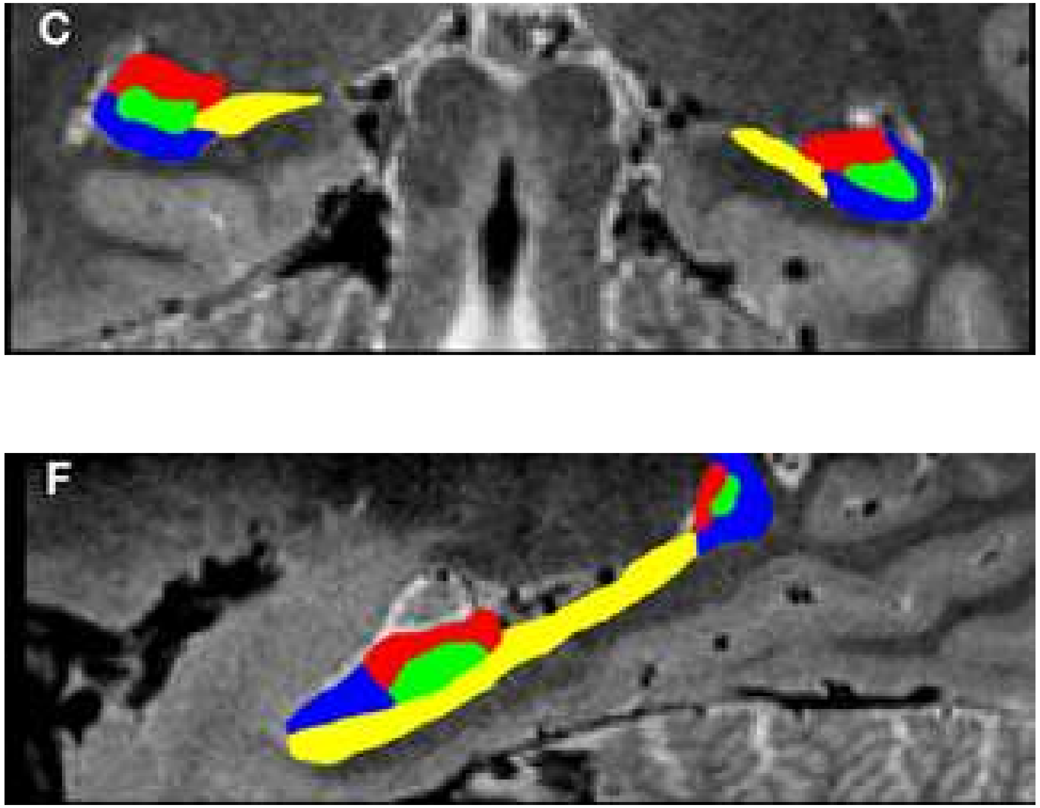
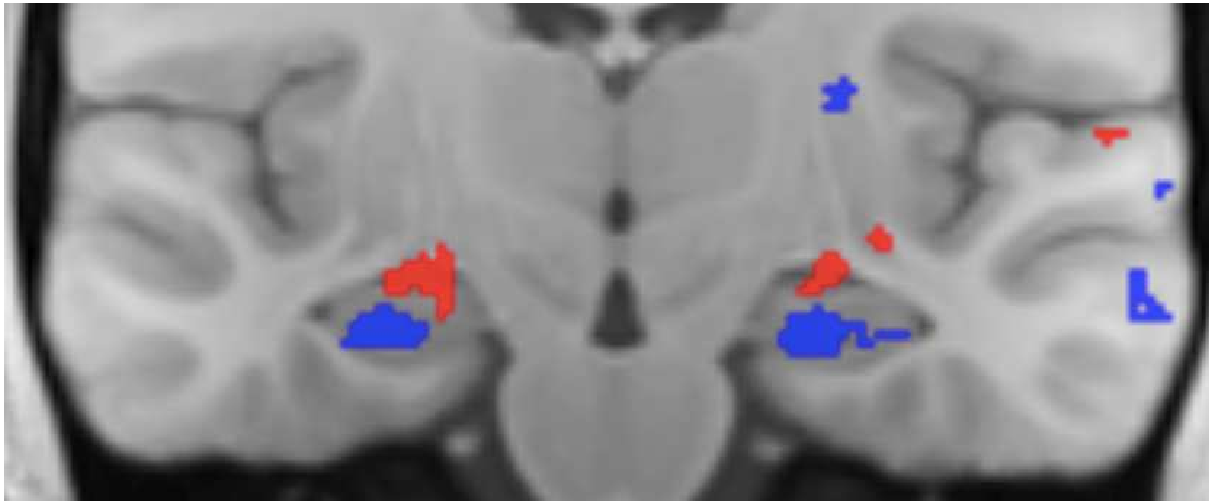


