Linking macroscale resting-state functional connectivity to acute and chronic stress

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Introduction

- **Acute stress** is adaptive to an ever-changing environment. [1]
- **Chronic stress** can lead to numerous adverse effects on health. [2]
- At rest, both types of stress show changes in several brain regions and functional networks. [3]
- Cortical gradients can be used to describe macroscale patterns of brain organisation. [4]

To capture patterns in **resting-state functional connectivity** associated with **acute and chronic** stress we investigated the corresponding **macroscale cortical organisation.**

Datasets

Acute psychosocial stress

- **NECOS dataset** [5]
- 67 male participants (20-35 years)
- Trier Social Stress Task (TSST) (a 5 min job interview or placebo)
- resting-state fMRI (rs-fMRI, 8.5 min)

Chronic stress

- **LEMON dataset** [6]
- 142 participants (20-40 years, 43 female)
- Trier Inventory of Chronic Stress (TICS) (a questionnaire, weighted average used)
- rs-fMRI (20 min)

Computing Cortical Gradients

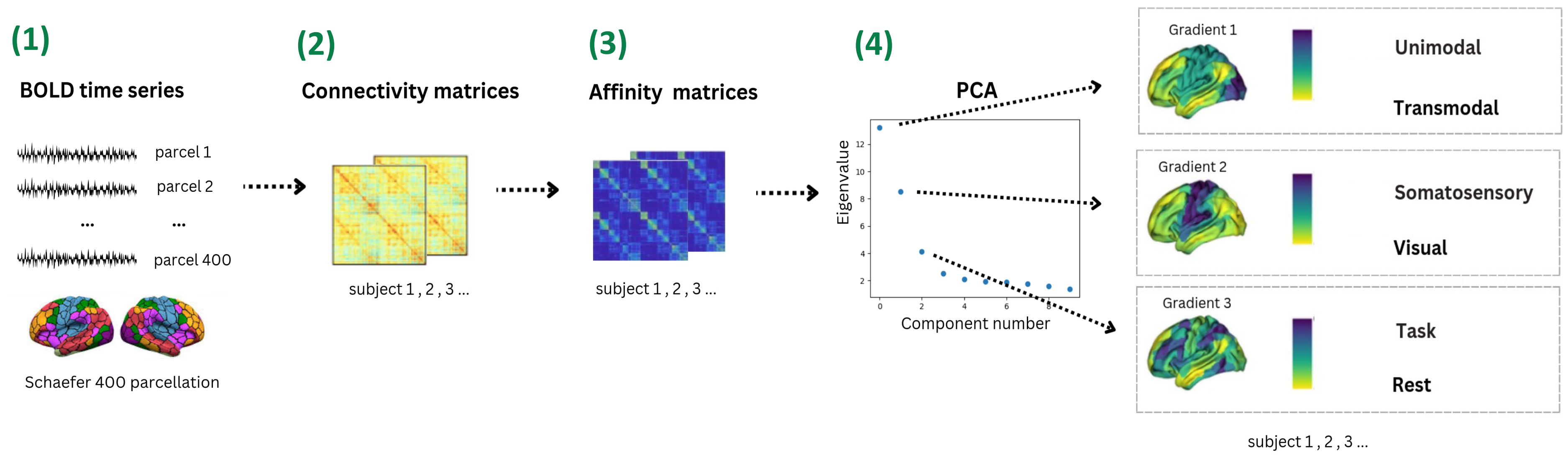

Fig 1: To obtain macroscale connectivity in a low dimensional space, we extracted rs-fMRI time series using Schaefer 400 parcellation **(1)** and computed a connectivity matrix for every participant using Pearson correlation **(2)**. We applied z-transform to the matrix to build an affinity matrix **(3)** and decomposed it using Principal component analysis (PCA). Our focus was on the first 3 gradients which explained approximately 50% of the variance **(4)**.

