

The background of the slide features a stylized, abstract representation of a brain's internal network. It consists of numerous circular nodes of varying sizes and colors—ranging from light green and blue to orange and grey—connected by thin, curved lines of the same color palette. This visual metaphor emphasizes the complex and interconnected nature of the brain regions being discussed.

Intrinsic Connectivity of Task-Defined Language Regions

Brain Hack School TW-SG 2025

Wei-Chen Huang

National Taiwan University

INTRODUCTION

- Previous studies have demonstrated the presence of intrinsic functional connectivity within the language network during resting state. (Tomasi & Volkow., 2012)
- Based on prior evidence of a resting-state language network, I want to explore the neural synchrony between core language areas and other major RSNs, including the DMN, SN, and FPN.

DATASET

Data Descriptor | [Open access](#) | Published: 30 September 2022

A synchronized multimodal neuroimaging dataset for studying brain language processing

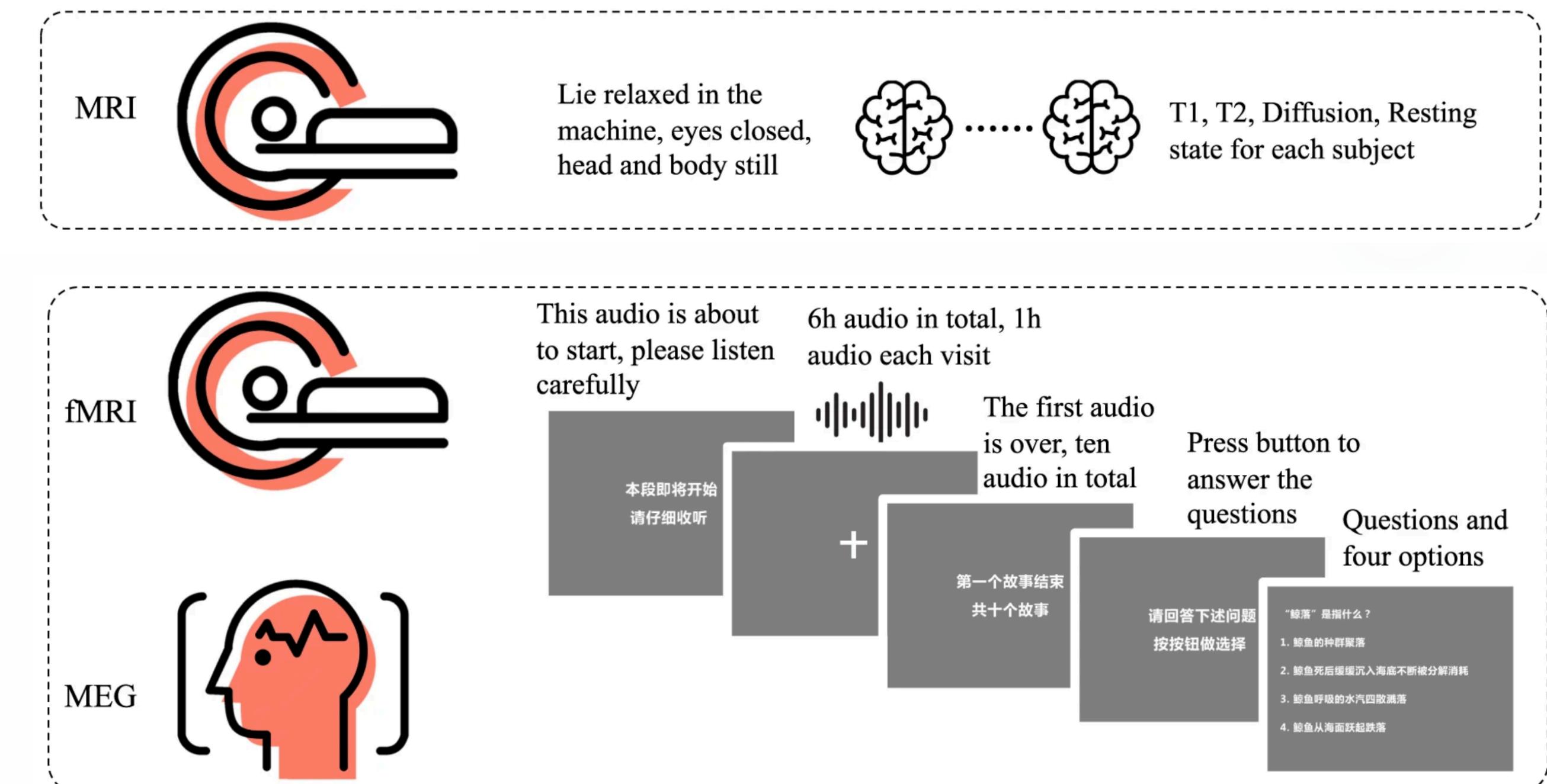
[Shaonan Wang](#) , [Xiaohan Zhang](#), [Jiajun Zhang](#) & [Chengqing Zong](#)

[Scientific Data](#) 9, Article number: 590 (2022) | [Cite this article](#)

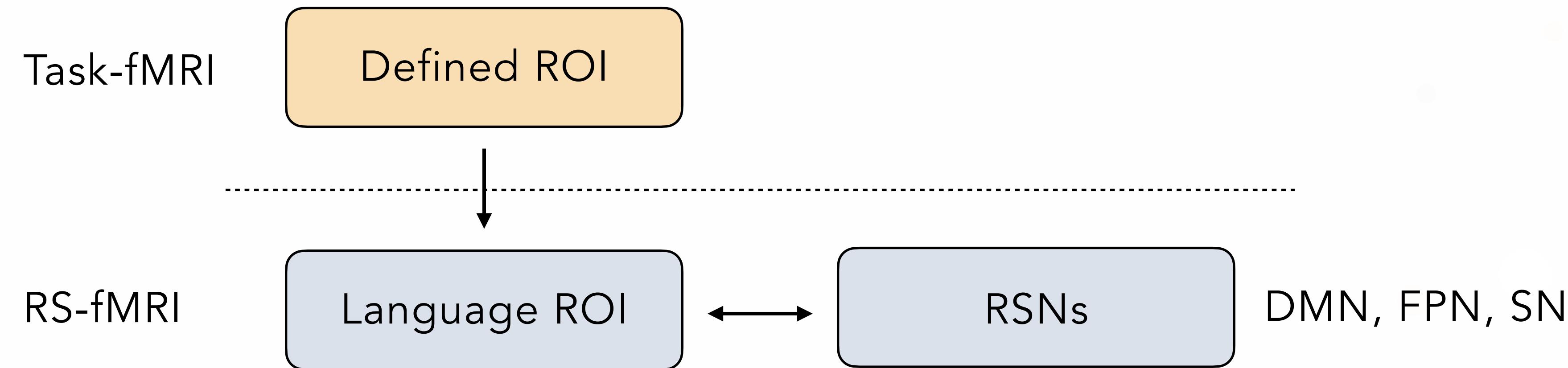
10k Accesses | 105 Altmetric | [Metrics](#)



