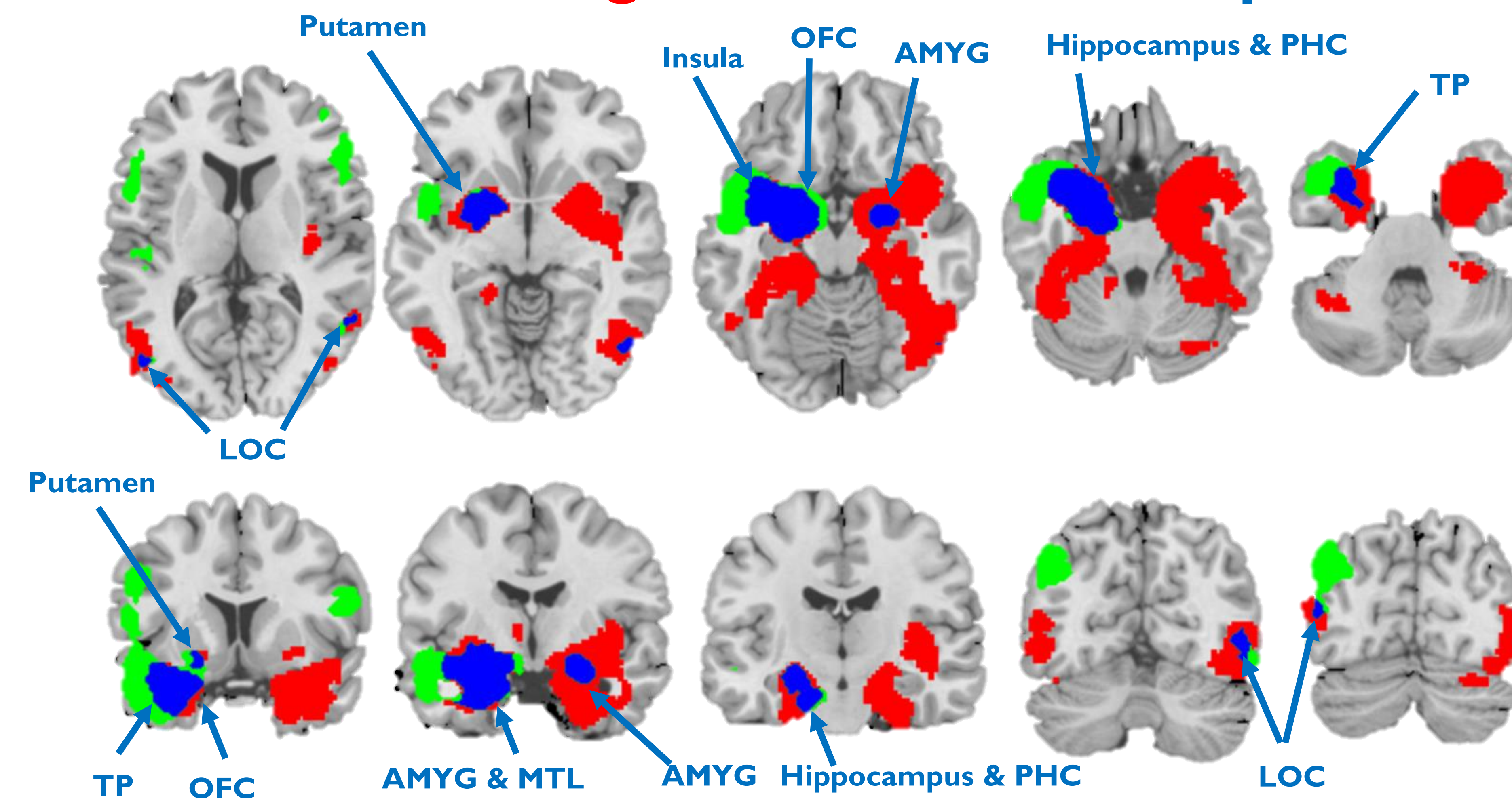
Retrieval



Successful **emotional memory retrieval** recruits brain regions involved in:

- Episodic memory retrieval**: hippocampus⁵, entorhinal cortex⁵, perirhinal cortex⁵, dorsolateral prefrontal cortex¹³ (DLPFC), angular gyrus¹⁴ (ANG)
- Emotion processing**: amygdala⁶ (AMYG), orbitofrontal cortex⁷ (OFC), temporal pole⁸, putamen⁹, insula¹⁰
- Perceptual processing**: lateral occipital cortex¹¹ (LOC), middle occipital cortex¹¹, middle temporal gyrus¹², Heschl's gyrus¹⁵.

