

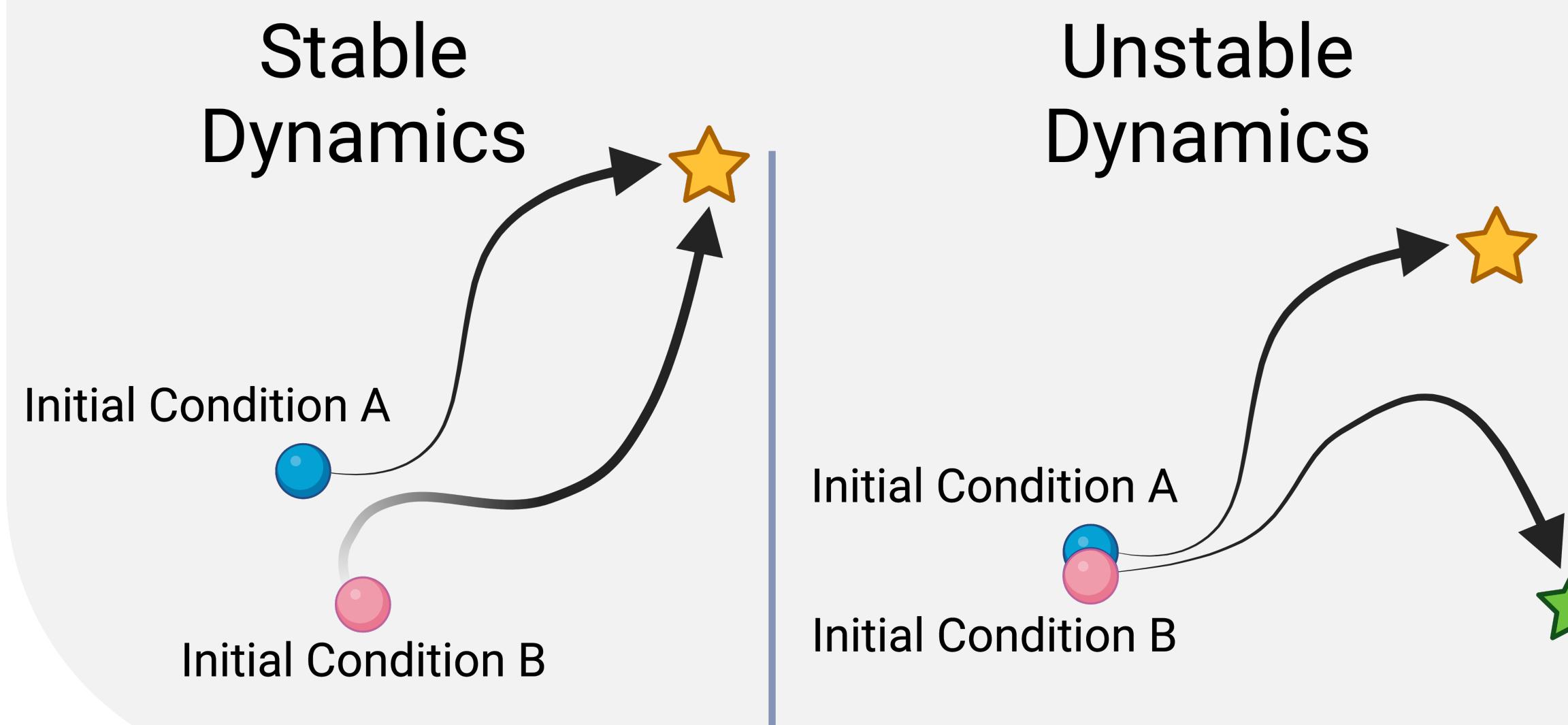
Propofol anesthesia destabilizes neural dynamics across cortex