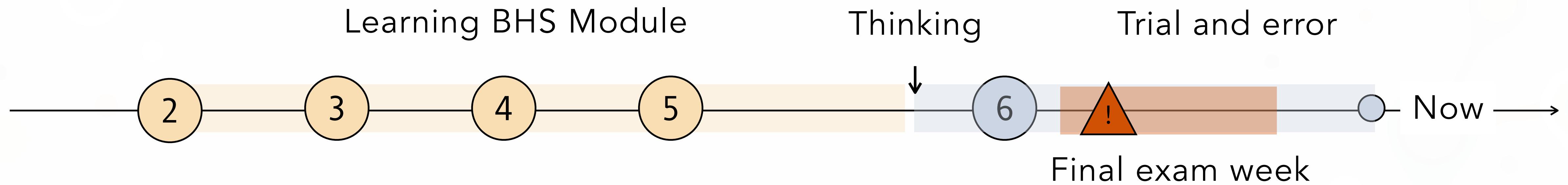
ds004078



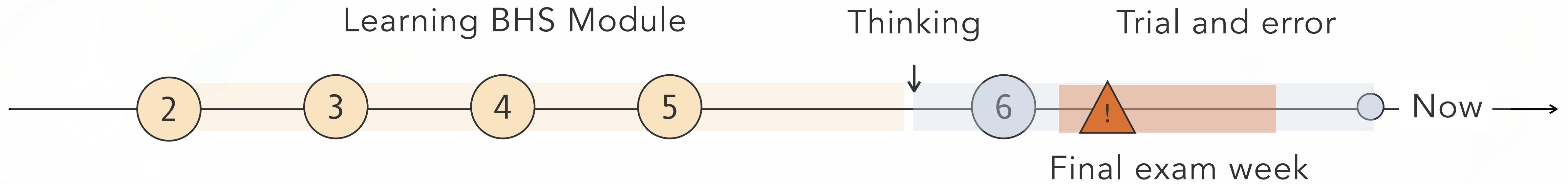
INTRODUCTION



PROJECT TIMELINE



PROJECT GOAL

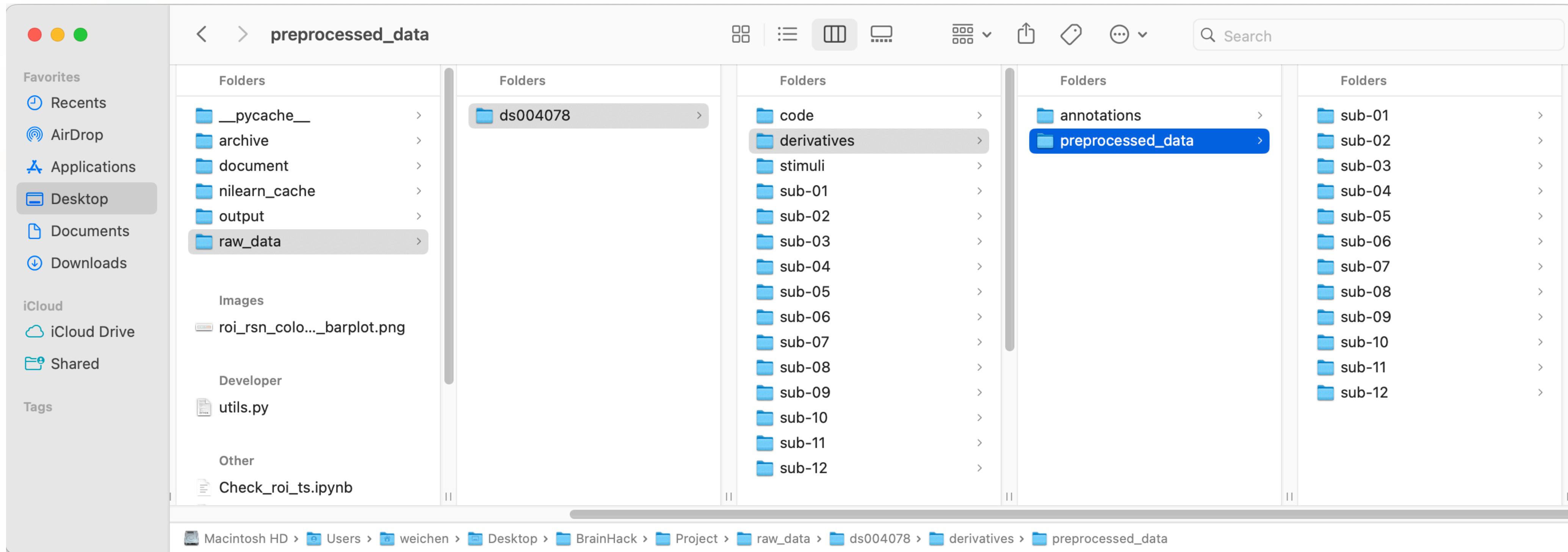


- Utilize open-access neuroimaging datasets
- Identify task-evoked brain activations using task-based fMRI (by Python)
- Conduct resting-state fMRI functional connectivity analysis

WHAT I HAVE DONE

1 Download Dataset

```
datalad install https://github.com/OpenNeuroDatasets/ds004078.git
```



WHAT I HAVE DONE

-
- 1 Download Dataset
 - 2 Subject-level analysis (task fMRI)
 - Subjects: 6 (sub-01~sub-06)
 - Tasks: 2 run
 - Contrast: story vs. baseline

WHAT I HAVE DONE

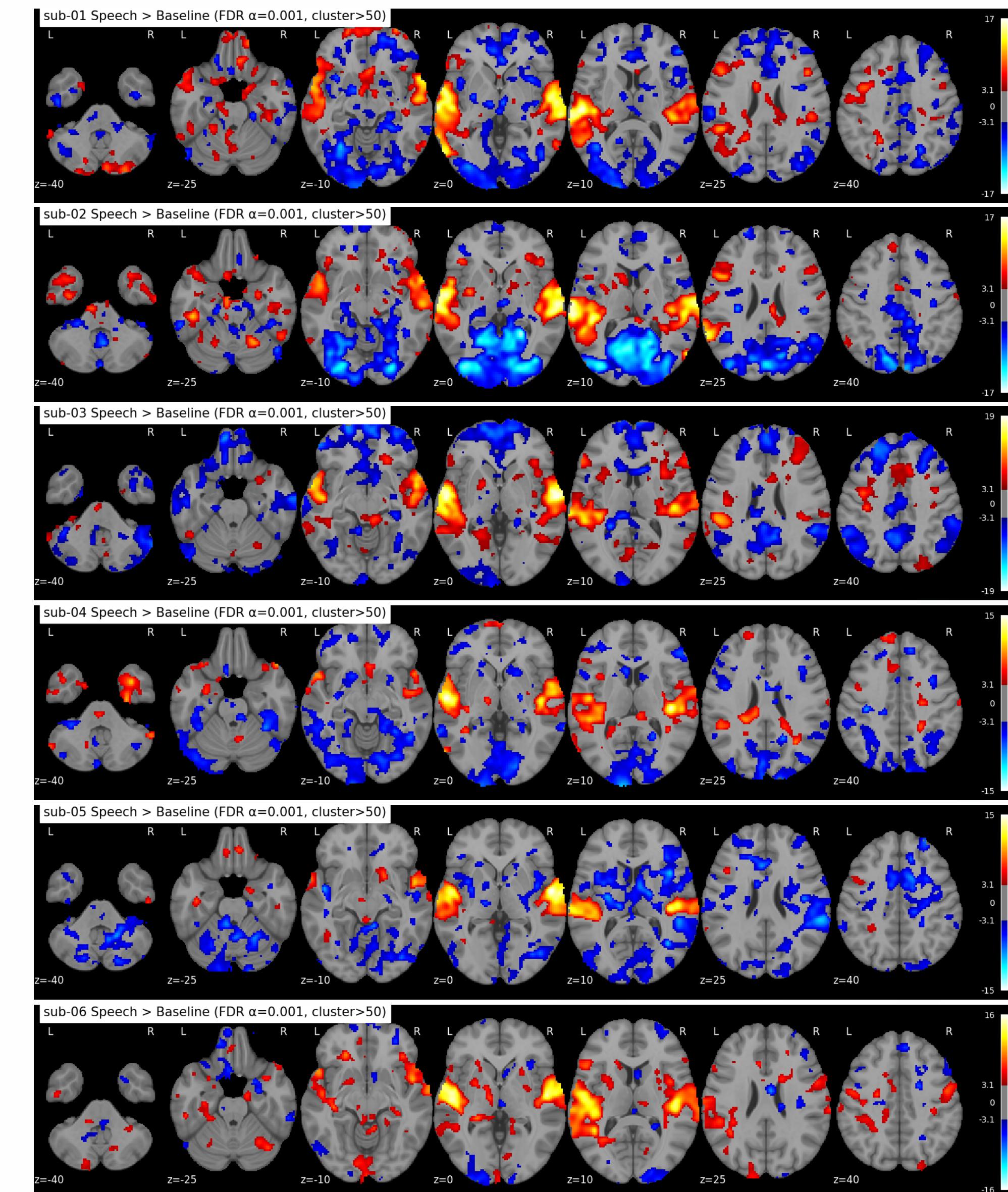
1

Download Dataset

2

Subject-level analysis (task fMRI)

- Subjects: 6 (sub-01~sub-06)
- Tasks: 2 run
- Contrast: story vs. baseline



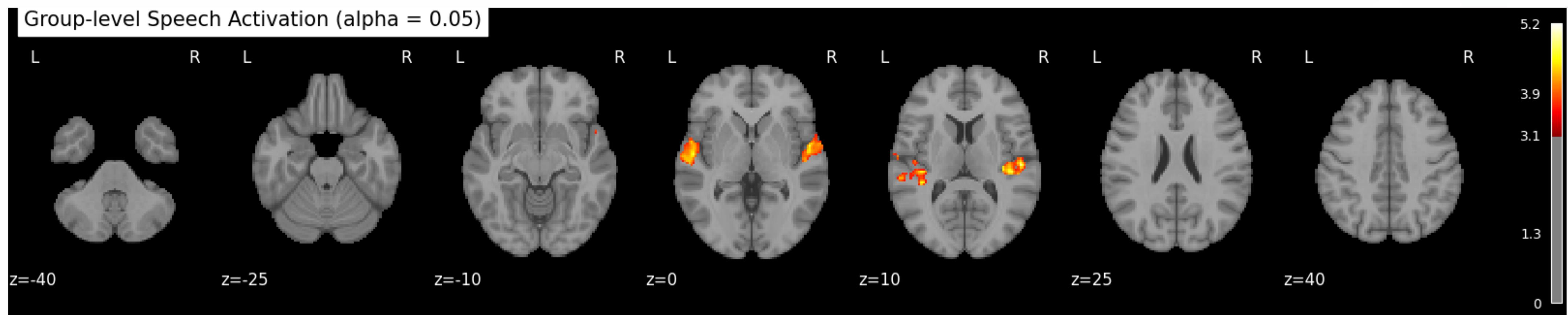
WHAT I HAVE DONE

- 1 Download Dataset
- 2 Subject-level analysis
- 3 Group-level analysis

Table 1.

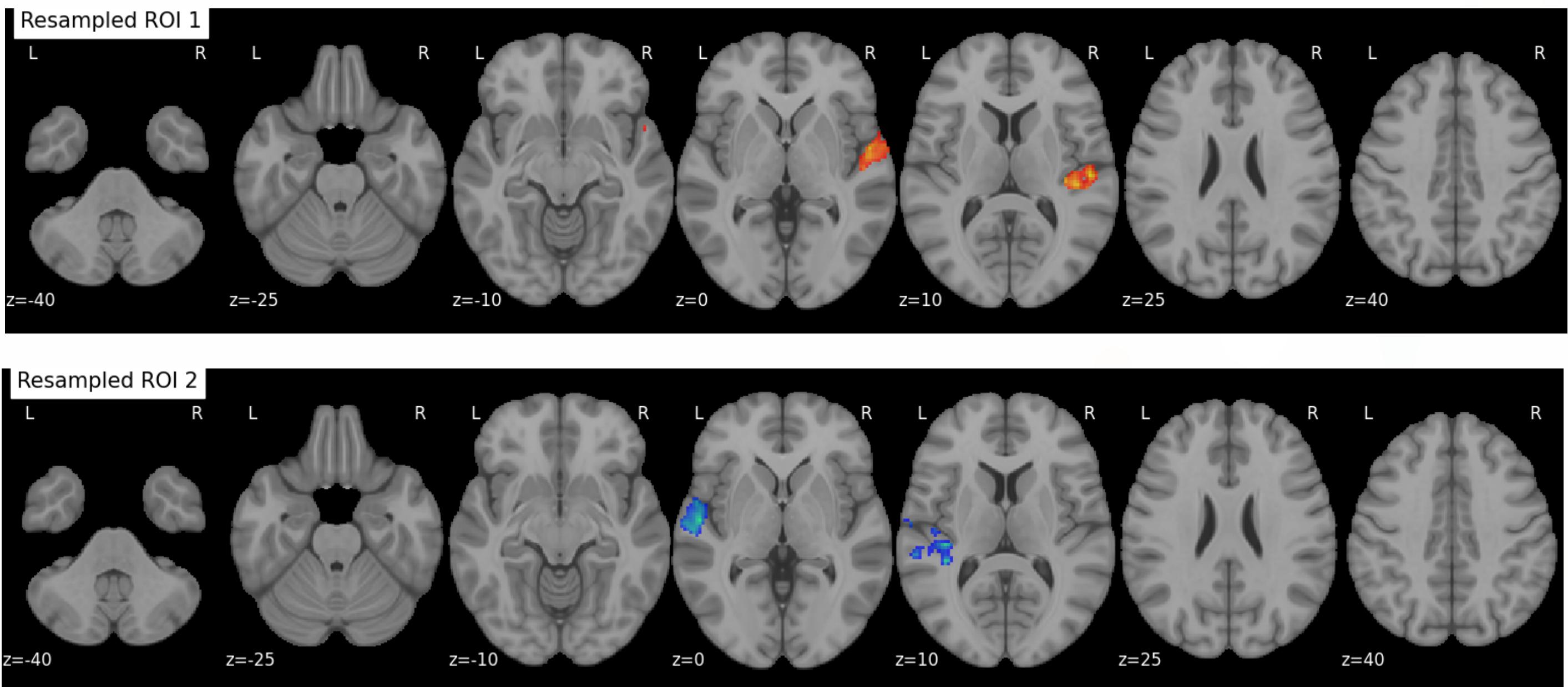
Brain area	X	Y	Z	Peak Stat	Cluster Size (mm ³)
Planum Temporale	44	-28	12	5.184	4648
Heschl's Gyrus	46	-20	6	5.181	
Central Opercular Cortex	54	-6	4	5.035	
Heschl's Gyrus	52	-20	10	4.959	
Heschl's Gyrus	-54	-16	4	4.893	5568
Planum Temporale	-62	-12	6	4.69	
Heschl's Gyrus	-40	-26	10	4.564	
Planum Temporale	-40	-36	10	4.546	

