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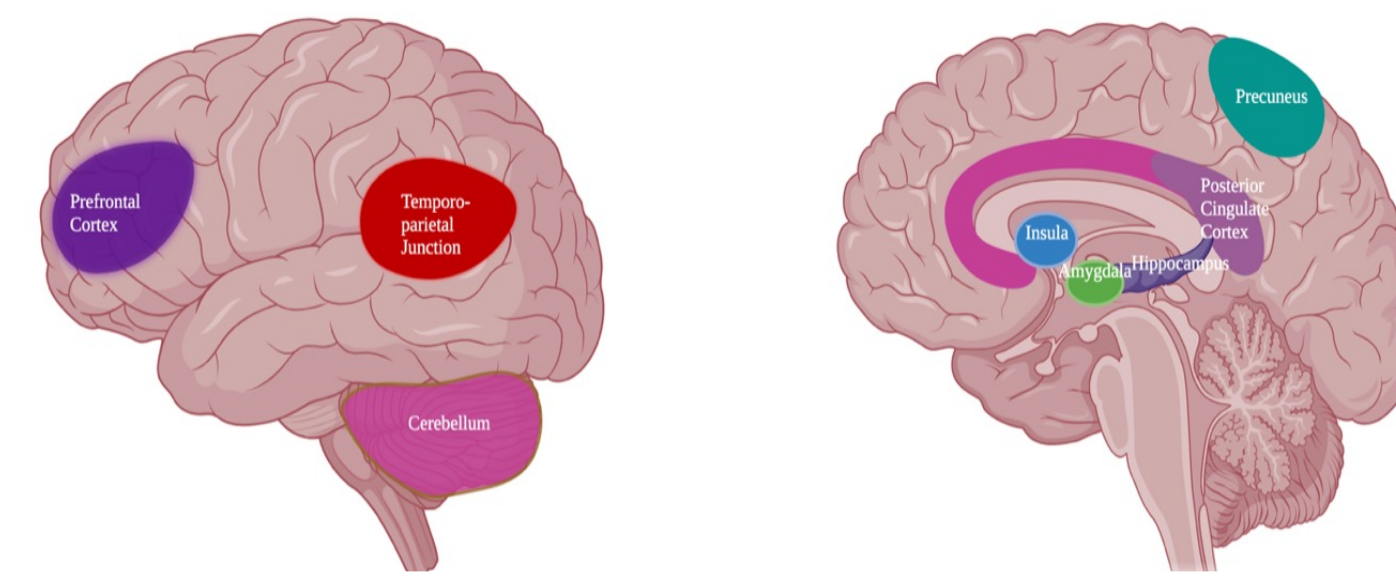
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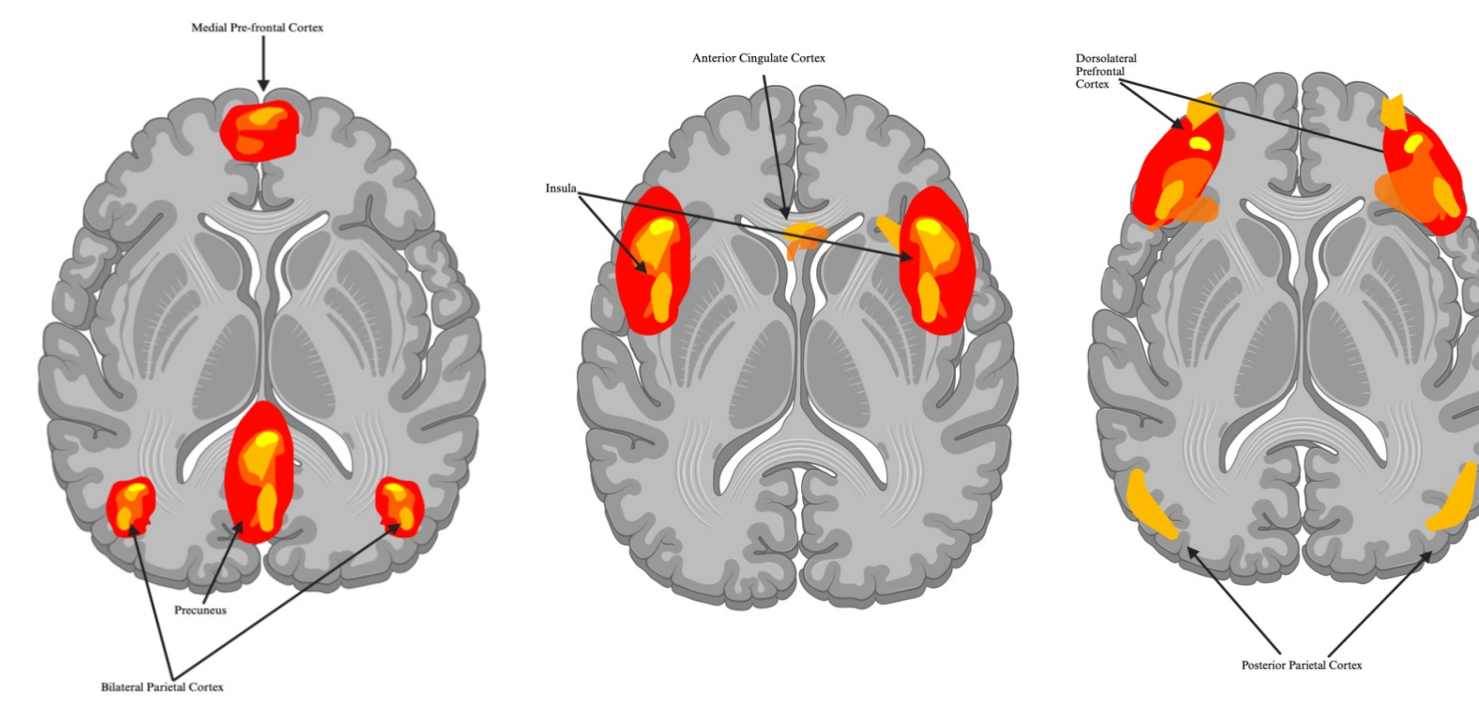
## Introduction

