Individual differences in emotion and cognitive processing related to spontaneous neural connectivity of prefrontal regions.

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INTRODUCTION

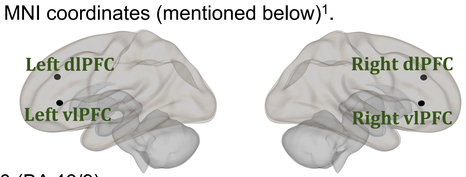
- The **ventral affective system (VAS), involved in emotion processing**, consists of the **ventral lateral prefrontal cortex (vlPFC), amygdala, and lateral occipital-temporal cortex**, while the **dorsal executive system (DES), involved in executive function**, consists of the **dorsal lateral prefrontal cortex (dlPFC)** and **lateral parietal cortex (LPC)**.[1,2]
- Extant research on emotion-cognition interactions shows **these networks largely operate in an opposing fashion**, as one system is engaged the other is suppressed.
- Task-related investigations have shown **system congruent behaviors are related to activation in areas of the network**. For example, vlPFC with the emotion metrics and dlPFC with the cognitive metrics. However, how these areas are connected at rest and if the system congruent behaviors remain related to their activity at rest remains largely unexplored.

Hypotheses

1. At rest, **vlPFC will be connected to other VAS regions**, while **dlPFC will be connected to other DES regions**.
2. We expect that the **brain-behavior relationships observed during task-related paradigms will remain at rest**. That is, the degree of connectivity for vlPFC and dlPFC and other areas at rest will be associated with measures of emotional behavior in an opposing fashion.

METHODS

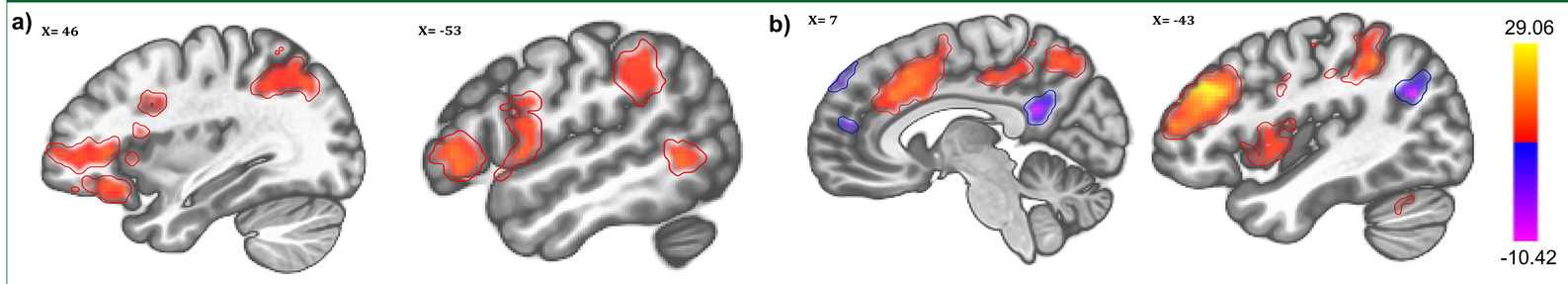
- N = 19 (18-31 years old) participants completed behavioural measures of **Emotional Contagion Scale (ECS;** measures the susceptibility to 'catching' other people's emotions (e.g. "I cry at sad movies"))[3], and **Emotional Regulation Questionnaire (ERQ;** measures the ability to regulate emotions by cognitive reappraisal and suppression (e.g. "I keep my emotions to myself"))[4]. This was followed by **a 5-minute resting-state scan on a 1.5 T scanner** (TR = 2000 sec).
- Data preprocessing and analysis were performed using **CONN**[5]. Typical preprocessing steps were implemented, and the data was **bandpass filtered from 0.01 Hz to 0.10 Hz**. **Motion correction was performed with Artifact rejection (ART) software** that regressed out the outlier scans (mean composite motion >0.9mm).
- Bilateral vlPFC and dlPFC anatomical seeds were created by generating a 6 mm sphere around the MNI coordinates (mentioned below)[1].



dlPFC: ± 36, 34, 30 (BA 46/9)
vlPFC: ± 50, 32, 4 (BA 45)

