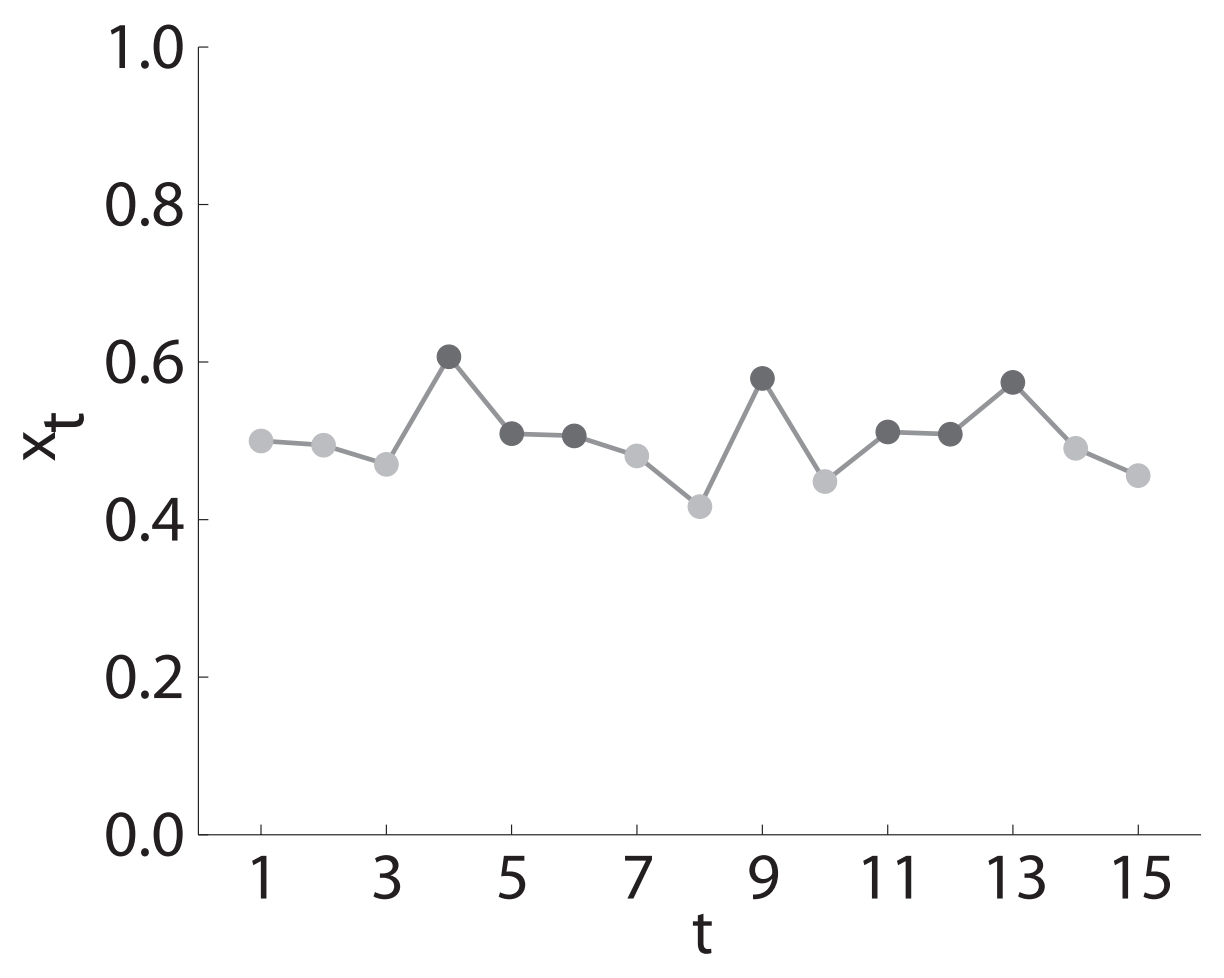
Neural fatigue influences memory encoding in the human hippocampus

Lynn J. Lohnas[1], Marijke A. Beulen[2], Joshua Jacobs[3], Michael J. Kahana[2], Endel Tulving[4]

[1]Department of Psychology, New York University; [2]Department of Psychology, University of Pennsylvania; [3]School of Biomedical Engineering, Science & Health Systems, Drexel University; [4]Department of Psychology, University of Toronto

Introduction / Motivation

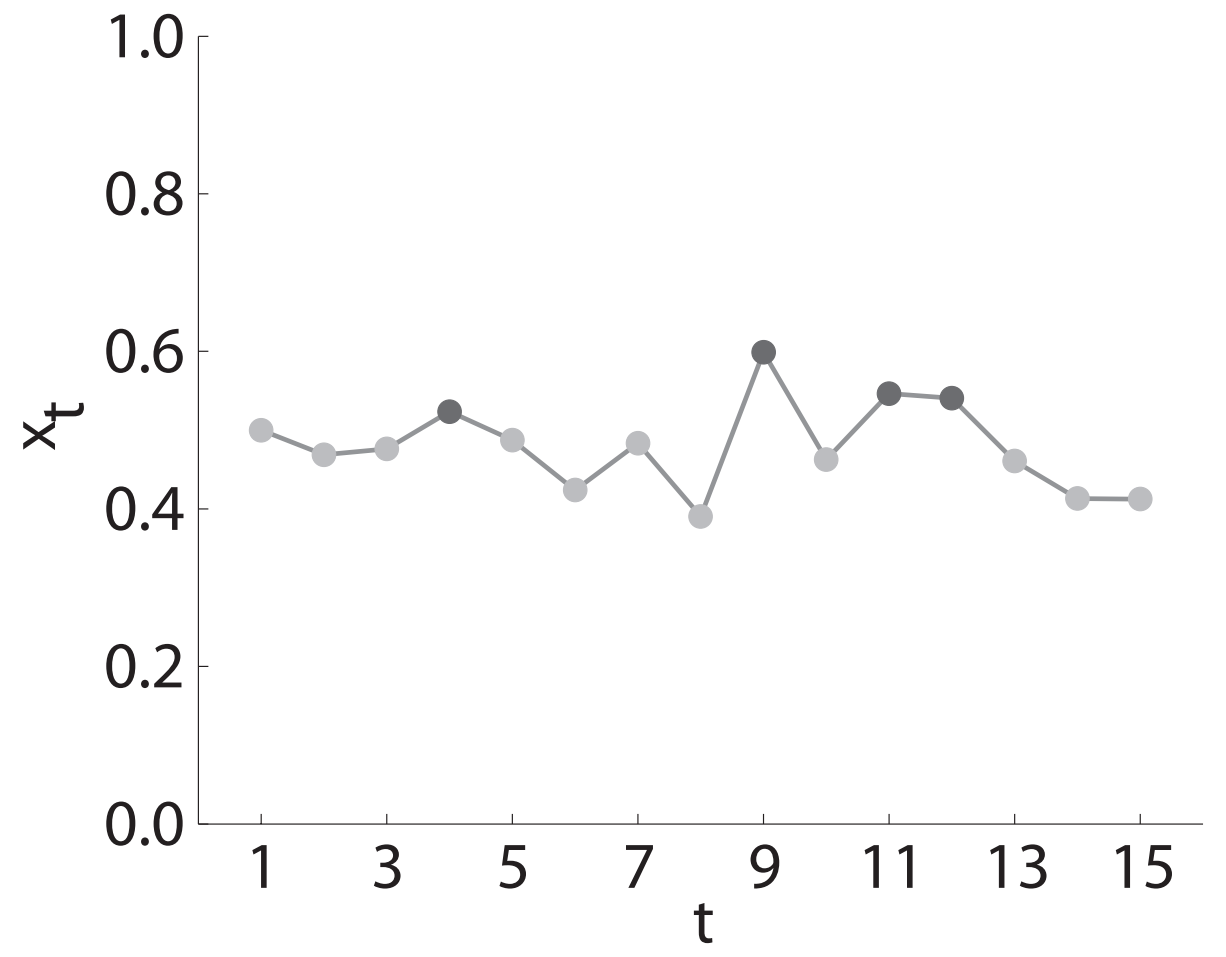
According to a standard view of variability in encoding efficacy over time, periods of encoding are persistent and autocorrelated



$$x_i = x_0 + \varphi_1 x_{i-1}\frac{dt}{\tau} + \varepsilon_i\sqrt{\frac{dt}{\tau}}$$
$$\varepsilon_i \sim \mathcal{N}(0,\sigma^2)$$

$$x_0 = 0.5, \varphi_1 = 1, \frac{dt}{\tau} = 0.01, \sigma = 0.6$$

The camatosis hypothesis (Tulving & Rosenbaum, 2006) proposes that extended periods of good encoding tend to deplete neural resources thus making epochs following efficient encoding more likely to be in a fatigued (high camatosis) state, leading to poor encoding



$$x_i = \begin{cases} x_0 + \varphi_1 x_{i-1}\frac{dt}{\tau} + \varepsilon_i\sqrt{\frac{dt}{\tau}} & \text{if } x_{i-1} \in (0, 0.5] \\ x_0 + \varphi_1 x_{i-1}\frac{dt}{\tau} + \varepsilon_i\sqrt{\frac{dt}{\tau}} & \text{if } x_{i-1} \in (0.5, 1) \\ \quad +\varphi_2(x_{i-1} + x_{i-2})\frac{dt}{\tau} & \end{cases}$$

