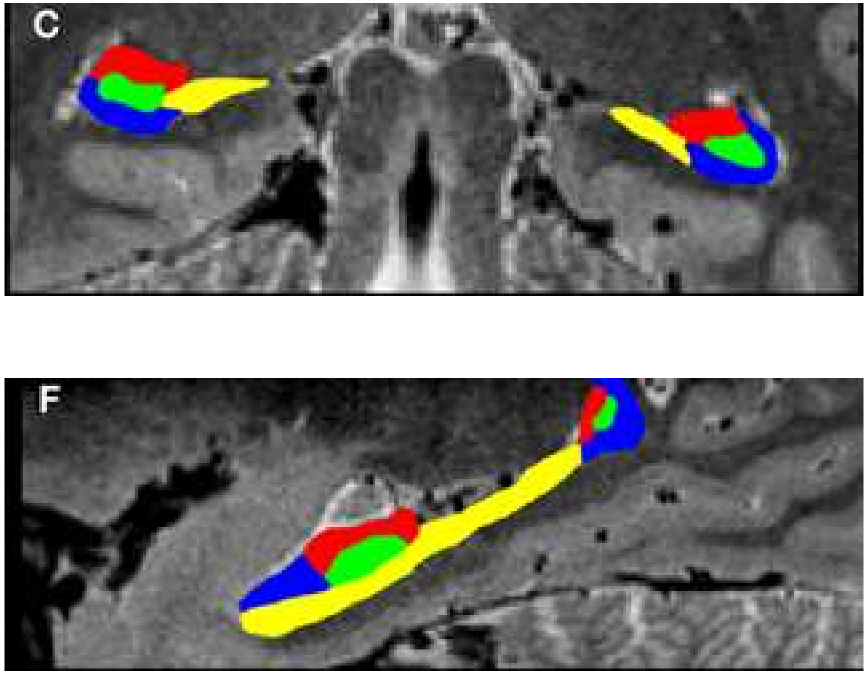

Theta modulation of CA1 responding to CA3 inputs

Eleanor Loh

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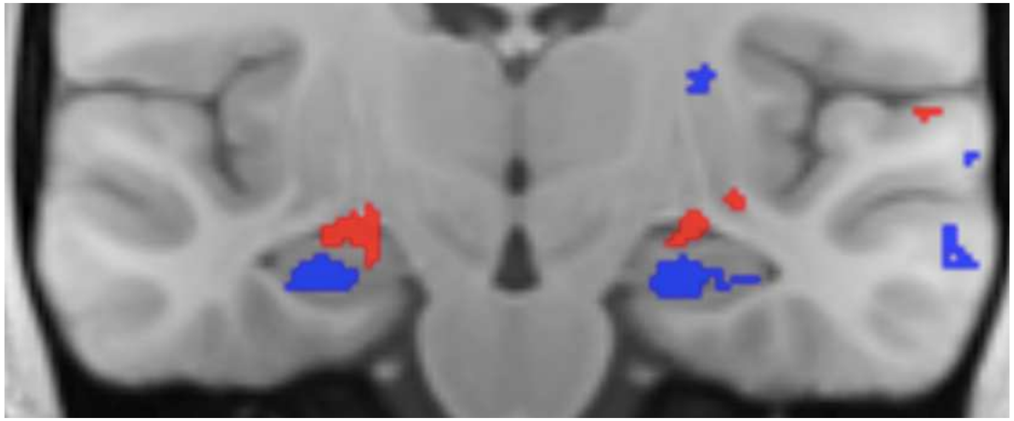
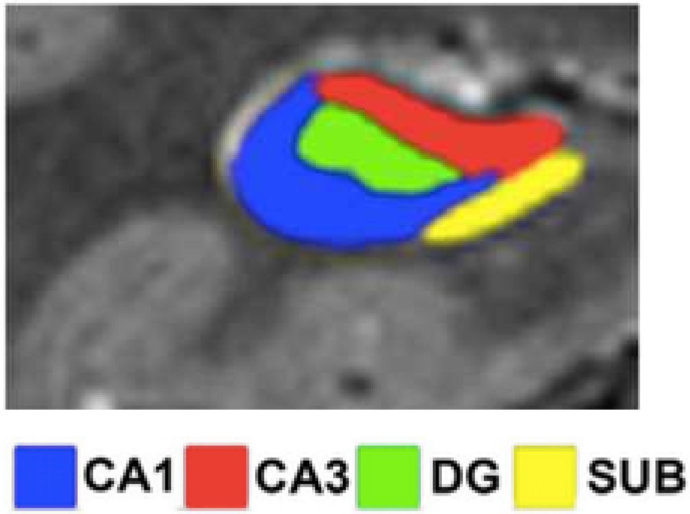
CA1 comparator for aversive threat (punishment)





