



Github



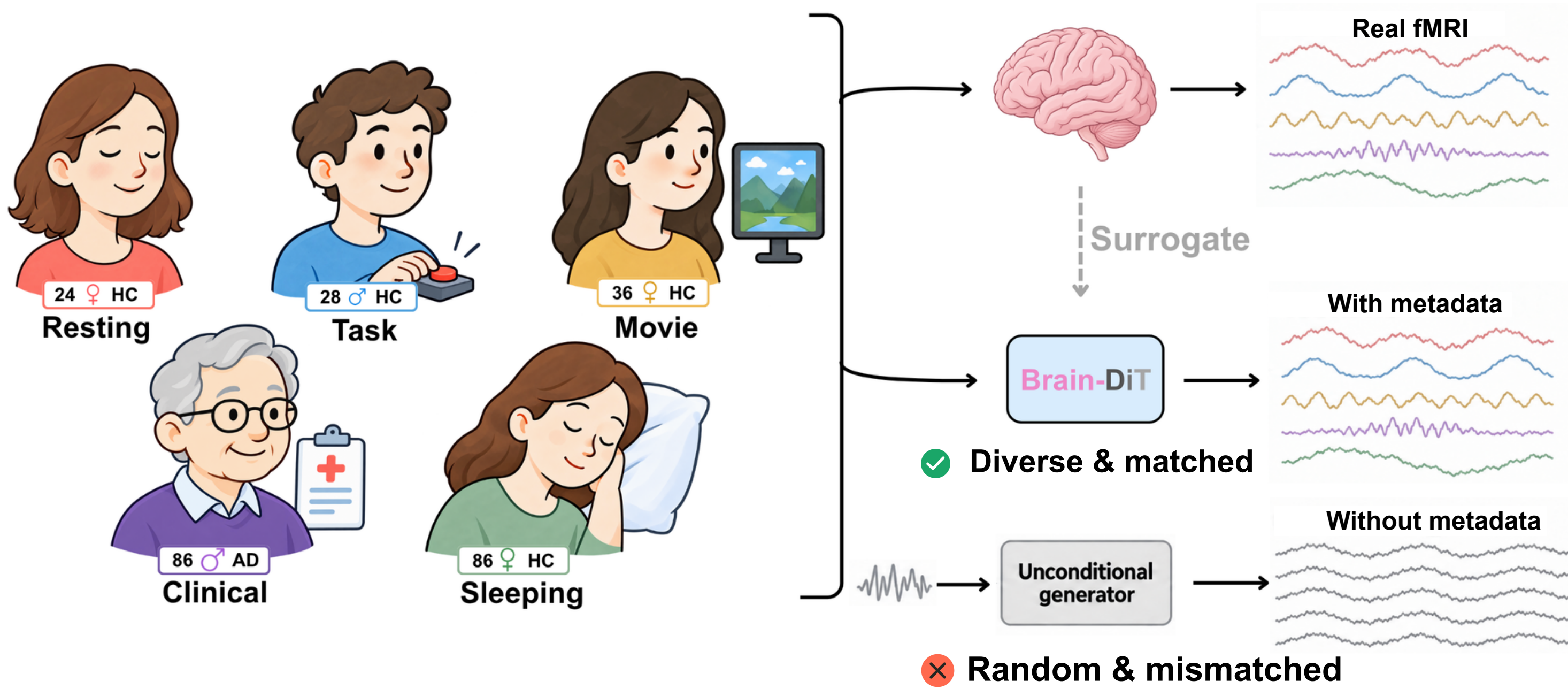
Follow up



More work~

Motivation

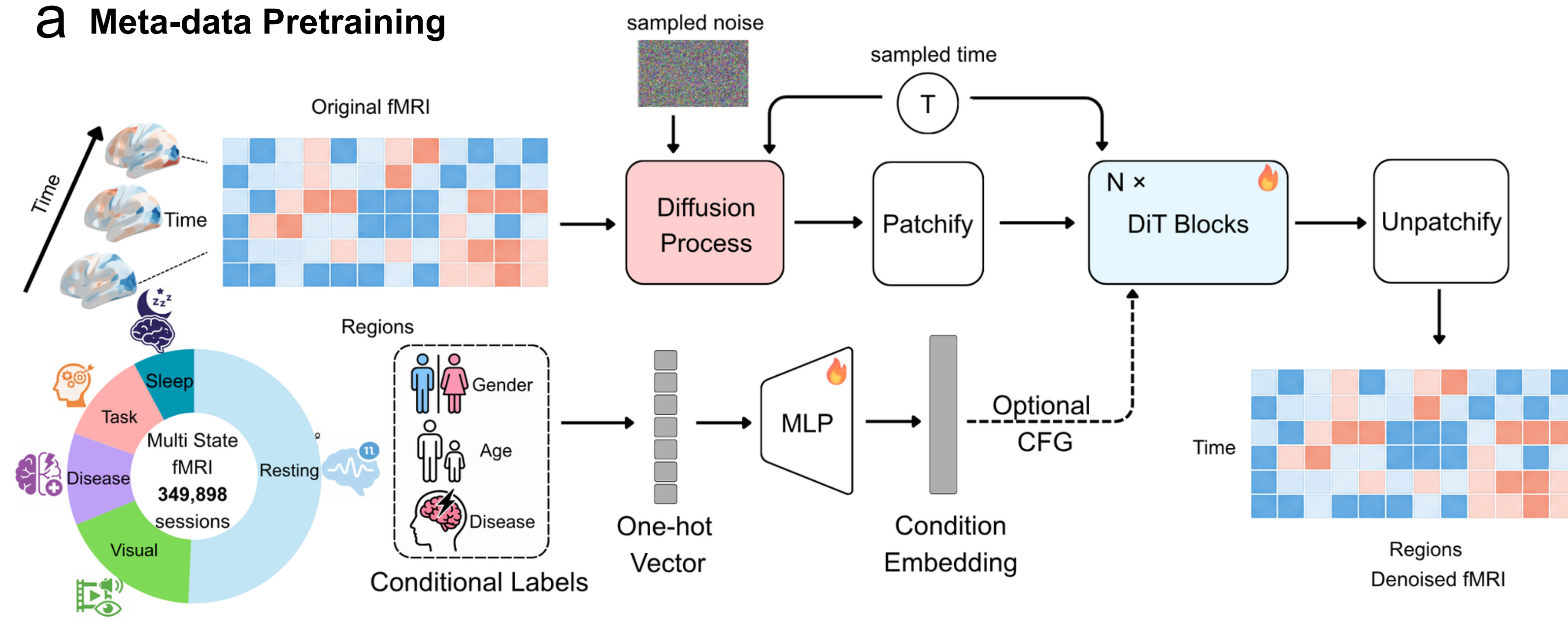
a Brain activity varies across states and individuals.