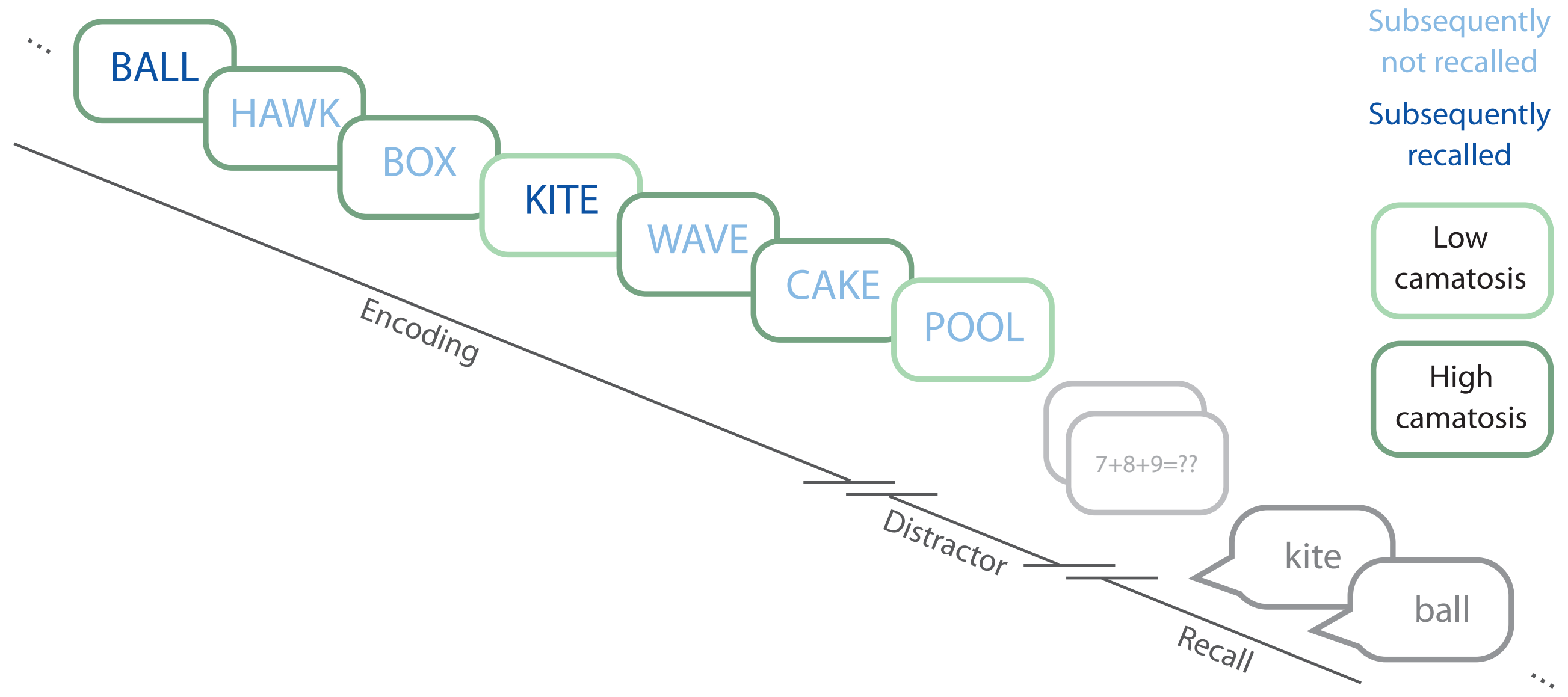
$$x_0 = 0.5, \varphi_1 = 1, \frac{dt}{\tau} = 0.01, \sigma = 0.6, \varphi_2 = -0.5$$

Methods

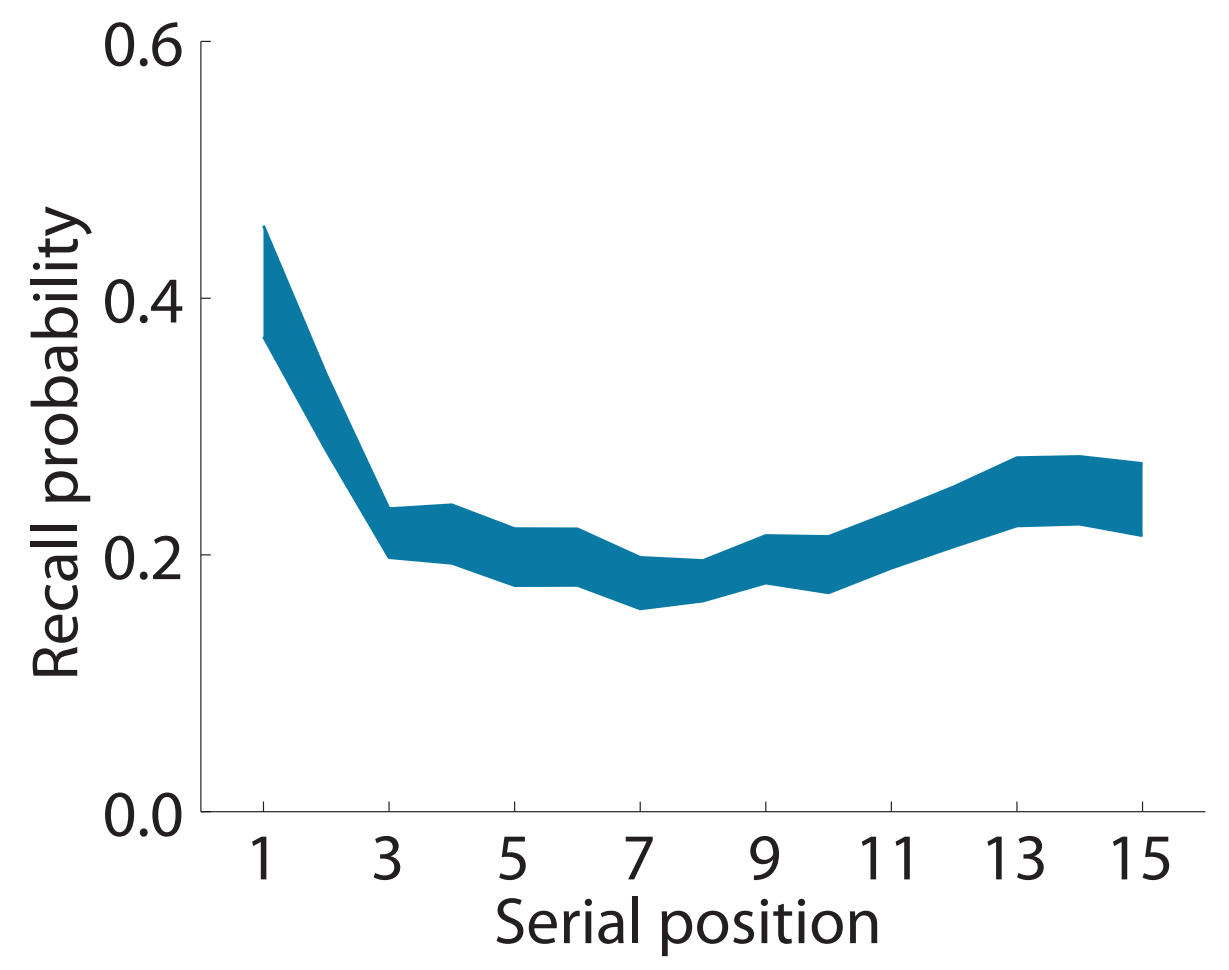
67 ECoG patients performed delayed free recall of list-length 15 or 20

Gamma power (65-95 Hz; Burke et al., 2014) was calculated during each 1600ms item presentation and classified according to:

- its current encoding state (subsequently recalled or not)
- its camatosis state (at least of the prior two items was recalled or not)



