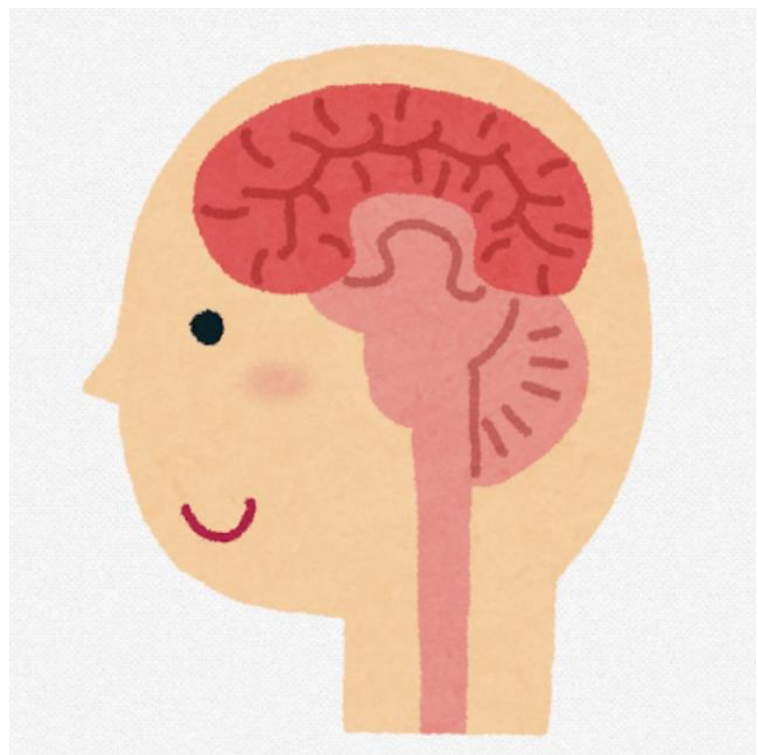
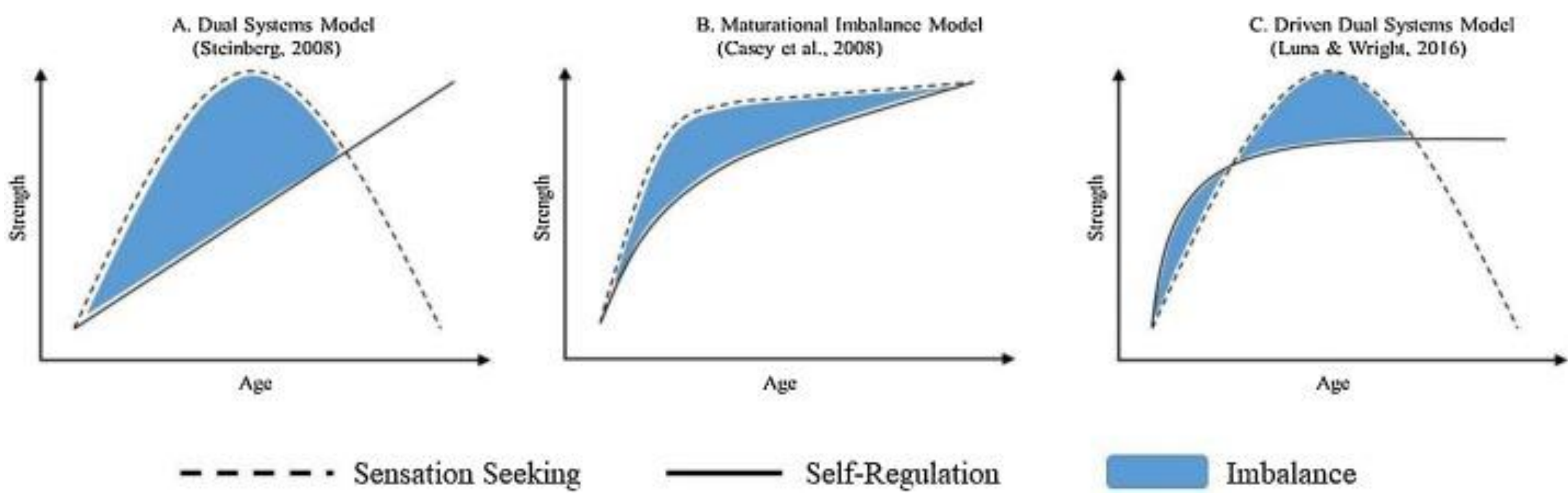
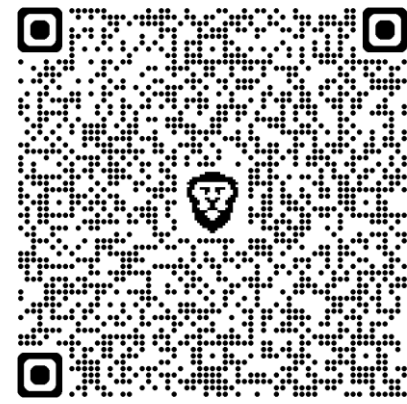


