

The Neural Cost of Witnessing Suffering: Network Disruption and Sustained Arousal After Vicarious Trauma



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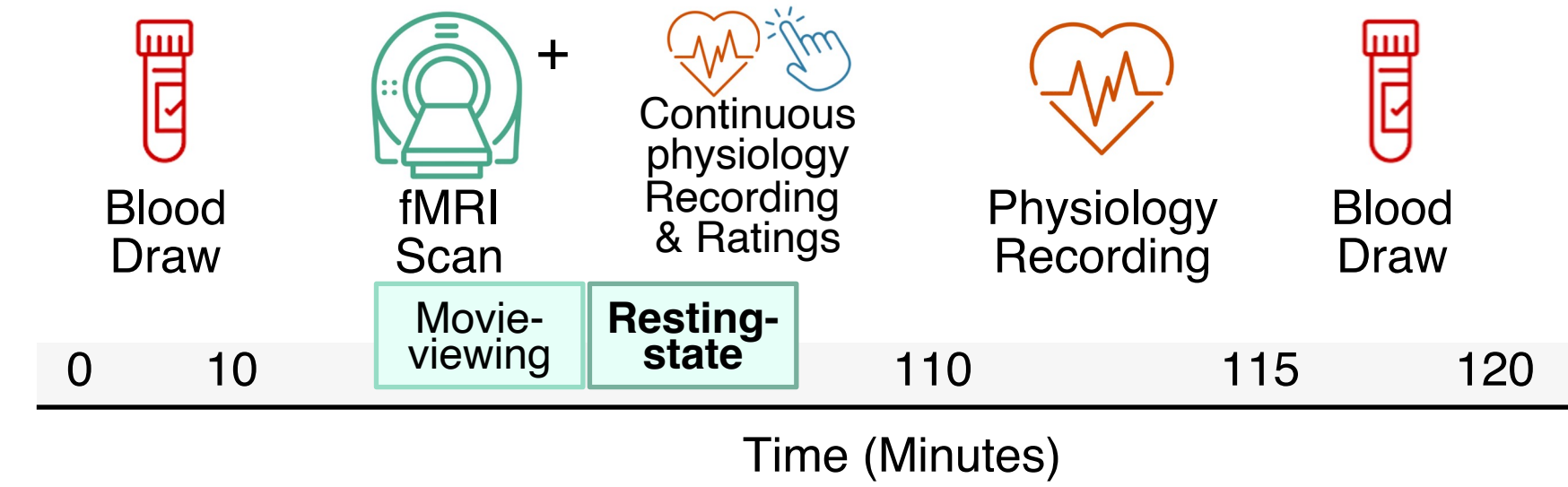
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INTRODUCTION

- Vicarious trauma—witnessing others' trauma—is a powerful stressor linked to PTSD, poor health, and reduced prosocial behavior (e.g., Koenig 2018; Branson 2019; MacNair 2002).
- Animal studies show witnessing conspecific distress triggers inflammation, depression-like behavior, social withdrawal, and increases in substance use (e.g., Hodes 2014; Sial 2016; Ródenas-González 2023).
- Observing harm signals danger, so the brain mounts anticipatory neuroimmune and autonomic responses to prepare for injury—an evolutionarily conserved, adaptive program that can raise allostatic load and long-term health risk (McEwen 2000; Cole 2013).
- Yet how vicarious trauma reorganizes brain, autonomic, and immune systems in healthy humans is poorly understood, due to few naturalistic paradigms and integrated measurements.
- To address this, we used a 30-minute morally salient documentary (Vicarious Trauma; showing farm animals being slaughtered in cruel ways) versus a matched positive film (Vicarious Community; positive human-animal interactions), combined with fMRI, continuous autonomic monitoring, and monocyte transcriptomics.