Statistical thresholding was applied using an initial voxel-wise threshold of $\alpha = 0.05$ (FDR-corrected), with a minimum cluster size of 200 voxels.



WHAT I HAVE DONE

- 1 Download Dataset
- 2 Subject-level analysis
- 3 Group-level analysis
→ ROI masks for rsfMRI



WHAT I HAVE DONE

4

Resting state fMRI

- Same subjects: sub-01~sub-06
- Resting state fMRI: 4 runs

```
sub-01_task-rest_run-1_bold.nii.gz  
sub-01_task-rest_run-1_bold.nii.gz  
sub-01_task-rest_run-1_bold.nii.gz  
sub-01_task-rest_run-1_bold.nii.gz
```

concat →

```
sub-01_task-rest_concat.nii.gz
```

Very time consuming

WHAT I HAVE DONE

4

Resting state fMRI

5

RSN ROI: DMN, FPN, SN

- Yeo's network atlas
- Resampled (due to the different affine between ROI & rsfMRI)

BOLD 影像 :

```
shape = (91, 109, 91, 2536)
affine =
[[ -2.    0.    0.   90.]
 [  0.    2.    0. -126.]
 [  0.    0.    2.  -72.]
 [  0.    0.    0.   1.]]
```

RSN mask :

```
shape = (256, 256, 256, 1)
affine =
[[ -1.    0.    0.  127.]
 [  0.    0.    1. -145.]
 [  0.   -1.    0. 147.]
 [  0.    0.    0.   1.]]
```

Very time consuming

WHAT I HAVE DONE

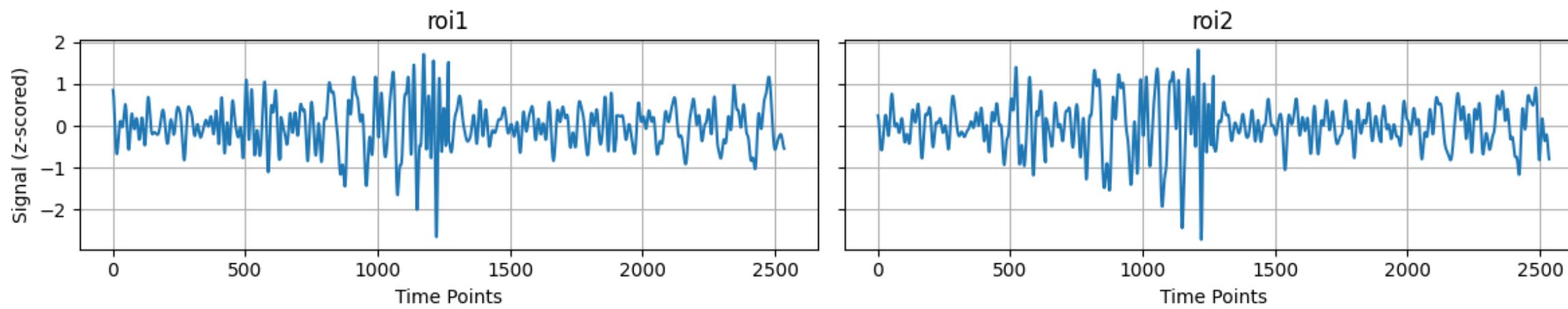
- 4 Resting state fMRI
- 5 RSN ROI: DMN, FPN, SN
- 6 Extract Time series of rsfMRI based on ROI & RSN maskers