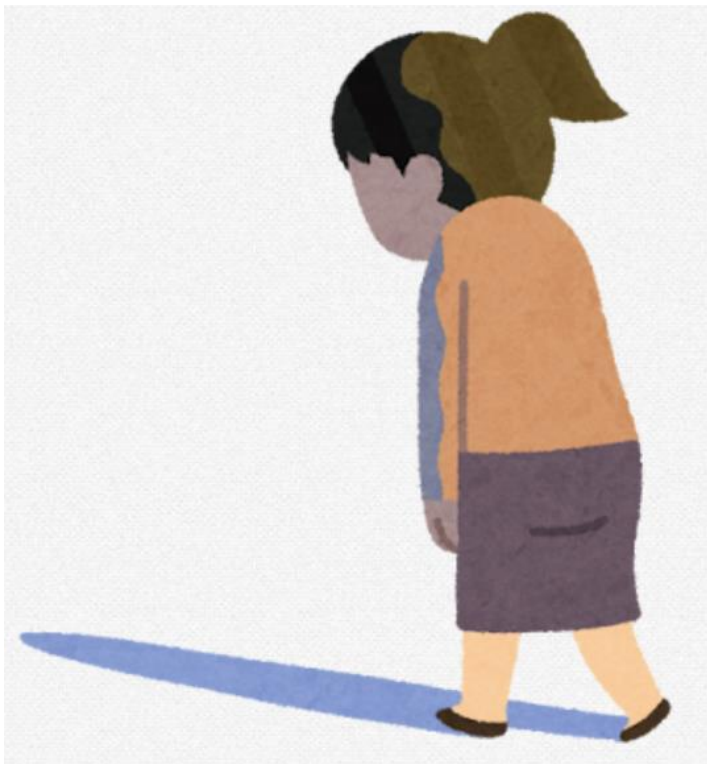
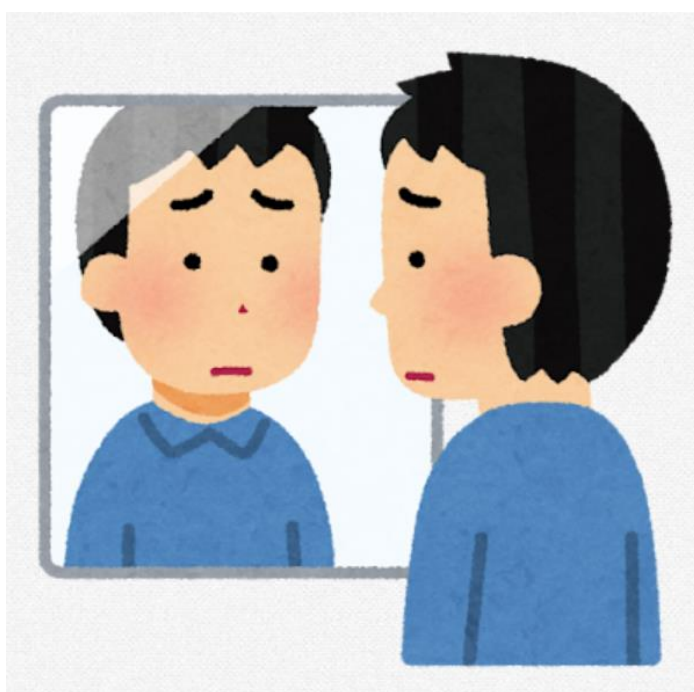
Interrelations between trait impulsivity and morphometric dissimilarities in the developing brain

Sieun Lee^{1,2}, Christopher Tench^{1,2}, Marianne Etherson³, Nitish Jawahar², Ellen Townsend⁴, Chris Hollis^{1,2,5}, Rory O'Connor³, Dorothee P. Auer^{1,2} on behalf of the Digital Youth Research Team