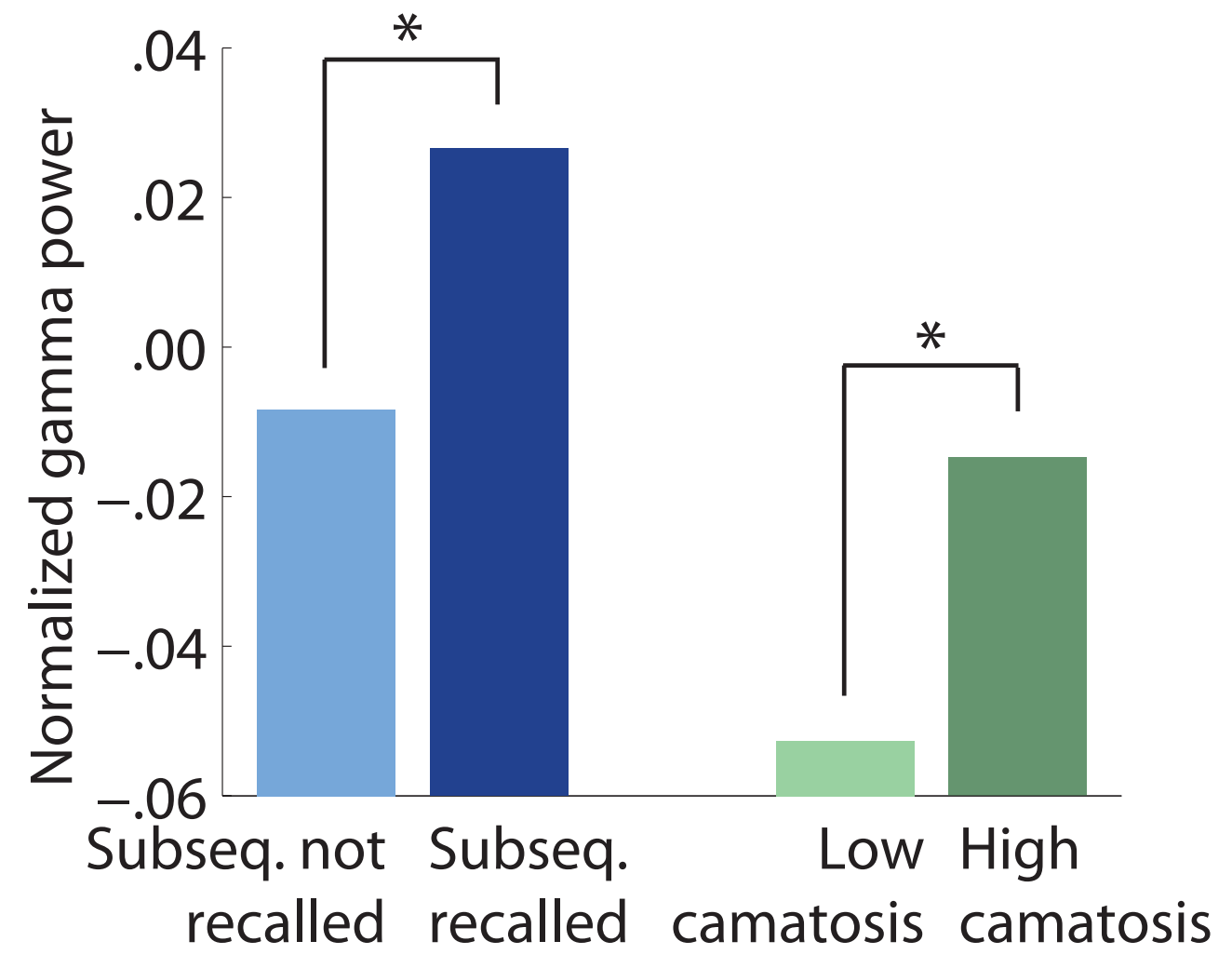
Recall performance



Given the high recall for early serial positions, we excluded serial positions 1-5 from the camatosis conditions below

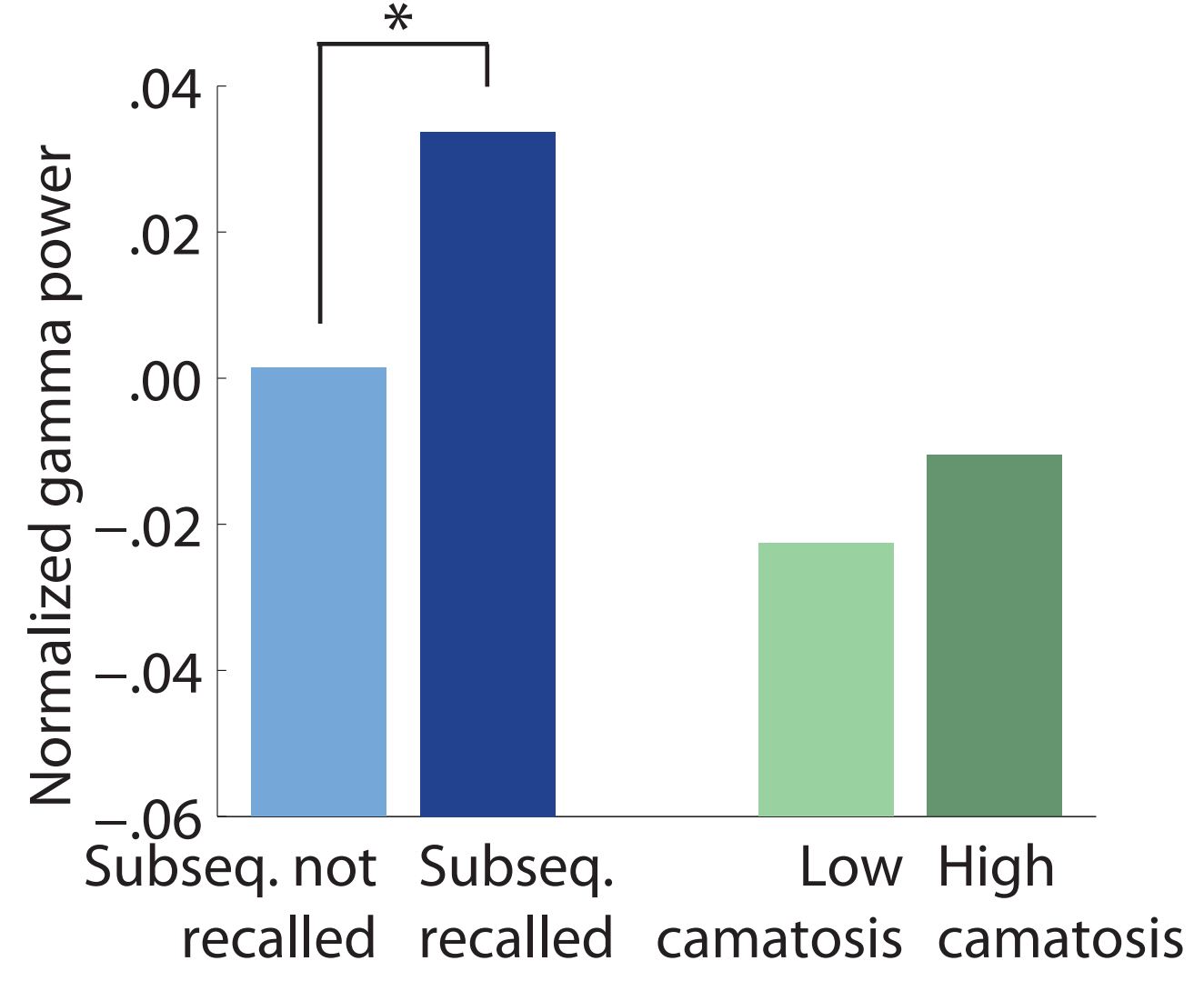
Effects of encoding and camatosis states

Left DLPFC (n = 25)