EXPERIMENTS

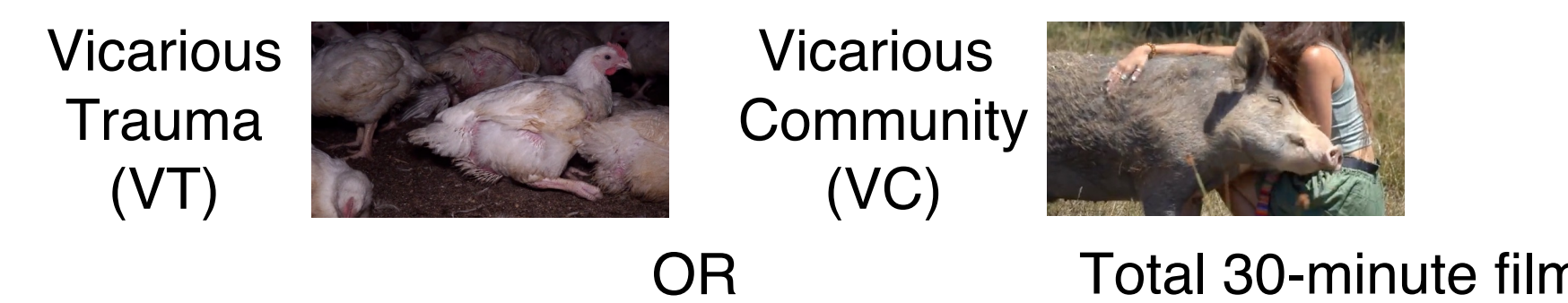
Two-day fMRI experiment sessions ($N = 88$)



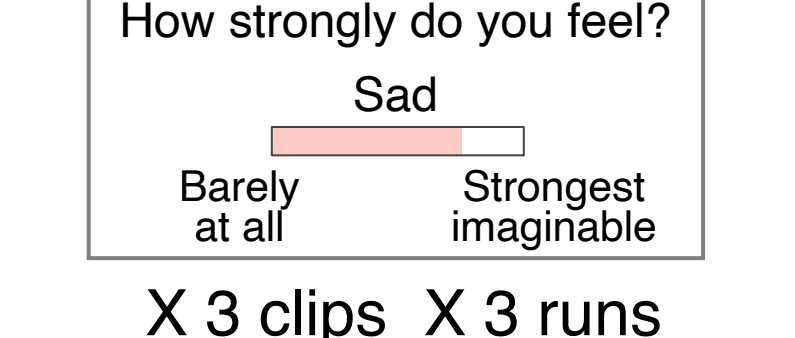
Multimodal dataset

- Behaviors
- Autonomic responses
- Cytokine gene expression of circulating monocytes
- Neural activity from fMRI