¹NIHR Nottingham Biomedical Research Centre, Queens Medical Centre, University of Nottingham, Nottingham, UK
²Mental Health and Clinical Neurosciences, School of Medicine, University of Nottingham, Nottingham, UK
³Suicidal Behaviour Research Lab, School of Health & Wellbeing, University of Glasgow, Glasgow, UK, ⁴School of Psychology, University of Nottingham, Nottingham, UK
⁵NIHR MindTech HealthTech Research Centre, University of Nottingham, Nottingham, UK



Adolescence is associated with **impulsive, risk-taking behaviours**.



Impulsivity also plays a role in **self-harm and suicidal behaviours** in youth.

Various theoretical models of development (e.g. Dual Systems Model, Maturation Imbalance Model, Driven Dual Systems Model) posit that adolescent risk behaviours results from an **imbalance between the development of cognitive control and socioemotional neural system**.¹

However, compared to the extensive research in the psychological and cognitive constructs, there are fewer studies on the **biological underpinnings** of these ‘imbalance’ models.

Meisel, Fosco, Hawk, and Colder (2019)

In this study², we analyse the **brain MRI data of preadolescent children (age 9-10)** to measure the **coordinated developmental changes across brain regions** using morphometrics similarity networks (MSNs).³ Our Hypotheses are:

1. **Brain morphometric similarities / dissimilarities** are associated **trait impulsivity** in preadolescence.
2. Brain morphometric similarity and impulsivity have moderating and/or mediating effects on **suicidal ideation and behaviour** in preadolescence.

Data and Methods



Adolescent Brain Cognitive Development (ABCD) is a 10-year longitudinal study of ~11,000 American children from age 9-10.⁴

Seventeen cortical structural and diffusion MRI metrics across 68 bilateral brain regions of interests (ROIs) based on the Desikan-Killiany atlas were obtained from the ABCD baseline data. Metric section was informed by a previous study.⁵ **Individual MSNs** were computed using ROI-to-ROI Pearson correlations of the z-scored metrics, followed by **consensus Louvain community detection**. **Intra- and inter-module similarities** were computed by averaging the network edges within and between modules.

Trait impulsivity was measured using UPPS (Urgency, Premeditation, Perseverance, Sensation seeking) Impulsive Behaviour Scale⁶ and BIS/BAS (Behavioural Approach / Inhibition System) Scale.⁷ As a preliminary analysis, uncorrected Pearson correlations were used to test associations between module similarity and impulsivity scores.

Results: Cortical Developmental Modules

We identified **four clusters of cortical ROIs (developmental modules, Fig.1, 2)**, sharing morphometry-based maturation similarity, spatial proximity, and functional network correspondence.