Very time consuming

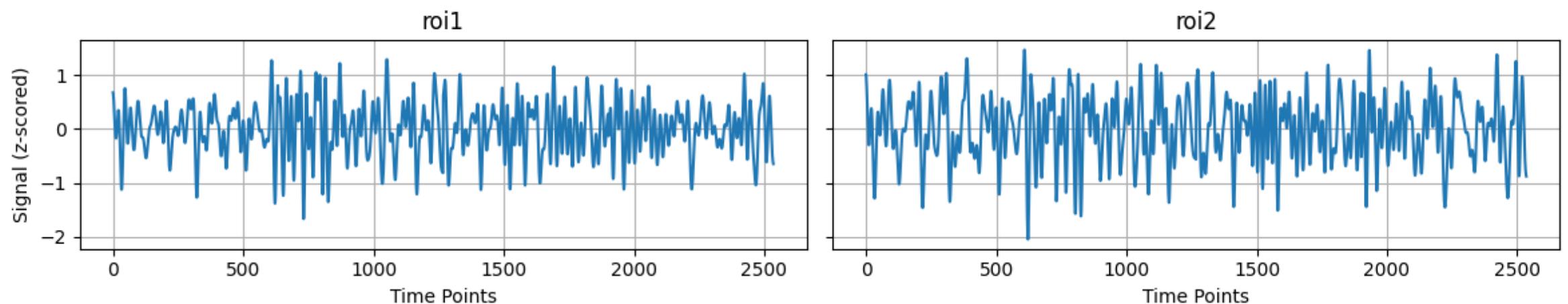
6 - 1

Time series based on ROIs

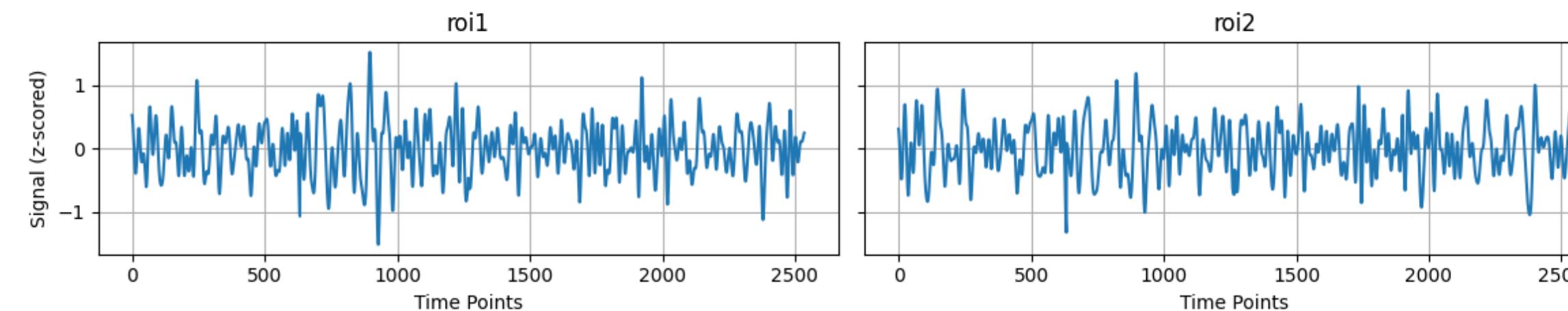
sub-01 ROI Time Series



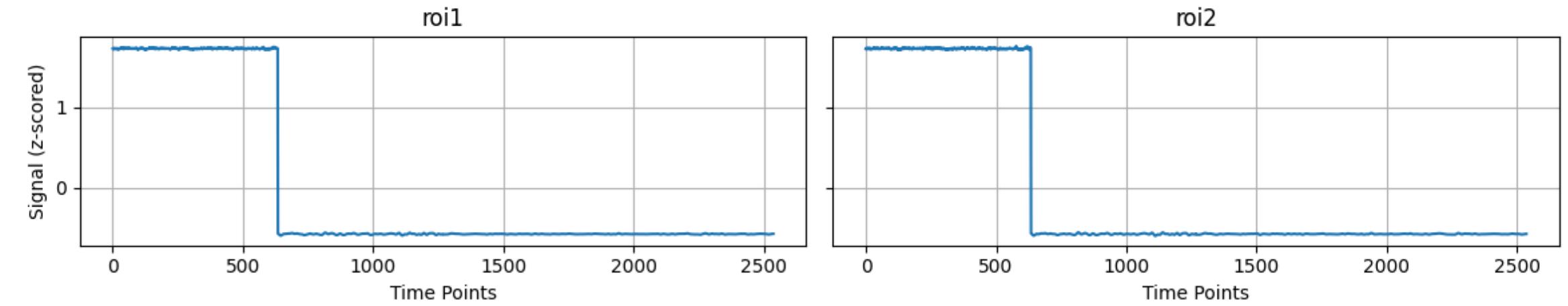
sub-04 ROI Time Series



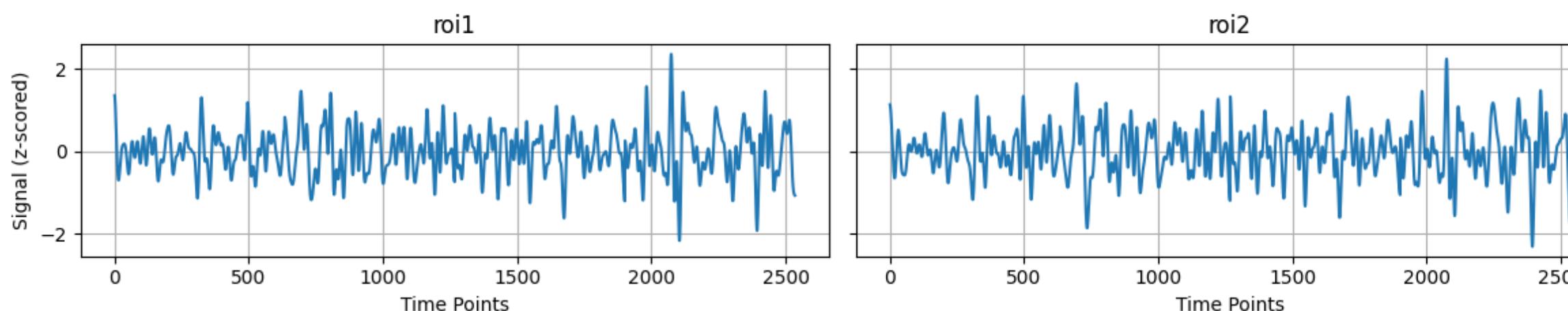
sub-02 ROI Time Series



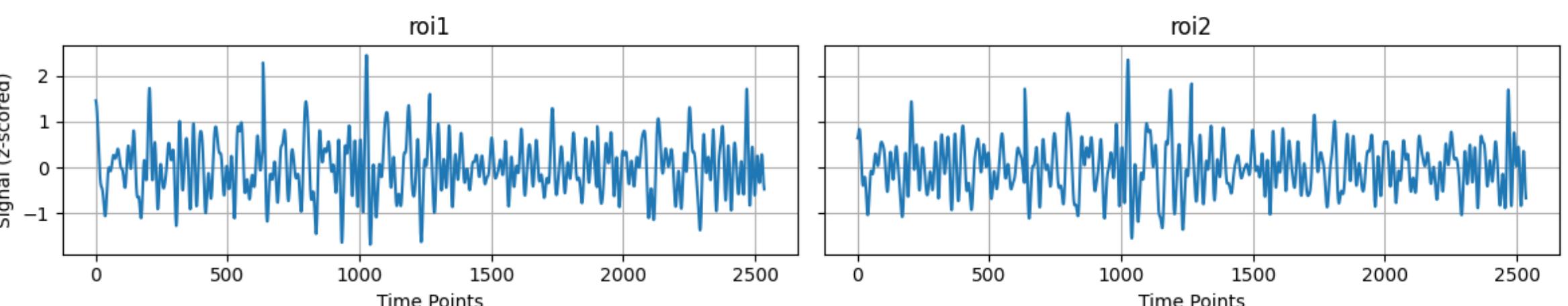
sub-05 ROI Time Series



sub-03 ROI Time Series



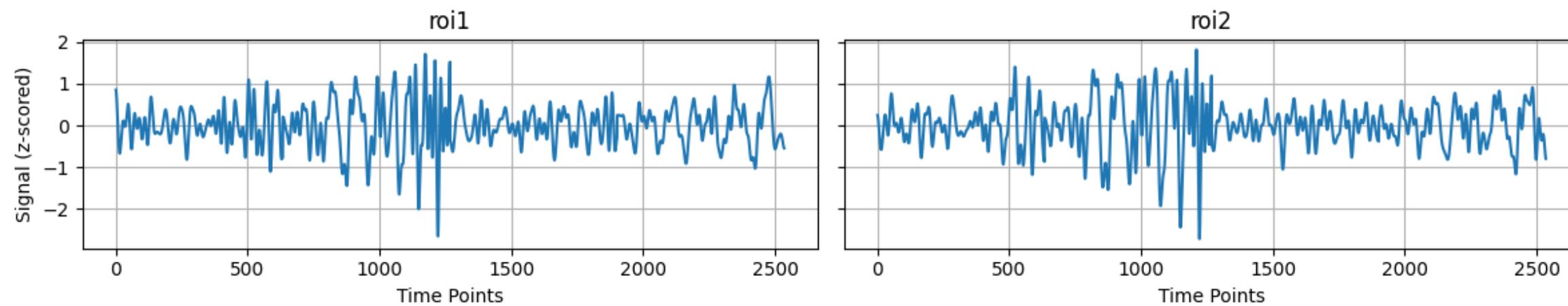
sub-06 ROI Time Series



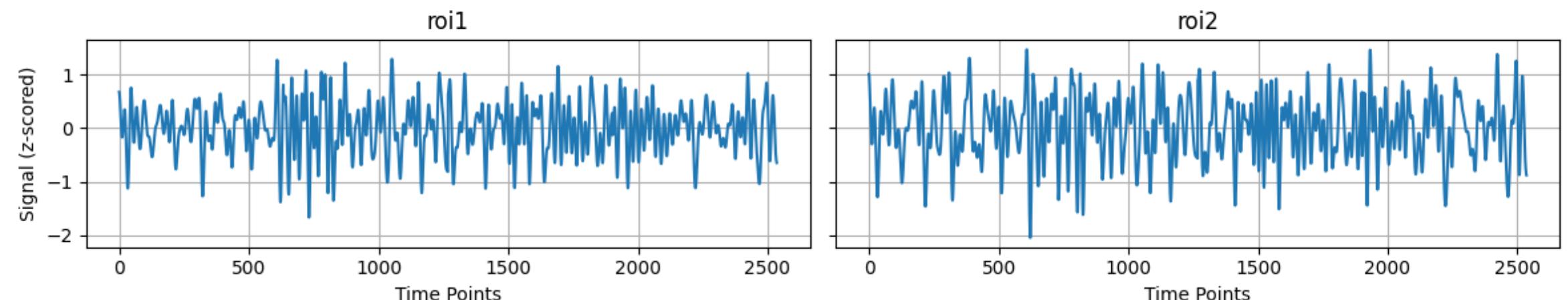
6 - 1

Time series based on ROIs