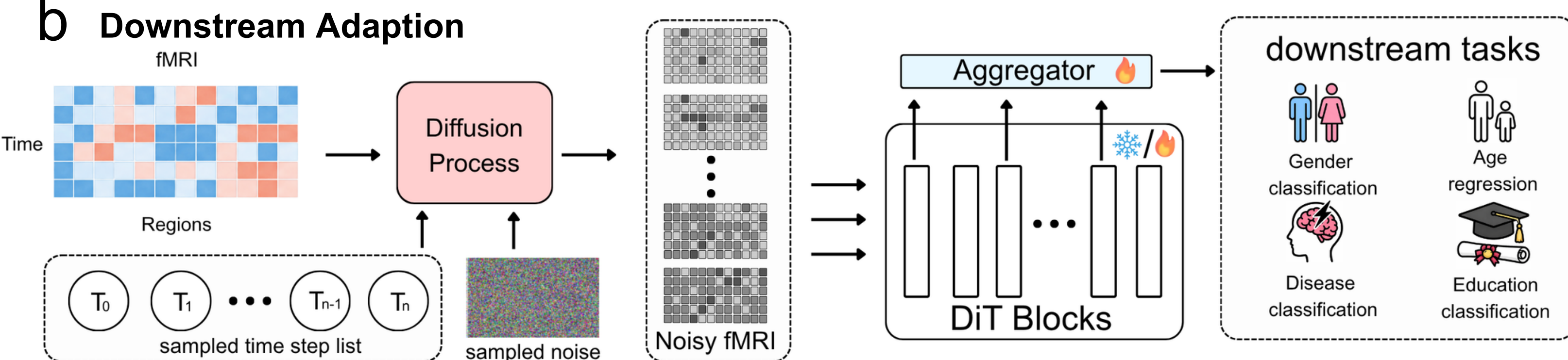
Brain activity differs across states and individuals. This diversity motivates a shared model that captures common patterns while accounting for individual characteristics.