Movie-viewing task during fMRI scan

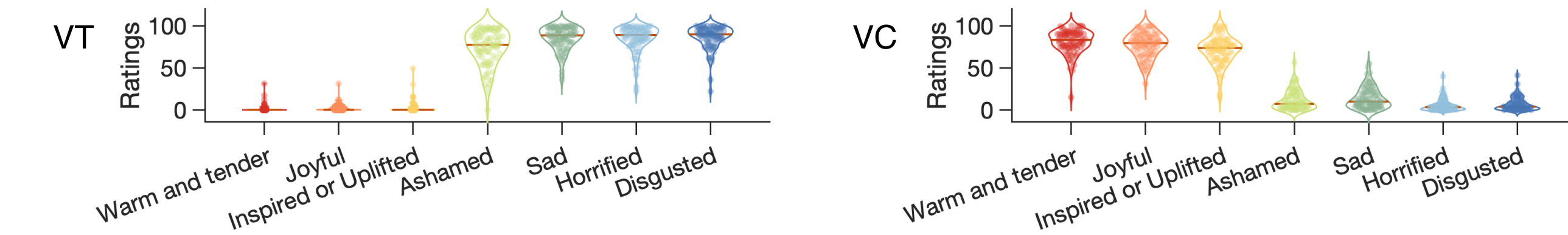


Self-report emotion ratings

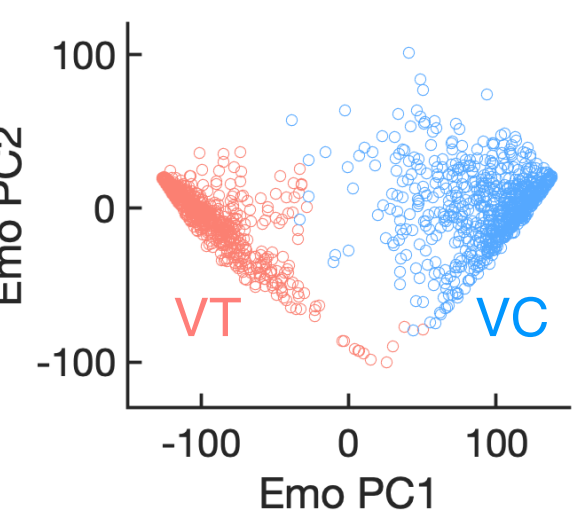


BEHAVIORAL RESPONSES

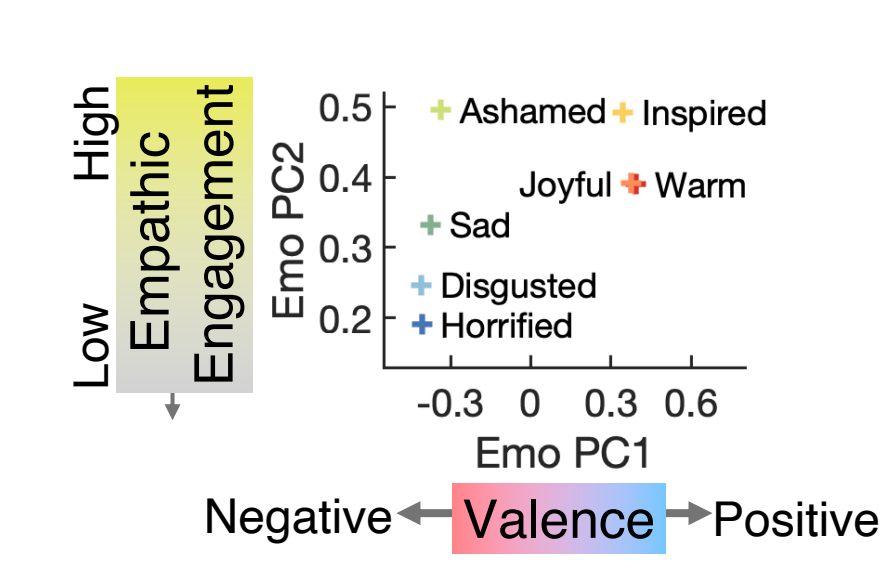
Averaged self-reported seven emotion ratings for nine clips



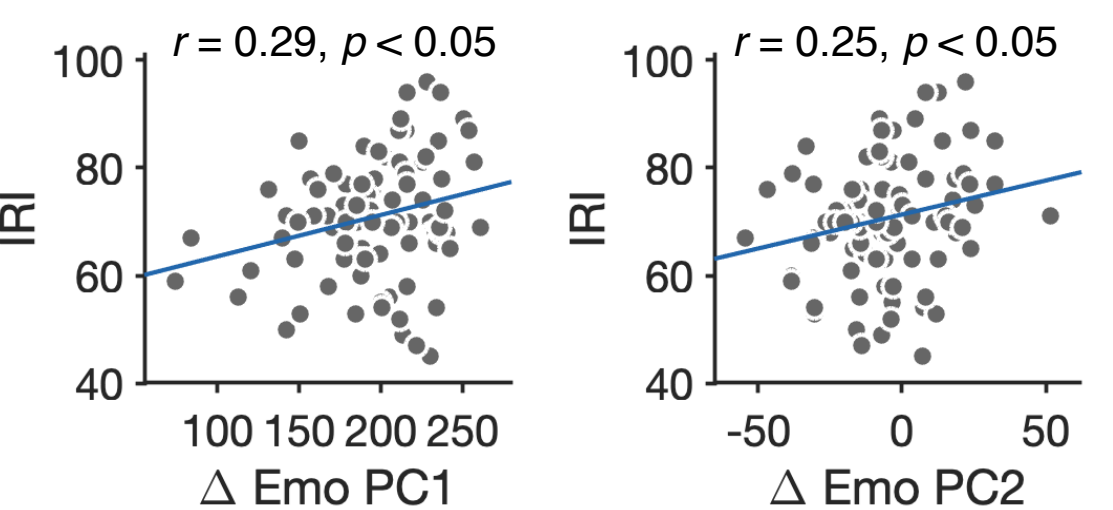
Emotion rating PC scores



PC coefficients of emotions



Correlation between EmoPC and Interpersonal Reactivity Index (IRI)