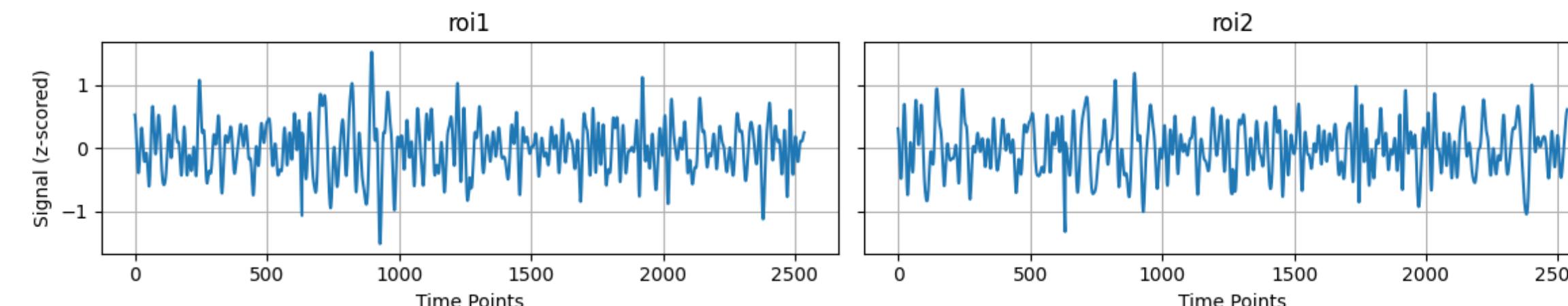
sub-01 ROI Time Series



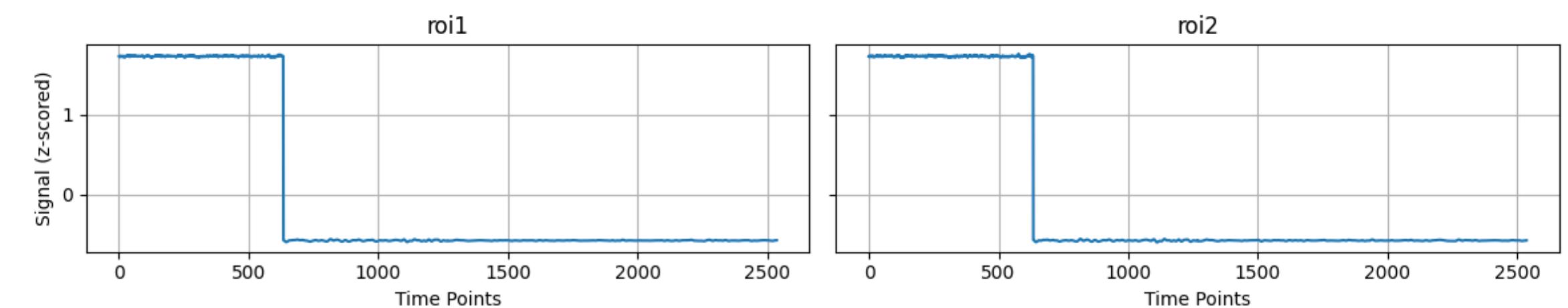
sub-04 ROI Time Series



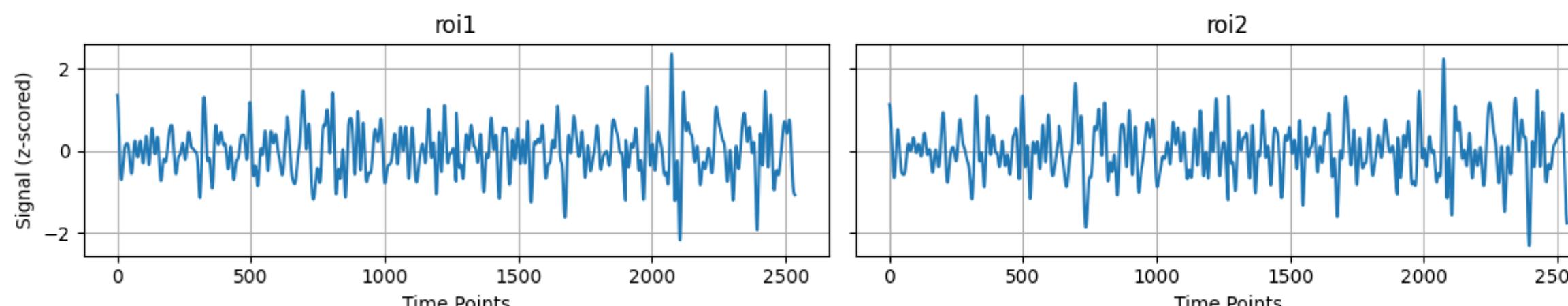
sub-02 ROI Time Series



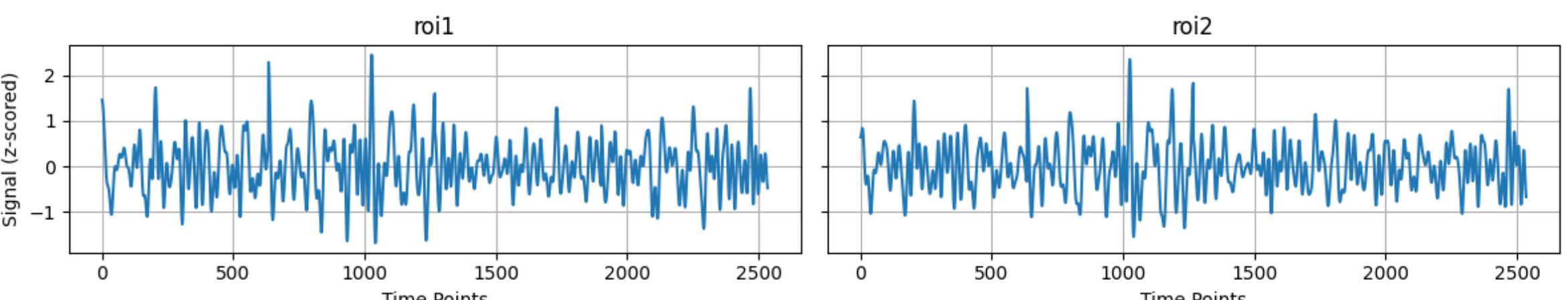
sub-05 ROI Time Series



sub-03 ROI Time Series

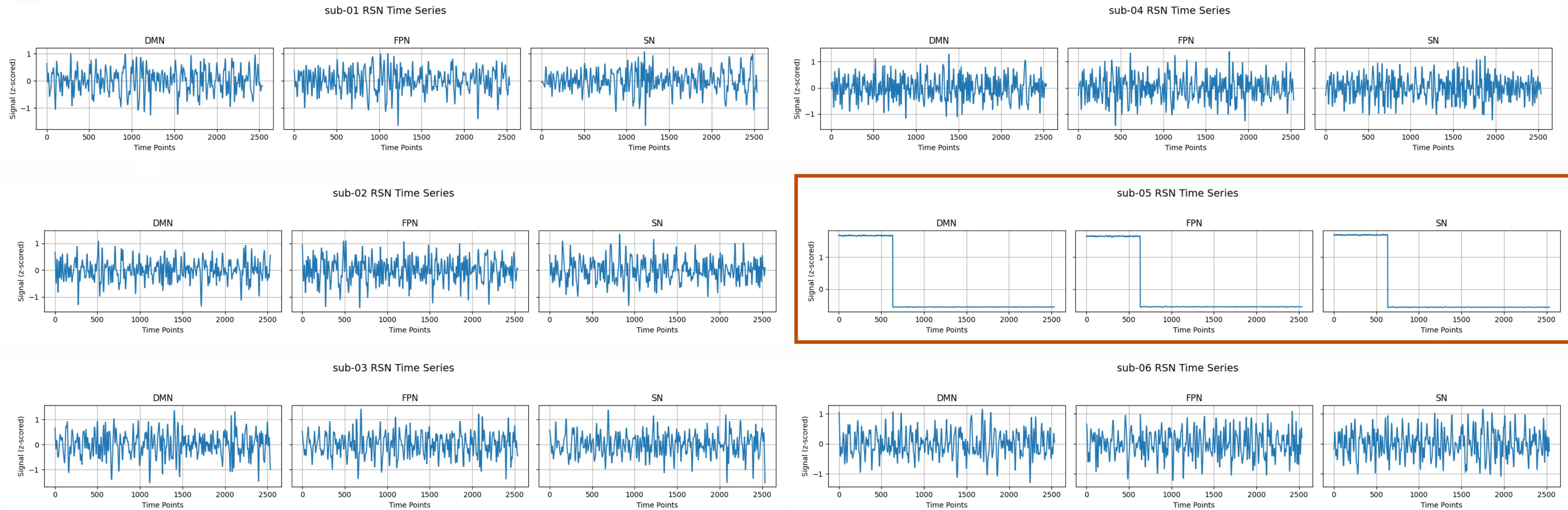


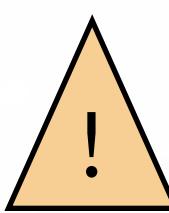
sub-06 ROI Time Series



6 - 2

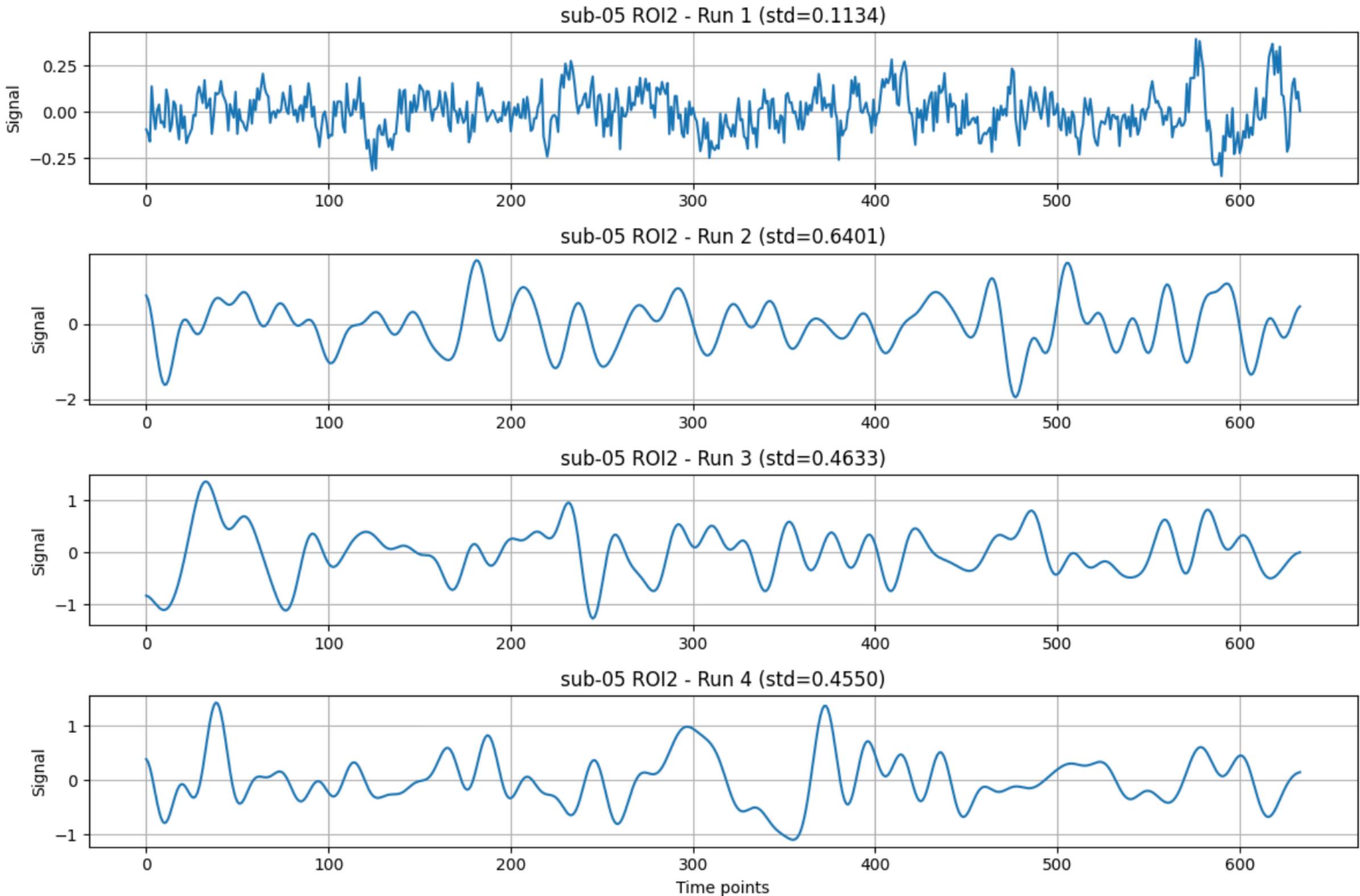
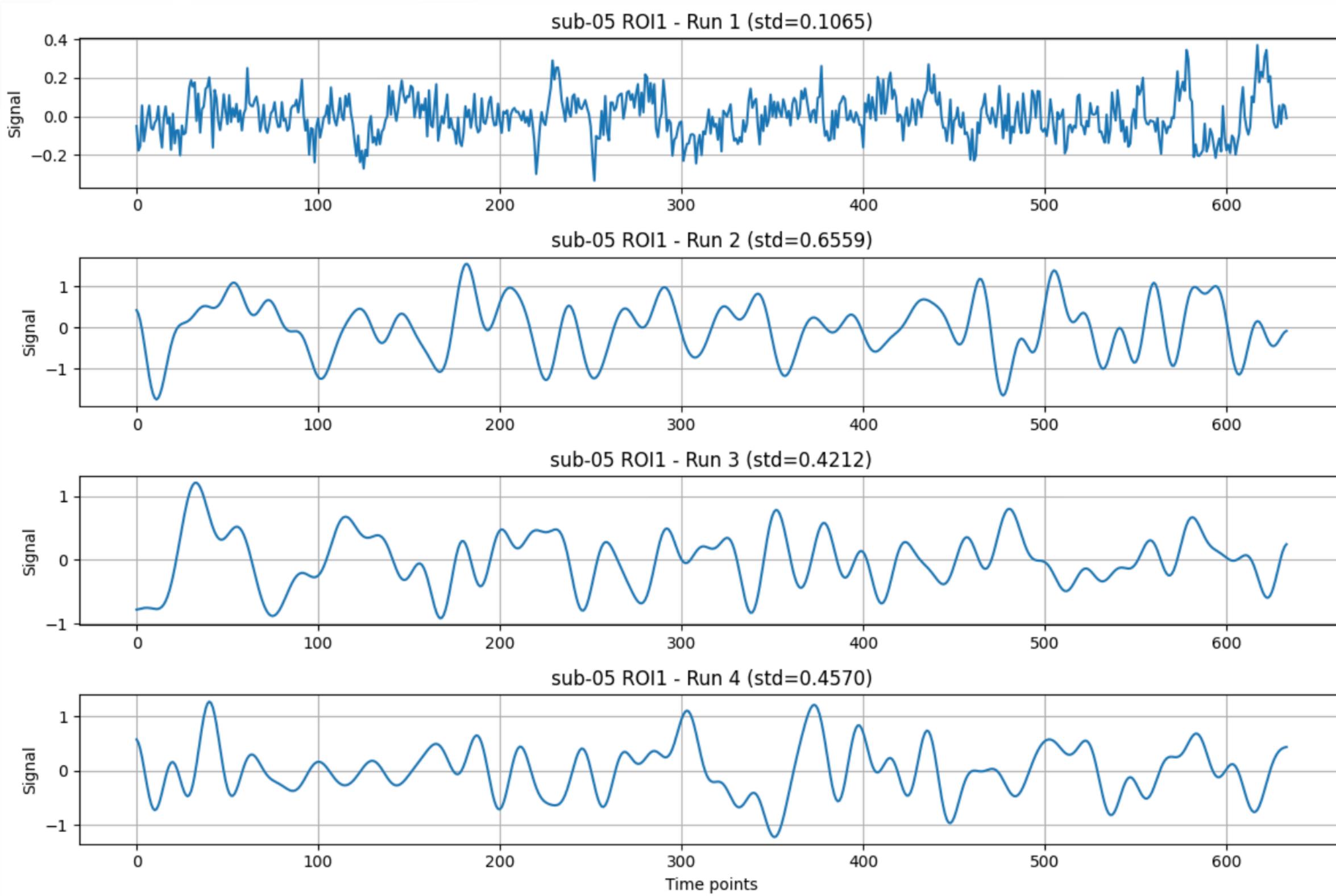
Time series based on RSNs