Framework

a Meta-data Pretraining



b Downstream Adaption

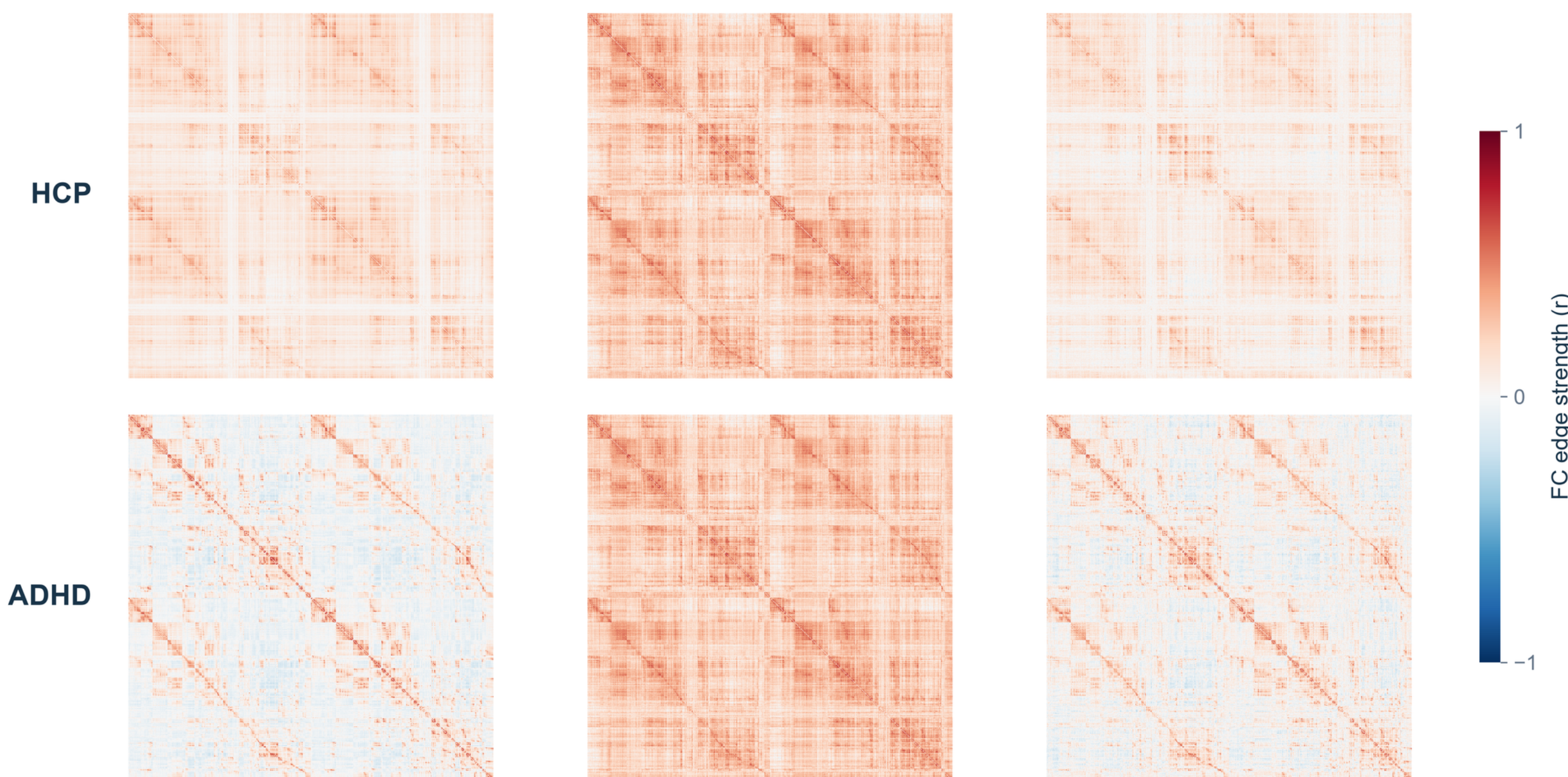


Brain-DiT learns to denoise fMRI from multiple brain states. Subject metadata—including age, sex, and diagnosis—conditions the denoising process. The pretrained DiT extracts features across noise levels and network layers. A learnable aggregator combines these features for downstream classification and regression.