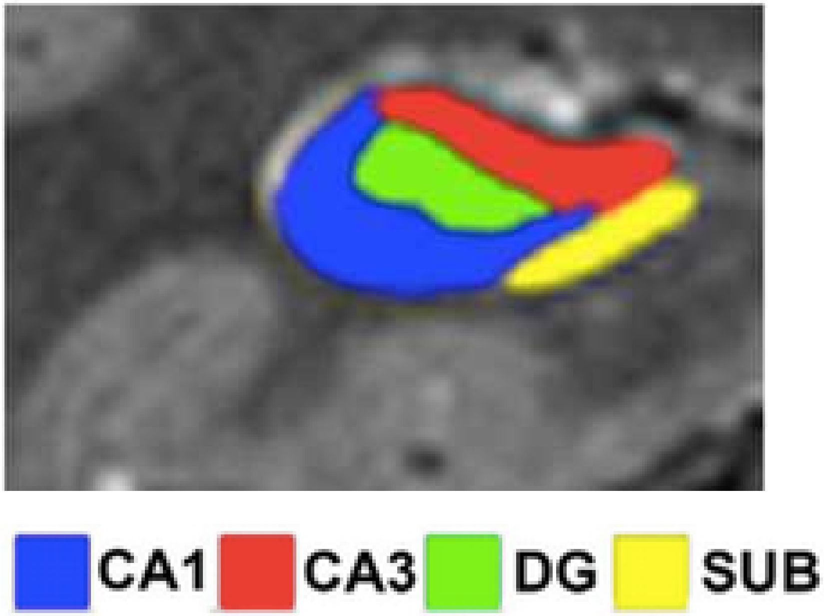
Theta modulation of CA1 responding to CA3 inputs

Eleanor Loh

UCL Wellcome Trust Centre for Neuroimaging

CA1 comparator for aversive threat (punishment)





Empirically

- **Theta oscillations are a reliable neural signature of anxiety** Gray & McNaughton, 2000
- **Emergence of instrumental aversive signal moving from CA3 to CA1** Loh et al (under review)