Correlation between EmoPC and IRI

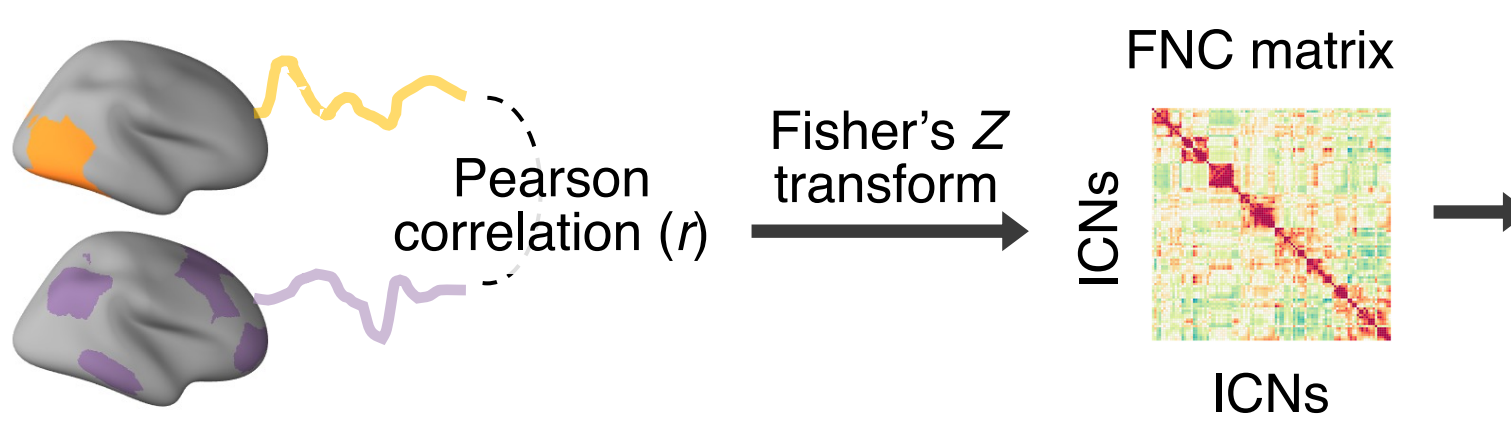
	Perspective Taking	Fantasy	Empathic Concern	Personal Distress	IRI total
EmoPC1	0.196	0.172	0.171	0.092	0.245*
EmoPC2	0.123	-0.010	0.209	0.261*	0.233*

Takeaway: VT elicited strong negative emotions and sustained increased heart rate, and these responses correlated with individuals' empathy traits.

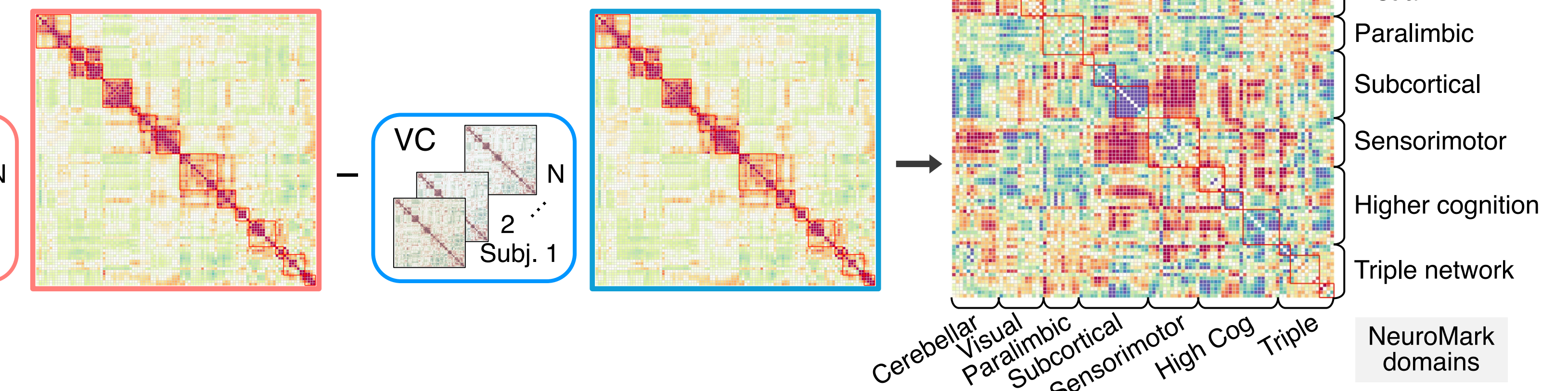
NEURAL FUNCTIONAL CONNECTIVITY on resting-state fMRI