<u>Empirically</u>

- **Theta oscillations are a reliable neural signature of anxiety** Gray & McNaughton, 2000
- **Emergence of aversive signaling moving from CA3 to CA1**

General hypothesis: Theta oscillations should lead to greater activity in CA1

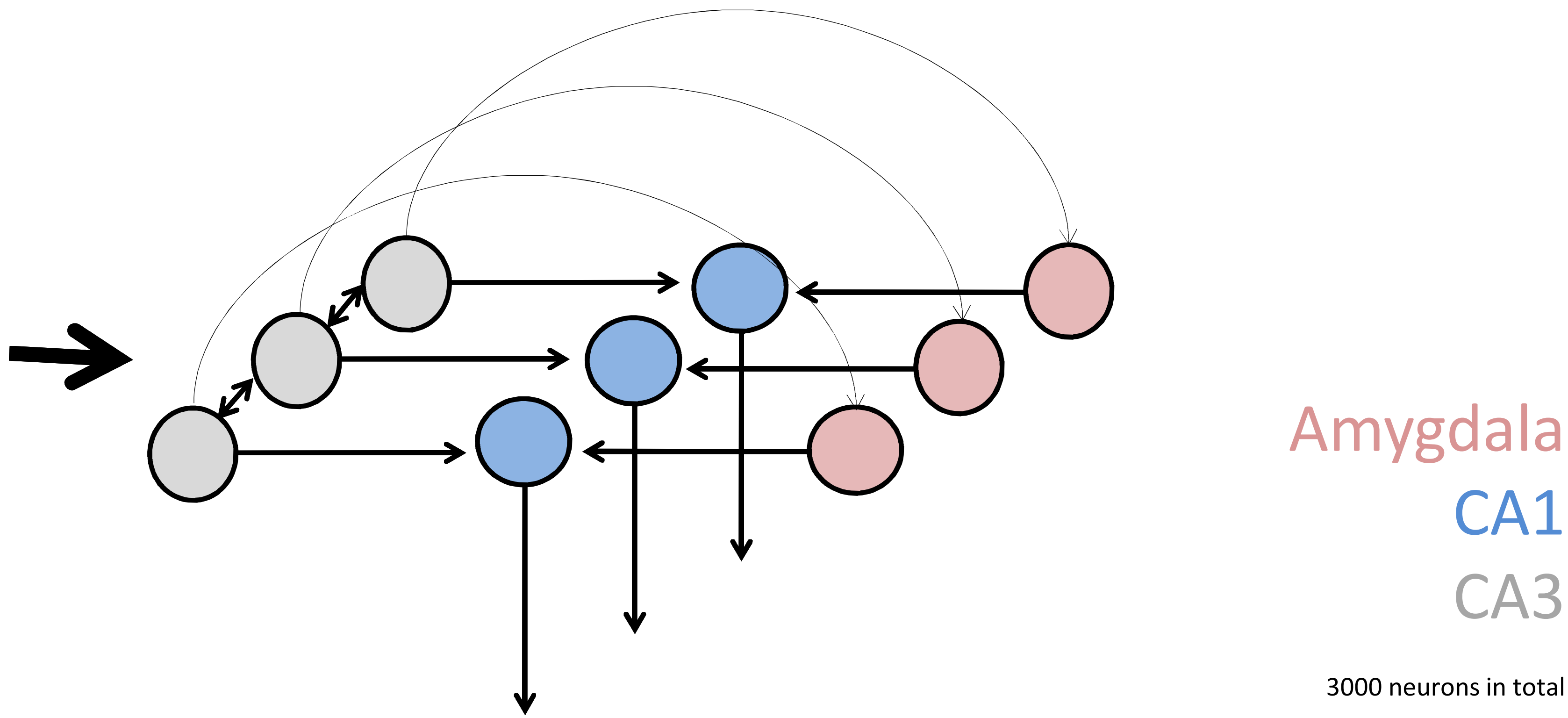
→ Potential mechanism for theta-modulated positive feedback of CA1 activation