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

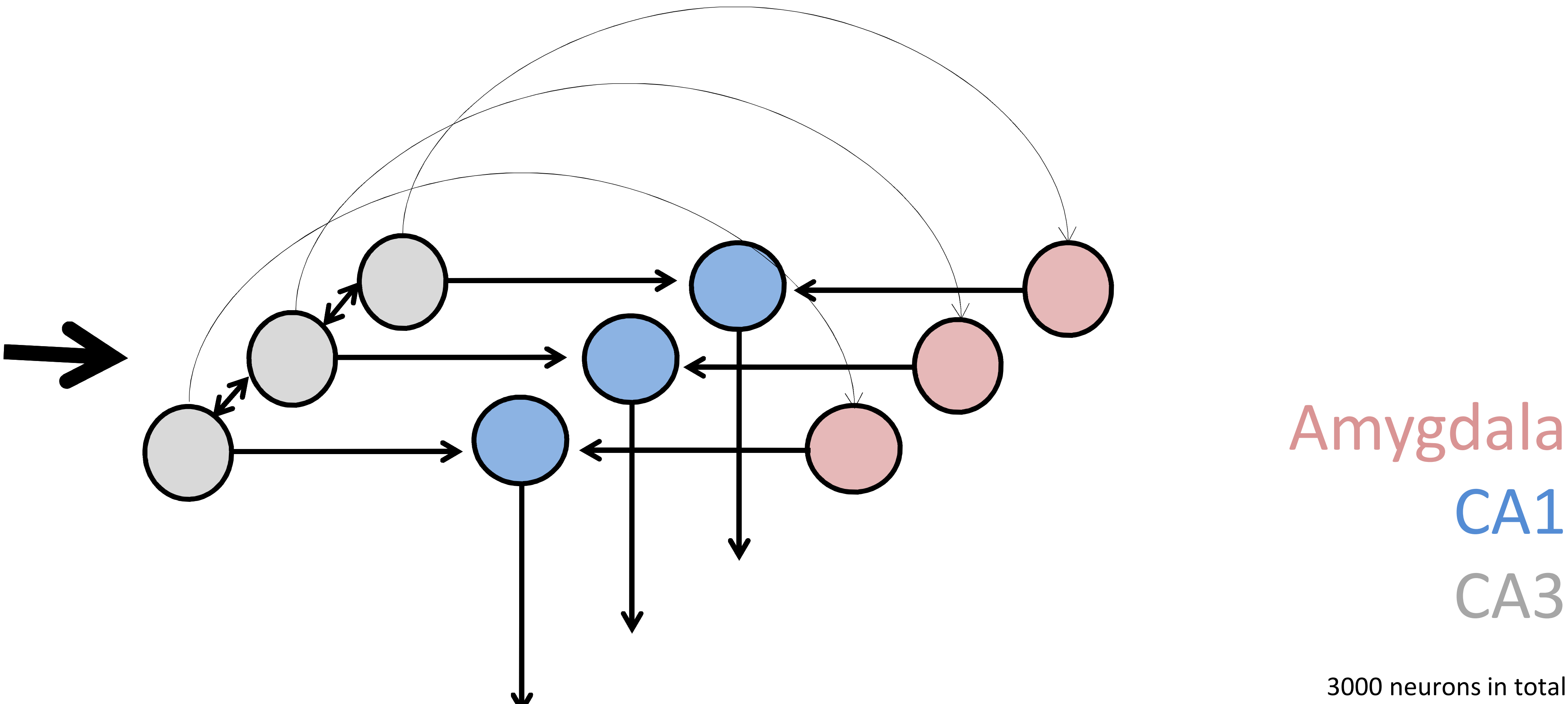
→ Potential mechanism for theta-modulated positive feedback of CA1 activation

Model setup: CA3, CA1 and Amygdala populations

1. Only CA3 receives non-noise inputs

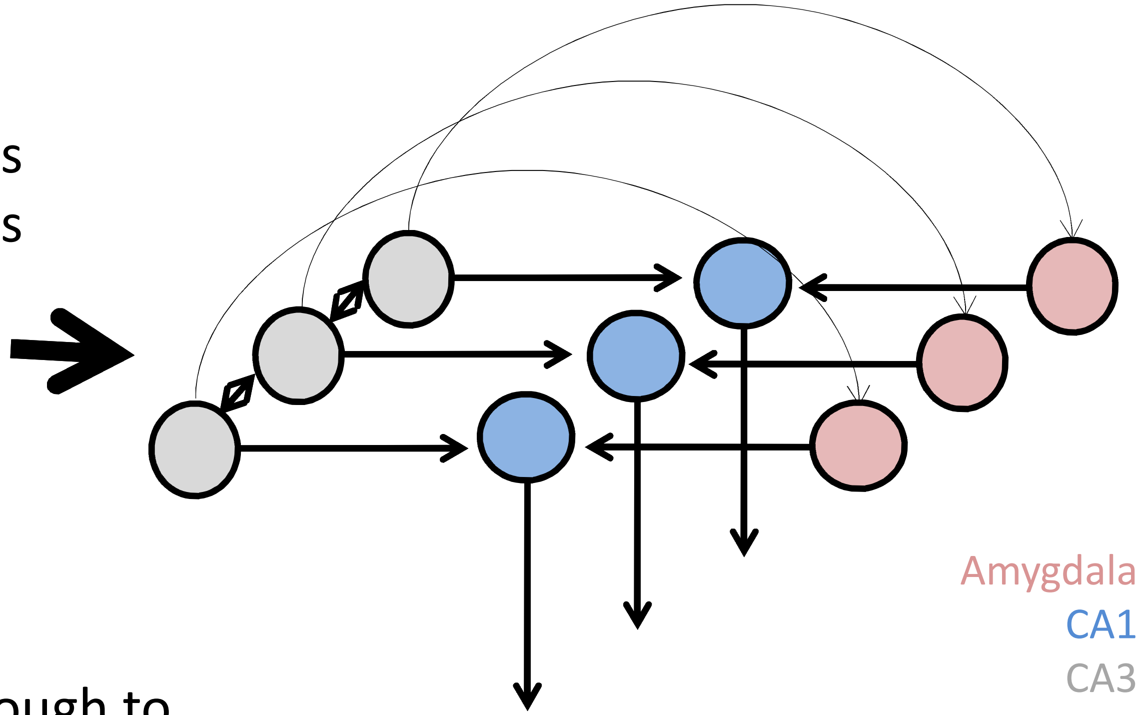
2. CA3 has a low probability of driving amygdala units