Overview of Functional Network Connectivity (FNC) analysis

Template-constrained independent component analysis (ICA) NeuroMark 2.2 (Iraji et al., 2023; 105 intrinsic connectivity networks) estimated timeseries of each ICN per condition and participant

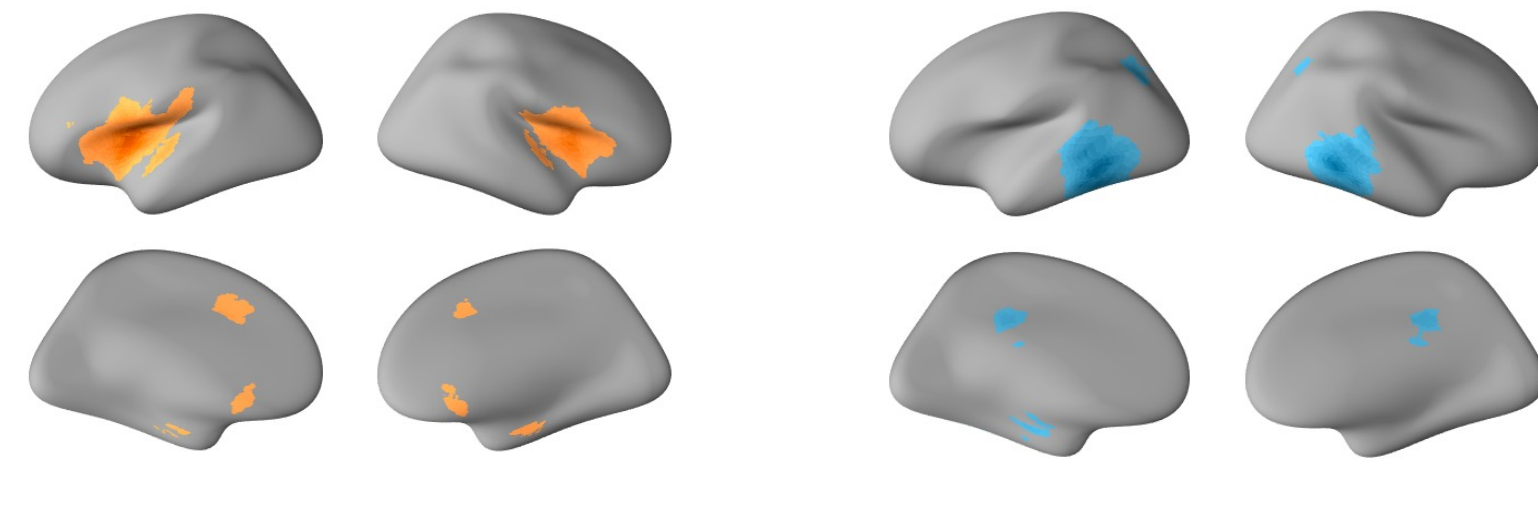


Averaged Functional Connectivity (sFNC)