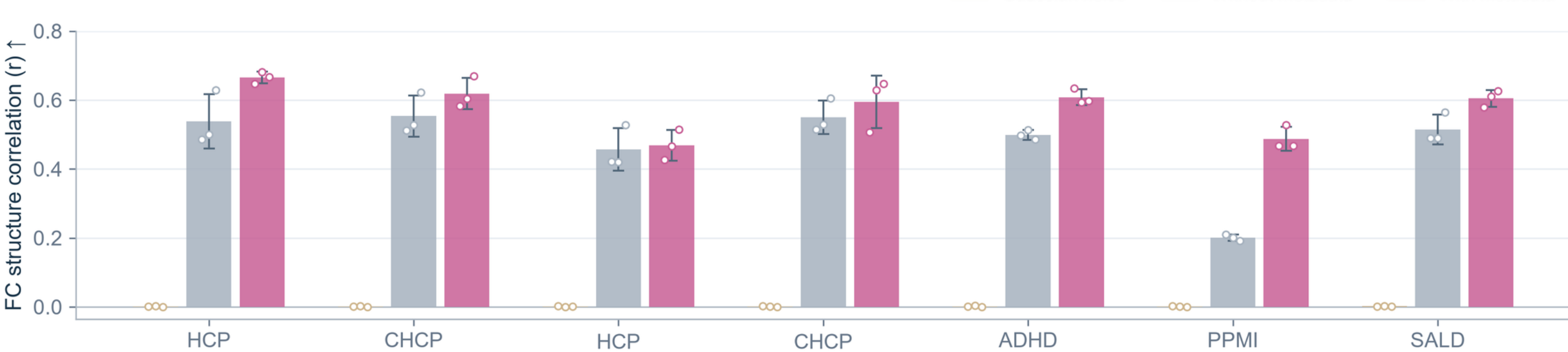
Generation

Subject metadata guides generation toward cohort-specific brain connectivity.