Encoding, Retrieval, & Overlap



SDM maps for successful encoding and retrieval of emotional memory overlapped in regions associated with:

- Episodic memory**⁵: medial temporal lobe (MTL) regions including hippocampus, entorhinal cortex, perirhinal cortex
- Emotion processing**: amygdala⁶ (Amyg), orbitofrontal cortex⁷ (OFC), temporal pole⁸ (TP), putamen⁹, insula¹⁰
- Perceptual processing**: lateral occipital cortex¹¹ (LOC), middle temporal gyrus¹² (MTG)

Red regions = Encoding SDM map
Green regions = Retrieval SDM map
Blue regions = Encoding/Retrieval overlap

- 5 clusters of overlap: 2555 voxels
- Dice similarity score between encoding and retrieval = .279

Conclusions

- Successful emotional memory encoding** recruited brain regions associated with **episodic memory encoding** (medial temporal lobe memory system), **emotional processing** (amygdala, orbitofrontal cortex, insula, putamen), and **perceptual processing** (ventral visual stream).
- Successful emotional memory retrieval** recruited many of the same brain regions recruited during **successful emotional episodic memory encoding** (medial temporal lobe memory system, amygdala, orbitofrontal cortex, temporal pole, putamen, insula, ventral visual stream)
- Successful emotional memory retrieval** also recruited brain regions that were **specific to emotional memory retrieval** (dorsolateral prefrontal cortex, angular gyrus, dorsal visual stream)
- These findings support the idea that **some of the processes present during emotional memory encoding are recapitulated** to some extent during emotional memory retrieval; however, emotional memory retrieval also involves **retrieval specific processes that are not shared with encoding**
- Some activations found in the previous emotional memory encoding meta-analysis were not identified in the current study (prefrontal cortex, parietal cortex) and new activations were identified in the current study that were not present in the previous meta-analysis (insula)

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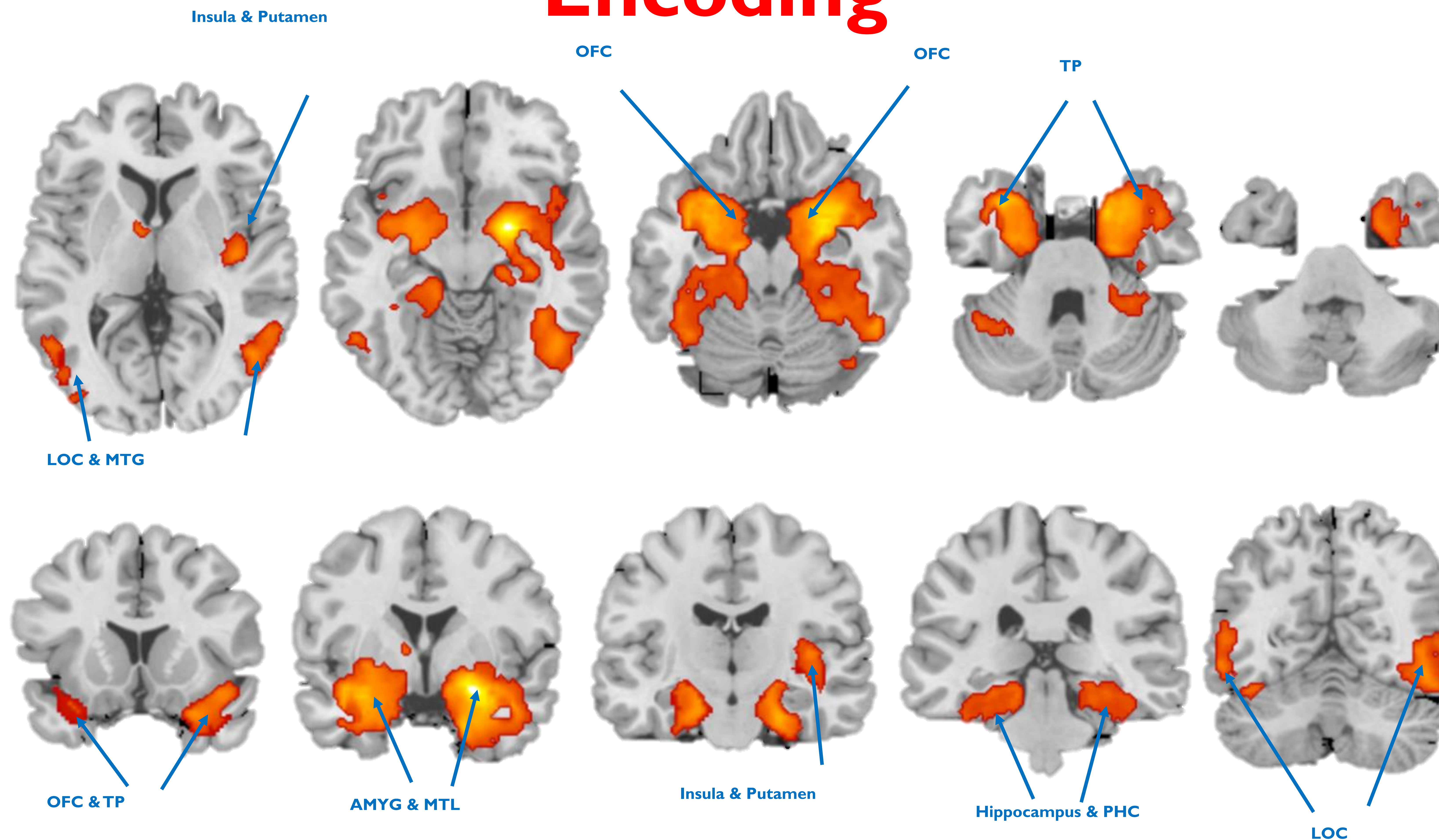
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Encoding