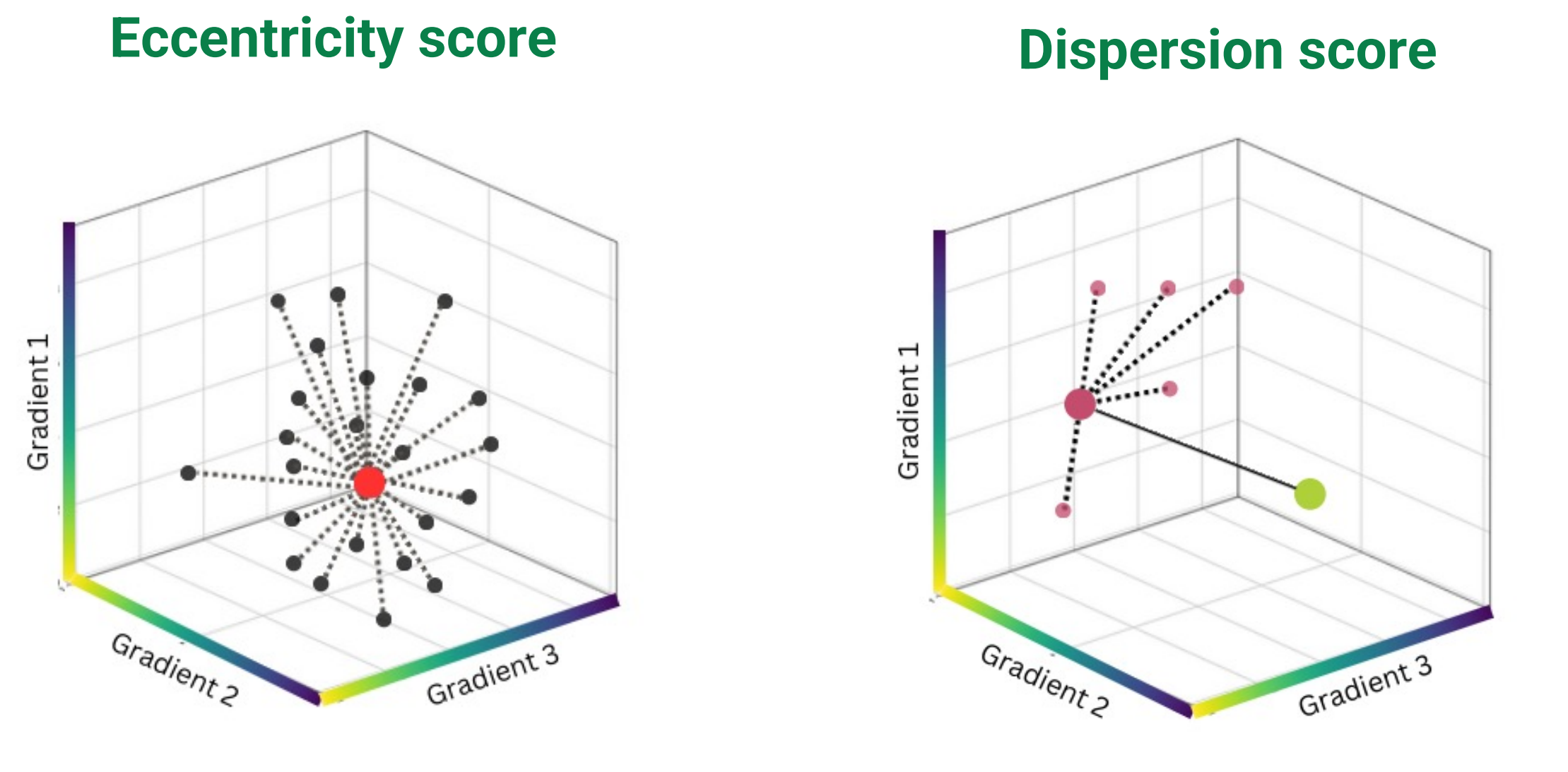

Fig 2: Eccentricity score defines the distance of the parcel in 3D gradient space with respect to the origin (in red). Dispersion score defines the spread of the network (in pink) and the distance between the networks (line between pink & green) in 3D gradient space.