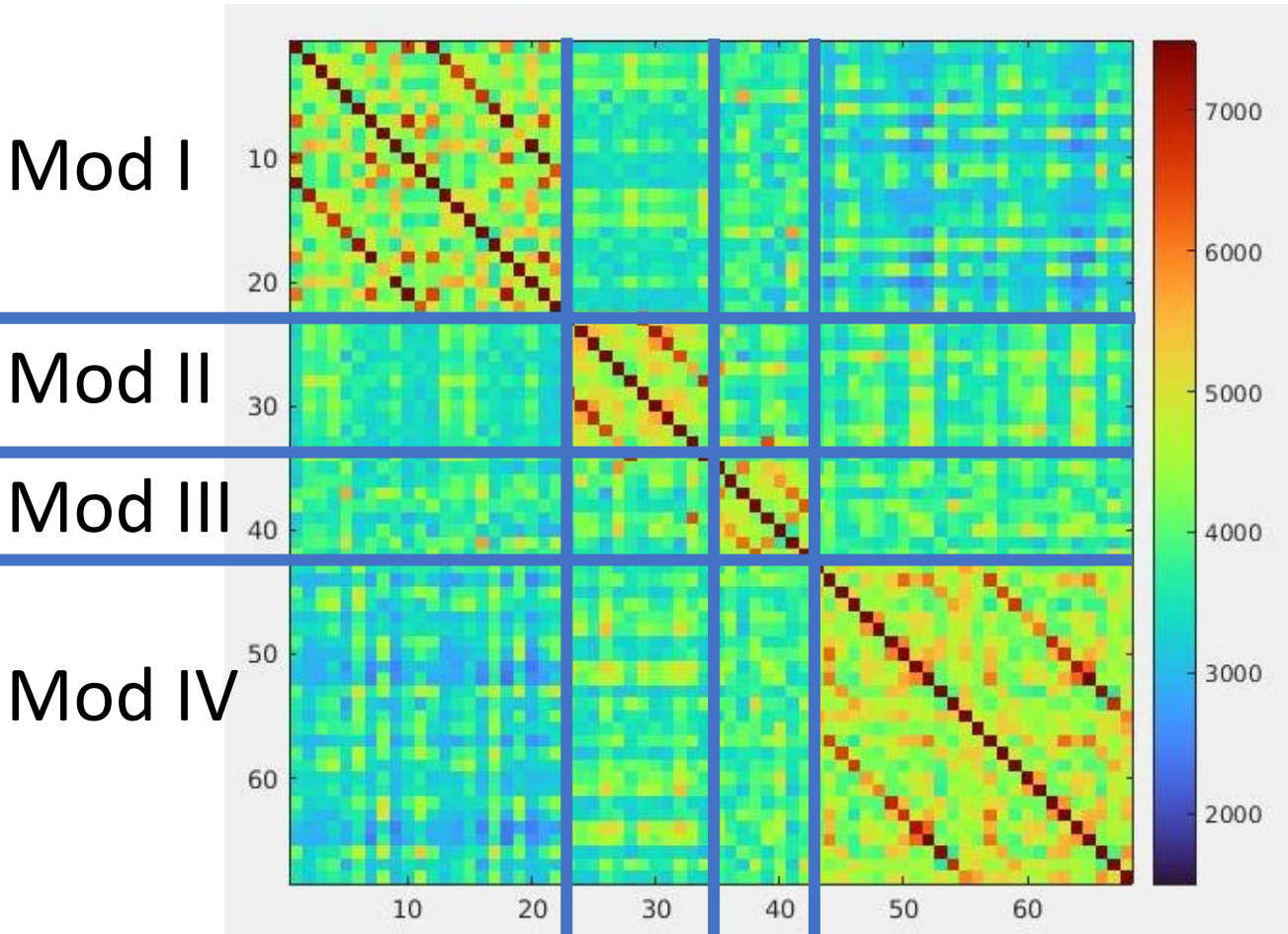


Fig 1. Louvain community co-classification frequencies between ROIs. High frequency indicates often similar z-scores between the ROIs. The off-diagonal patterns represent bilateral ROIs, demonstrating the regional variation in developmental bilaterality.