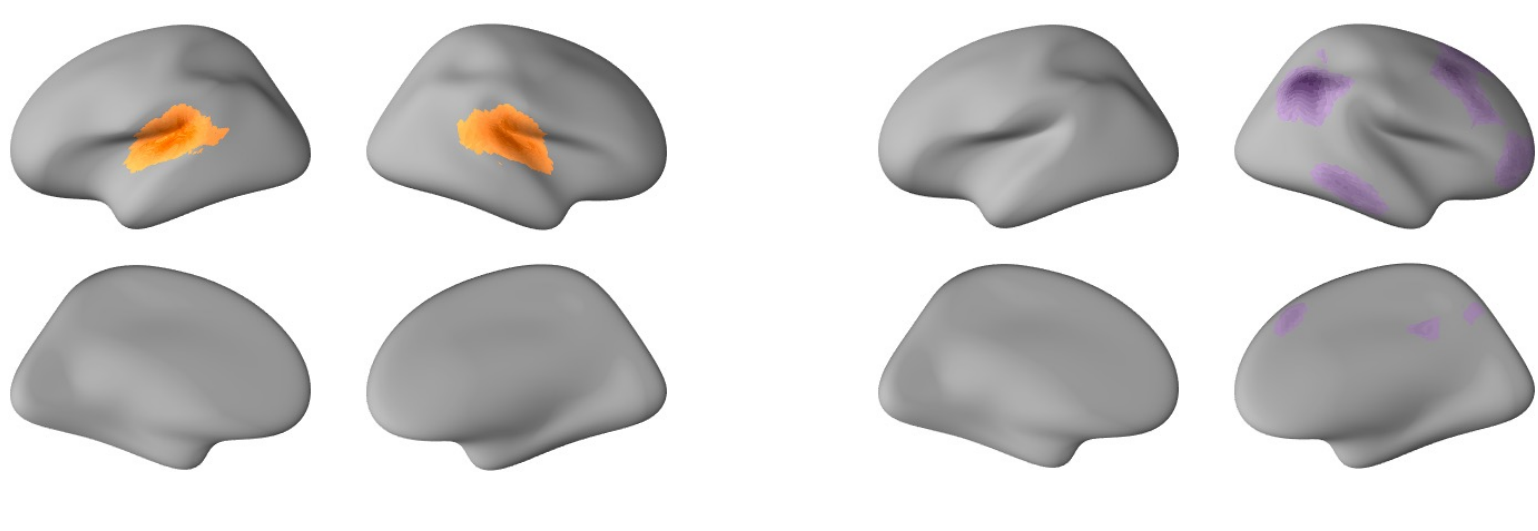


Significant connectivity changes (FDR $q < 0.05$)

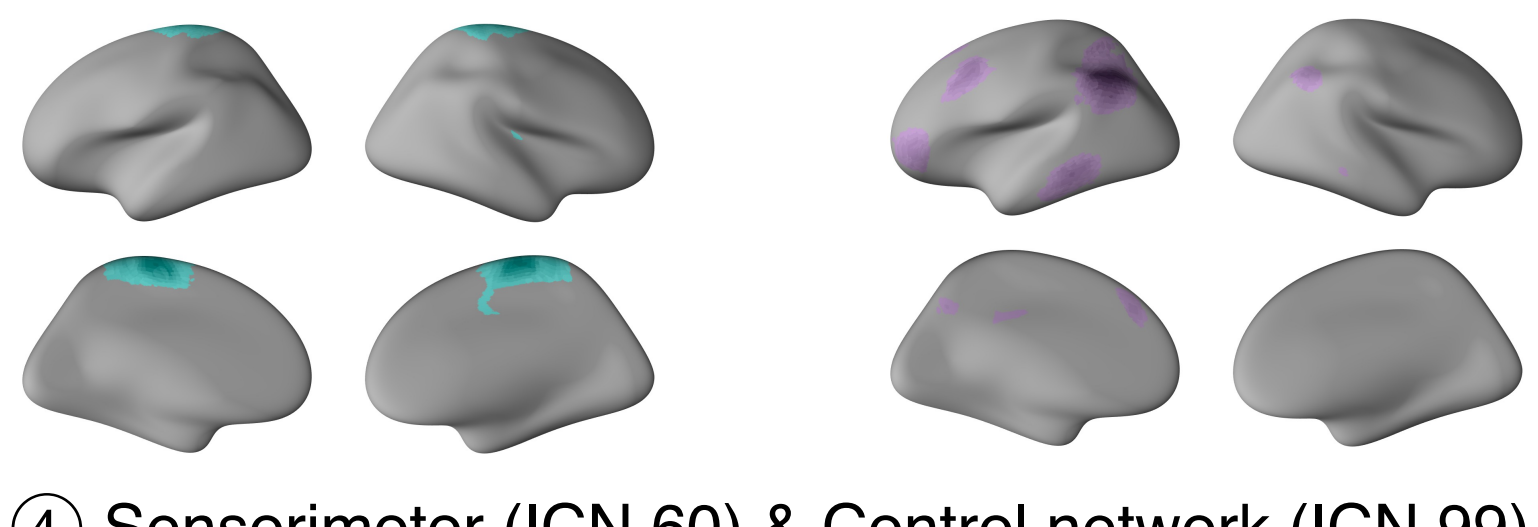
① Insula (ICN 71) & Middle Temporal Gyrus (ICN 80)