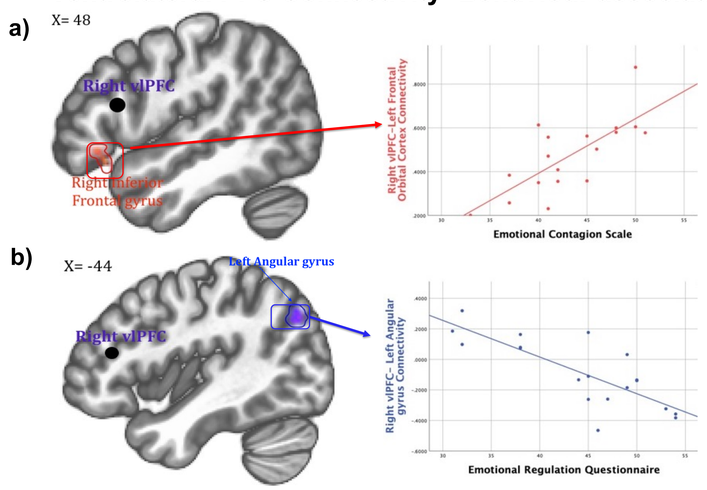
- **ECS and ERQ scores were correlated with the seed-to-voxel connectivity maps of bilateral vlPFC and dlPFC**.
- **All results** (seed-based connectivity maps and brain-behavior correlation maps) are **reported at a p < .05 (corrected**, using a cluster defining threshold of p < 0.001). Data from peak voxels were extracted for visualization purposes.

RESULTS



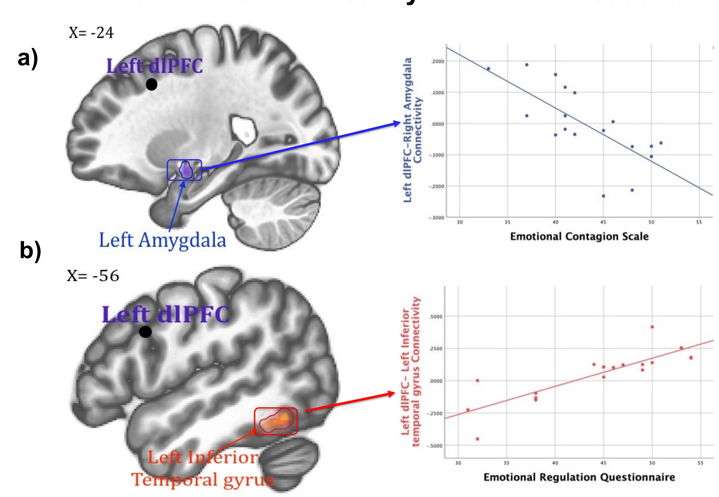
Seed-to-voxel connectivity maps for a) right vlPFC and **b) right dlPFC**, Red, positive connectivity; Blue, negative connectivity

Ventrolateral PFC Connectivity- Behaviour association



Connectivity-behaviour relationship between **vlPFC and a) ECS and, b) ERQ**, seed regions are indicated by black circle. There were no other areas displaying a positive correlation, but left cingulate gyrus also showed increased anticorrelation with vlPFC to explain ERQ scores.

Dorsolateral PFC Connectivity- Behaviour association



Connectivity-behaviour relationship between **dlPFC and a) ECS and, b) ERQ**, seed regions are indicated by black circle. Right putamen displayed increased anticorrelation, while left medial frontal cortex showed positive correlation with dlPFC to explain ECS scores.

DISCUSSION & FUTURE DIRECTIONS

1. At rest, **the vlPFC and dlPFC are positively connected to corresponding VAS and DES areas**, respectively. Interestingly, **dlPFC was negatively connected to DMN regions** (posterior cingulate cortex). Contrary to the results from task-based paradigms, which show **vlPFC and amygdala** to co-activate during emotion processing, these regions **were not found to be functionally connected at rest**.
2. **As expected, connectivity of the two seed ROIs related to emotional behavior in an opposing fashion.** Increased connectivity of the vlPFC with a different sub-region of itself resulted in increased emotion contagion, while increased anti-correlation (i.e., separation) between this area and left angular gyrus resulted in decreased emotion regulation. Conversely, increased connectivity of dlPFC was associated with higher emotion regulation, while increased anti-correlation was associated with lower emotion contagion.
3. Taken together, these results show that **patterns at rest in these key nodes of the VAS and DES networks are related to how individuals interact with and handle emotional information** and suggest that patterns at rest might be useful for better understanding performance on cognitive tasks in the presence of emotional distraction.
4. **Future directions:** Oscillations in the simultaneous fMRI-EEG associated with the two prefrontal hubs will be investigated to study spatial and temporal dynamics of emotion-cognition interaction.

REFERENCES 1. Dolcos et al., 2006; 2. Moore et al., 2019; 3. Doherty, 1997; 4. Gross & John, 2003; 5. Whitfield-Gabrieli & Nieto-Castanon, 2012

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