



# Latent variable modeling for temporal profiles of neural activity during continuous stimuli viewing

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## Introduction

### Visual and Audio Narratives in fMRI

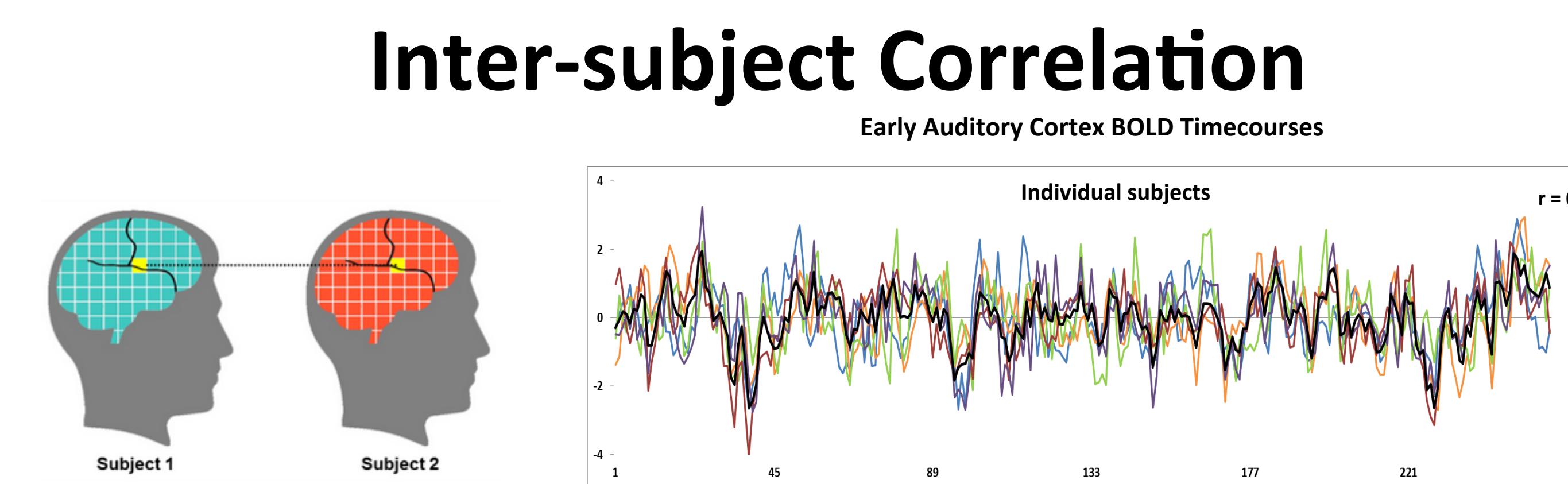
Recent findings suggest that measuring similarity between participants while they view complex, natural stimuli reveals a hierarchy of increasing timescales in the brain.

We present a simple model for relating similarity within and across groups of subjects, as they perform complex tasks.