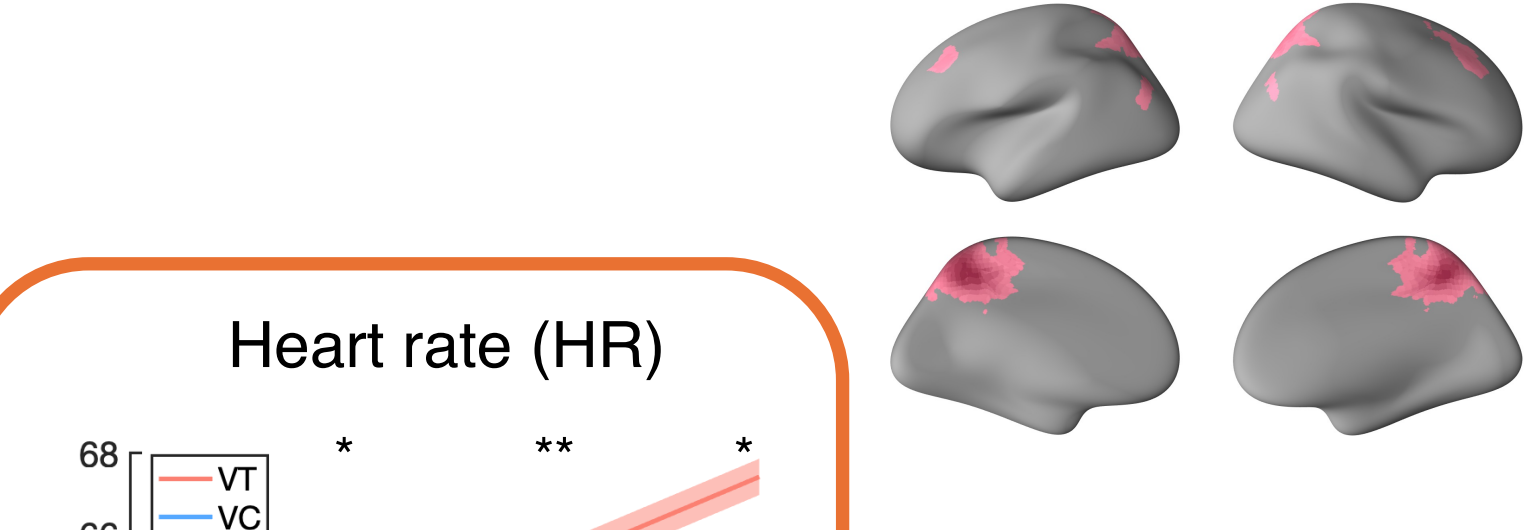
② Insula (ICN 74) & Central Executive network (ICN 91)



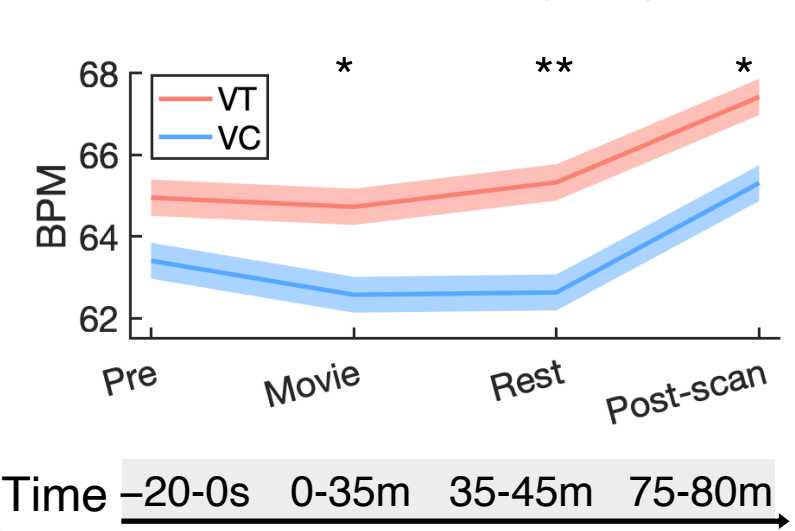
③ Sensorimotor (ICN 60) & Central Executive network (ICN 92)



④ Sensorimotor (ICN 60) & Control network (ICN 99)



