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BrainLM: A Foundational Model For Brain Activity

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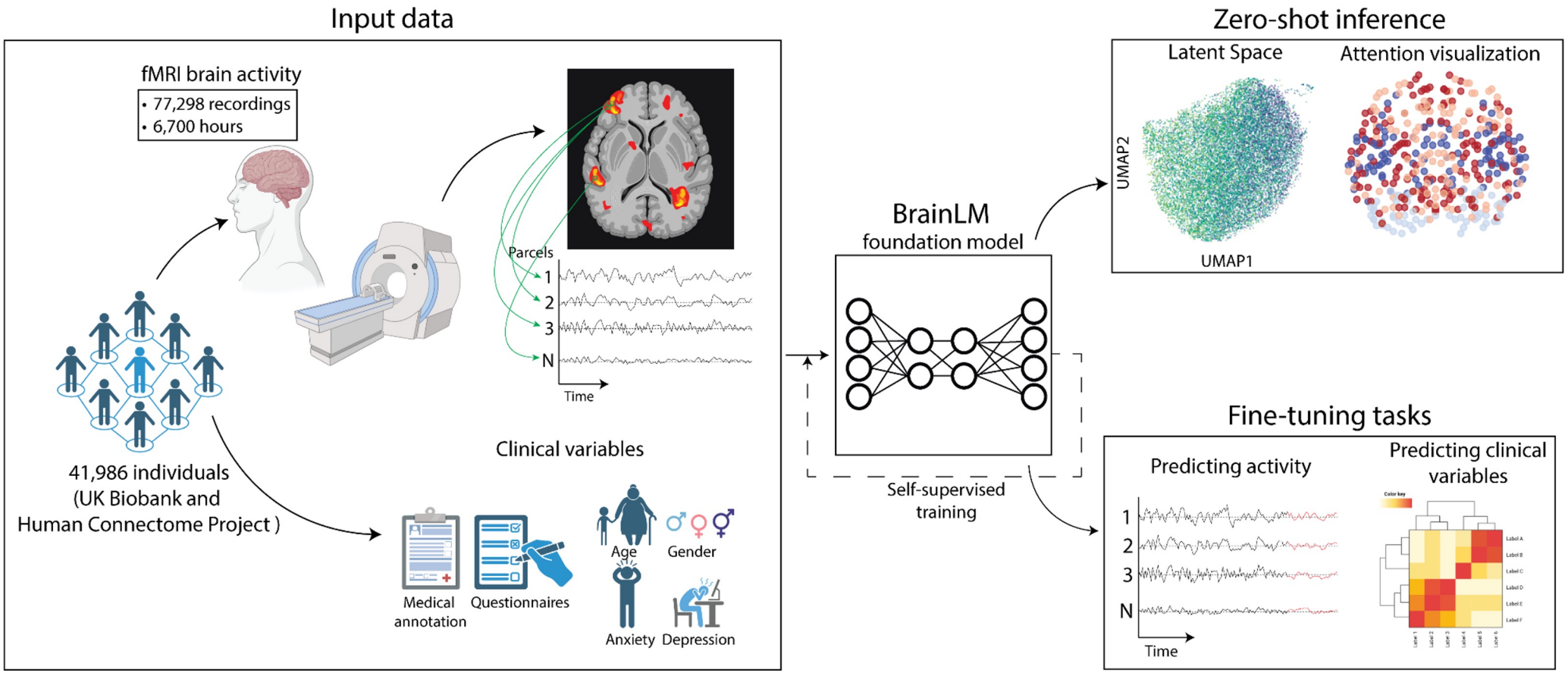
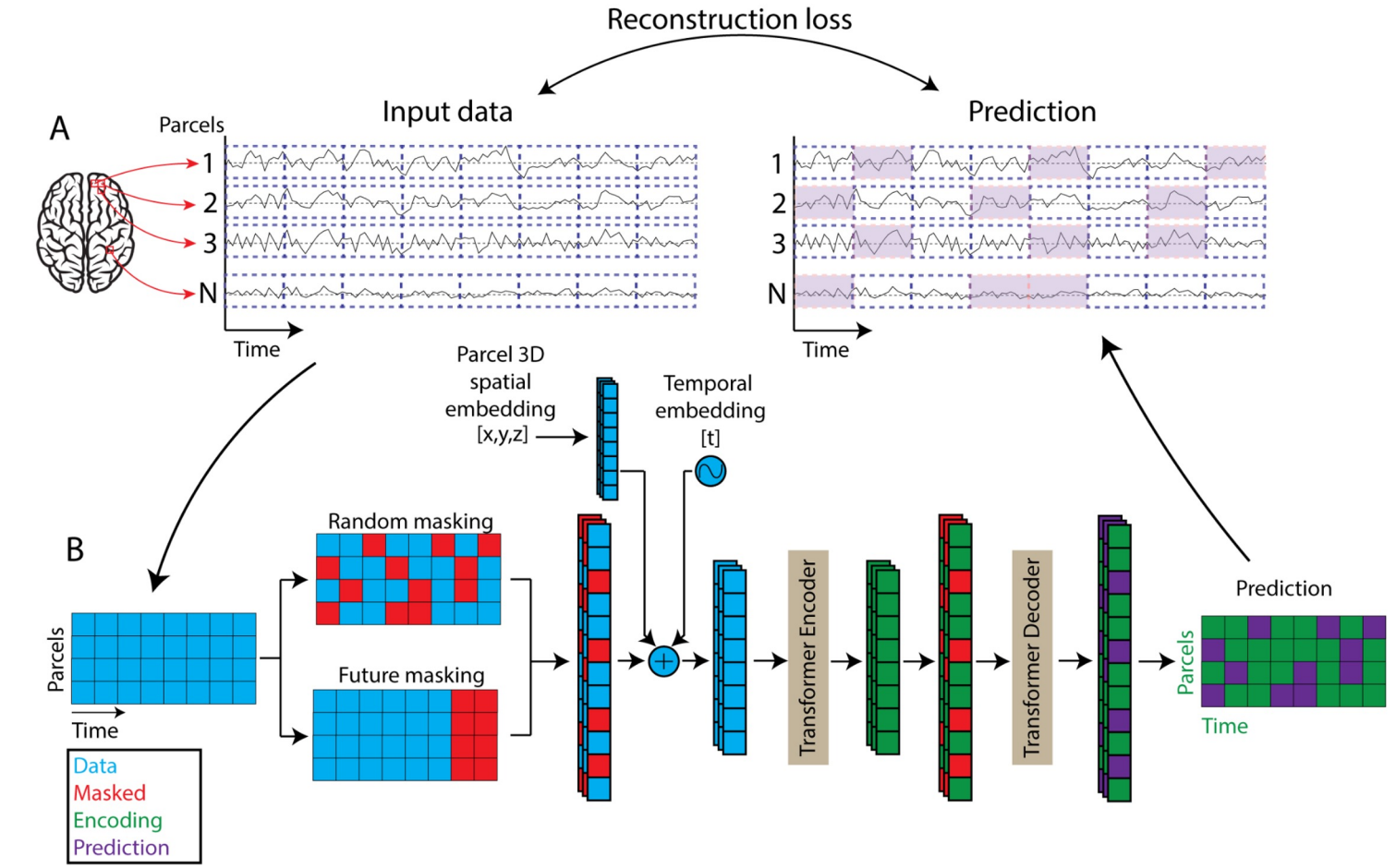
BrainLM captures brain activity from fMRI recordings