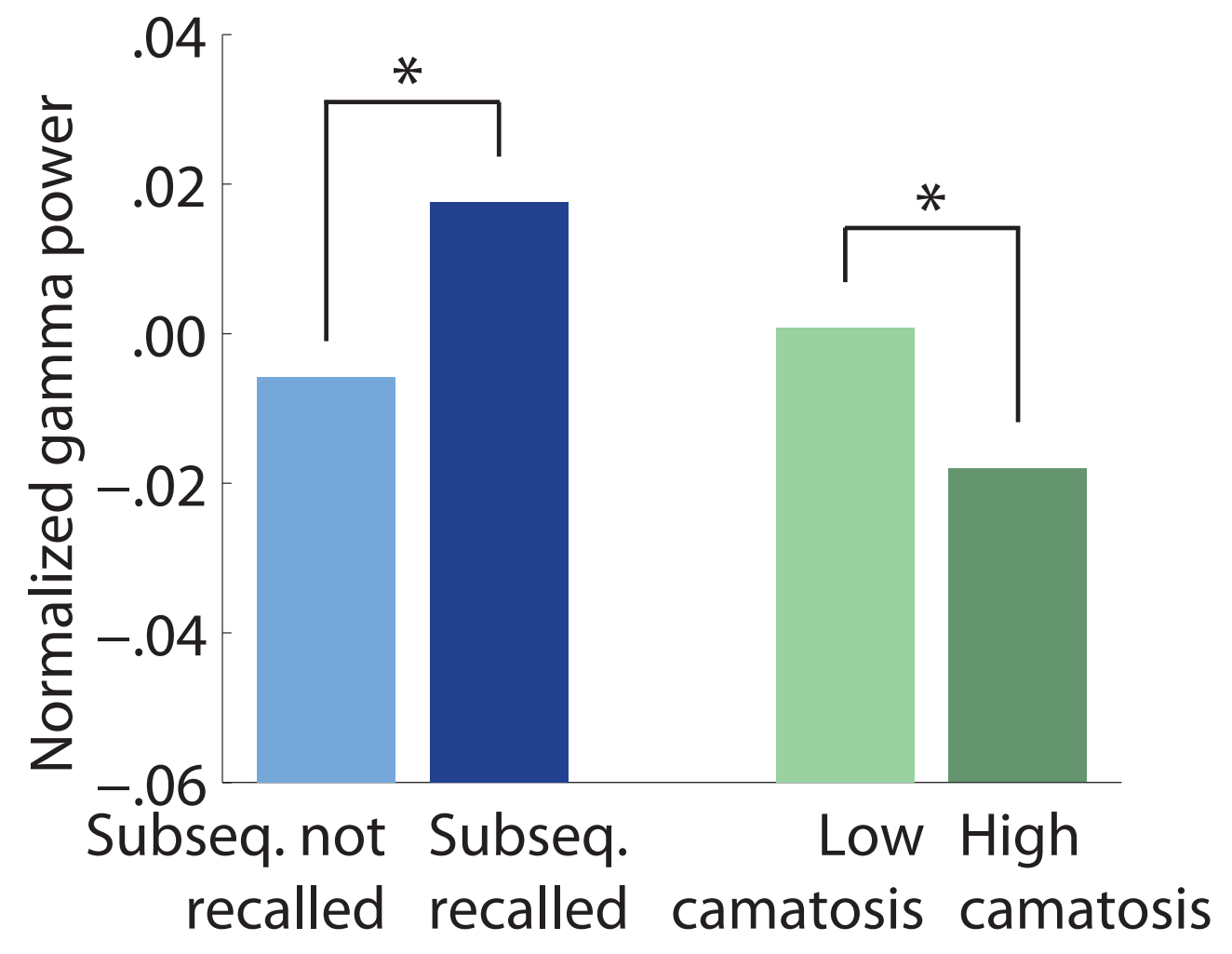
Greater gamma power for both successful encoding state and successful encoding history

Left hippocampus (n = 35)



Greater gamma power for successful encoding state but no modulation of gamma power by encoding history

Right hippocampus (n = 27)



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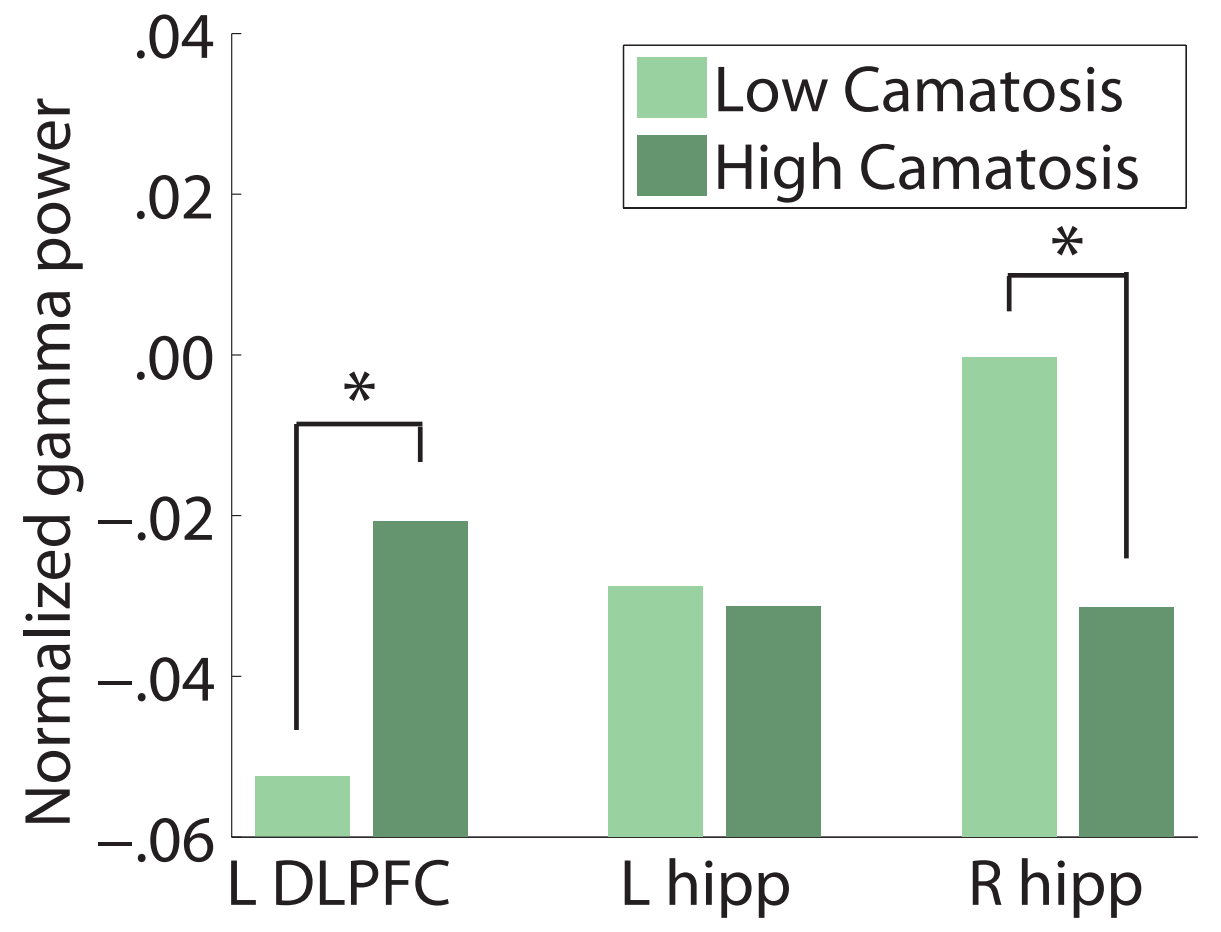
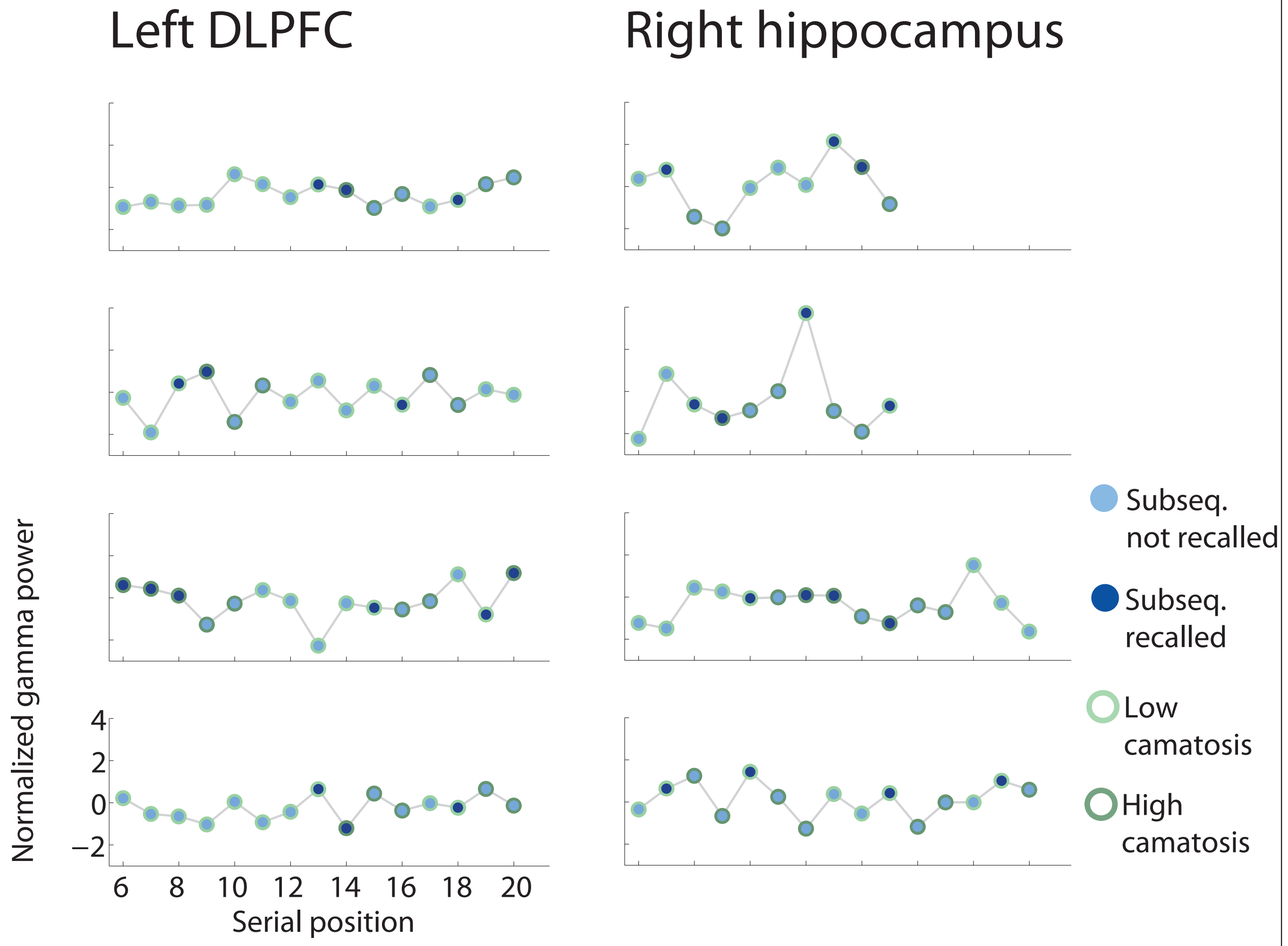
Camatosis states for nonrecalled items only