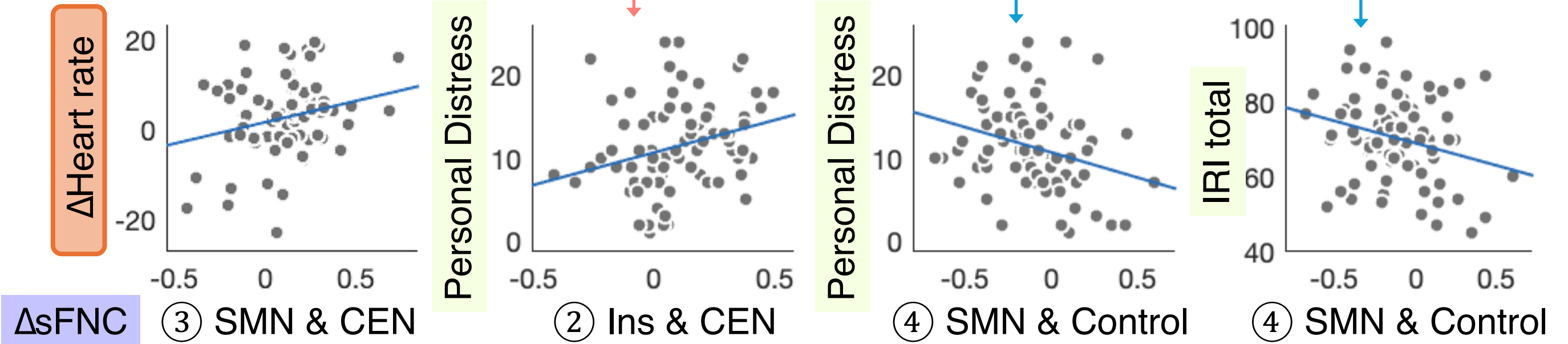
Heart rate (HR)



AUTONOMIC RESPONSES

Correlation between ΔsFNC (VT-VC) & IRI

Pairs	Perspective Taking	Fantasy	Empathic Concern	Personal Distress	IRI total
①	-0.073	-0.056	-0.071	-0.025	-0.086
②	-0.067	-0.029	-0.129	0.255*	0.044
③	0.195	0.043	0.114	0.059	0.153
④	-0.127	-0.101	-0.082	-0.246*	-0.234*



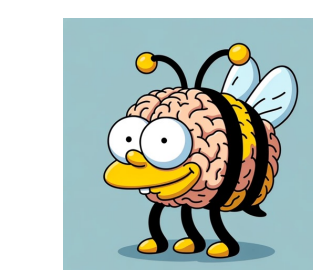
DISCUSSION

- Vicarious trauma (VT) produced significantly stronger negative emotions and sustained sympathetic arousal. Precision fMRI revealed widespread network reconfiguration during resting-state following the VT condition compared to the VC. Specifically, we observed significantly weakened connectivity—characterized by both increased negative and decreased positive connectivity—between the sensorimotor network (SMN), the central executive network (CEN), and control networks. Furthermore, VT led to weakened connectivity between the insula and both the middle temporal gyrus and the CEN.
- These results suggest that VT does not simply increase negative affect, but rather induces a state of neural dysregulation where executive control becomes uncoupled from the sensory and autonomic processing of others' suffering. Critically, changed SMN-CEN connectivity was associated with sustained post-movie heart rate, suggesting a direct link between large-scale network integration and the autonomic arousal associated with vicarious trauma.
- Finally, these connectivity changes within the SMN and insula were most pronounced in individuals with higher trait personal distress (IRI). Together, these results shed light on the neurobiological mechanisms underlying vicarious trauma and empathy, highlighting how the breakdown of inter-network communication may drive the transition from empathy to overwhelming distress and long-term health costs.

REFERENCES

Koenig et al., 2018, Journal of Religion & Health; Branson, 2019, Traumatology; MacNair, 2002, Peace & Conflict: Journal of Peace Psychology; Sial et al., 2016, J. of Neuroscience Methods; Iñiguez et al., 2018, Biological Psychiatry; Wardwell et al., 2020, Stress; Warren et al., 2013, Bio. Psychiatry; Hodes et al., 2014, PNAS; Ródenas-González et al., 2023, Biomedicine; McEwen, 2000, Neuropsychopharmacology; Cole, 2013, American Journal of Public Health; Iraji et al., 2023, Human Brain Mapping

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Scan to view the preprint for the first paper of this project. Feel free to get in touch!