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



3000 neurons in total

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

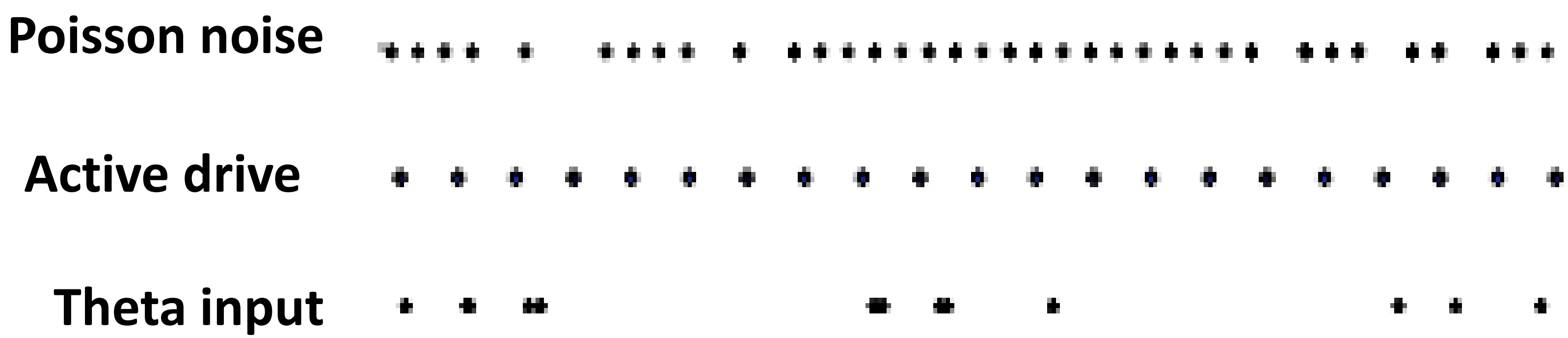


Details of CA3-CA1 connectivity from Taxidis et al, 2011 Hippocampus

<u>Connectivity</u>

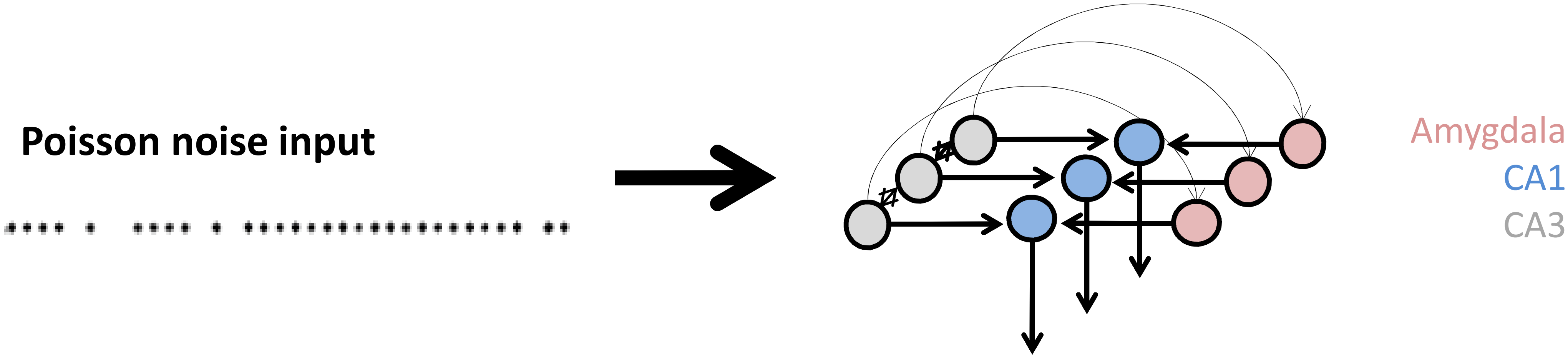
- CA3 recurrents
- CA3 → Amygdala: weak connectivity
- CA3 → CA1 connectivity is not strong enough to actively drive CA1