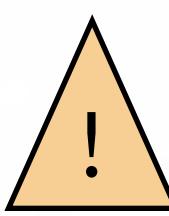




What happened to sub-05 !!!!!

→ extract time series from each run rather than the concat (based on ROIs maskers)





What happened to sub-05 !!!!!

→ extract time series from each run rather than the concat (based on ROIs maskers)

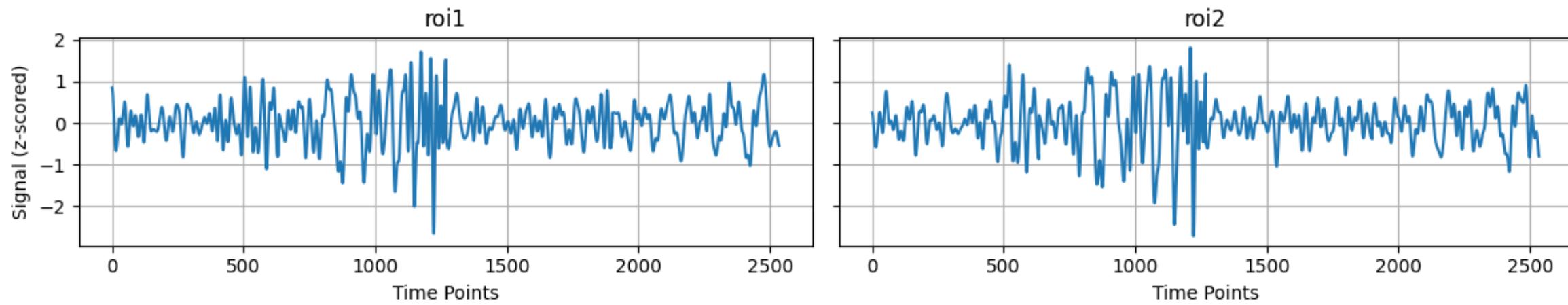


Very time consuming

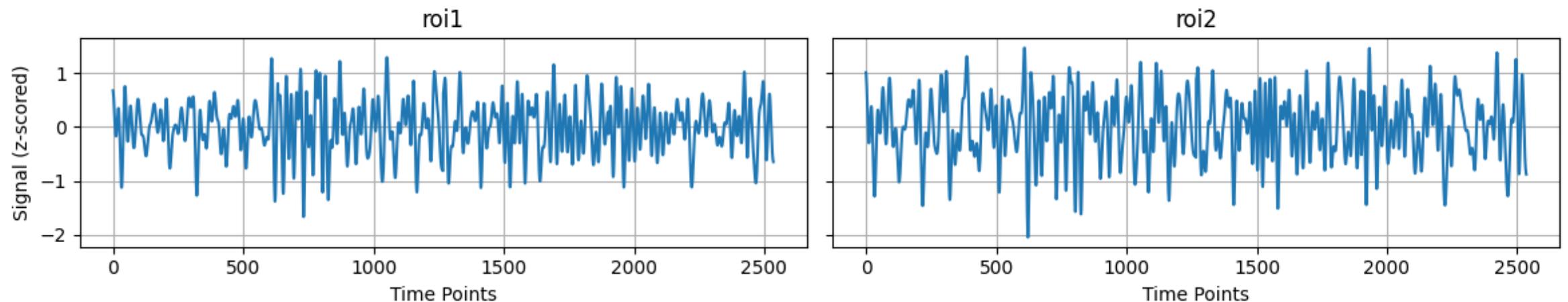
6 - 1

Time series based on ROIs

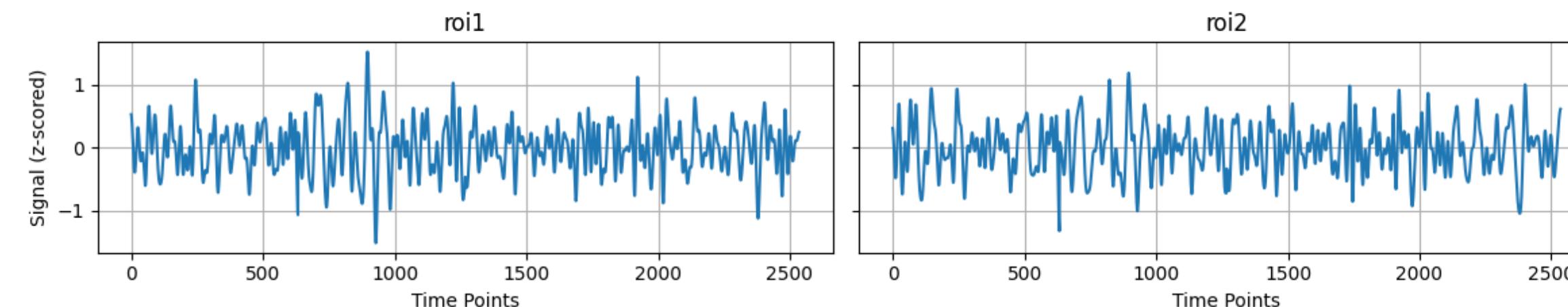
sub-01 ROI Time Series



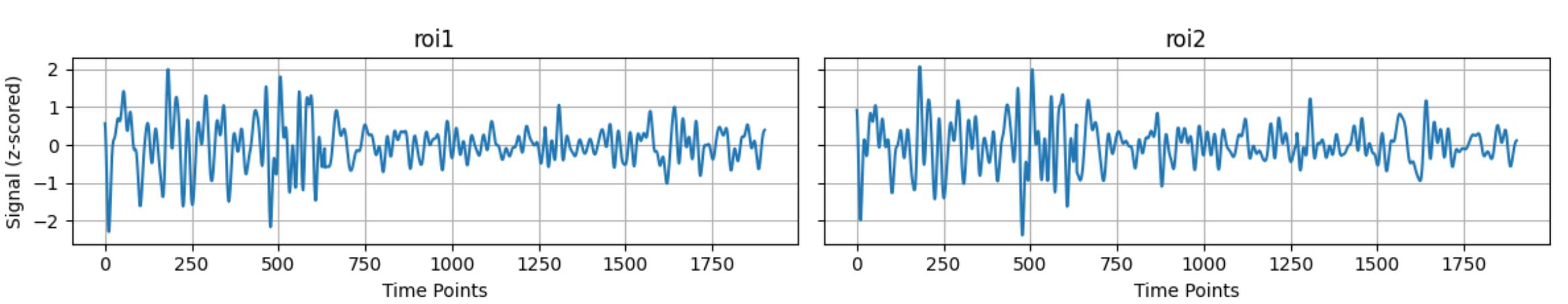
sub-04 ROI Time Series



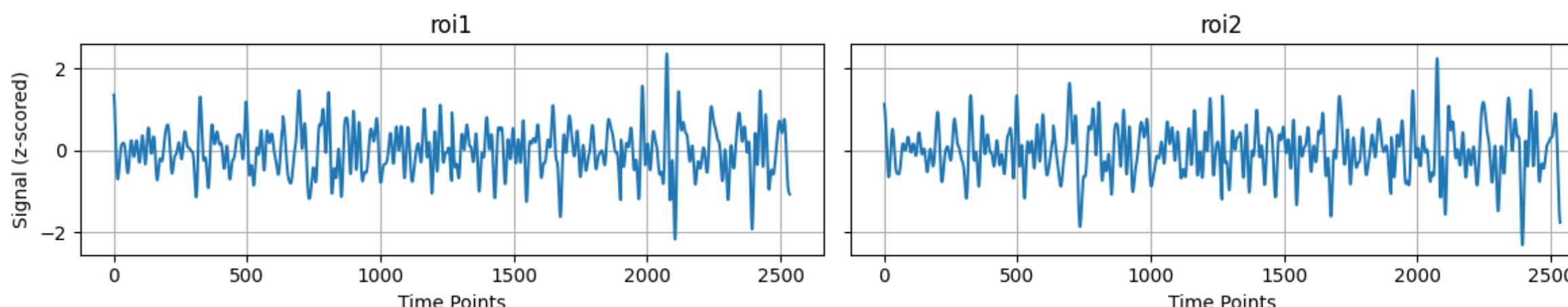
sub-02 ROI Time Series



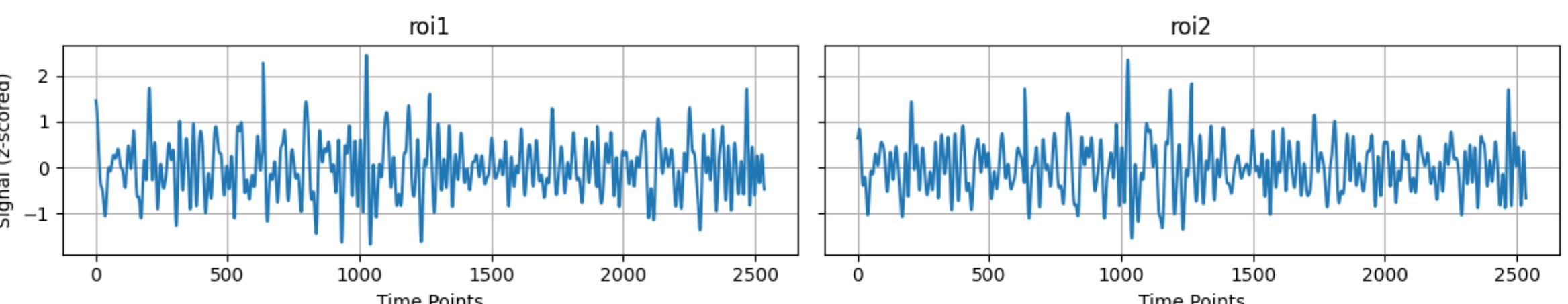
sub-05 ROI Time Series



sub-03 ROI Time Series

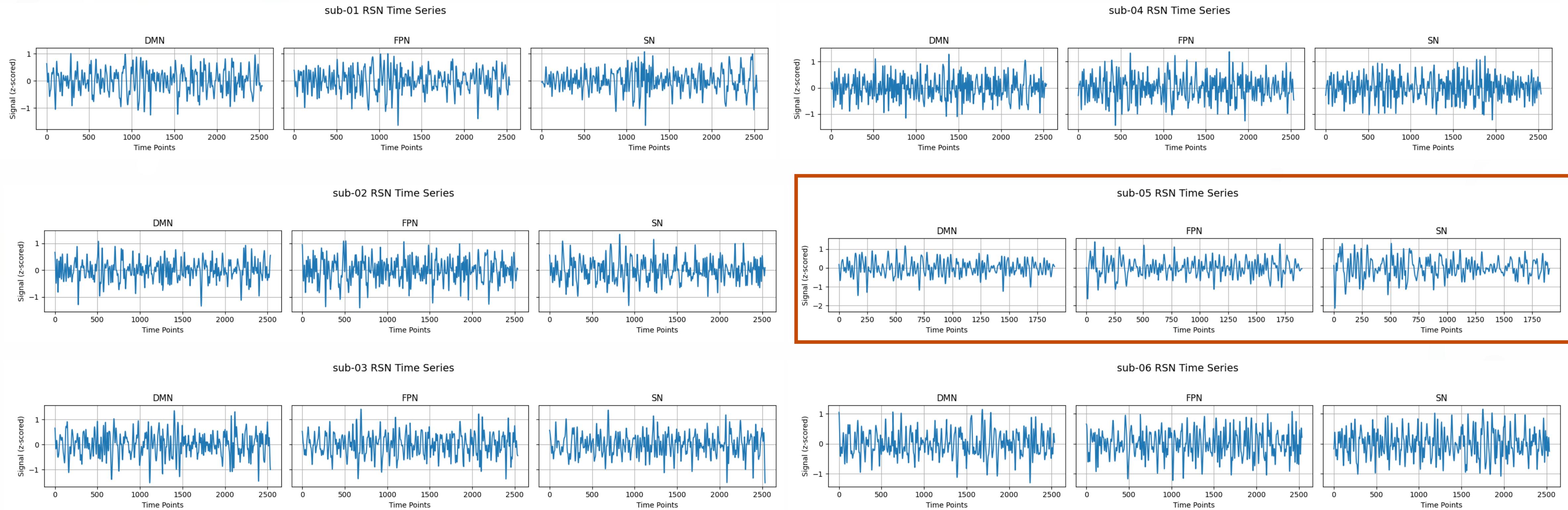


sub-06 ROI Time Series



6 - 2

Time series based on RSNs



WHAT I HAVE DONE

4 Resting state fMRI

5 RSN ROI: DMN, FPN, SN

6 Extract Time series of rsfMRI based on ROI & RSN masker

7 Correlation of time series

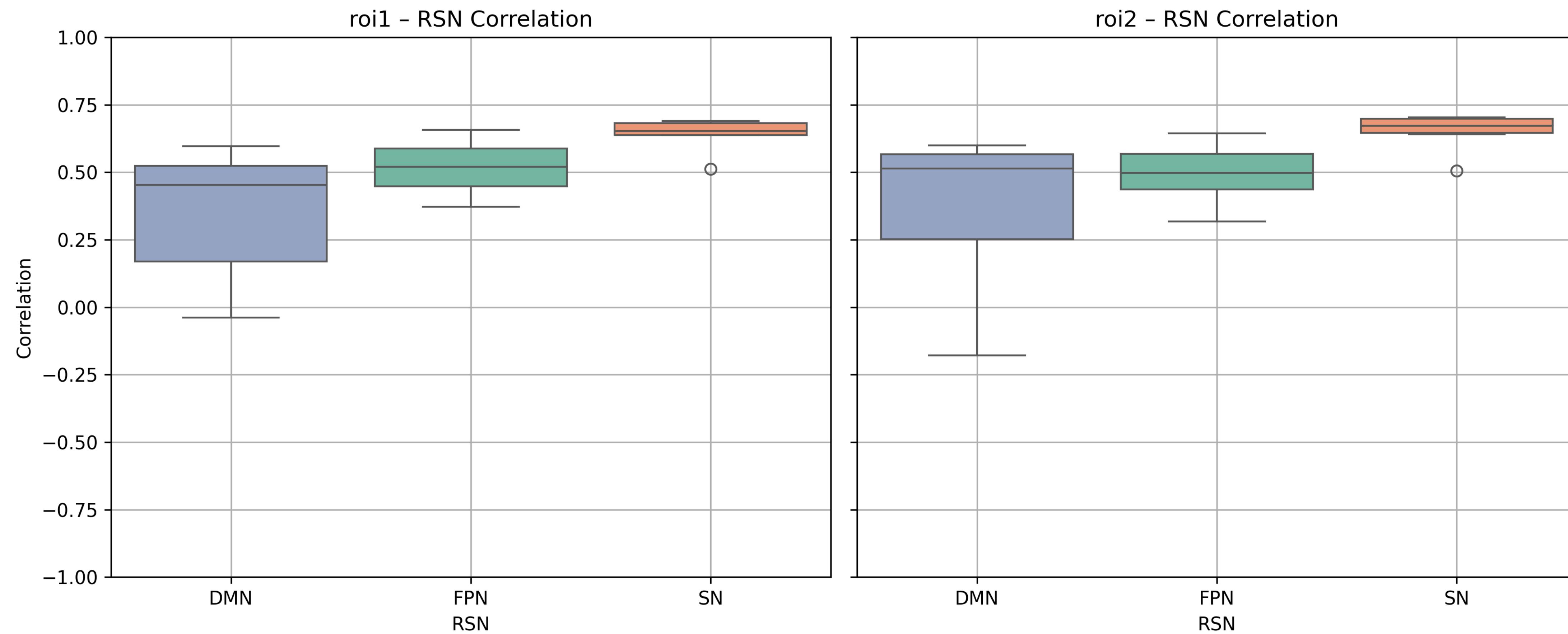
- 2 ROIs x 3 RSNs

Table 2. Correlation of the time series of ROIs & RSNs

Subject	ROI	RSN	Correlation
sub-01	roi1	DMN	0.544
		FPN	0.59
		SN	0.69
	roi2	DMN	0.568
		FPN	0.583
		SN	0.685