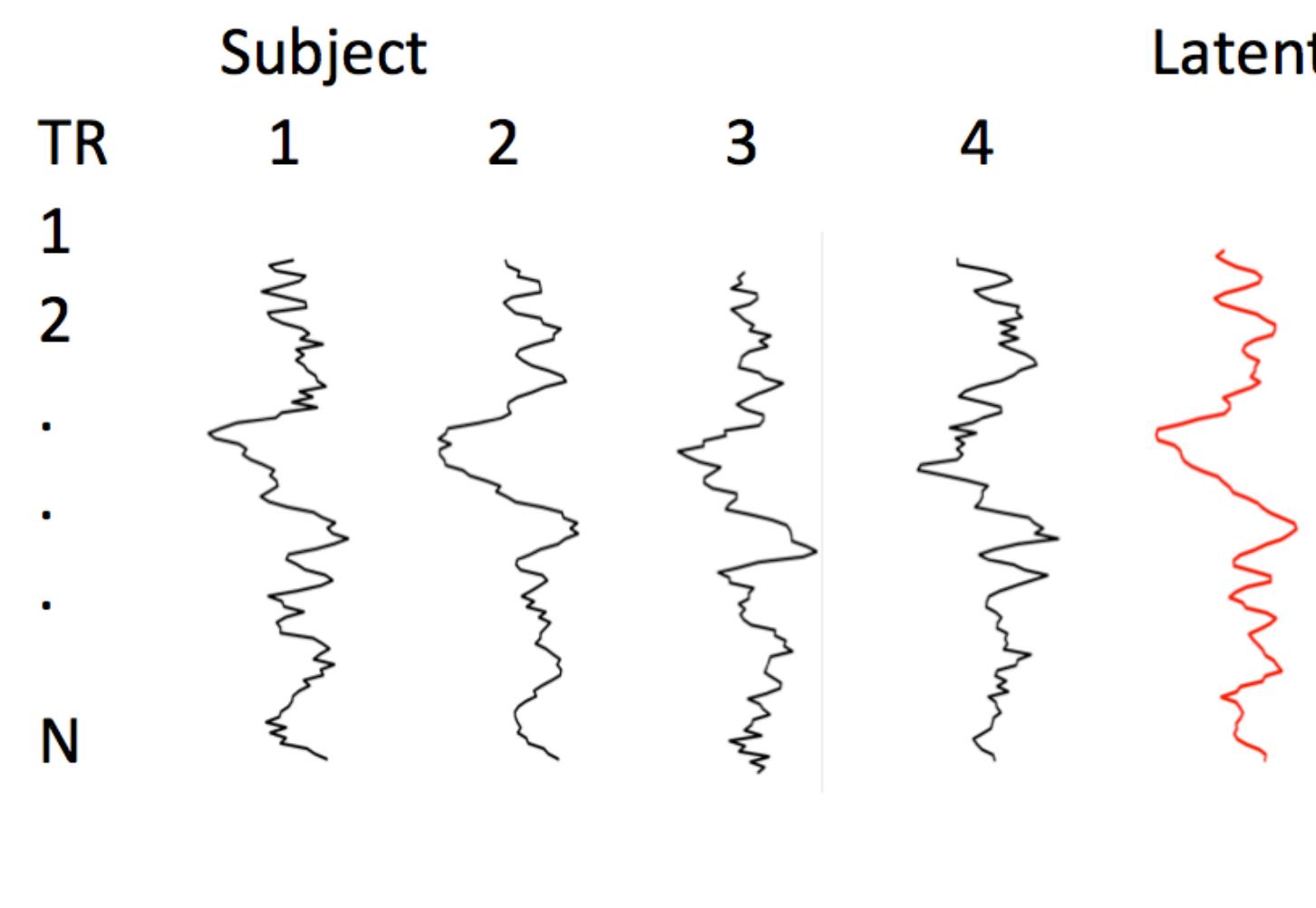
### Previous Approach (two steps)

- (1) estimate latent time courses through averaging
- (2) correlate(subject,  $\widehat{\text{latent1}}$ )  
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This fails to take into account measurement error of estimated latent timecourses.