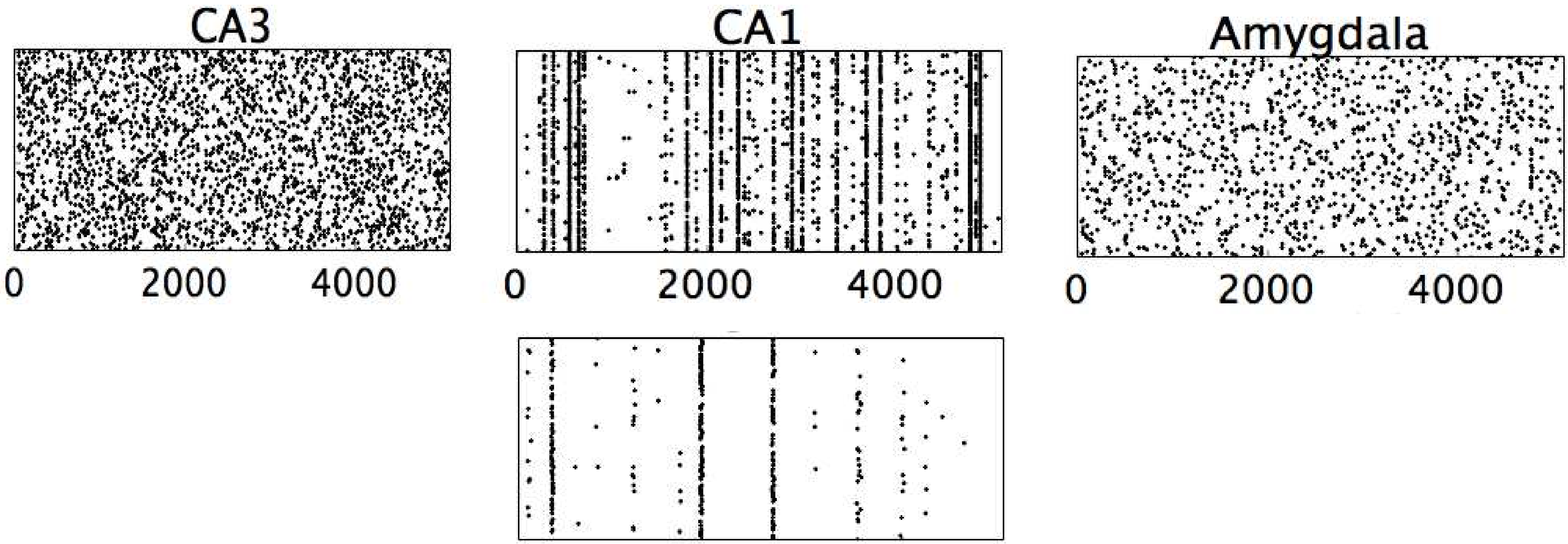
<u>Network is driven with varying inputs</u>