Model setup: CA3, CA1 and Amygdala populations

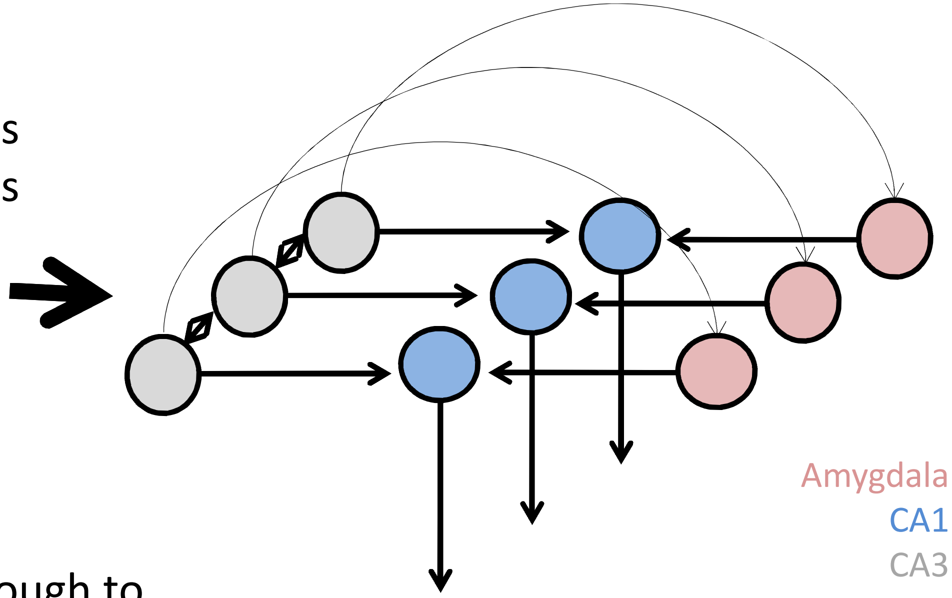
1. Only CA3 receives non-noise inputs

2. CA3 has a low probability of driving amygdala units

3. CA1 activity depends on convergent inputs from CA3 and Amygdala



CA3: Excitatory and Inhibitory (10%) neurons
CA1: Excitatory and Inhibitory (10%) neurons
Amygdala: Excitatory neurons



Details of CA3-CA1 connectivity from Taxidis et al, 2011 Hippocampus

<u>Connectivity</u>

- CA3 recurrents
- CA3 → Amygdala: weak connectivity
- CA3 → CA1 connectivity is not strong enough to actively drive CA1