Controlling for the current encoding state, modulations of gamma power by camatosis state are unchanged from the analysis that includes all items

Bipolar electrode examples by list



Summary

Modulations of gamma power in DLPFC are consistent with autocorrelated goodness of encoding

Modulations of gamma power in right hippocampus are consistent with the camatosis hypothesis

References

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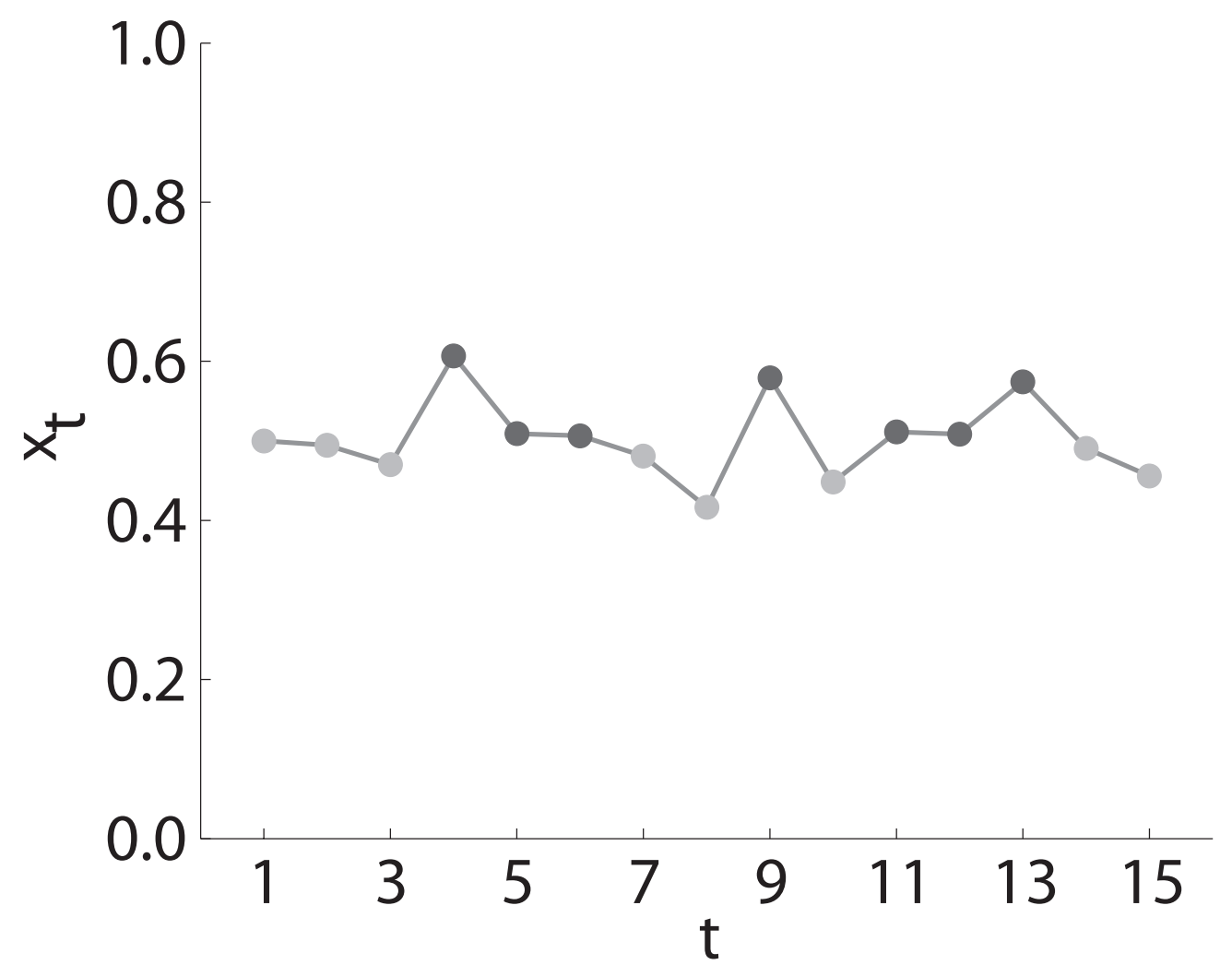

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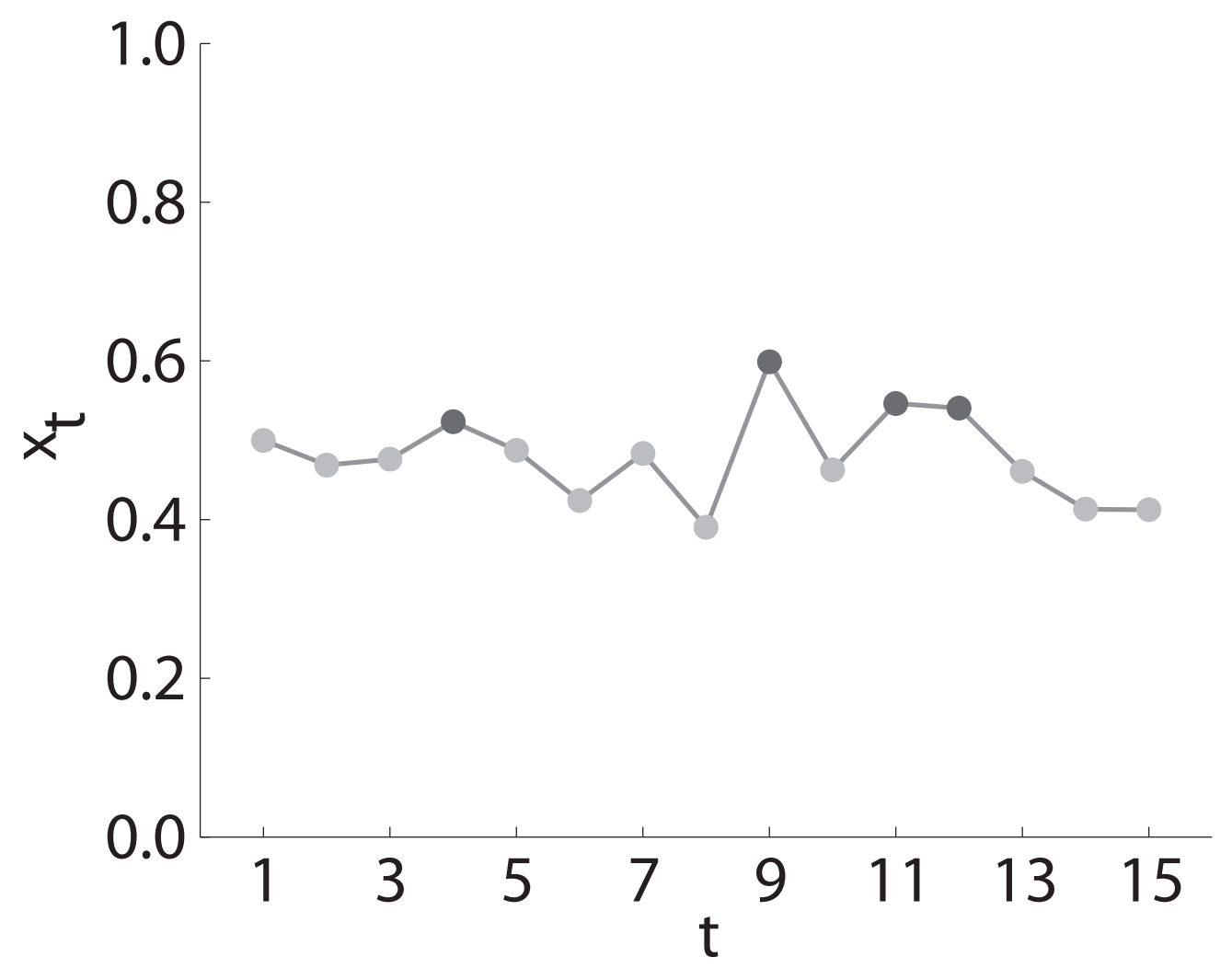