Results

Acute psychosocial stress

1a Significant changes in eccentricity score after psychosocial stress

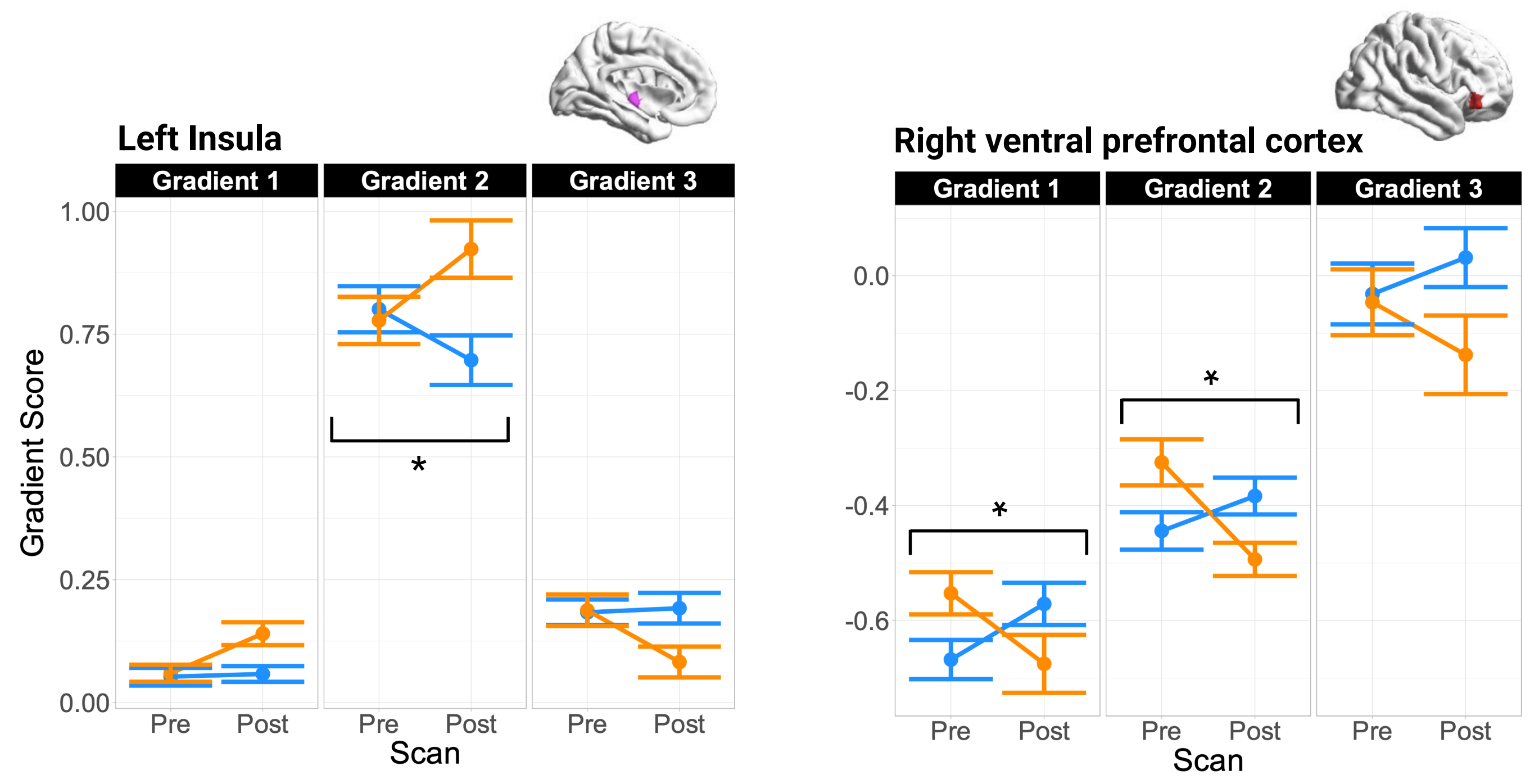

Fig 3: Post hoc analysis of the two significant parcels from the eccentricity analysis. The eccentricity score was divided into three gradients by (stress/control) and scan (pre/post).