- Mental health disorders are often associated with changes and dysregulation or dysfunction of brain structures.
- Some of the most highly efficacious treatments involve mindful meditation as a component.
- Functional magnetic resonance imaging (fMRI) experiments have established regions of interest (ROI) associated with mindfulness.
- Current neuroimaging investigations of mindfulness-based interventions identify key networks (i.e., Default Mode Network, Salience Network, and Frontoparietal Network) and provide evidence of neural plasticity.
- This coordinate based meta-analysis used an activation likelihood estimation (ALE) procedure to statistically identify ROIs based on how likely the activity of one voxel is associated with activity in another voxel during mindful meditation tasks.
- Using identified ROIs from the Omnibus ALE, a meta-analytic connectivity model (MACM) was created, quantifying shared functional connectivity and directionality.
- Paradigm Class and Behavioral Domain analyses were conducted to aid in functional interpretation of MACM.

## Hypothesized Brain Regions



**Mindful Meditation:** Frequently Reported Active Brain Regions



**Triple Network Model:** Default Mode Network, Salience Network, Frontoparietal Network

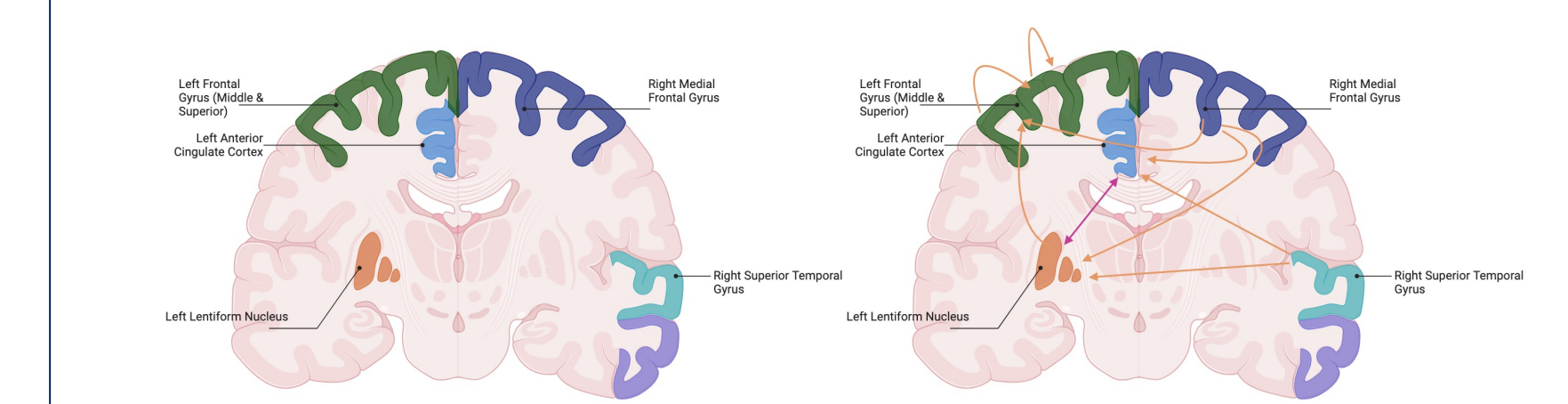