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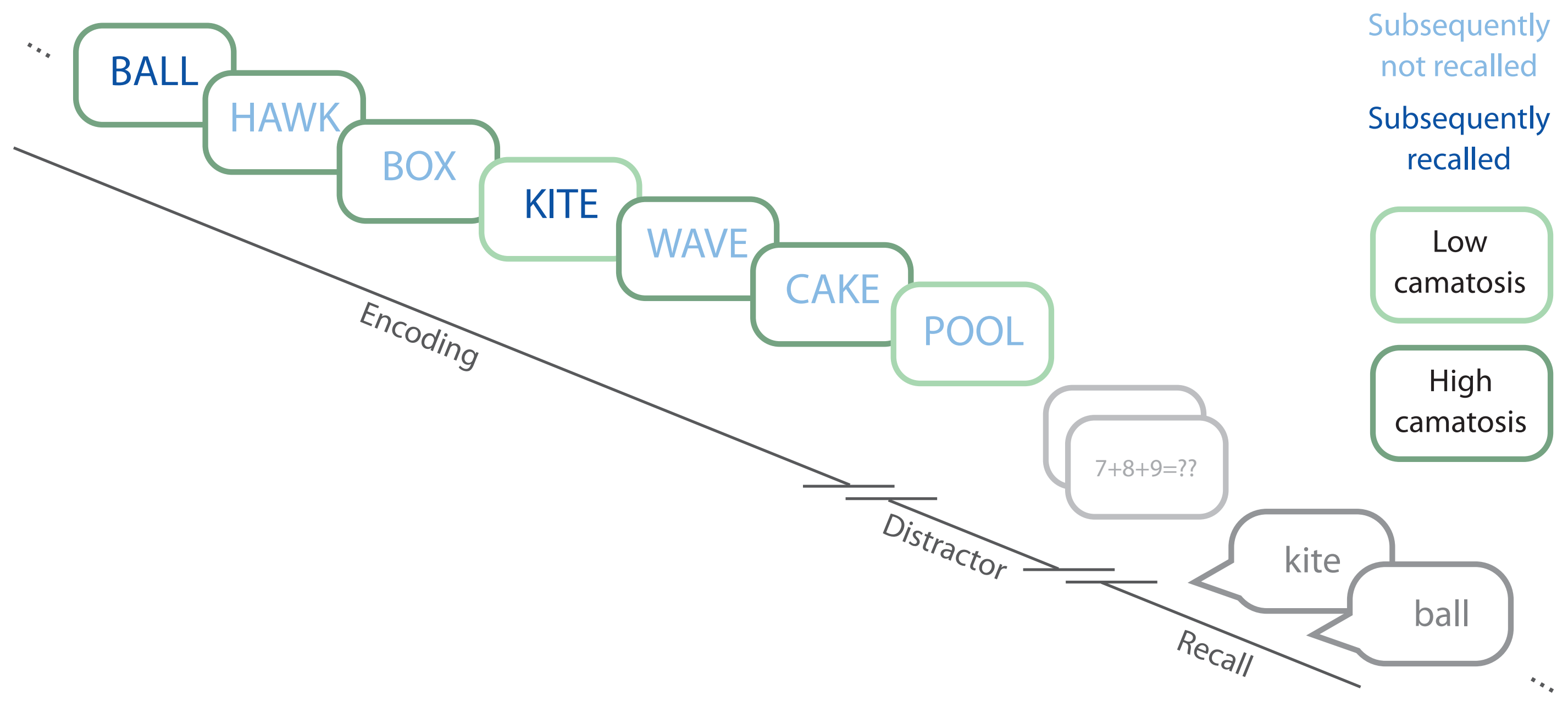

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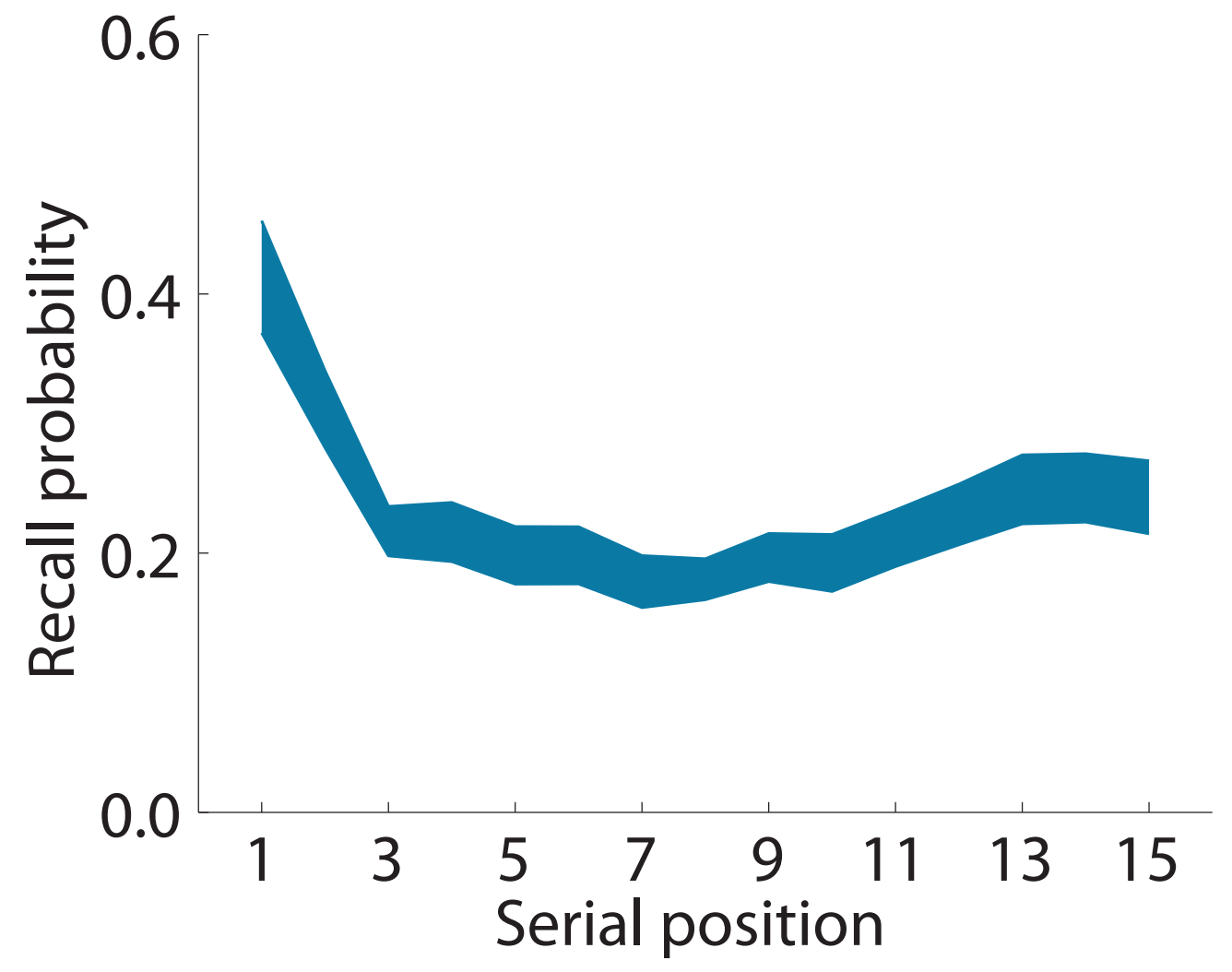