SCAN ME

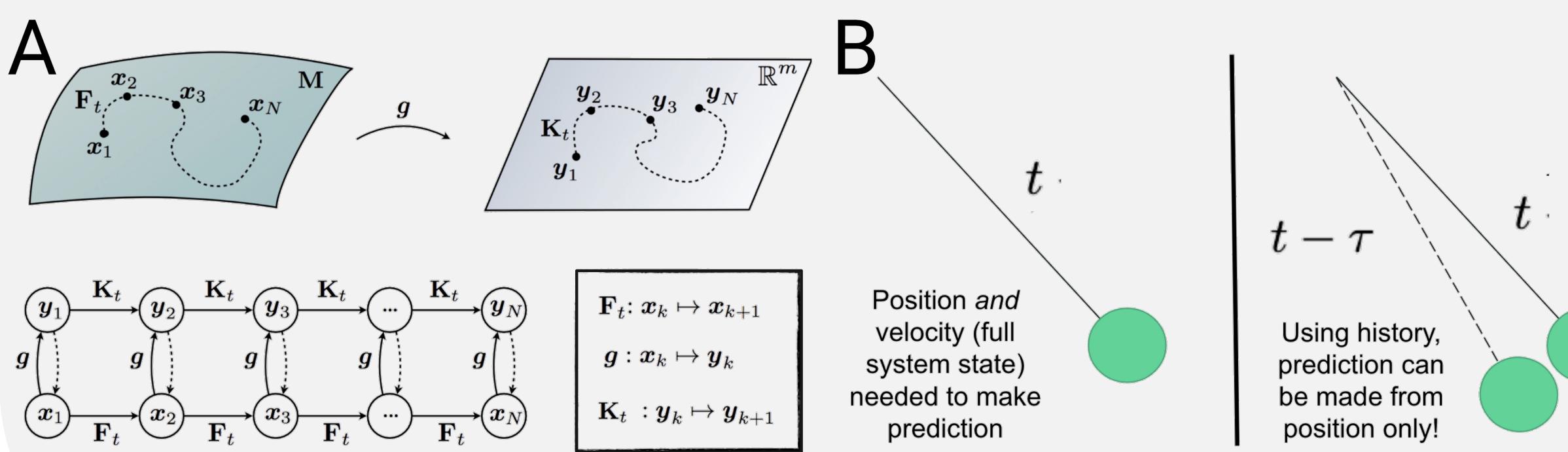
INTRODUCTION

- The neural basis of consciousness is unknown – anesthesia allows exploration of the transition between consciousness and unconsciousness.
- Theories suggest that dynamic stability is critical to cortical function¹⁻⁴. Networks balance flexibility with reliability. Network activity needs to stay “on track”, be dynamic yet constrained enough to perform consistent computations.
- Anesthesia could stabilize or destabilize neural dynamics. Current approaches have not resolved this^{5,6}.
- We leveraged tools from dynamical systems theory.



METHODS Model Building

By looking backwards in time, we can find a fully linear representation of the brain’s complex nonlinear dynamics. We can reduce complex dynamics to a simple relationship (coefficients) between states across time⁷⁻¹³.