<u>Network is driven with varying inputs</u>

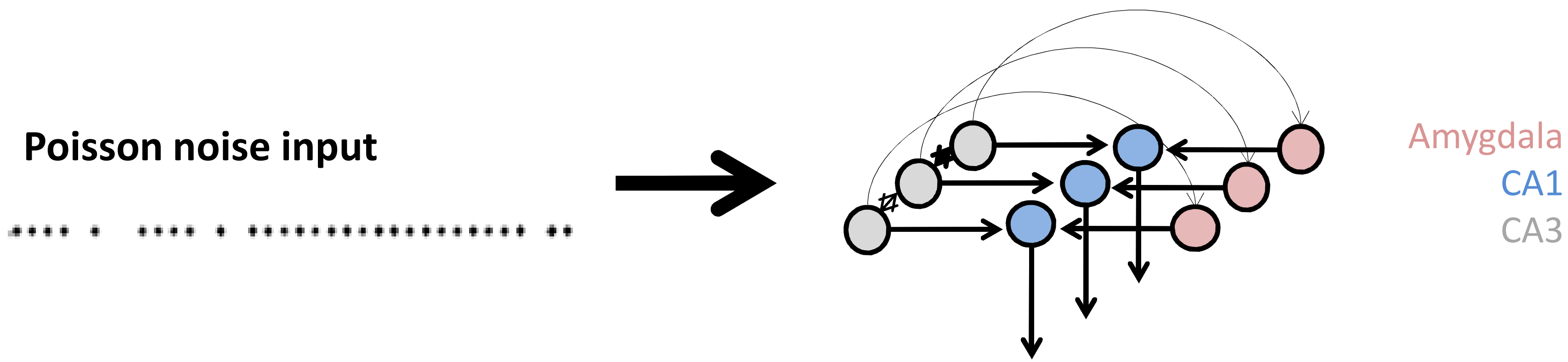
Poisson noise

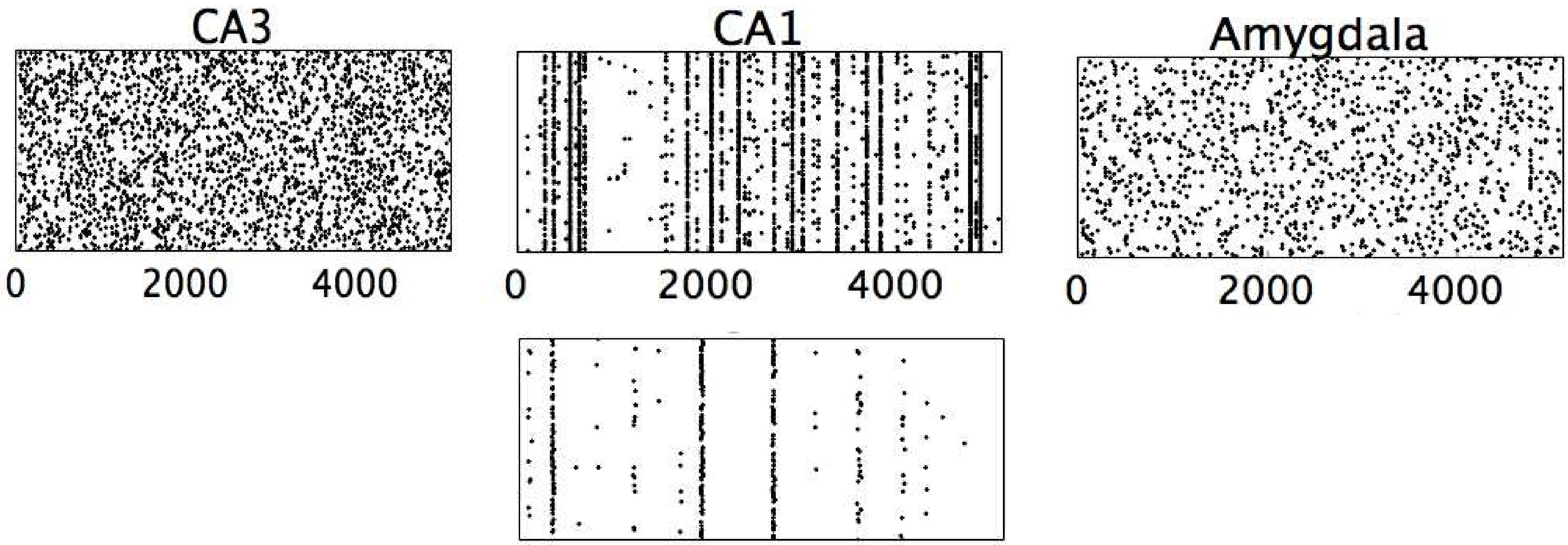
Active drive

Theta input