sub-02	roi1	DMN	0.078
		FPN	0.371
		SN	0.637
	roi2	DMN	0.178
		FPN	0.317
		SN	0.505
sub-03	roi1	DMN	0.596
		FPN	0.657
		SN	0.64
	roi2	DMN	0.6
		FPN	0.644
		SN	0.703
sub-04	roi1	DMN	0.443
		FPN	0.581
		SN	0.664
	roi2	DMN	0.56
		FPN	0.523
		SN	0.641
sub-05	roi1	DMN	0.464
		FPN	0.46
		SN	0.688
	roi2	DMN	0.468
		FPN	0.426
		SN	0.704
sub-06	roi1	DMN	-0.039
		FPN	0.443
		SN	0.512
	roi2	DMN	-0.179
		FPN	0.47
		SN	0.658

WHAT I FOUND

Correlation of time series



WHAT I FOUND

Does there have different correlation pattern between RSNs?

1 friedman test

→ DMN-ROI vs. FPN-ROI vs. SN-ROI

```
roi1: Friedman chi2 = 8.333, p = 0.0155 *
roi2: Friedman chi2 = 9.333, p = 0.0094 *
```

2 wilcoxon (pairwise comparison)

```
roi1 pairwise comparisons:  
DMN vs FPN: W = 1.000, p = 0.0625  
DMN vs SN: W = 0.000, p = 0.0312 *  
FPN vs SN: W = 1.000, p = 0.0625  
roi2 pairwise comparisons:  
DMN vs FPN: W = 5.000, p = 0.3125  
DMN vs SN: W = 0.000, p = 0.0312 *  
FPN vs SN: W = 0.000, p = 0.0312 *
```

Mean		
ROI	RSN	
roi1	DMN	0.453324
	FPN	0.520456
	SN	0.652103
roi2	DMN	0.514119
	FPN	0.496501
	SN	0.671520

DMN < SN

DMN = FPN < SN

WHAT I FOUND Does there have different correlation pattern between ROI?