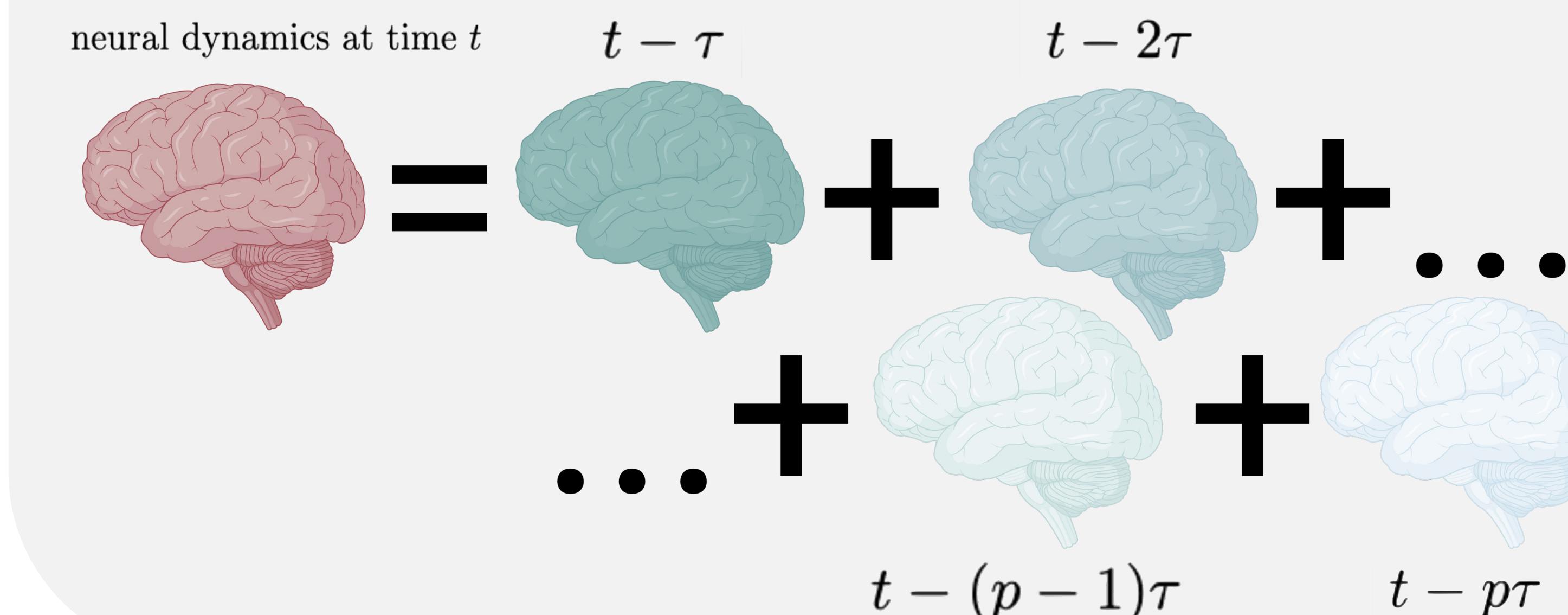


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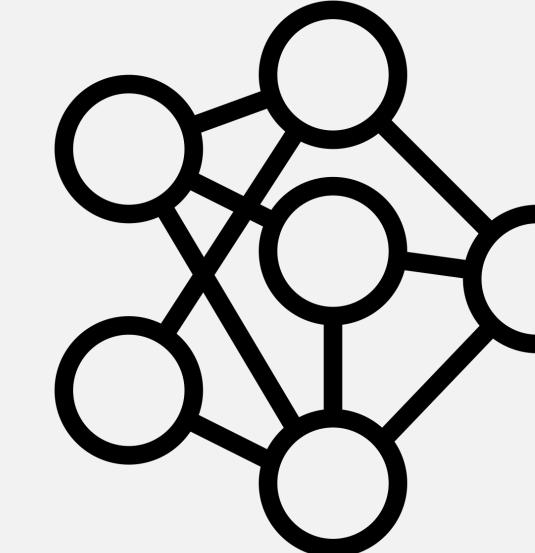
METHODS Stability Estimation

Using methods from linear delay differential equations (DDEs), we estimate stability by **discounting the impact of previous states on dynamics**^{14, 15}.