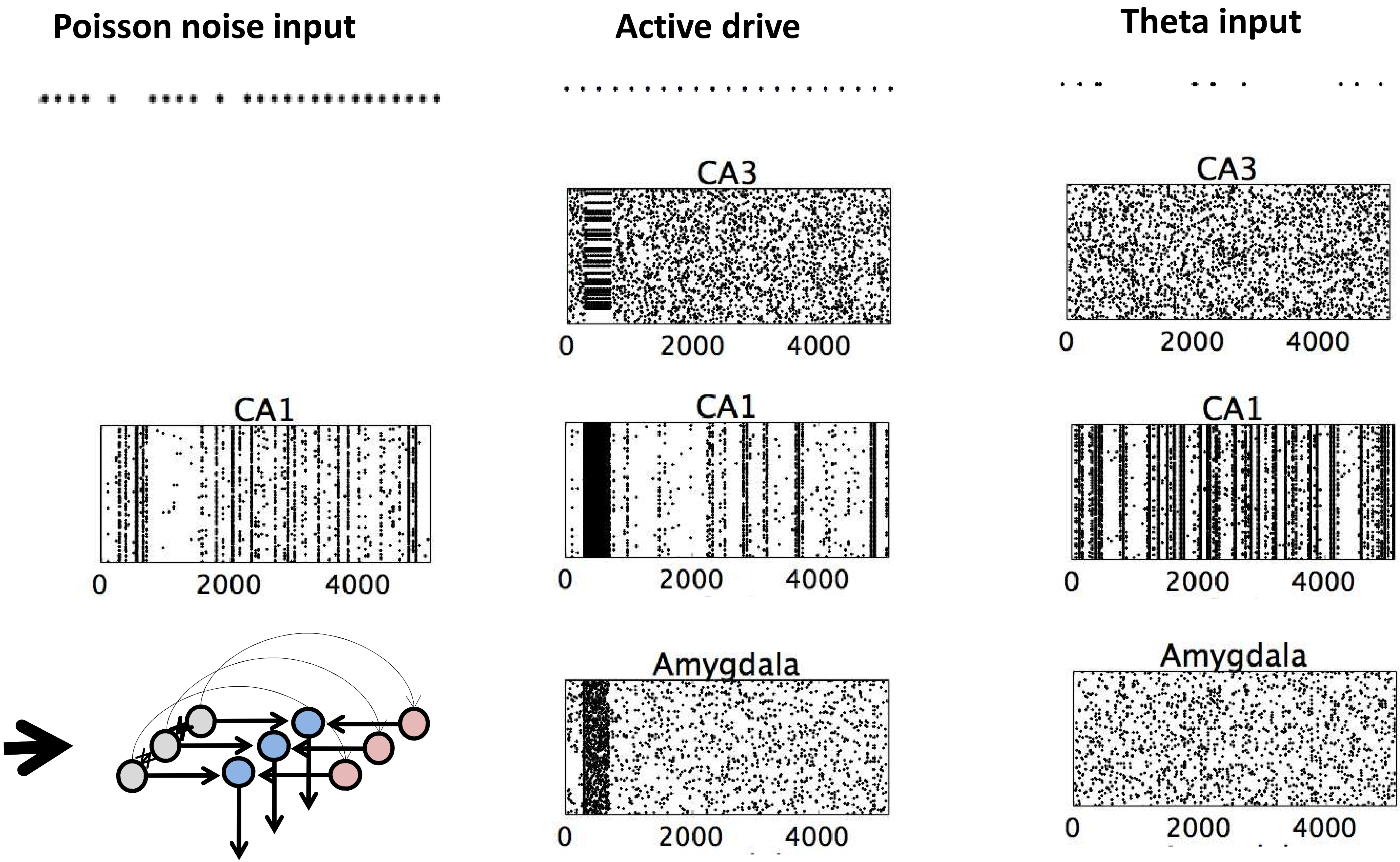
Poisson noise modulated by theta frequency