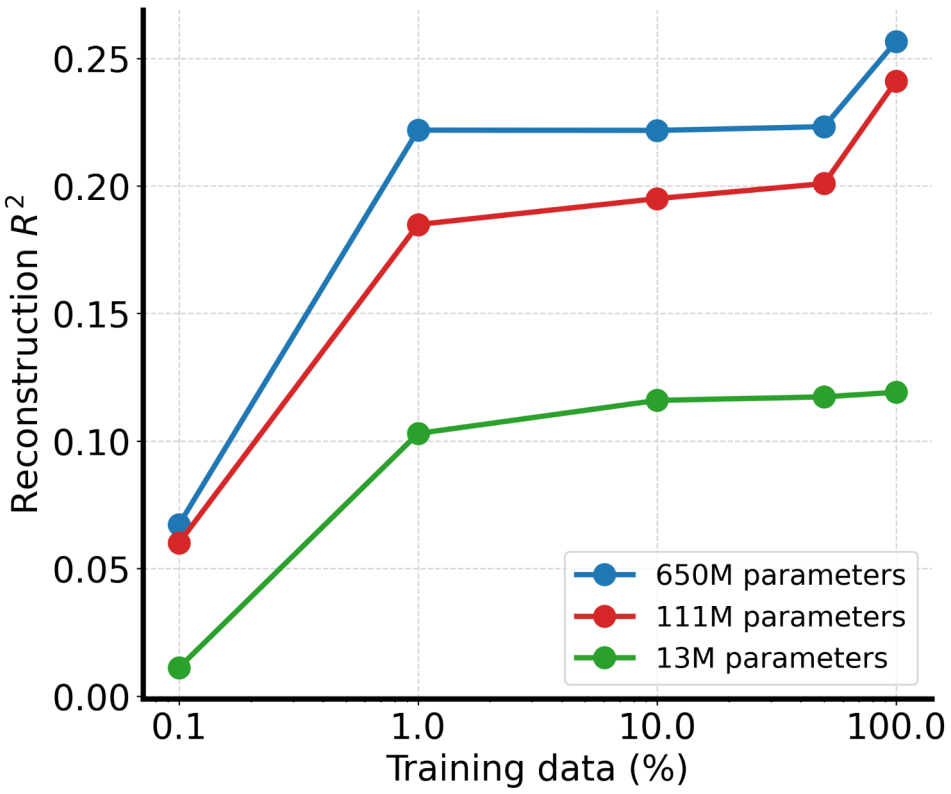


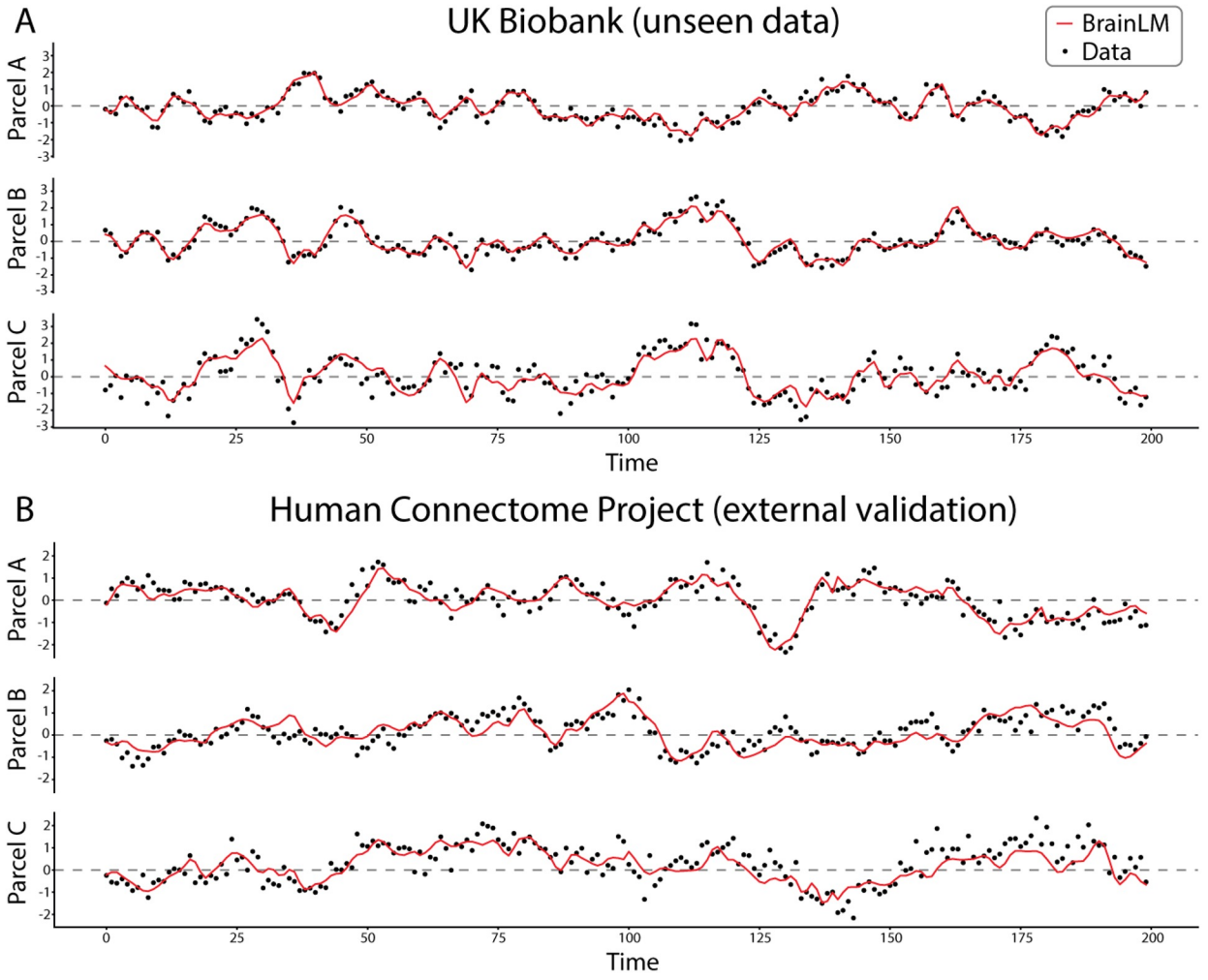
Vision transformers effectively encode brain activity