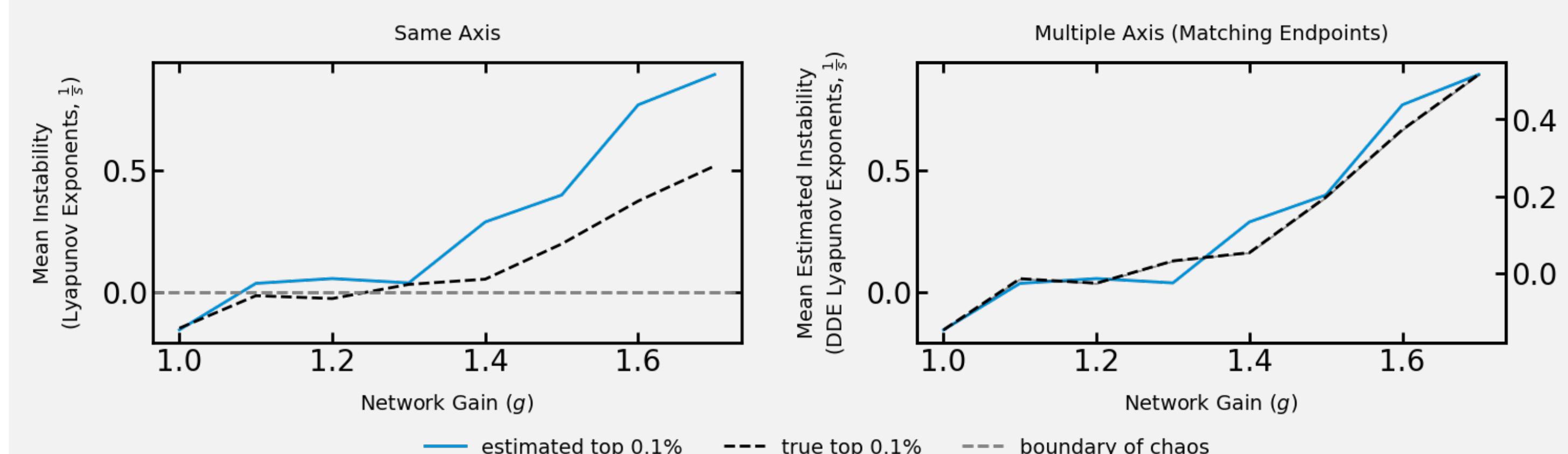


RESULTS Accurately stability estimation in simulation

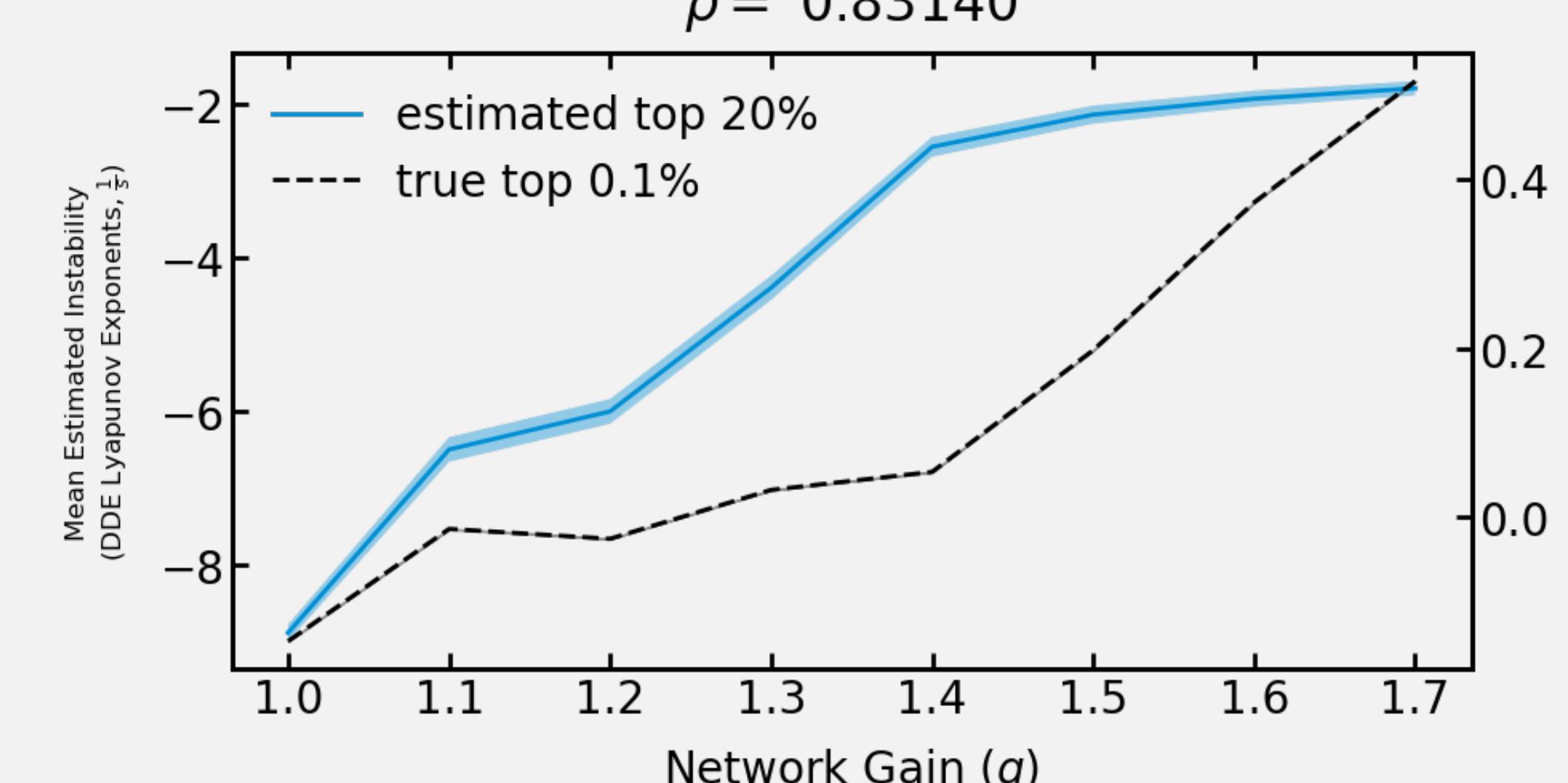
We predicted relative changes in stability between RNNs using only partial observation (50 of 512 neurons observed)