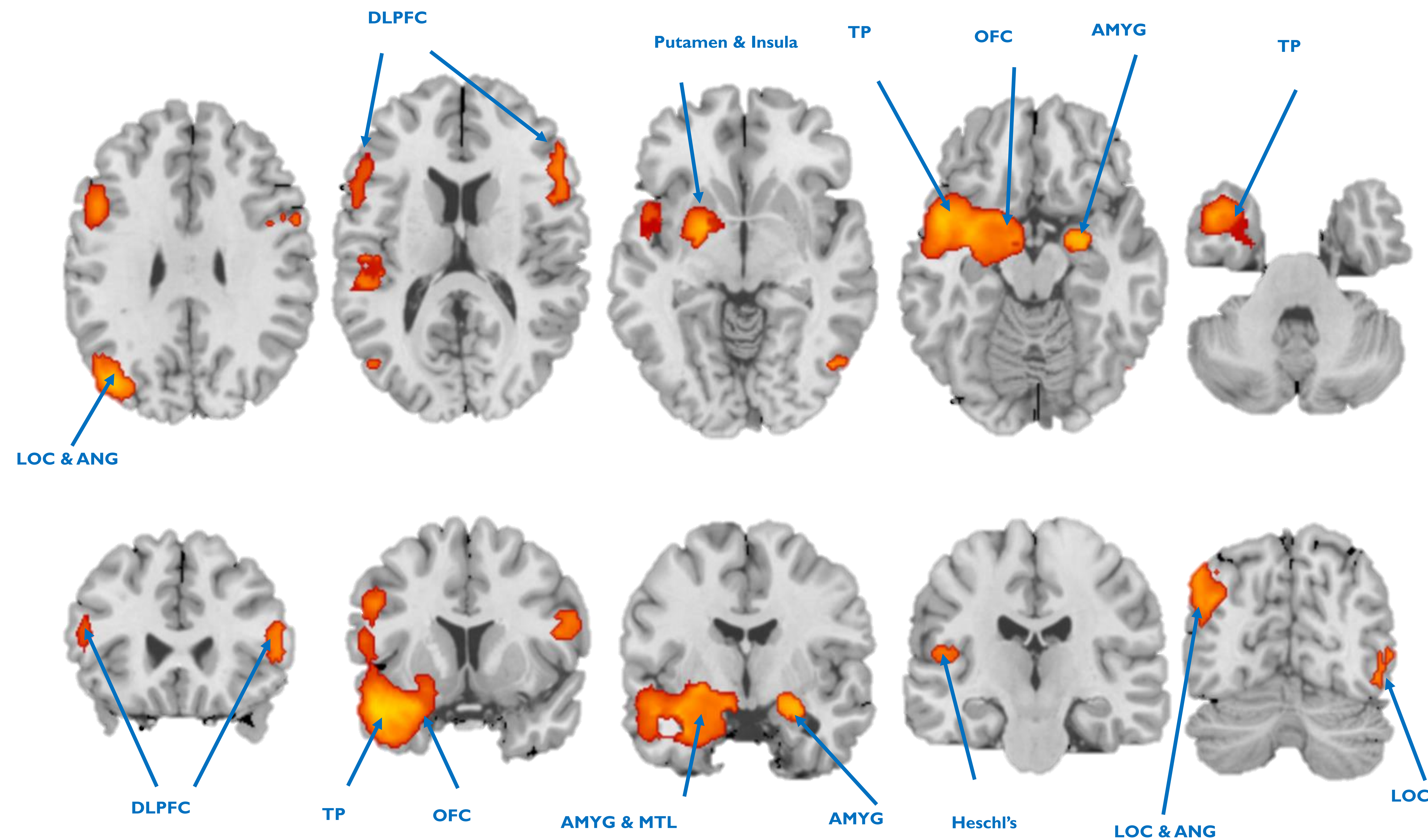
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