## Latent Neural Timecourses



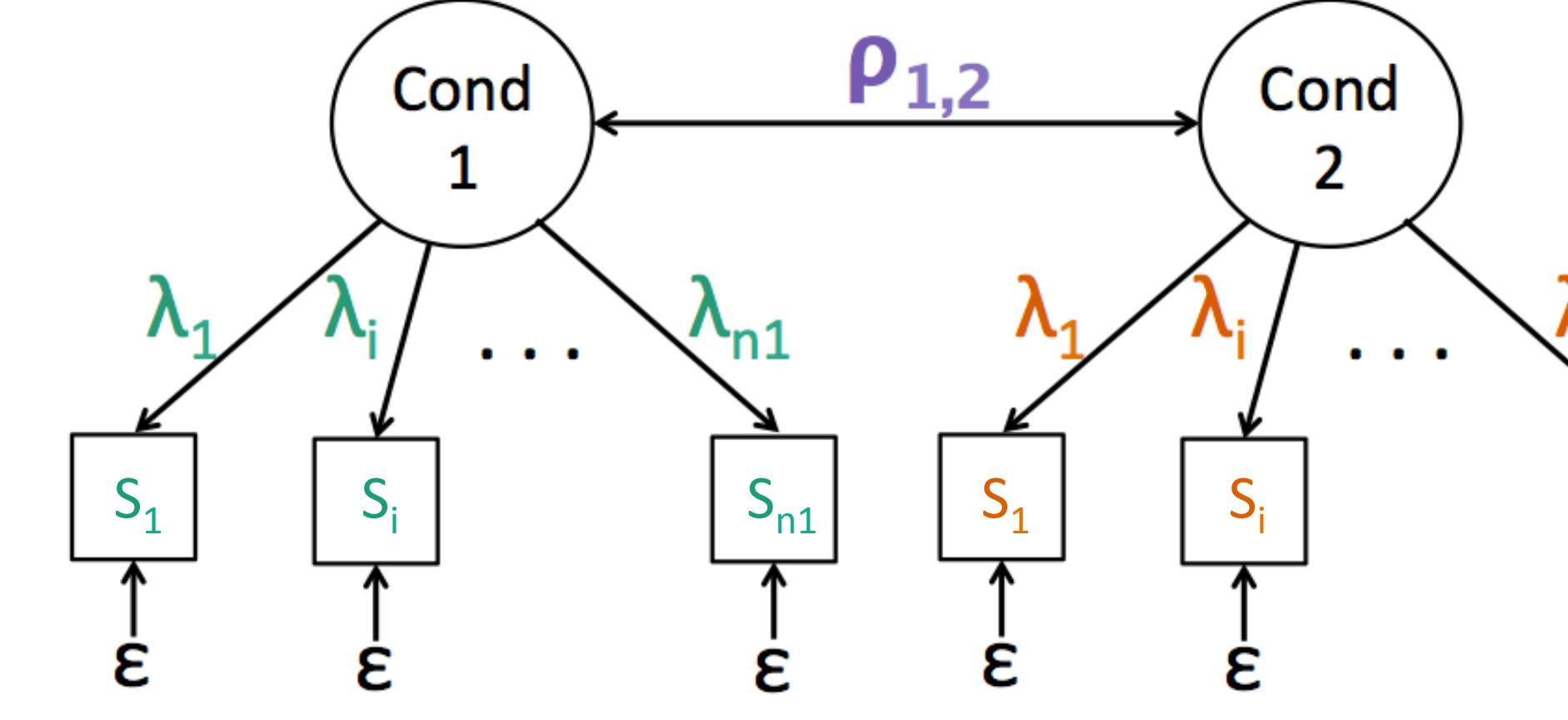
### Measurement Error

When averaging subjects to estimate a latent timecourse, we need to take into account reliability. ( $R_1$ : rel of  $\widehat{\text{latent1}}$ )

$$\text{Corr}(\text{subject}_i, \widehat{\text{latent1}}) = \lambda_i \sqrt{R_1}$$

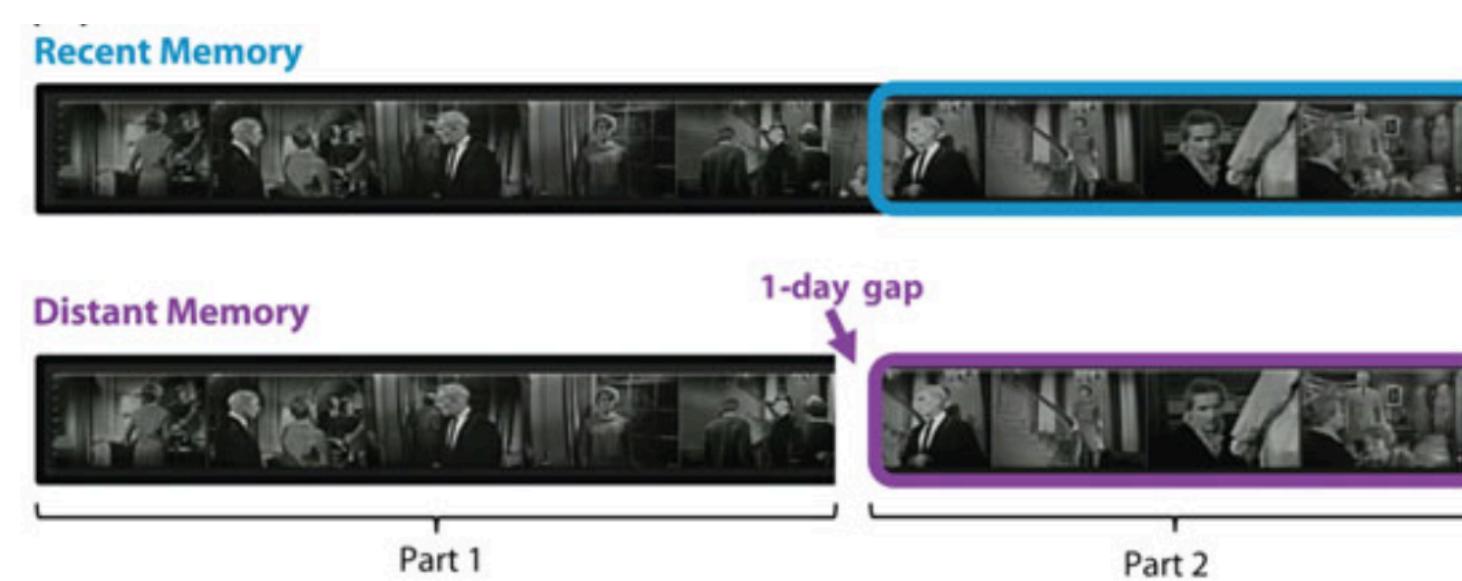
$$\text{Corr}(\text{subject}_i, \widehat{\text{latent1}}) = \lambda_i \rho_{1,2} \sqrt{R_1}$$