Chaotic Network Estimated vs. True Instability ($\rho = 0.98426$)



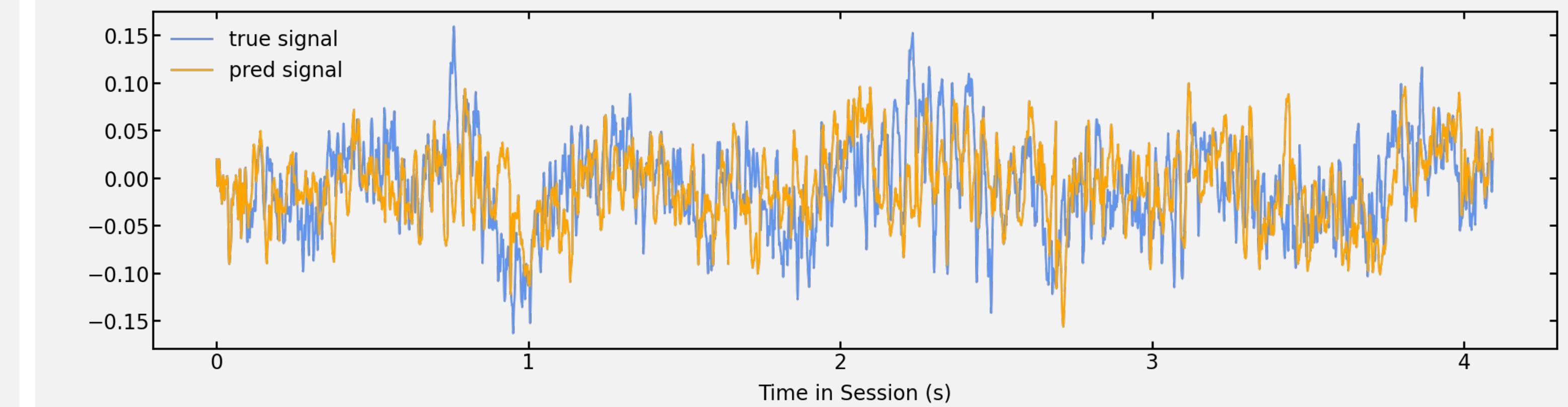
Chaotic Network Estimated vs. True Instability (Matching Endpoints)