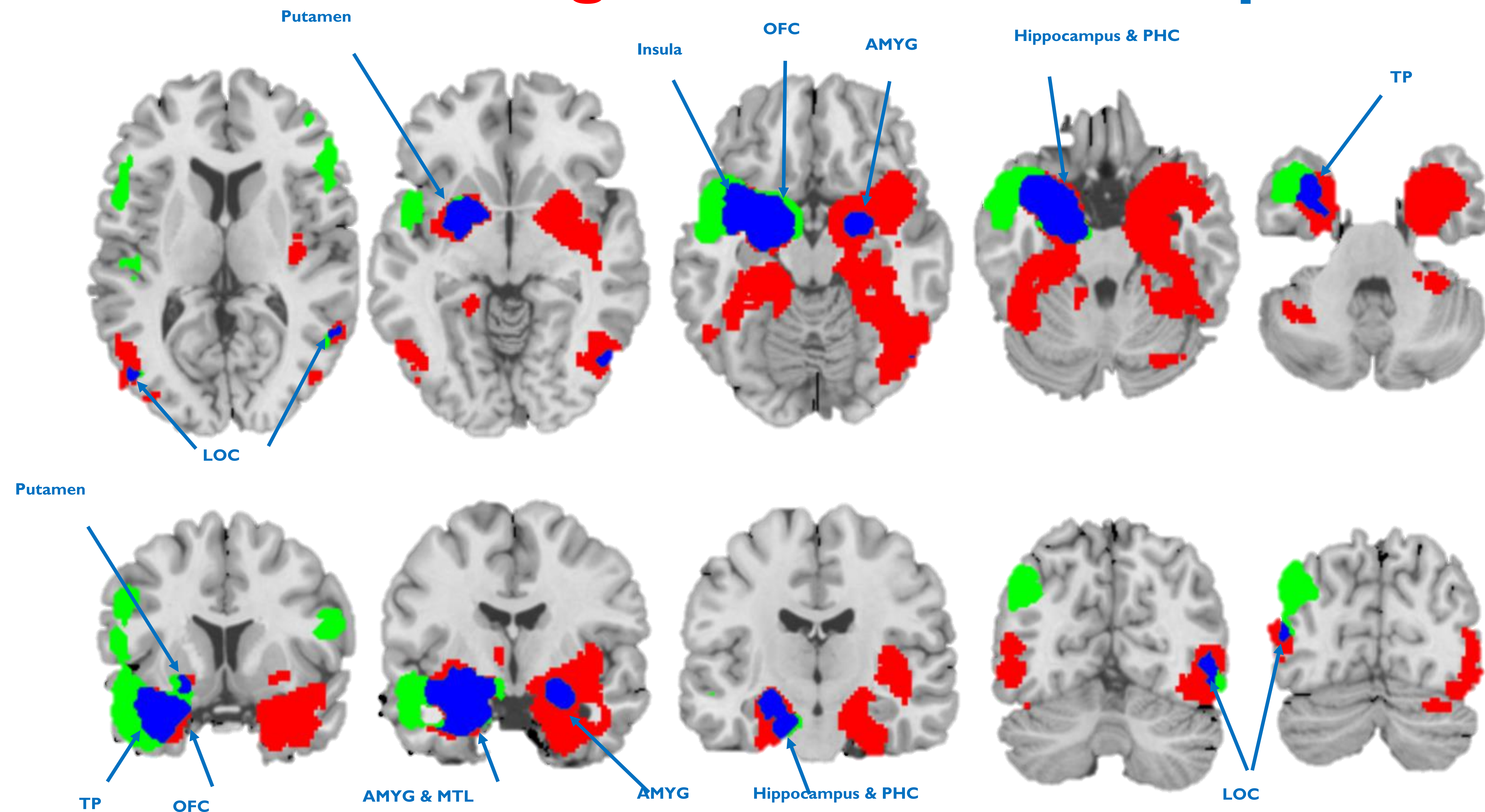
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