Observed Without metadata With metadata

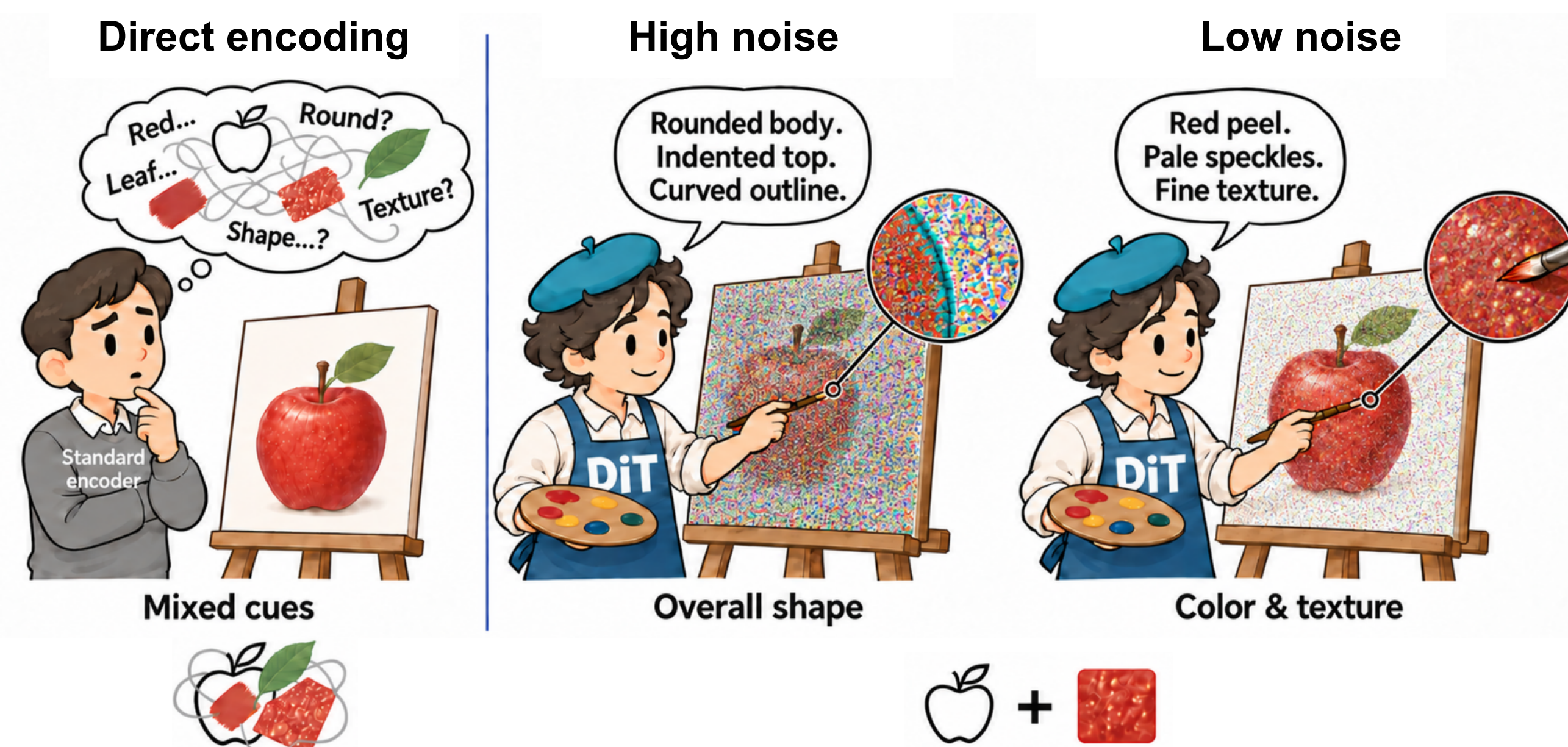


FC structure similarity



Metadata-conditioned generation achieves higher mean group-level FC structure similarity than unconditional generation across the seven datasets shown.

b Different noise levels may encourage complementary features



✗ Entangled representations

✓ Complementary representations

The apple illustrates how noise level can change the recovery task, from overall shape to fine detail. We hypothesize that varying the noise level during fMRI denoising may encourage complementary features for downstream prediction.

Downstream

Brain-DiT learns transferable representations

Model	In-distribution (ID)				
	HCP Gender classif.	ABIDE-AGE Age regression		SALD Age regression	
	ACC (%) ↑	MSE ↓	R ↑	MSE ↓	R ↑
BrainLM	62.71±4.43	0.91±0.01	0.24±0.02	0.68±0.06	0.62±0.06
Brain-JEPA	69.97±2.73	0.98±0.07	0.17±0.02	1.13±0.11	0.30±0.06
BrainMass	67.65±1.02	0.70±0.04	0.50±0.04	0.70±0.08	0.63±0.06
Brain-DiT _{AAL424}	81.71±0.77	0.80±0.02	0.59±0.01	0.53±0.02	0.65±0.01
Brain-DiT _{uncond}	80.98±1.22	0.77±0.02	0.60±0.02	0.39±0.02	0.75±0.01
Brain-DiT	82.71±0.79*	0.75±0.01	0.61±0.01*	0.33±0.01*	0.79±0.01*

Model	Out-of-distribution (OOD)				
	PPMI Disease classif.	ADHD Disease classif.	NKI-EDU Education classif.	NKI-AGE Age regression	
	ACC (%) ↑	ACC (%) ↑	ACC (%) ↑	MSE ↓	R ↑
BrainLM	54.86±1.20	58.37±1.04	60.46±0.73	0.50±0.02	0.68±0.01
Brain-JEPA	47.91±3.61	54.89±4.98	49.21±2.15	1.03±0.08	0.33±0.03
BrainMass	58.68±4.21	57.21±3.45	62.36±1.24	0.60±0.06	0.62±0.04
Brain-DiT _{AAL424}	58.99±1.46	<u>62.38±0.67</u>	60.18±1.81	0.44±0.04	0.77±0.02
Brain-DiT _{uncond}	60.99±2.14	62.06±0.36	69.78±3.29	0.40±0.02	0.80±0.01
Brain-DiT	61.15±1.84*	62.53±1.56*	69.92±0.02*	0.38±0.01*	0.81±0.01*