Poisson noise modulated by theta frequency

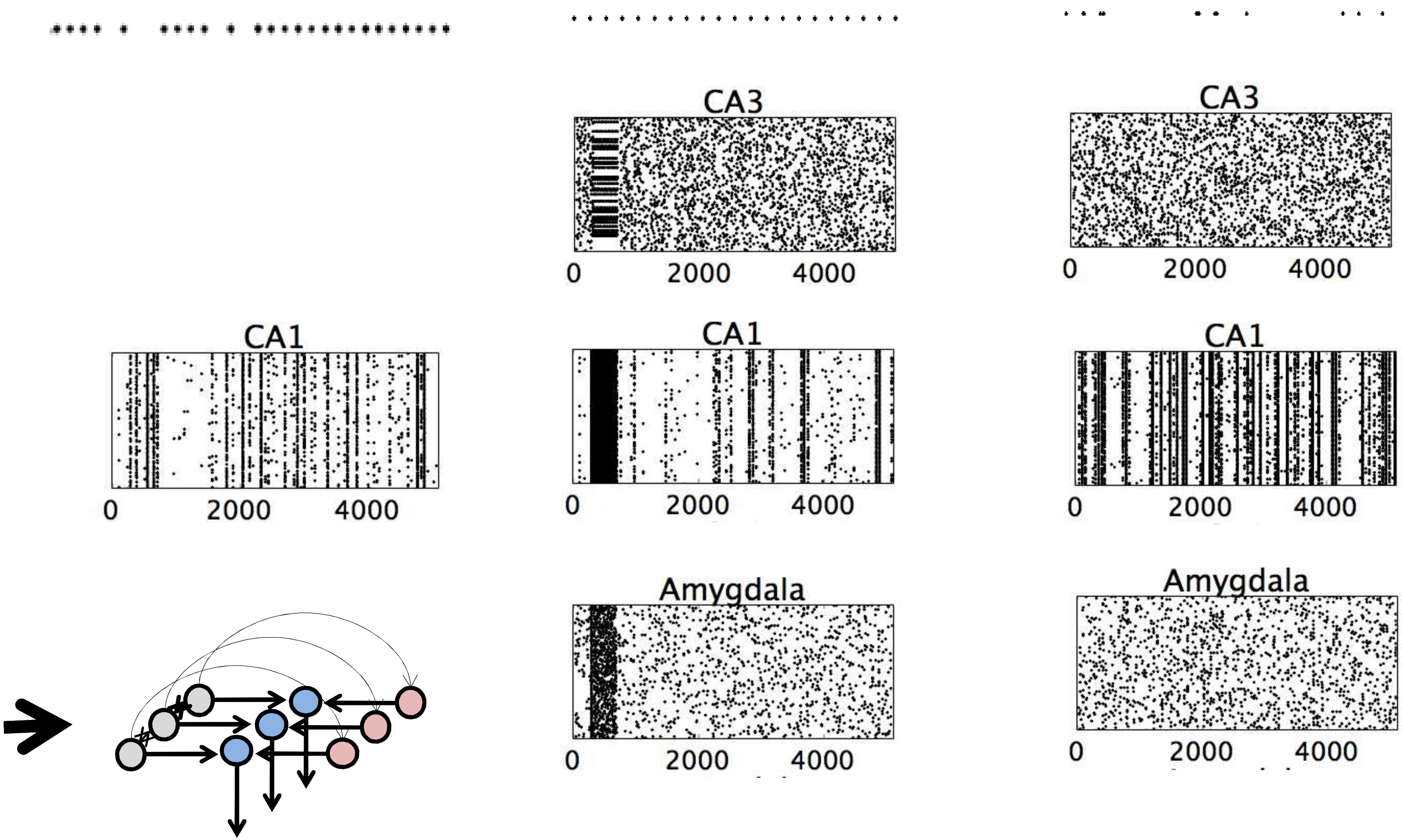
Result #1: When CA3 is driven by Poisson noise, CA3 → CA1 connectivity produces synchronous irregular CA1 activity