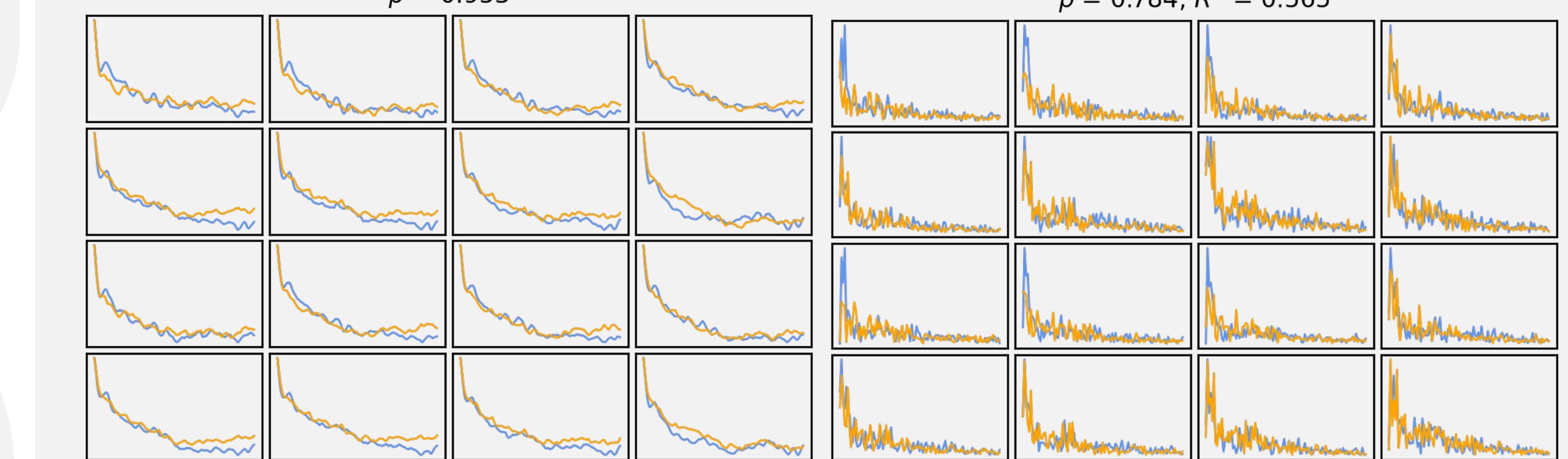
RESULTS

Propofol destabilizes neural activity

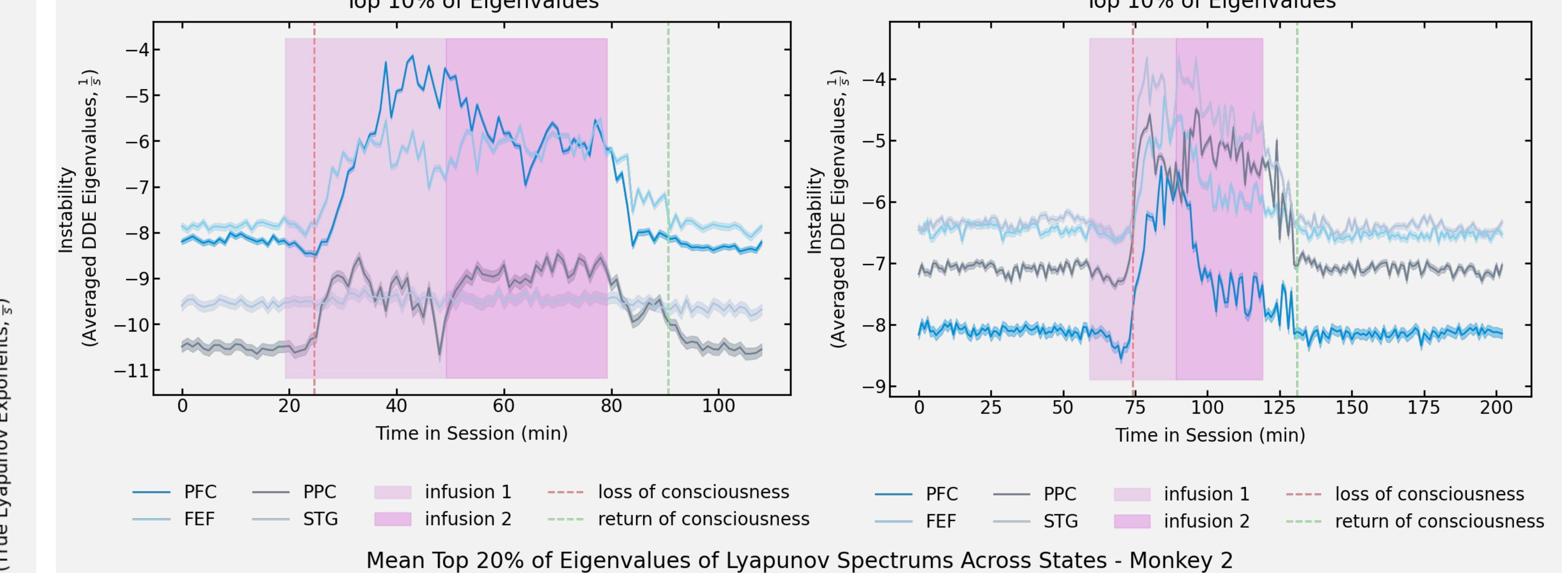
Model Performance on Test Signal
Wakeful Data ($p = 93$, reseed = 50 ms)
Index 0 Prediction