Legend
- ● Stress
- ● Control

1b Significant between network dispersion changes after acute psychosocial stress

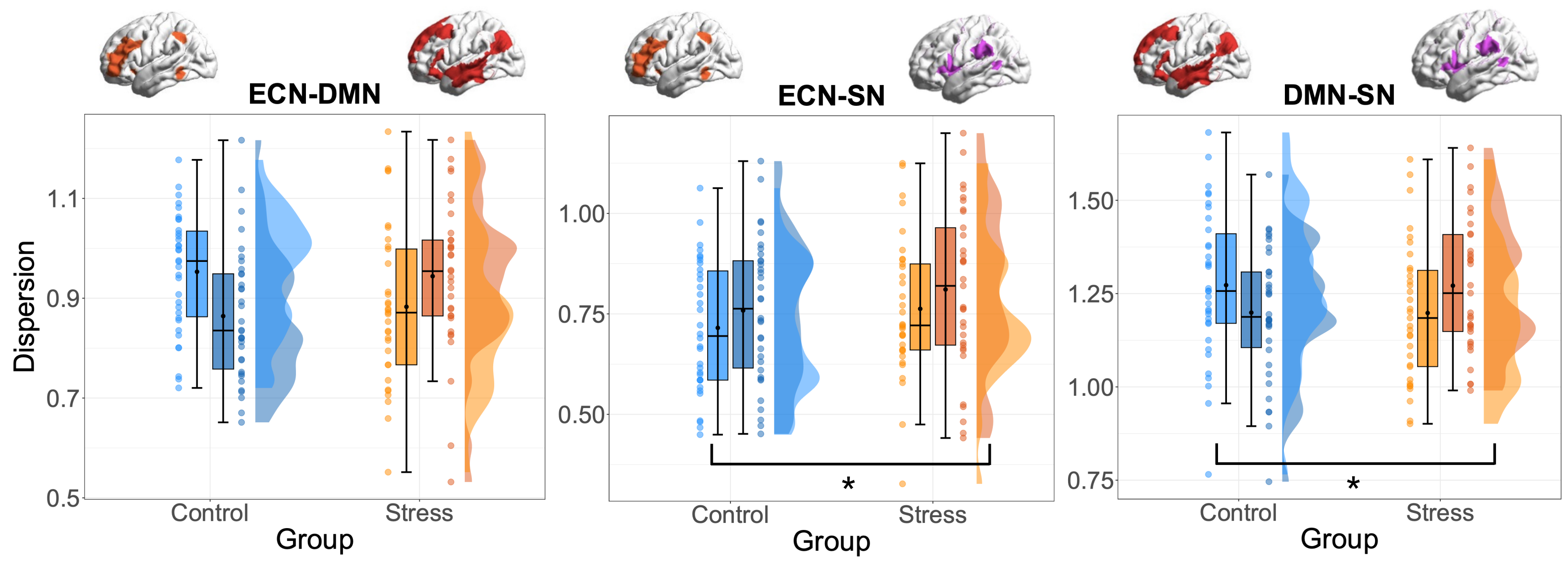

Fig 4. The distance of two networks in gradient space by group (stress/control) and scan (pre/post). ECN = Executive-control-network, DMN = Default-mode-network, SN = Salience-network