## Discussion

### Significant Regions:

- Middle Frontal Gyrus:** Used during high-level executive functioning.
- Superior Frontal Gyrus:** Used during self-reflection and working memory tasks.
- Medial Frontal Gyrus:** Used during high-level executive functioning and decision-making.
- Anterior Cingulate Cortex:** Involved with motivation, emotional interpretation, self-monitoring, learning, and decision-making.
- Lentiform Nucleus (putamen & globus pallidus):** Involved with working memory tasks, executive functioning, learning, and reward processing.
- Superior Temporal Gyrus:** Involved with social cognition, language, and auditory processing.

### Directionality:

- The **R STG** communicates to the **L ACC** and the **L LN**.
- The **R MFG** communicates to the **L ACC**, **L LN**, and **L SFG**.
- The **L MFG** communicates to the **L SFG**.
- The **L SFG** communicates to the **L SFG**.
- The **L LN** communicates to the **L SFG**.
- The **L LN** and **L ACC** communicate with each other, creating a feedback loop.



Images visualized with BioRender.com

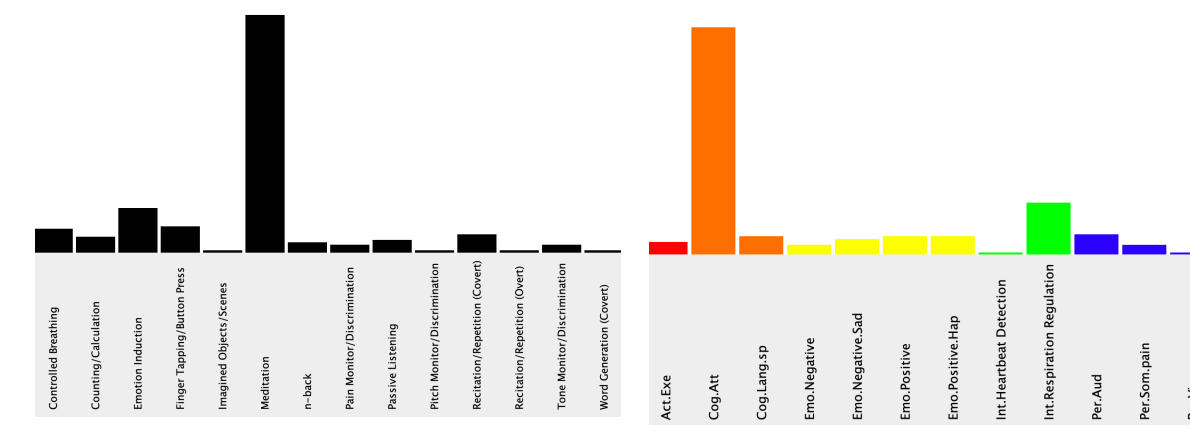
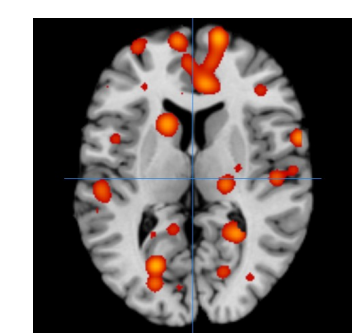
## Literature Search and BrainMap Methods

Omnibus Workspace: 20 papers, 89 experiments, 58 conditions, 457 locations, 461 subjects.