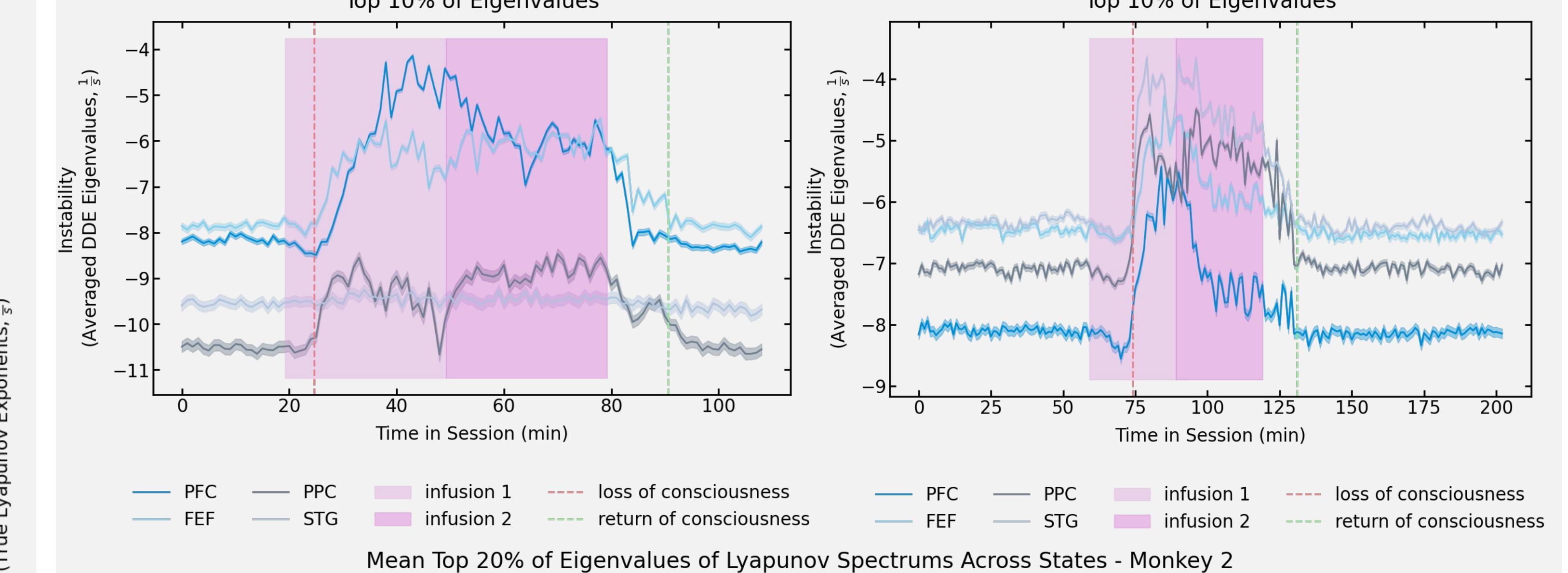
Example Autocorrelations



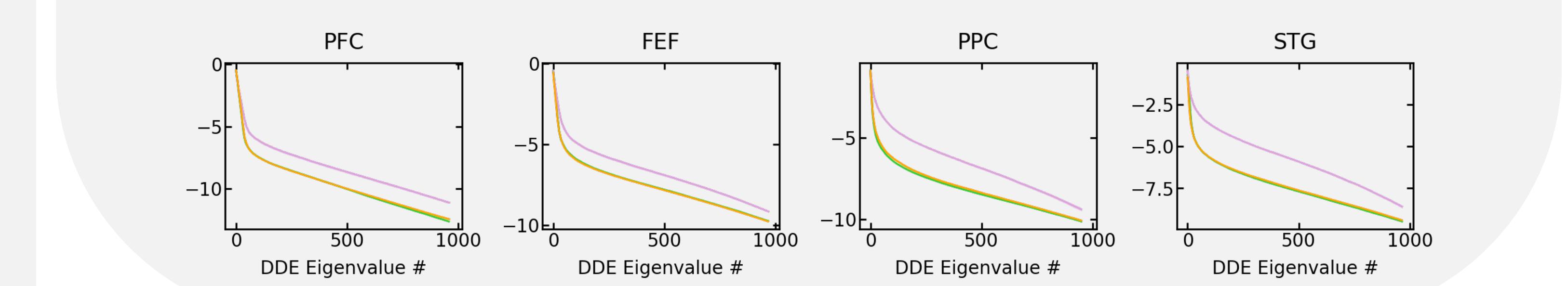
Instability Across Session - Monkey 1
Top 10% of Eigenvalues



Instability Across Session - Monkey 2
Top 10% of Eigenvalues



Mean Top 20% of Eigenvalues of Lyapunov Spectrums Across States - Monkey 2



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