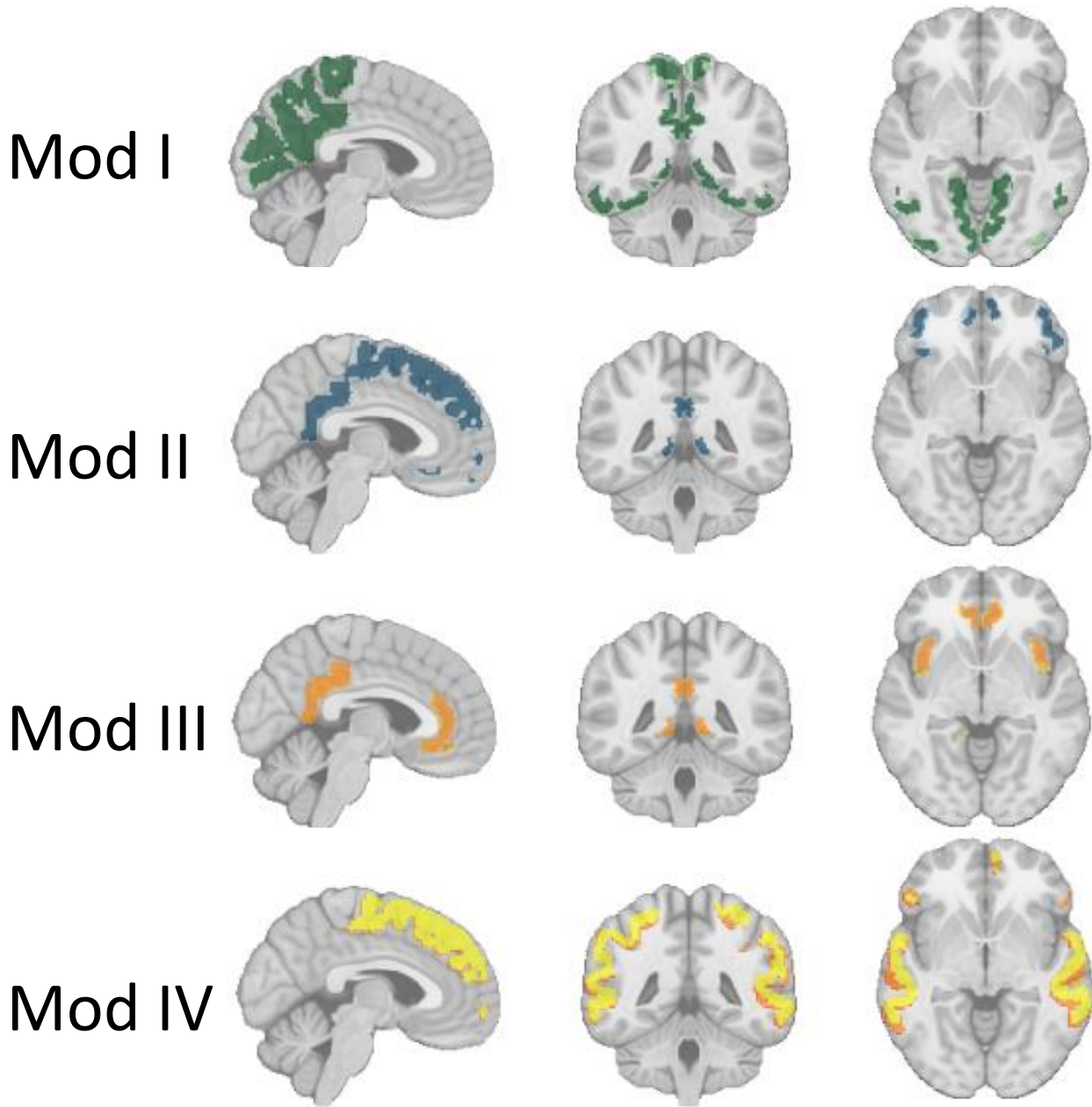


Fig 2. Brain regions forming developmental modules

- Module I. Posterior-Medial** (visual processing, memory)
- Module II. Orbitofrontal-Limbic** (reward-based decision making, emotion regulation)
- Module III. Medial-Lateral** (salience, auditory processing)
- Module IV. Fronto-Parietal** (neurocognitive control, sensorimotor integration)