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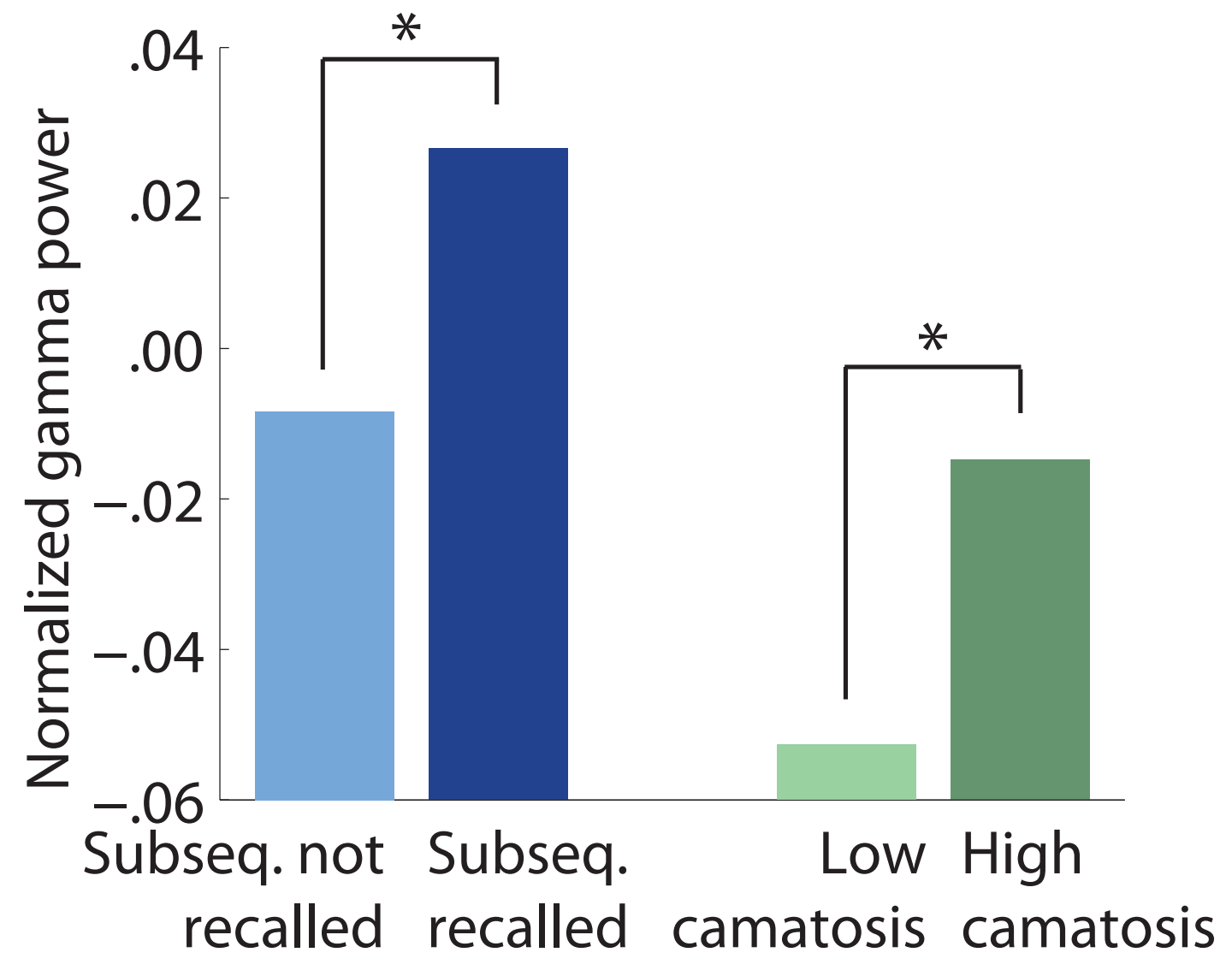

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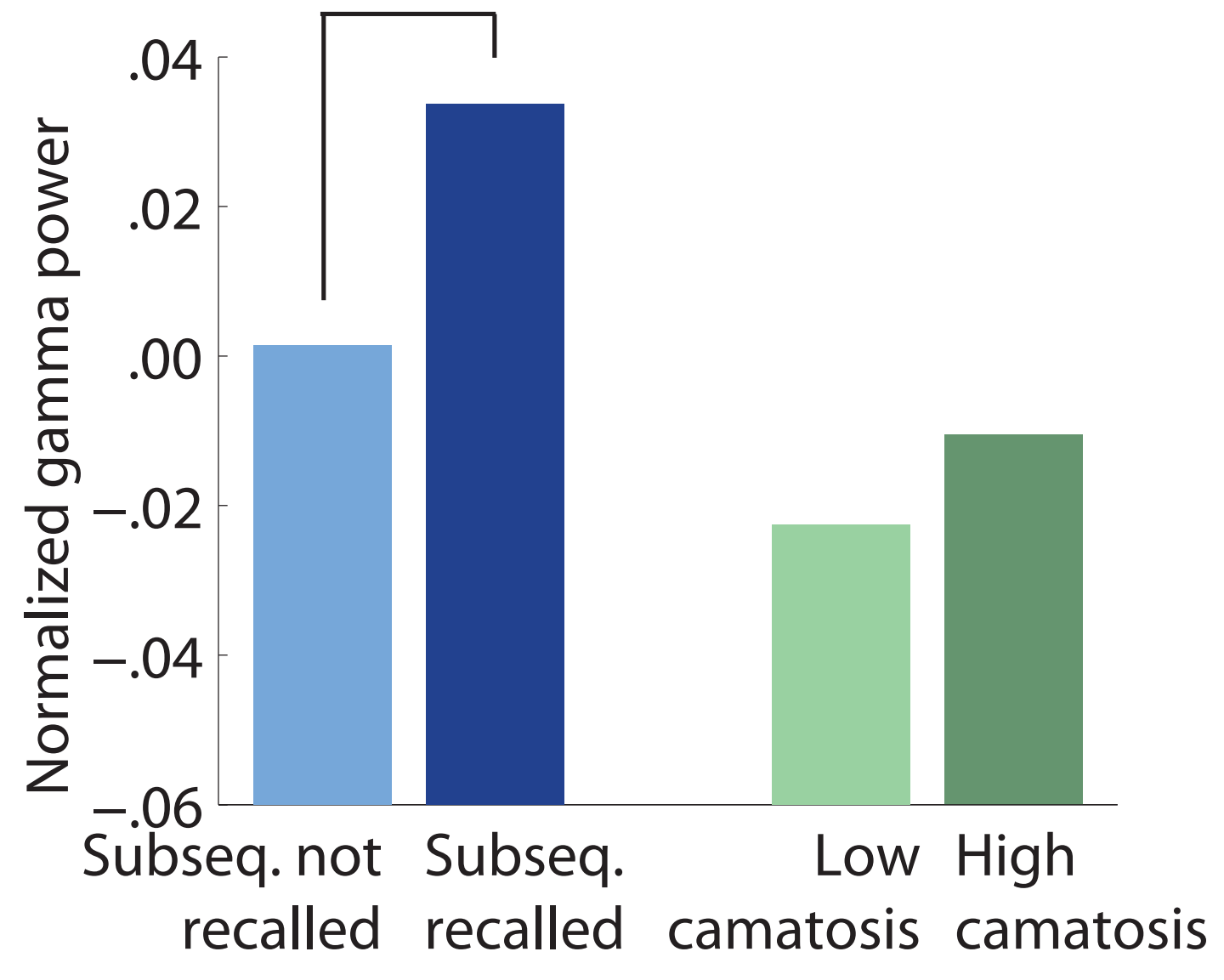

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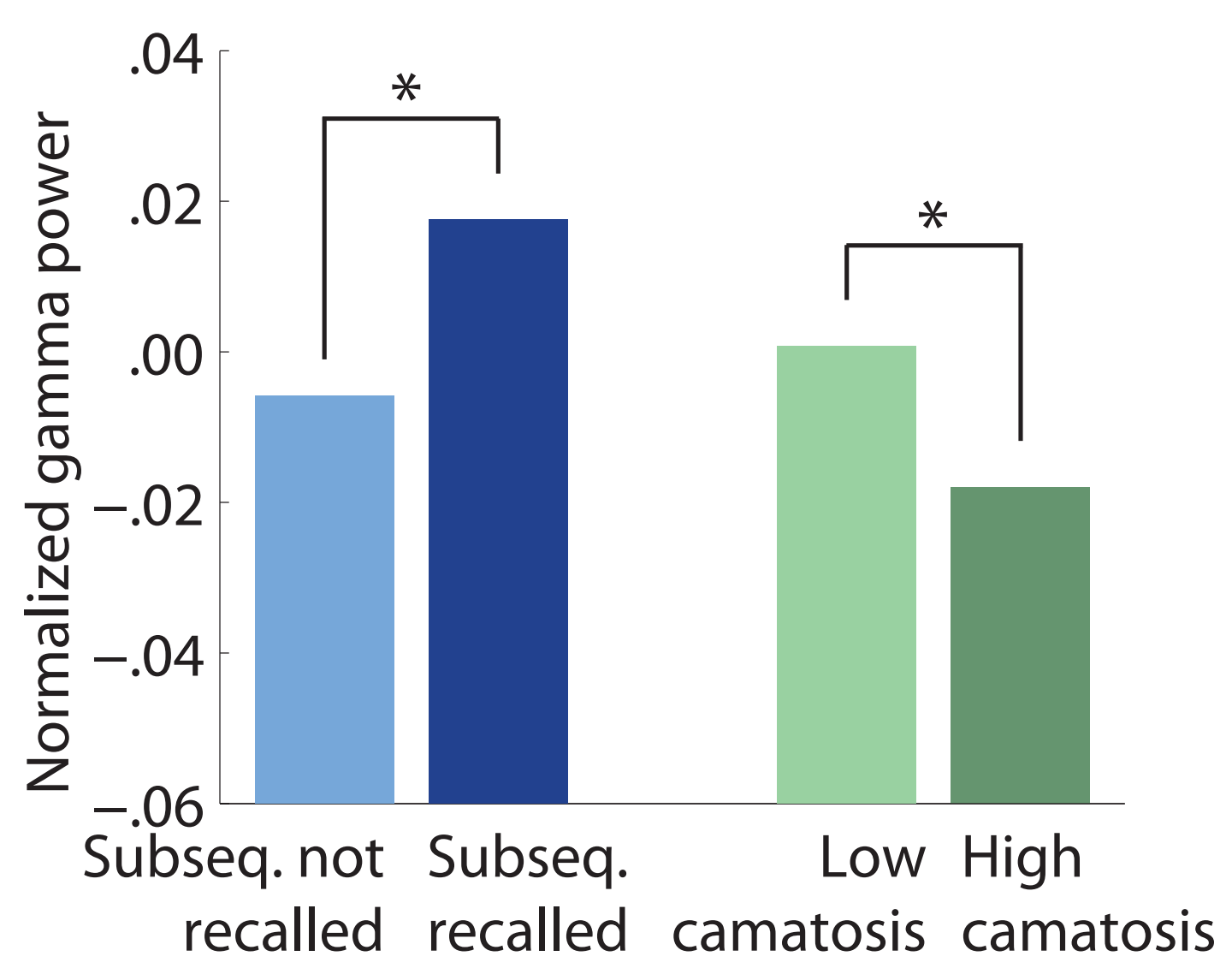