$$\text{Corr}(\widehat{\text{latent1}}, \widehat{\text{latent2}}) = \rho_{1,2} \sqrt{R_1 R_2}$$



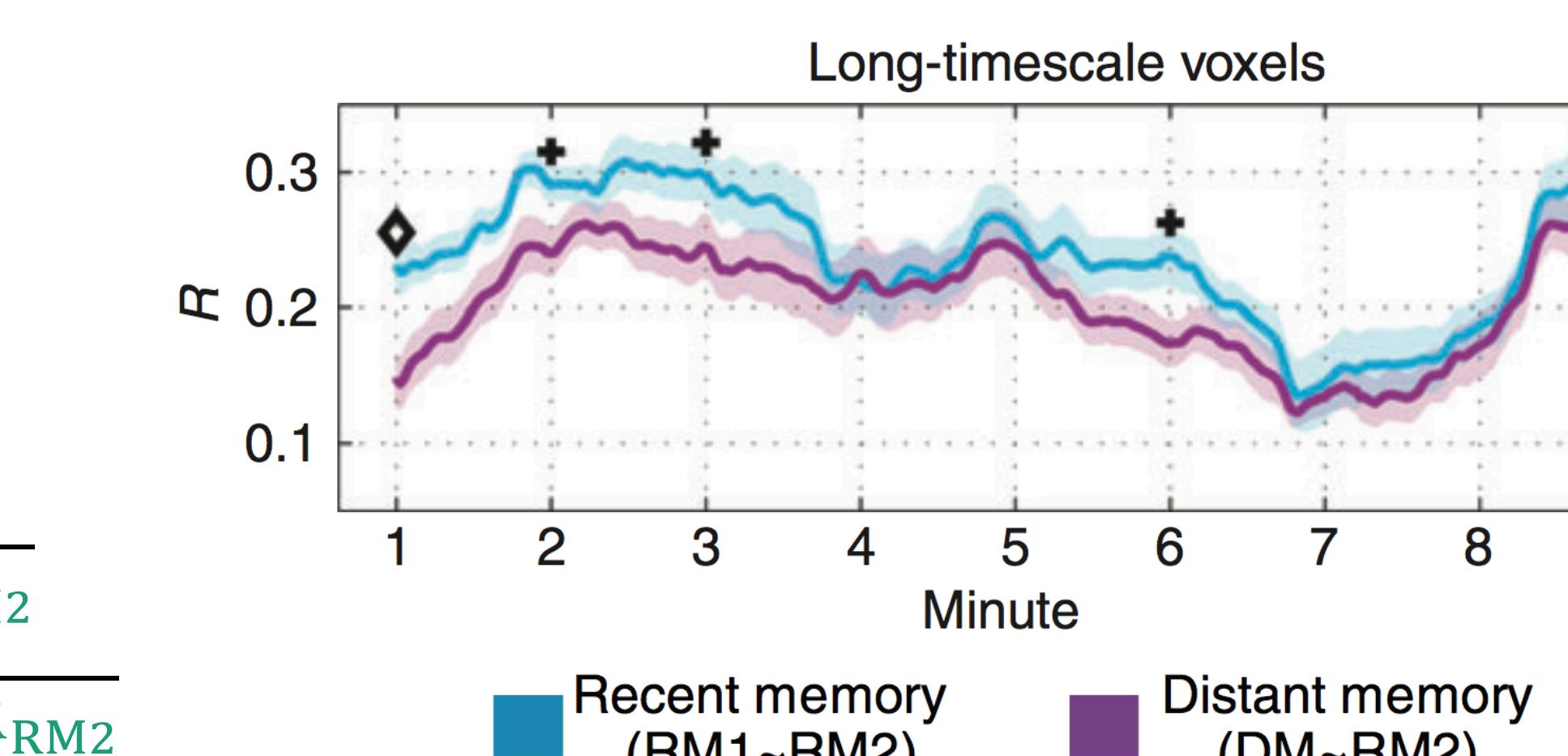
## Testing $\rho_{1,2} < 1$

### Previous analysis



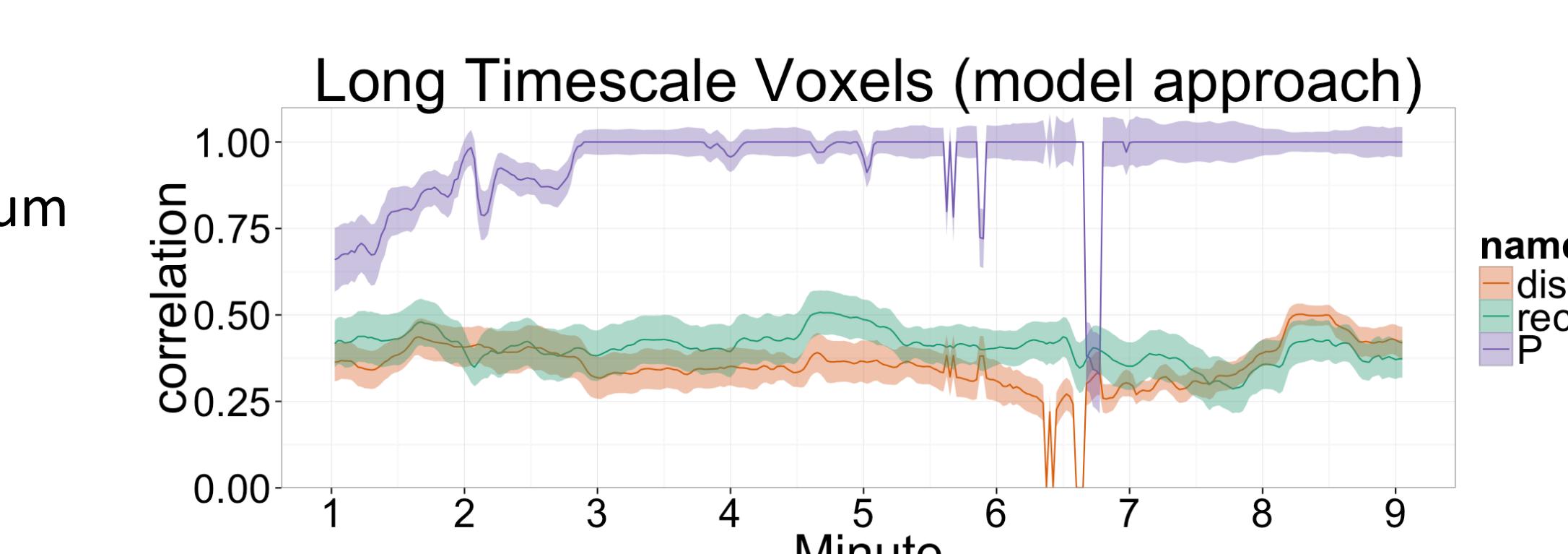
Participants watched an episode of the Twilight Zone. The Distant Memory (DM) group watched the first half of the episode the day before. The Recent Memory (RM) group watched the entire episode in one sitting.<sup>[3]</sup>

The researchers asked when groups had similar underlying temporal signals.



