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Predicting Empathy from Task-Positive Connectivity Patterns Within Task-Free Data: A Cross-Cohort Approach

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SHORT ON TIME? HERE'S THE SUMMARY

We **predicted multiple dimensions of empathic function** from connectivity patterns in resting-state fMRI data using a **cross-cohort approach**. We trained models on **two groups of participants** (n=51,42) and **tested each group's model on the other**. We found that **we could robustly predict all dimensions of empathy from task-free data,** and that **a priori task-associated networks performed better than classical networks.** **Empathic concern was the most complexly represented aspect of empathic function**. Cross-cohort approaches are a useful step toward robust prognostic neuroscience.

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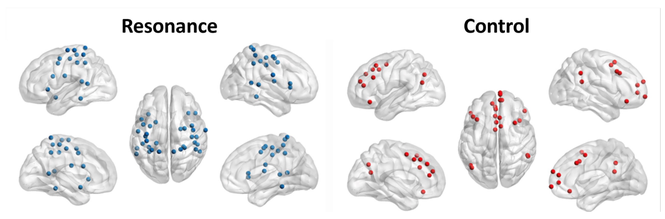
MOTIVATION

- ➔ Empathy is crucial for community function, with downstream impacts on social isolation, social (re)integration, employment, recidivism, and even clinical outcomes.
- ➔ Diagnosing empathic function can be difficult due to the need for complex in-scanner tasks or questionnaires that are frequently difficult to complete in neurodivergent populations.
- ➔ Prognostic neuroimaging can alleviate this issue by predicting fine-grained aspects of cognitive function from resting-state data, but statistically robust, multi-cohort methods are necessary to make these techniques widely applicable.