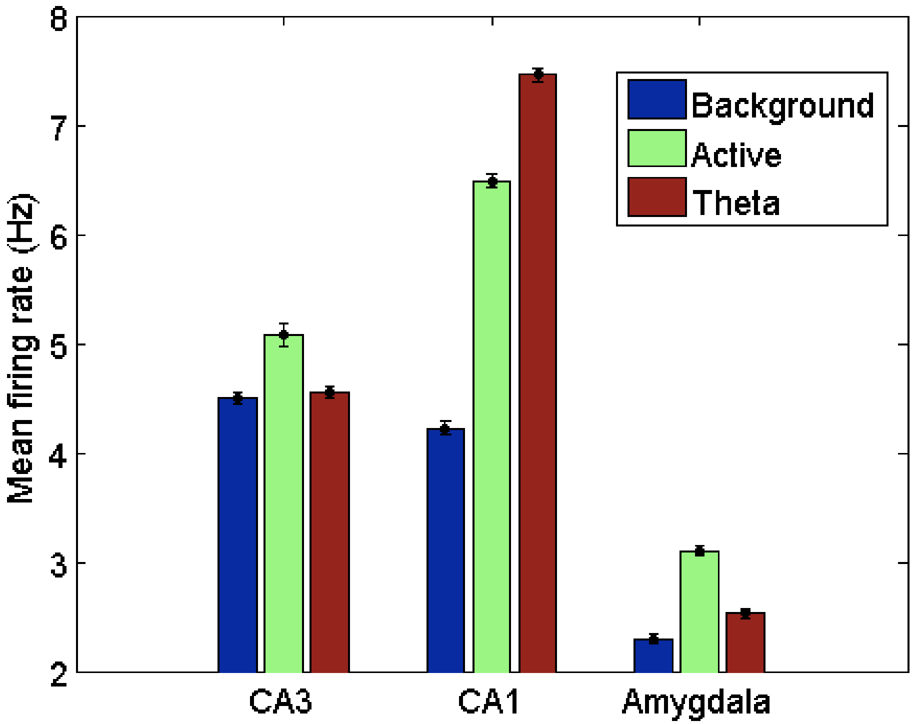


Result #2: Active drive to CA3 doesn't increase banding in CA1, but theta input to CA3 does

Poisson noise input | **Active drive** | **Theta input**

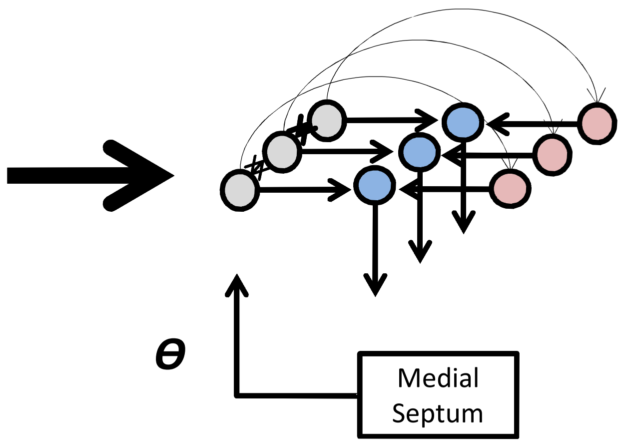


Result # 3: Theta input has a disproportionate effect on CA1 firing rates



Theta modulation may increase the magnitude of CA1 responses to CA3 inputs

Potential positive feedback mechanism for CA1 activation



Poisson noise

Active drive

Theta input

Summary

- Theta modulation increases magnitude of CA1 response to CA3 inputs
- Potentially by synchronizing activity in CA1 population