### Current analysis

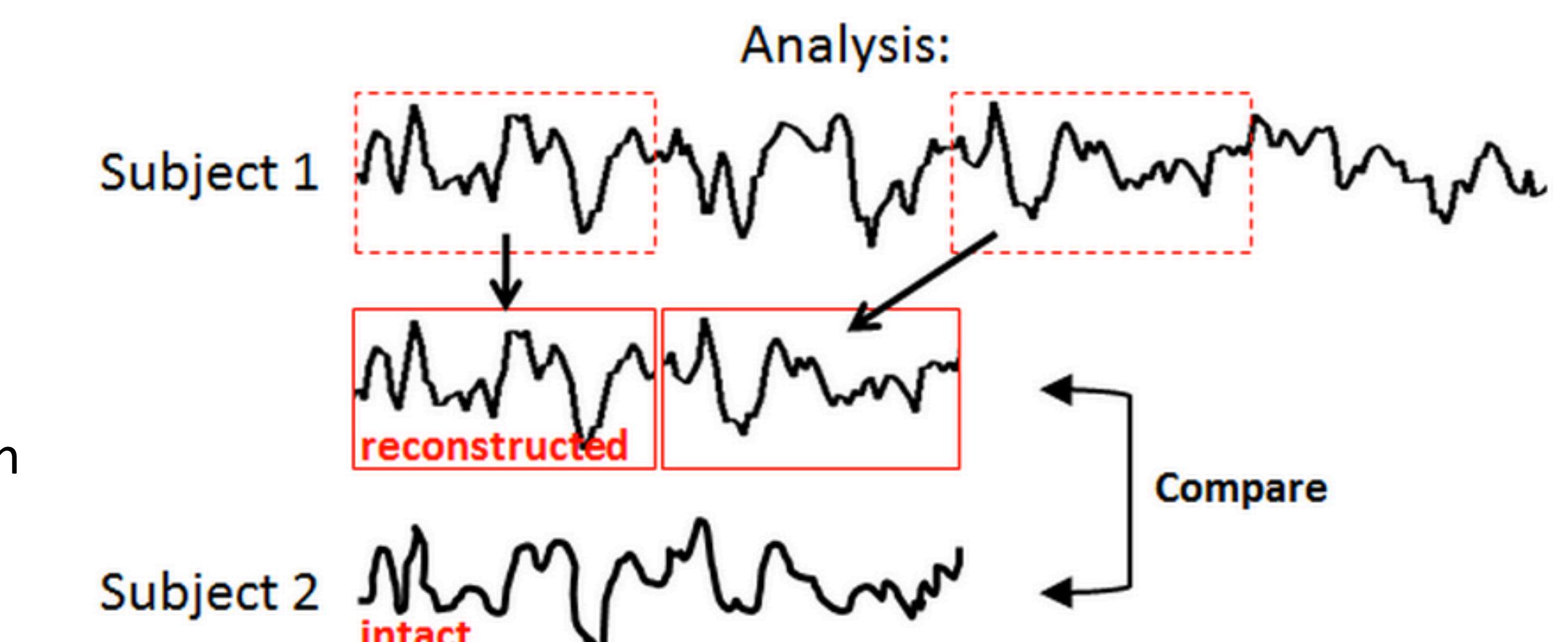
Fit latent variable model using Maximum Likelihood Estimation, with latent variables for DM and RM1, average lambdas, and test when rho is < 1.