- 14 BrainMap paradigm classes
- 12 BrainMap behavioral subdomains

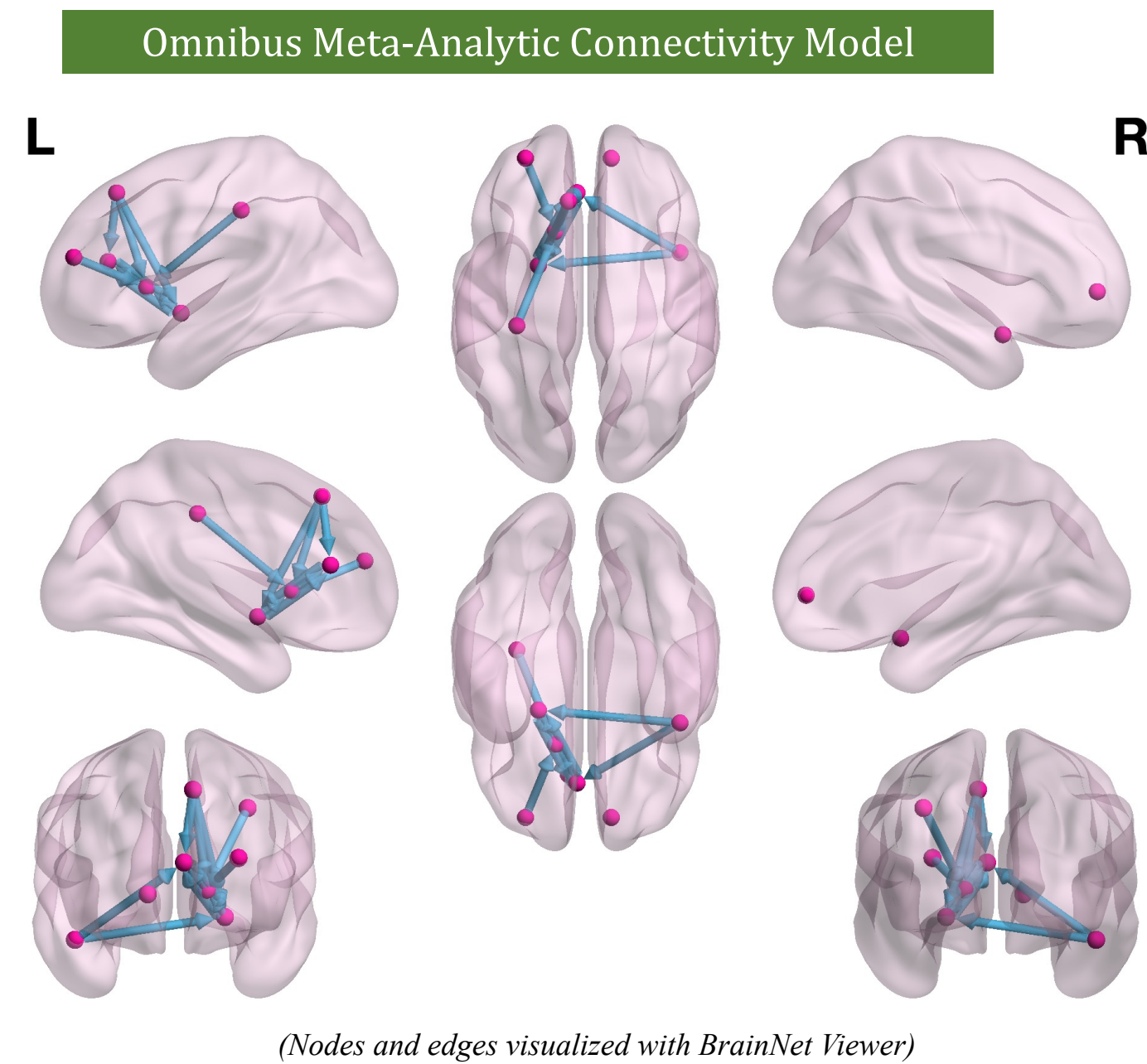
**Activation Likelihood Estimation:** Revealed 8 peak regions of interest (ROIs). Cluster-level family-wise error (FWE) was used within the ALE, set to 0.001; thresholding permutations were set to 7500; thresholding value was set to 0.01.

**Meta-Analytic Connectivity Modelling:** Revealed one-way and two-way significant connections between nodes. Connectivity between ROIs indicate brain regions associated with mindfulness and communication between specific regions. Feedback loops will be interpreted.