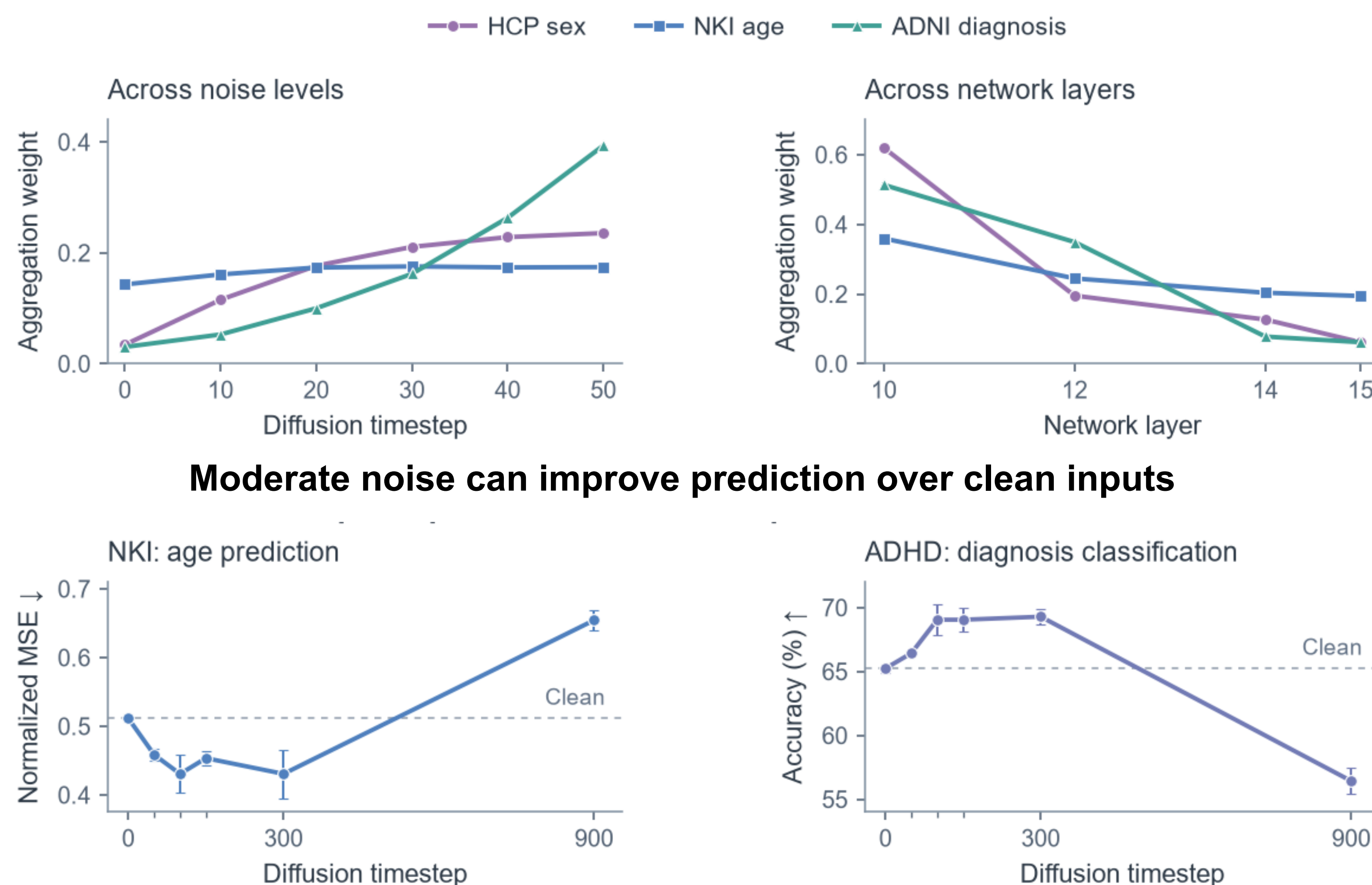
Model	Frozen backbone			
	ADHD Disease classif.	SALD Age regression	NKI-EDU Education classif.	NKI-AGE Age regression
	ACC (%) ↑	MSE ↓	ACC (%) ↑	MSE ↓
BrainLM	53.57±2.77	0.80±0.01	47.95±1.12	0.76±0.02
Brain-JEPA	52.24±2.66	0.76±0.01	38.69±0.23	0.95±0.02
BrainMass	54.89±3.38	0.78±0.03	54.89±3.38	0.72±0.01
SlimBrain _{jepa}	55.74±6.51	0.72±0.01	53.83±6.62	0.89±0.02
SlimBrain _{mae}	55.72±1.01	<u>0.71±0.07</u>	<u>60.59±2.77</u>	<u>0.68±0.01</u>
Brain-DiT	62.04±1.22*	0.67±0.01*	62.80±0.63*	0.58±0.03*

Bold red: best in each column; **underlined:** runner-up. AAL424 and uncond are Brain-DiT ablations.

* $p < 0.05$ versus the best baseline. For ID/OOD, baselines are BrainLM, Brain-JEPA and BrainMass; no tests among Brain-DiT variants. For frozen-backbone results, all five baselines are considered.

Ablations

Brain-DiT learns to combine information differently for different tasks



Broader brain-state coverage lowers error at a fixed pretraining budget