1 Wilcoxon

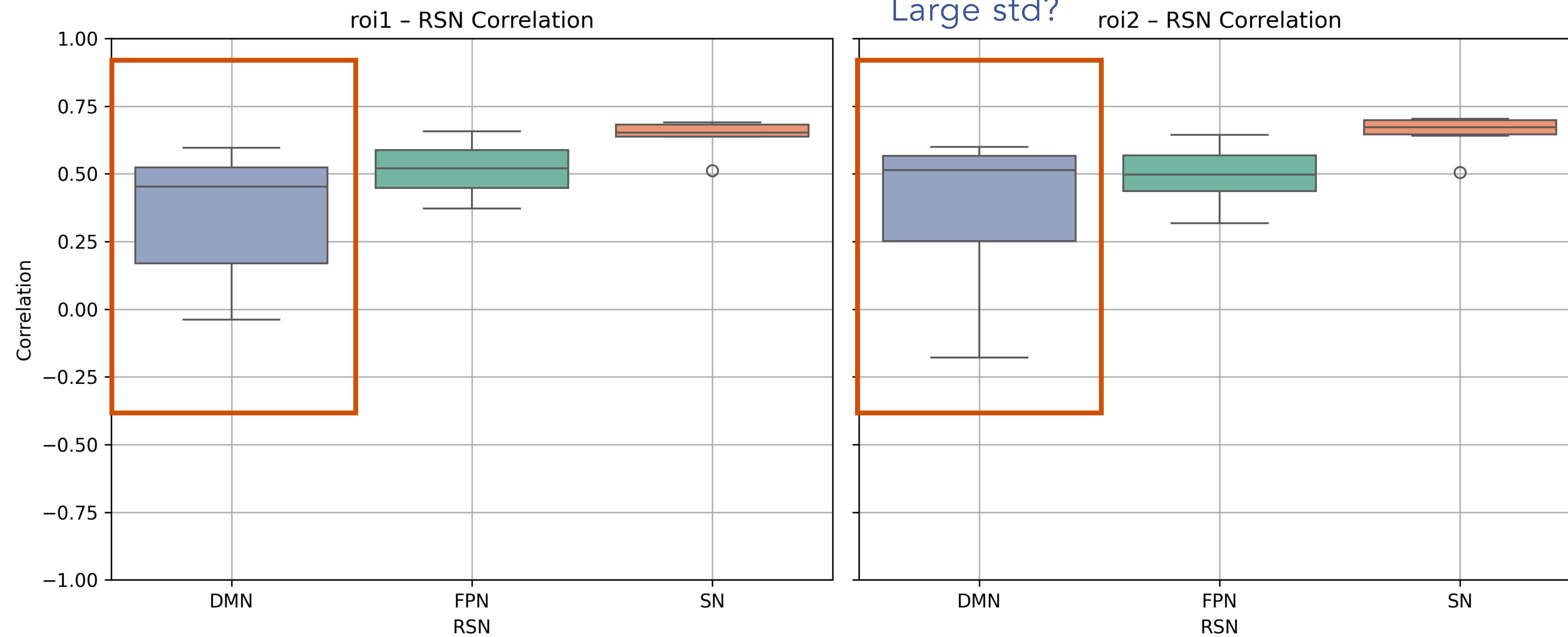
→ ROI 1 vs. ROI 2

```
DMN: roi1 vs roi2 → W = 6.000, p = 0.4375  
FPN: roi1 vs roi2 → W = 3.000, p = 0.1562  
SN: roi1 vs roi2 → W = 9.000, p = 0.8438
```

No significant

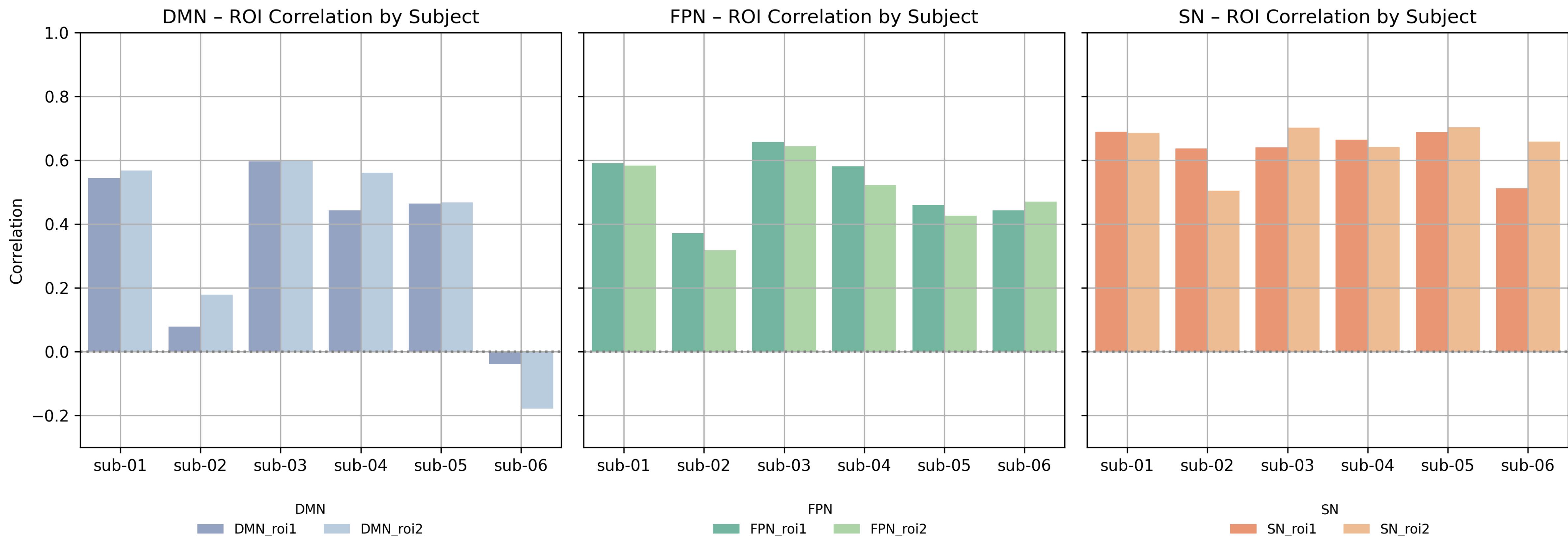
WHAT I FOUND

Correlation of time series



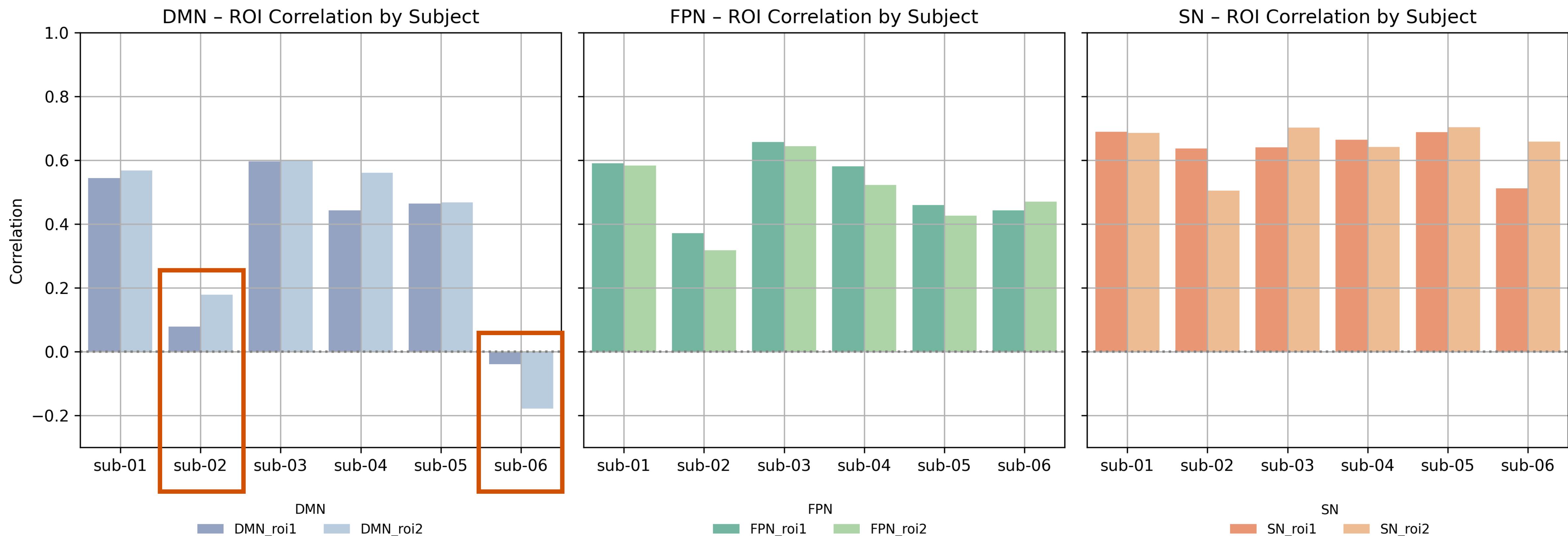
WHAT I FOUND

Correlation of time series



WHAT I FOUND

Correlation of time series



WHAT I FOUND Does demographic features and quiz performance correlate to ROI-RSN?

Table 3. Demographic and behavior data

Subject	age	sex	hand	quiz_accuracy
sub-01	25	M	R	94.17
sub-02	30	F	R	89.17
sub-03	26	M	R	92.5
sub-04	28	M	R	82.5
sub-05	26	M	R	85
sub-06	25	M	R	89.17

WHAT I FOUND Does demographic features and quiz performance correlate to ROI-RSN?

Subject	age	sex	hand	quiz_accuracy
sub-01	25	M	R	94.17
sub-02	30	F	R	89.17
sub-03	26	M	R	92.5
sub-04	28	M	R	82.5
sub-05	26	M	R	85
sub-06	25	M	R	89.17

1 Age ↔ Correlation

DMN – age vs correlation: $r = -0.127$, $p = 0.6950$
FPN – age vs correlation: $r = -0.524$, $p = 0.0806$
SN – age vs correlation: $r = -0.372$, $p = 0.2336$

2 Accuracy ↔ Correlation

DMN – fMRI_accuracy vs correlation: $r = 0.060$, $p = 0.8537$
FPN – fMRI_accuracy vs correlation: $r = 0.337$, $p = 0.2848$
SN – fMRI_accuracy vs correlation: $r = 0.022$, $p = 0.9468$

No significant

In the end

Project goal

- ✓ Utilize open-access neuroimaging datasets
- ✓ Identify task-evoked brain activations using task-based fMRI (by Python)
- ✓ Conduct resting-state fMRI functional connectivity analysis

In the end

Project Limitation

- Small sample size → exploratory analysis only
- Only focus on few ROI

Future directions

- Language RSN - RSN
- Link word-level meaning to brain activity patterns using encoding approaches



The background features a light gray surface with scattered organic shapes in various colors: teal, orange, yellow, and white. These shapes resemble stylized leaves, bubbles, or molecular structures, creating a modern and biological feel.

THANK YOU!