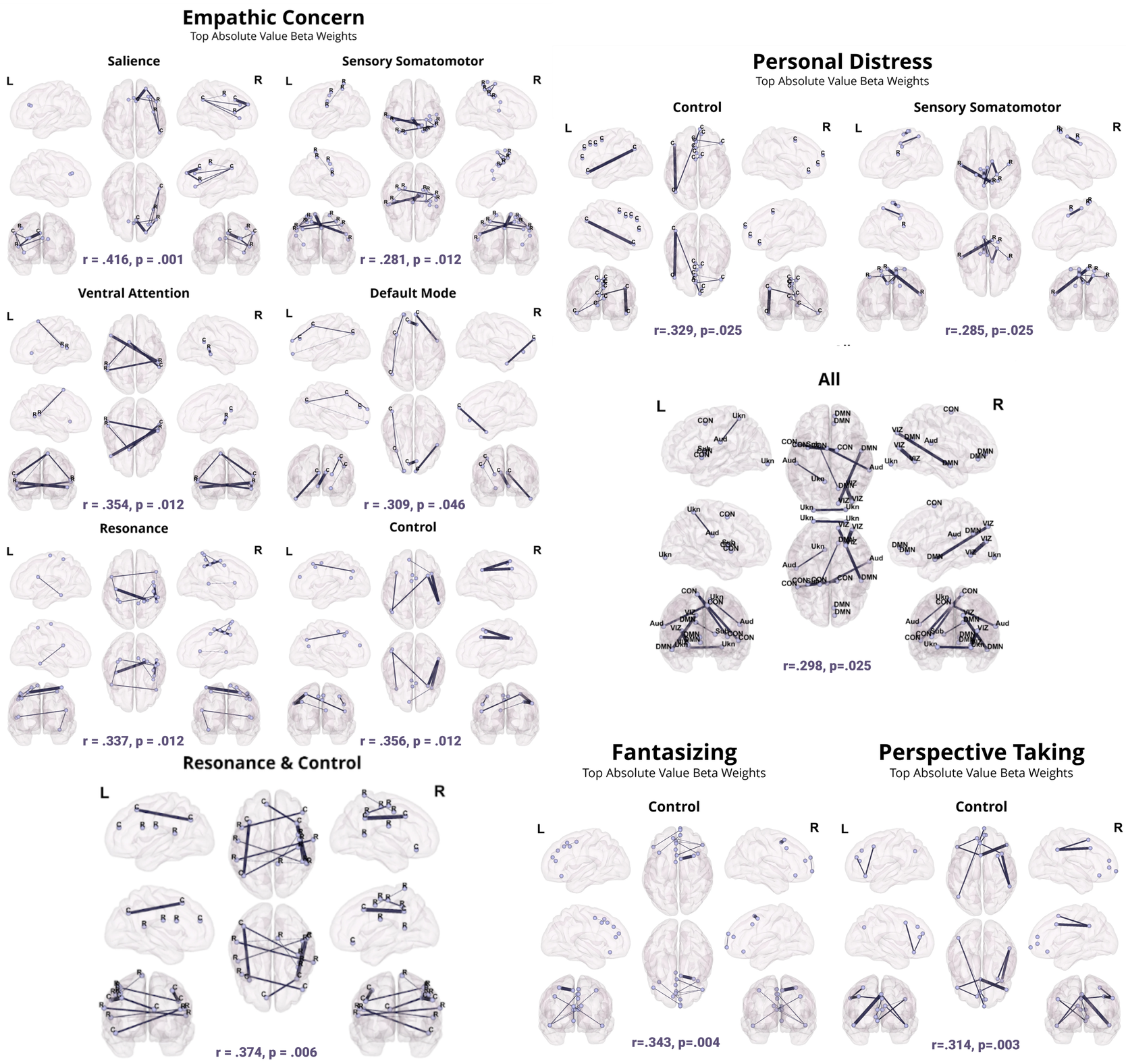
METHODS

- ➔ 47 participants aged 18-26 (23 female) were recruited and scanned at UCLA between 1/12/2015 and 6/22/2016, along with a cohort of 51 participants aged 18-35 (26 female) scanned at UCLA between 5/1/2013 and 11/7/2014. All right-handed, no neurological or psychiatric disorders, and no history of drug or alcohol abuse. All data was acquired via SIemens 3T scanner. Resting-state data was acquired while participants observed a fixation cross, and preprocessed using motion correction, high-pass filtering, smoothing, and probabilistic ICA to remove non-neuronal signals.
- ➔ Participants completed the Interpersonal Reactivity Index (IRI[1]), a widely used measure of cognitive and affective components of empathy: Fantasizing (FS), Empathic Concern (EC), Perspective Taking (PT), and Personal Distress (PD).
- ➔ Two theory-driven networks were created: Resonance (34 ROIs associated with neural resonance) and Control (22 ROIs associated with top-down control), derived from the Power et al. (2011)[2] cortical atlas.



- ➔ BOLD timeseries were extracted from each ROI to create pairwise functional connectivity matrices. Data-driven approaches were used to optimize regularization parameters, and cross-cohort testing with LASSO regression models was performed to predict empathy scores. Bootstrapping (10,000 iterations) was used to assess statistical significance of cross-cohort predictions, and a leave-ten-subjects-out cross-validation was implemented to assess predictive power of network-specific feature sets. False discovery rate (FDR) correction (Benjamini-Hochberg approach) was applied to p-values for each behavioral measure, considering each measure as a separate family.

Distinct facets of empathy can be predicted without task-relevant data



Most informative connections in each network successfully used by the LASSO models in cross-cohort predictions. Sublabels (C,R,Vis, Aud) reflect affiliation in other networks.

CONCLUSIONS

- ➔ We were able to robustly predict all four dimensions of empathic function from patterns of connectivity in resting-state networks despite training and testing in distinct cohorts.
- ➔ Our a priori task-relevant Resonance and Control networks performed as well or better than classical resting-state networks, suggesting useful ways to constrain and augment task-free prognostic neuroimaging approaches.
- ➔ Multicohort approaches may help prognostic neuroimaging achieve its promise of accessible, scalable, personalized diagnosis and treatment.

References:

1. Davis, M. H. (1983). Measuring Individual Differences in Empathy: Evidence for a Multidimensional Approach. *Journal of Personality and Social Psychology*, *44*(1), 113–126
2. Power, J. D., et al. (2011). Functional Network Organization of the Human Brain. *Neuron*, *72*(4), 665–678.

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