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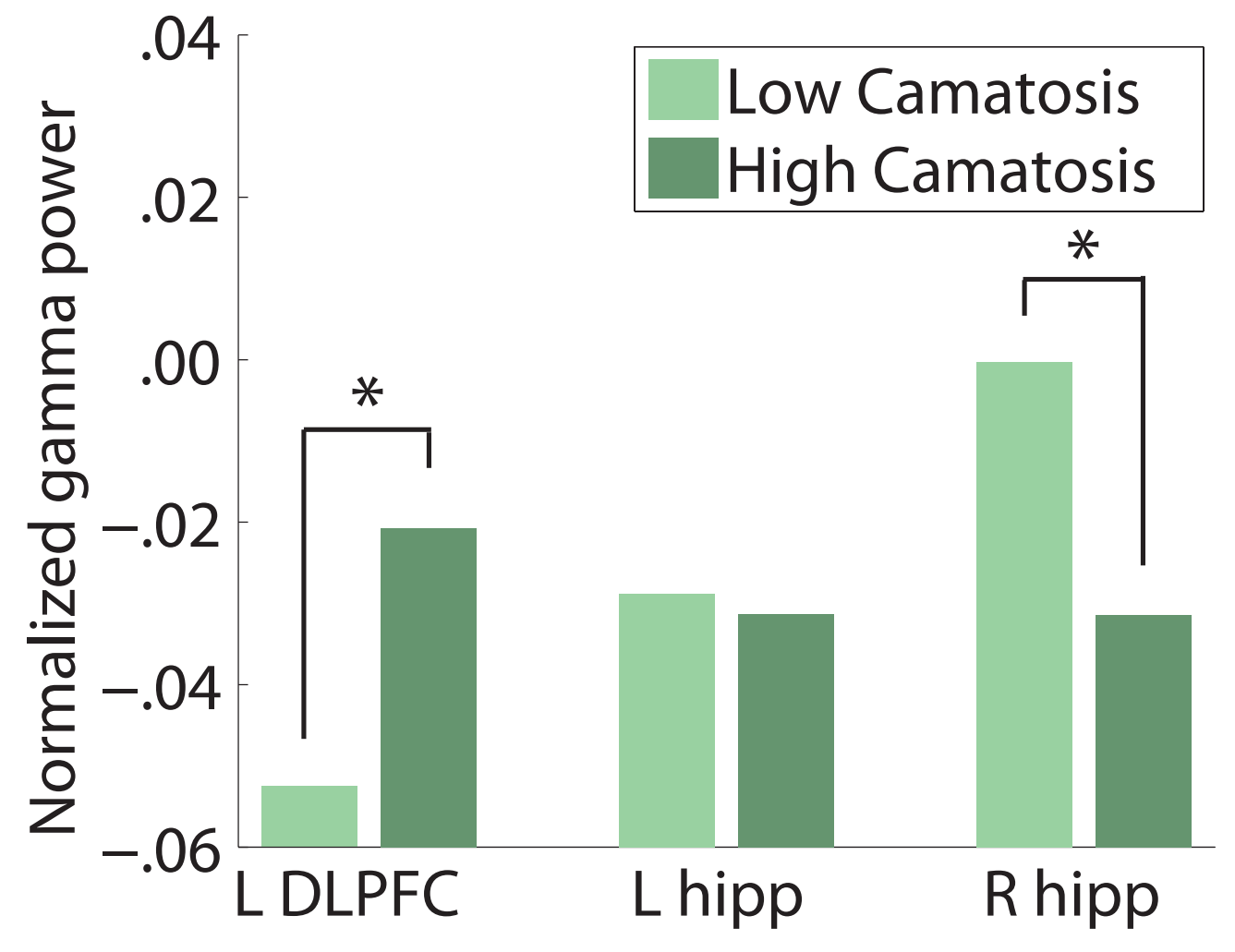

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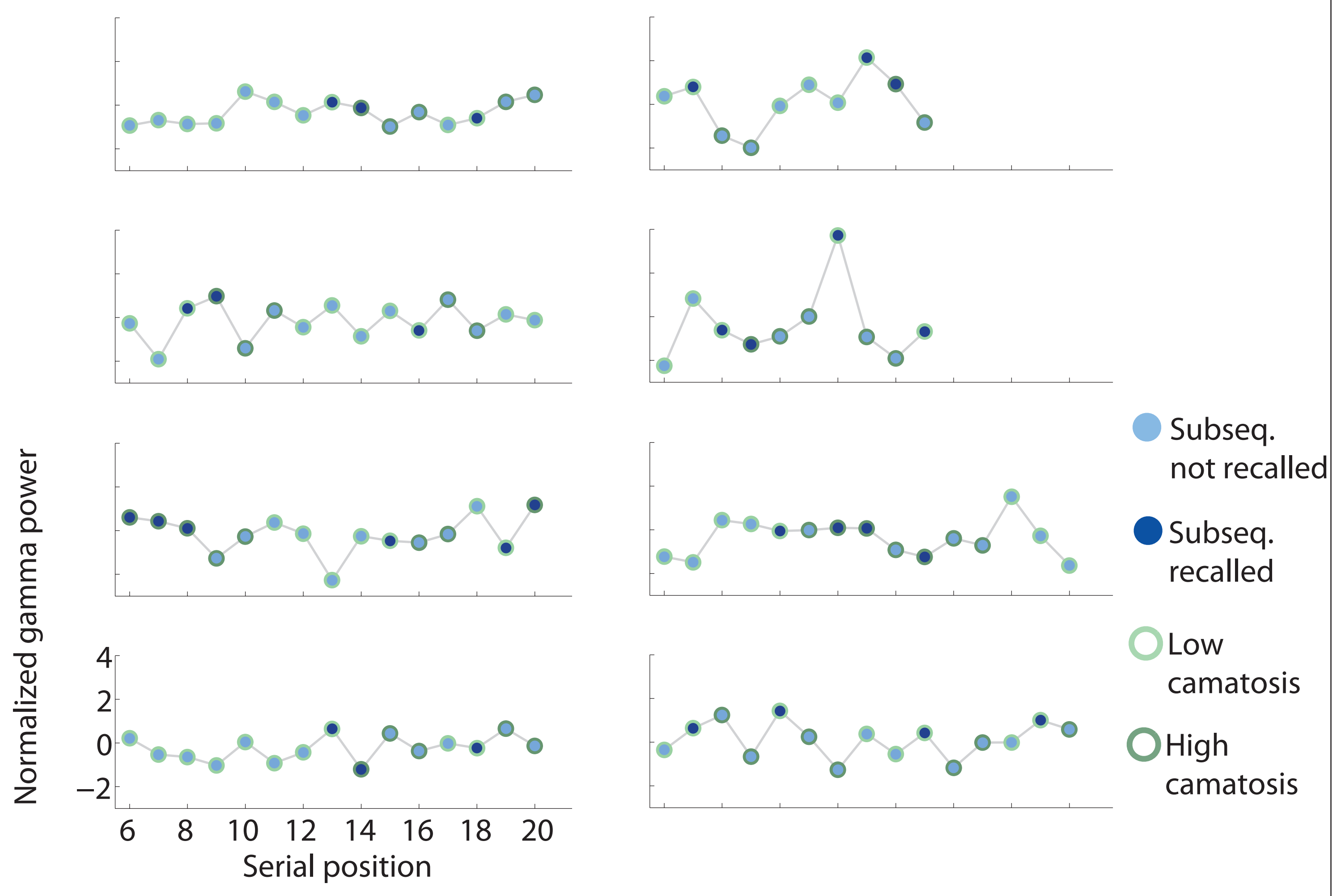
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