- Vision Transformer inspired architecture
- Pretraining objective:
  - Masked prediction of signal windows



BrainLM accurately reconstructs brain activity



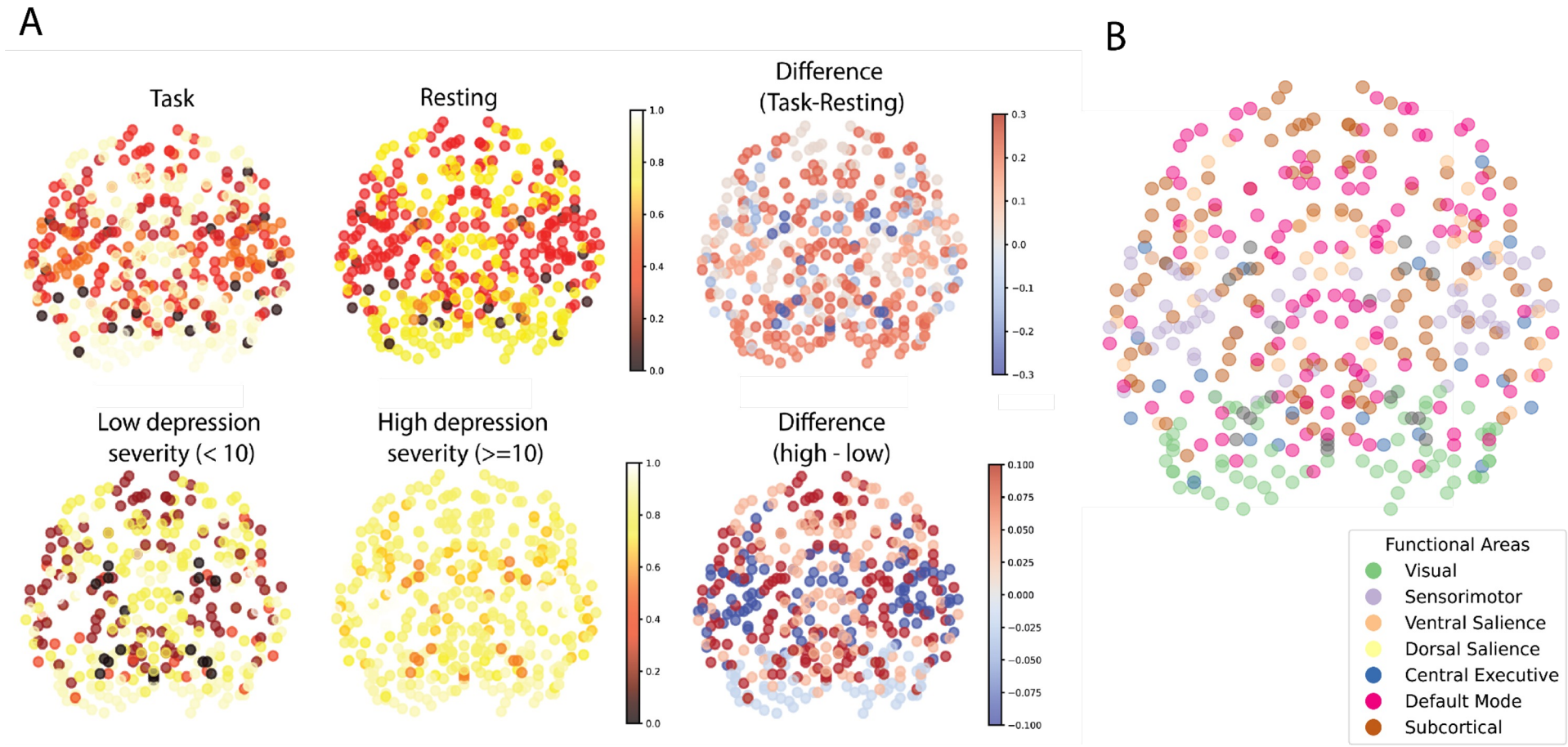


BrainLM latent space reflects clinical variables

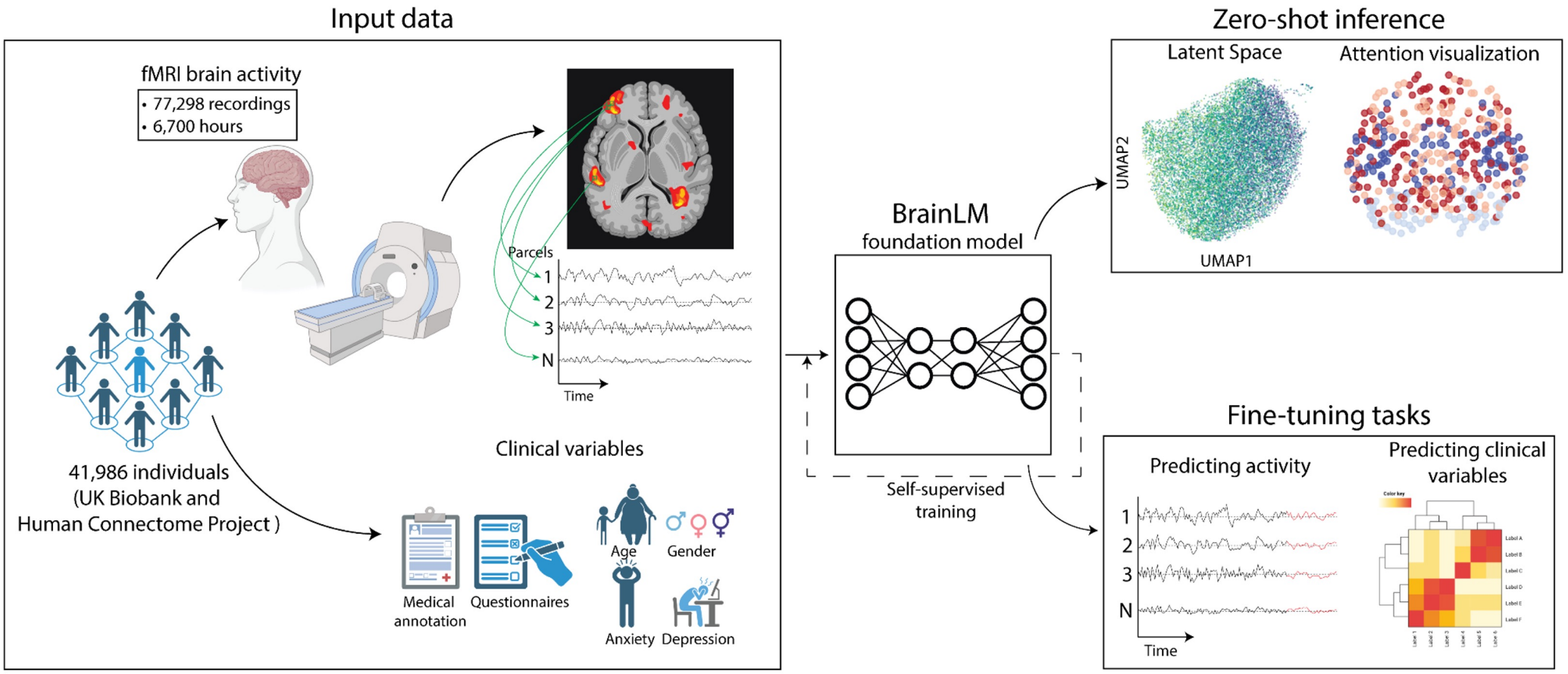
- BrainLM outperforms baseline models at clinical variable prediction on the UK Biobank dataset

	Age	PTSD (PCL-5)	Anxiety (GAD-7)	Neuroticism
Raw data	2.0 ± 0.2219	0.034 ± 0.0027	0.172 ± 0.0066	0.160 ± 0.0137
SVR	0.659 ± 0.036	0.022 ± 0.004	0.090 ± 0.010	0.087 ± 0.008
MLP	0.693 ± 0.001	0.021 ± 0.0003	0.081 ± 0.001	0.079 ± 0.0005
LSTM	0.596 ± 0.040	0.019 ± 0.001	0.083 ± 0.0022	0.076 ± 0.002
GCN	0.862 ± 0.09	0.021 ± 0.002	0.083 ± 0.02	0.077 ± 0.006
BrainLM 13M	**0.464 ± 0.0252**	0.018 ± 0.0008	0.074 ± 0.0053	0.072 ± 0.0049
BrainLM 111M	0.503 ± 0.0207	**0.015 ± 0.0003**	**0.073 ± 0.0031**	**0.069 ± 0.0038**

Attention analysis reveals functional region activity



Discussion


Input data
fMRI brain activity
• 77,298 recordings
• 6,700 hours
Parcels
1
2
3
N
Time
41,986 individuals
(UK Biobank and
Human Connectome Project)
Clinical variables
Medical annotation
Questionnaires
Age
Gender
Anxiety
Depression
BrainLM
foundation model
Self-supervised training
Zero-shot inference
Latent Space
Attention visualization
UMAP2
UMAP1
Fine-tuning tasks
Predicting activity
Predicting clinical variables
1
2
3
N
Time