Legend
- ⊞ Control Pre
- ⊞ Control Post
- ⊞ Stress Pre
- ⊞ Stress Post

Chronic stress

2b No significant movement along gradients

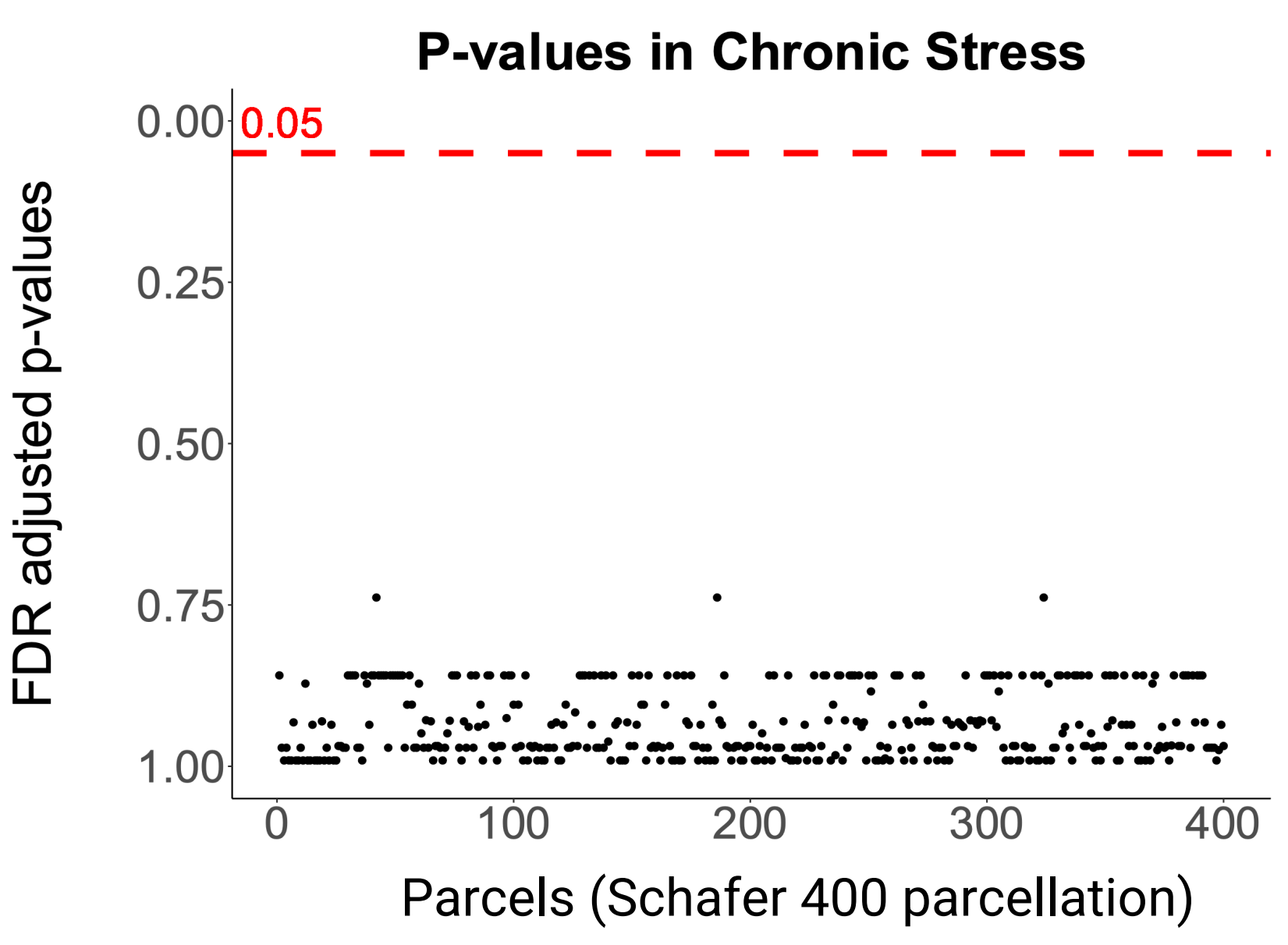

Fig 5: False Discovery Rate (FDR) - adjusted p-values of all 400 points of measurement of the cortex.