ROI Connectivity Matrix (p<0.01)

	R STG	L ACC	L MFG	L SFG	R MFG	L IPL	L LN	L SFG
R STG	1	0	0	0	0	0	0	0
L ACC	0	1	0	0	1	0	1	0
L MFG	0	0	1	0	0	0	0	0
L SFG	0	0	0	1	0	0	0	0
R MFG	0	0	0	0	1	0	0	0
L IPL	0	0	0	0	0	1	0	0
L LN	0	1	0	0	0	0	1	0
L SFG	0	0	1	1	1	0	1	1



(Nodes and edges visualized with BrainNet Viewer)

Analysis revealed bidirectional connectivity between the Left Lentiform Nucleus and Left Anterior Cingulate Cortex, as well as unidirectional connectivity within the Right Superior Temporal Gyrus, Left Middle Frontal Gyrus, Left Superior Frontal Gyrus, and Right Medial Frontal Gyrus.

- Bidirectional:** Significant connection from Seed 1 to ROI 2 and Seed 2 to ROI 1
- Unidirectional:** Significant connection from Seed 1 to ROI 2

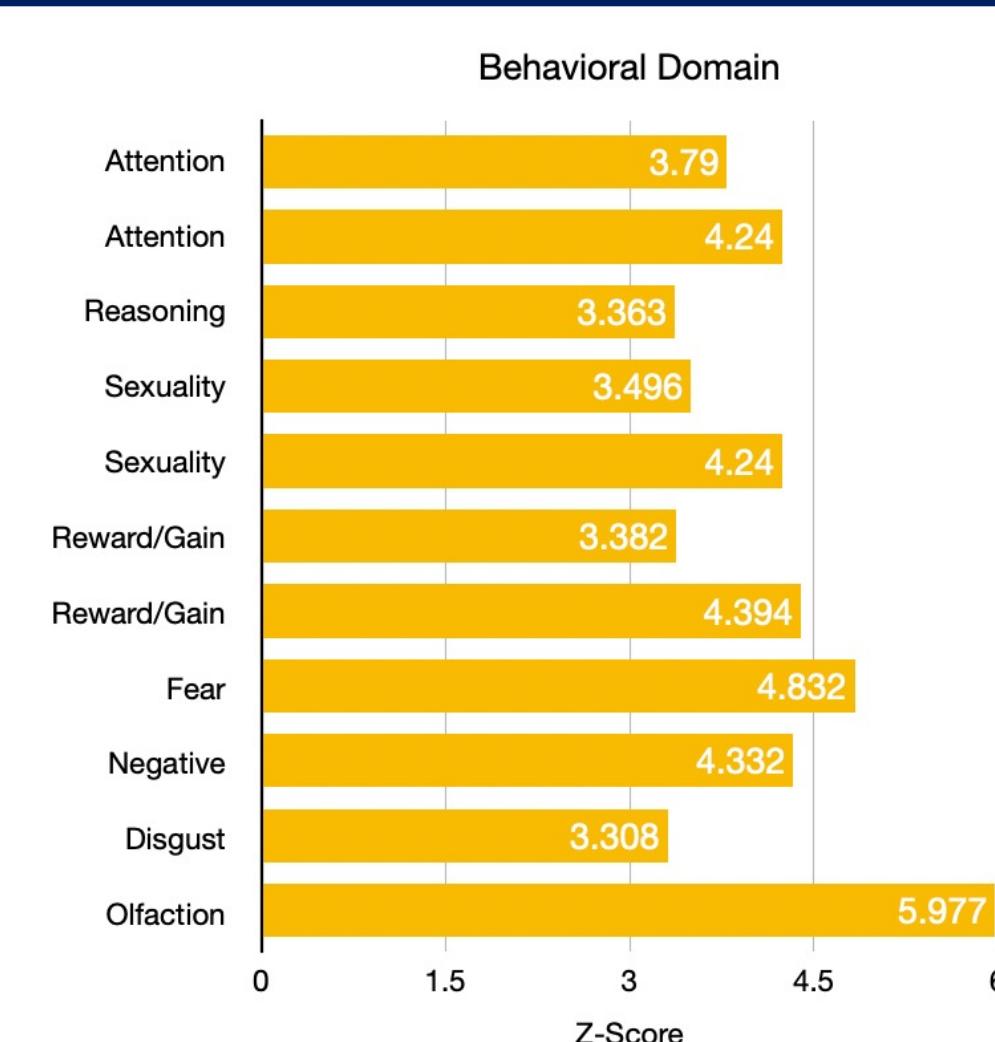
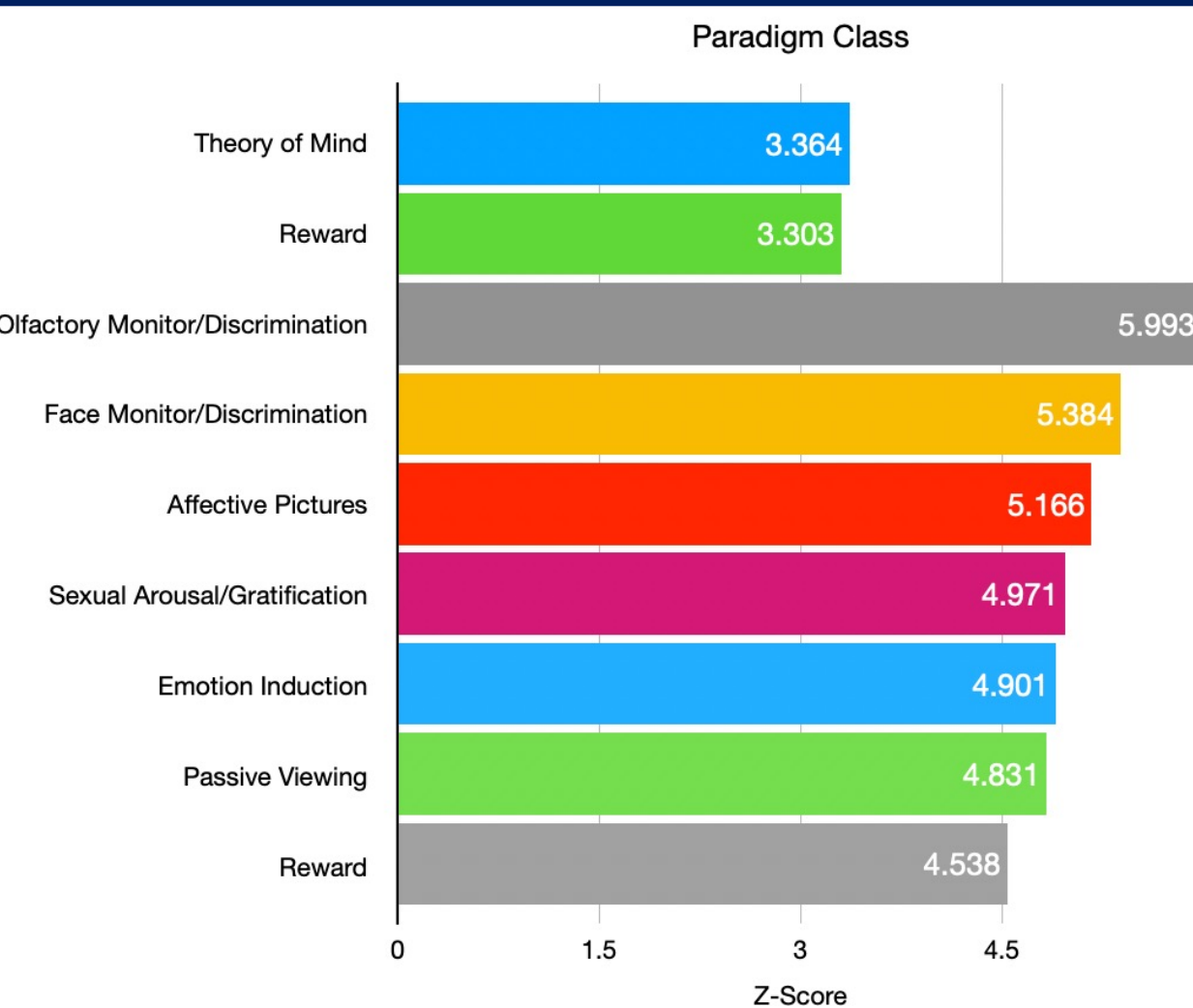
## Paradigm Class and Behavior Analyses

Z-scores  $\geq 3.0$  are considered significant

**Paradigm Class:** the experimental task within a study

**Behavioral Domain:** action contrasts within an experiment

3/8 significant node associations across 9 paradigm classes and 11 behavioral domains.



## Hypotheses & Aims

### Aims:

- To conduct an updated quantitative meta-analysis of the brain regions identified by functional brain imaging associated with mindful meditation.
- To develop the first meta-analytic connectivity model of those regions identified by the ALE in order to establish patterns of network functional connectivity.

### Hypothesis:

It is hypothesized that regions active during mindful meditation have shared brain regions with networks involved in the Triple Network Model (TNM)

## Acknowledgements

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