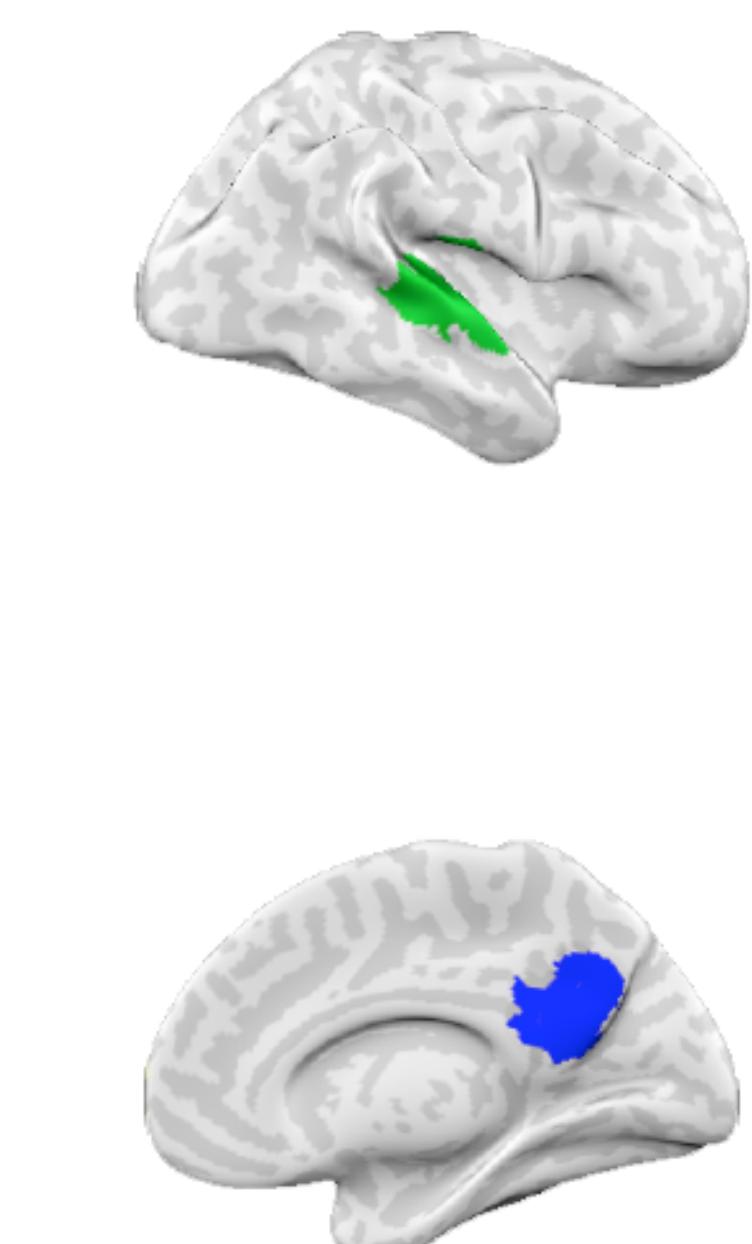
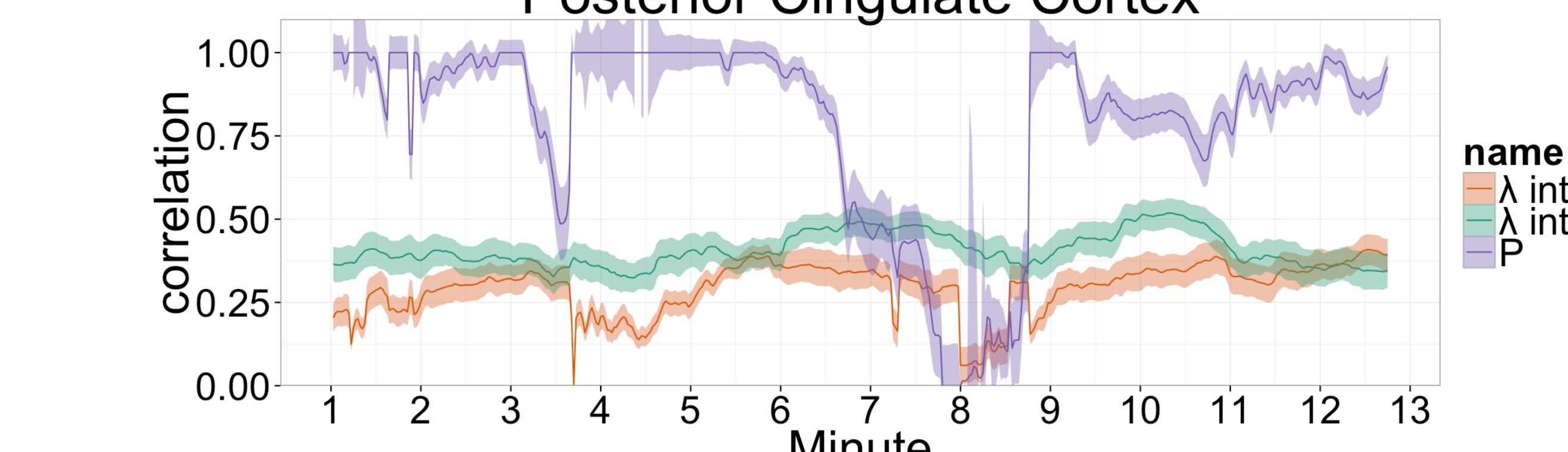
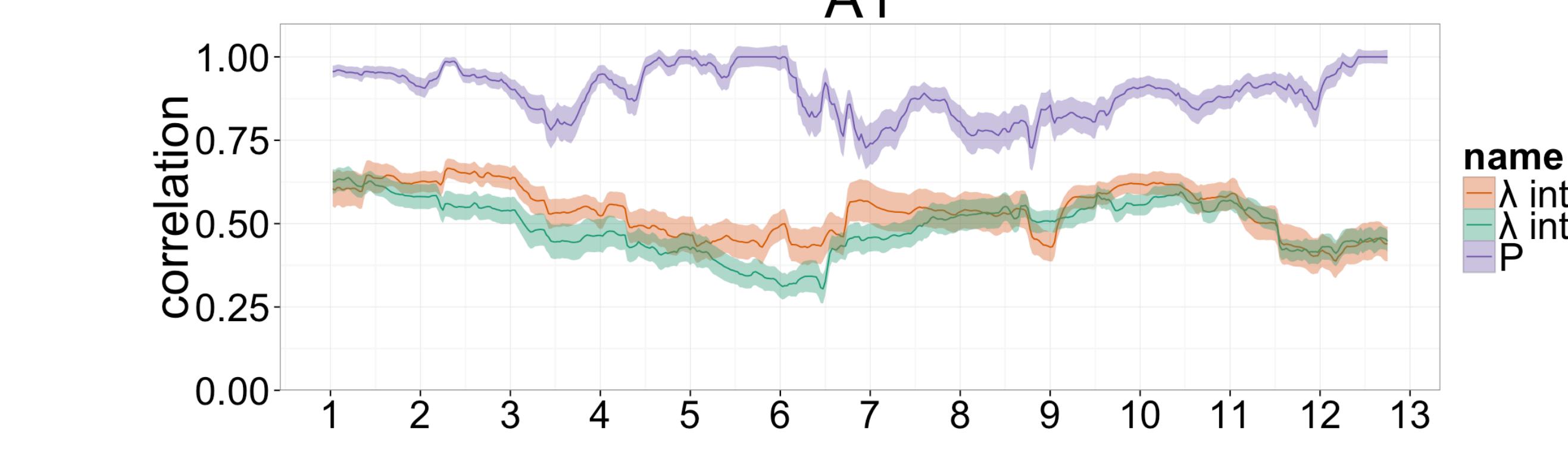
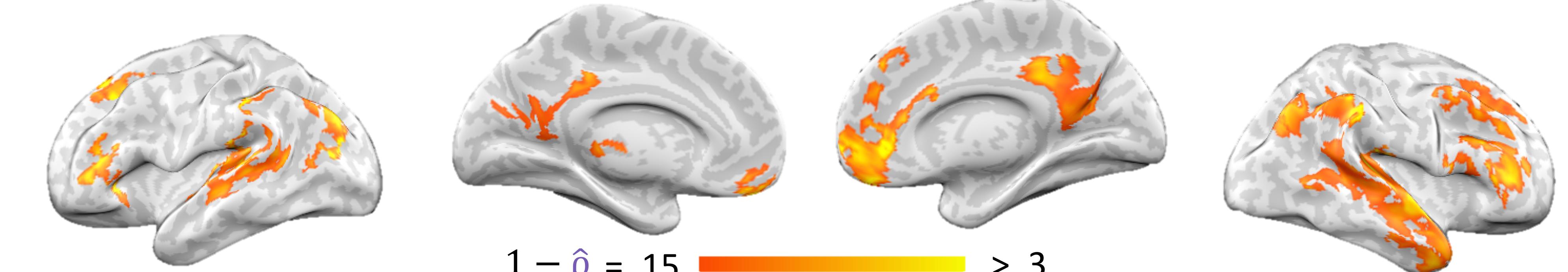
## Empirical



Story A was 17 segments. Story B was 16 segments. Stories A and B were from a popular storytelling event in New York. The A post-scan fill-in-the-blank test assessed memory for narrative content.



### Distinct Latent Timecourse



## Discussion

[1] Reliability of latent neural timecourses is an important factor that is not taken into account by previous approaches.

[2] Studies using inter-subject correlation may be integrated under a simple latent variable model.

### References

1. Hasson et al. (2004). Intersubject synchronization of cortical activity during natural vision.
2. Lerner et al. (2011). Topographic mapping of a hierarchy of temporal receptive windows [...].
3. Data from Chen et al. (2015). Accessing real-life episodic information from minutes versus hours earlier modulates hippocampal and high-order cortical dynamics.

[3] Latent variable models estimate both within and between group similarity while taking into account measurement error. This allows us to explicitly test for group differences.