2b No significant dispersion within or between networks along gradients

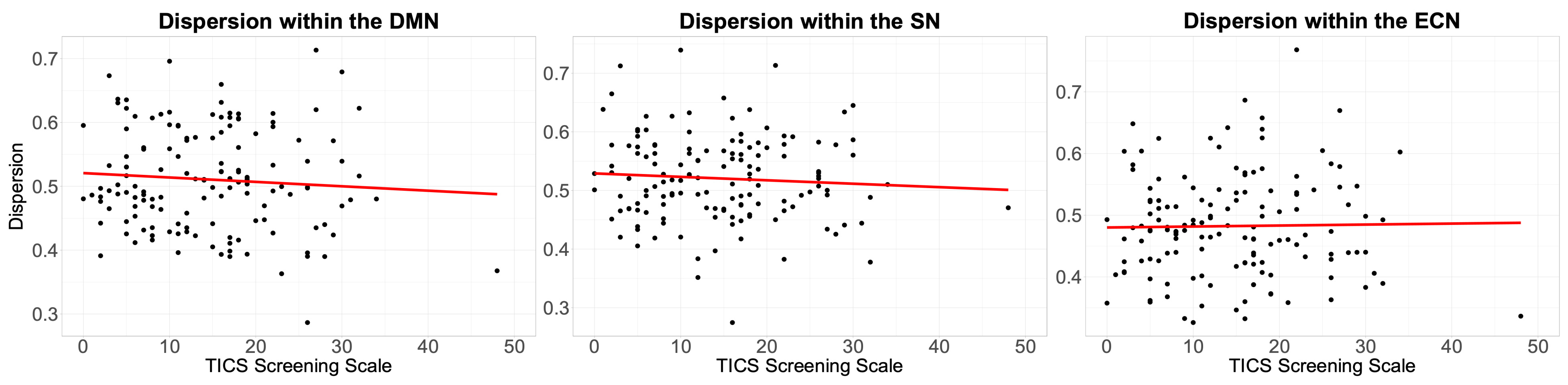

Fig 6: Average dispersion of all parcels of one network per participant and corresponding TICS score.

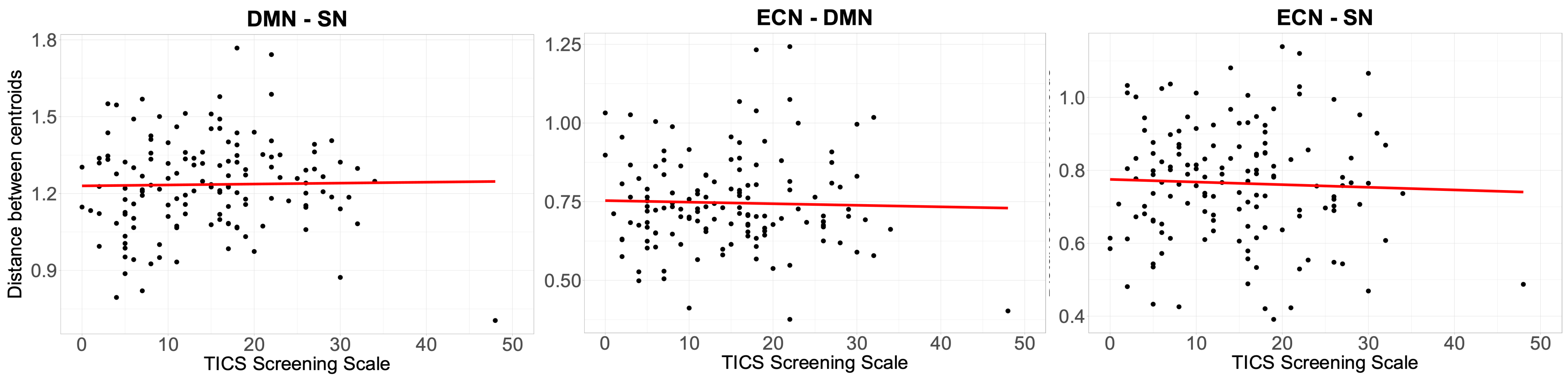

Fig 7: The change in the distance between networks in gradient space for every participant and corresponding TICS score.

Discussion

- **After acute stress**, the left insula and right ventral prefrontal cortex changed their position along gradients. The default-mode network moved away from both the salience network and the executive control network.
- **No evidence** of an association between chronic stress and cortical gradients. This is likely due to the thorough screening of participants and insufficient variability in TICS scores.

Our findings provide **new evidence for alterations in cortical organisation after acute stress.**

References

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