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

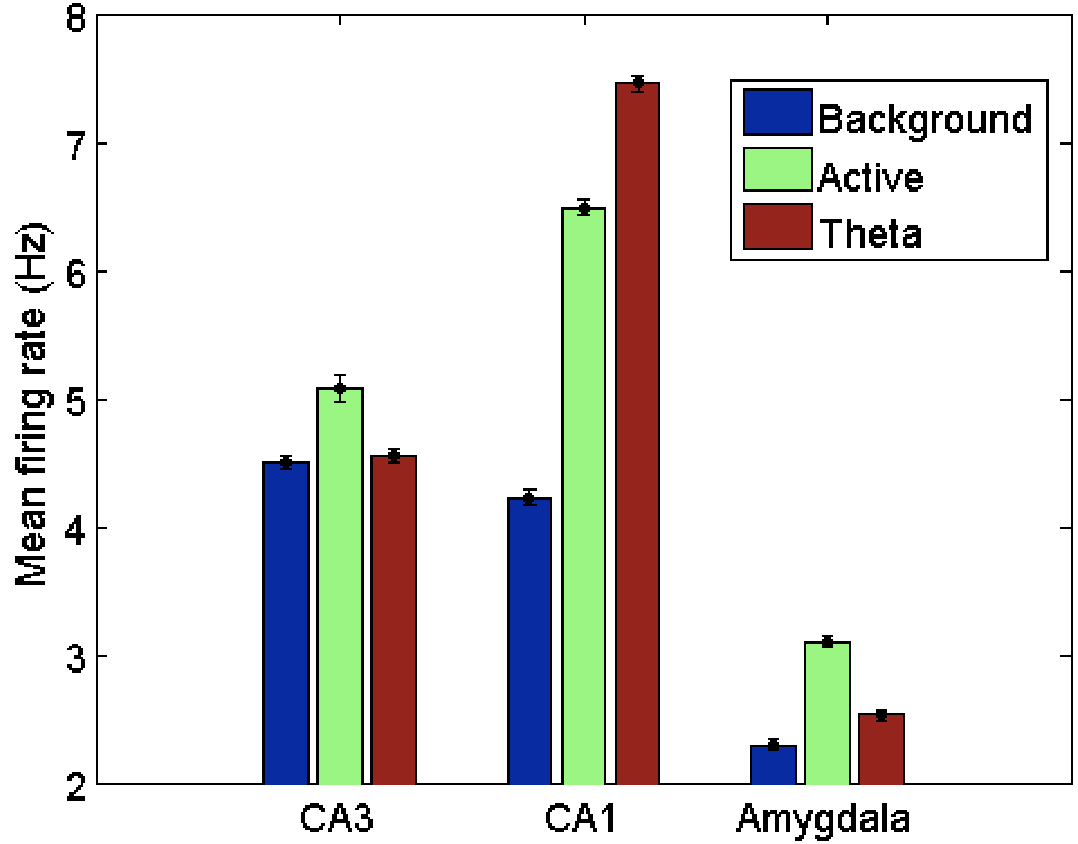




Result #2: Active drive to CA3 doesn't increase banding in CA1, but theta input to CA3 does

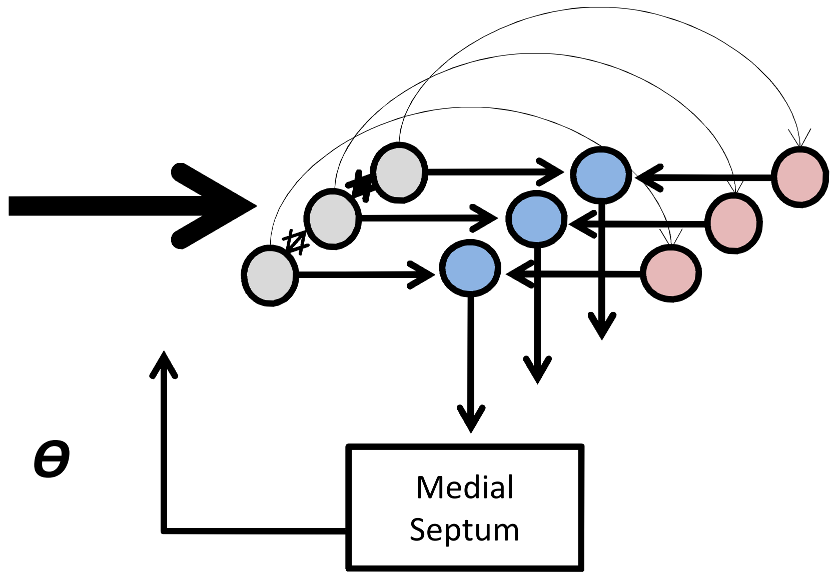


Result # 3: Theta input has a disproportionate effect on CA1 firing rates



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