Results: Intra and Inter-module Similarities

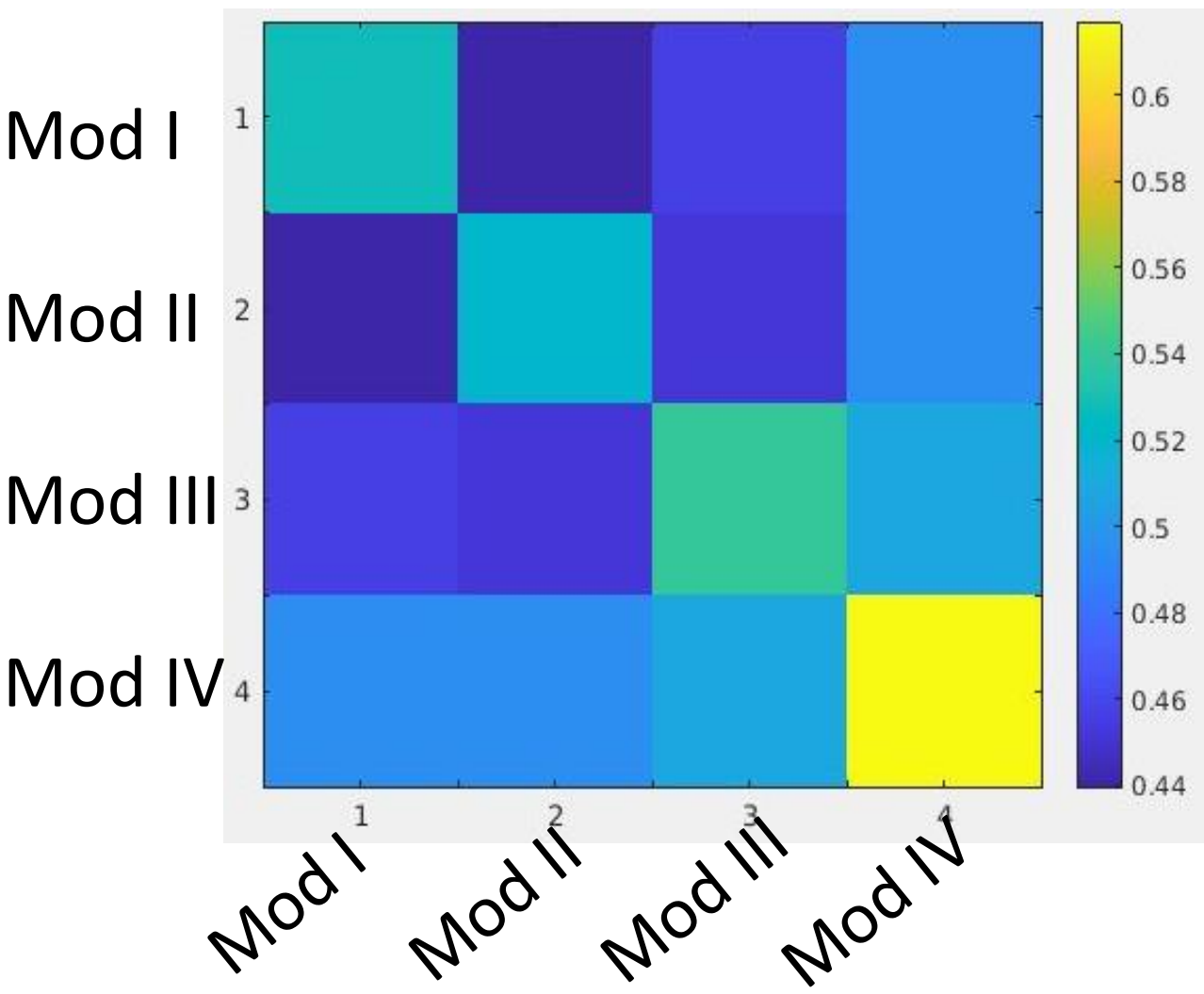


Fig 3. Intra- and Inter-module similarities

Fig. 3 visualizes the Intra- and inter-module similarities. **Module IV** (fronto-parietal) showed the highest intra-module similarity as well as the highest inter-module similarities. **Module II** (orbitofrontal-limbic) shows the lowest intra-module similarity as well as the lowest inter-module similarities.

Results: Modular Similarities, Impulsivity, and Suicidality

BAS Reward Responsiveness (BAS-RR) was positively associated ($t = 3.70, p = 0.0002$) with the **Mod I-II inter-module similarity**. **BIS Inhibition** was negatively associated with **Mod IV intra-module similarity** ($t = 2.05, p = 0.040$), which was also positively associated with **UPPS Negative Urgency (UPPS-NU, $t = 2.52, p = 0.010$)**. BAS-RR and UPPS-NU were associated with **suicidality** in the same cohort.

		Odds Ratio	<i>p</i>
Suicidal Ideation	BAS-RR	1.064	<.001
	UPPS-NU	1.216	<.001
Suicidal Behaviour	BAS-RR	1.085	0.044
	UPPS-NU	1.379	<.001

Discussion and Next Steps

These findings link regional brain morphometric similarity to impulsivity traits in preadolescents, with possible downstream associations with suicidality. Rather than mapping neatly onto “control” vs “sensation-seeking” systems, the data-driven modules reflect the transitional nature of preadolescent brain development—when neural systems are still organizing and differentiating. Greater synchrony (or reduced differentiation) within and between certain modules may underlie elevated behavioural reactivity at this stage. These results invite a more nuanced view of the ‘maturation imbalance’ model, where timing, strength, and context of brain development may shape outcomes. Next, we will examine longitudinal trajectories using 2-year follow-up data and test mediation and moderation models to clarify pathways linking brain development, impulsivity, and suicidality.

1. Meisel et al., *Dev Cogn Neurosci* 2019
2. Lee et al., *University of Nottingham* 2024
3. Seidlitz et al., *Neuron* 2018
4. Casey et al., *Dev Cogn Neurosci* 2018
5. Wu et al., *Molecular Psychiatry* 2022
6. Whiteside & Lynam, *Pers Individ Dif* 2001
7. Carver & White, *J Pers Soc* 1994