Taming inhibition
in a spiking model of motion processing

Philip Meier, PhD
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Vision

Motor Control

Research & Technology

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Motion Processing

This research:

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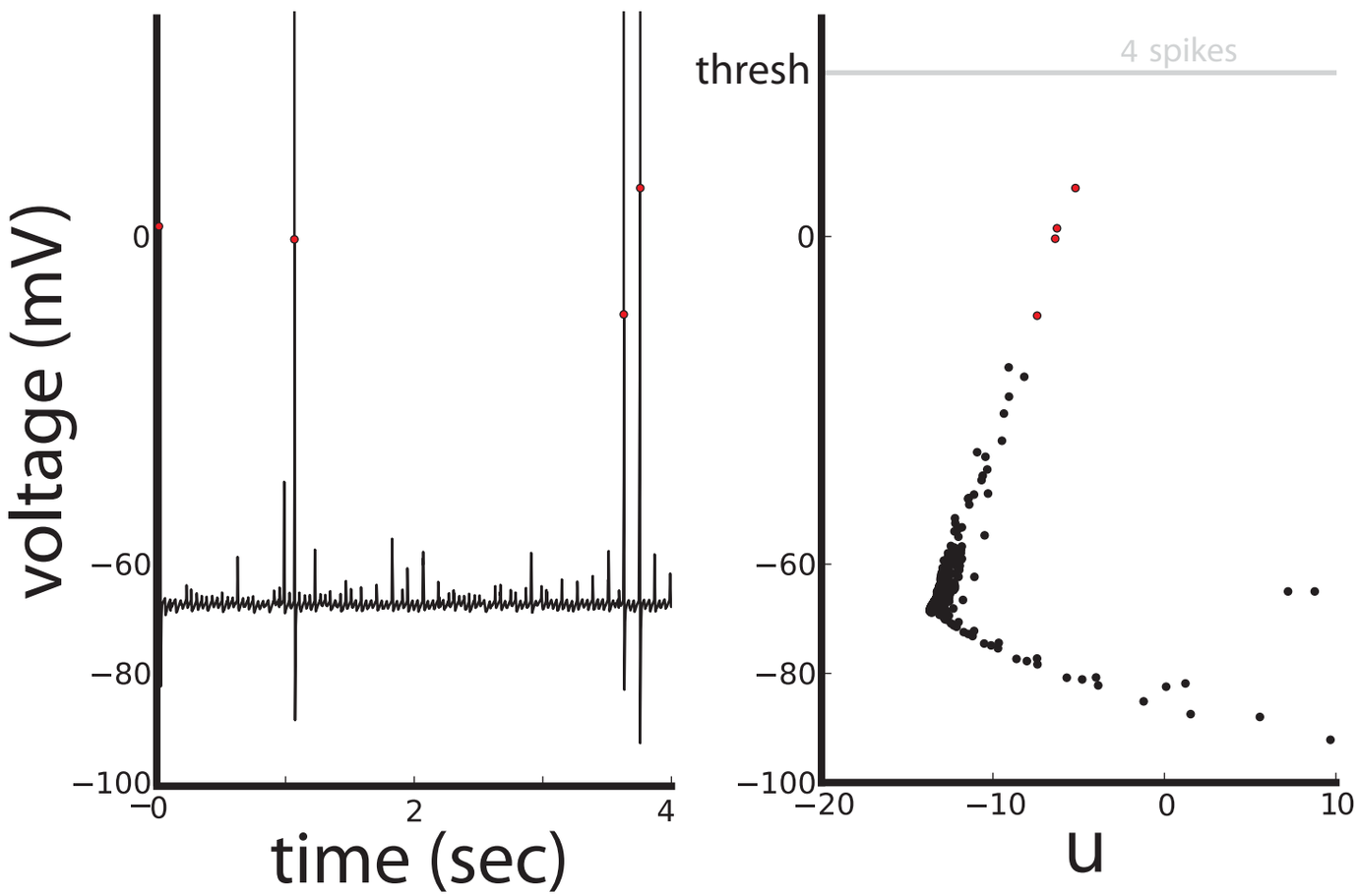
Eugene Izhikevich, PhD

Computing with spikes

single cell dynamics



$$\dot{v} = f(v) - u(E - v) + I$$

What determines a spike?

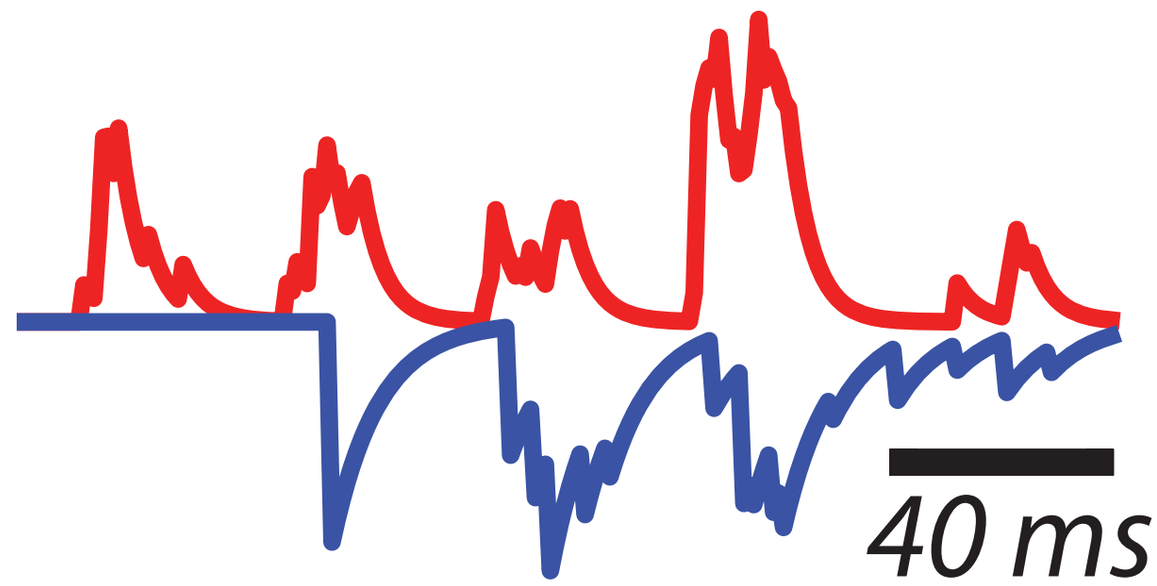
[v, u] , [a,b,c,d] , I

Exc >? Inh

Inhibitory Balance

AMPA

GABA



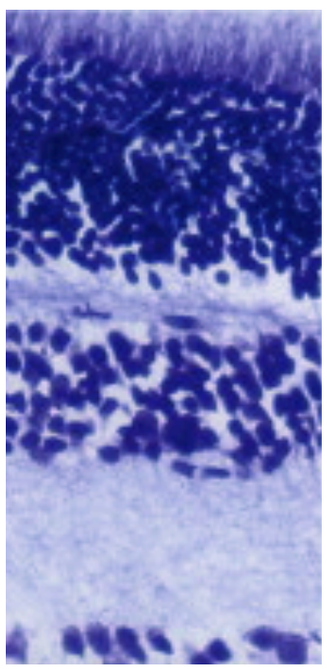
Why Balance?

- Critical Point ("Everything matters")
- Random variability
- Gain control
- Predictive coding
- Redundancy Reduction

Okun, 2008
Atallah, 2009
Butts, 2010
Vogels, 2011

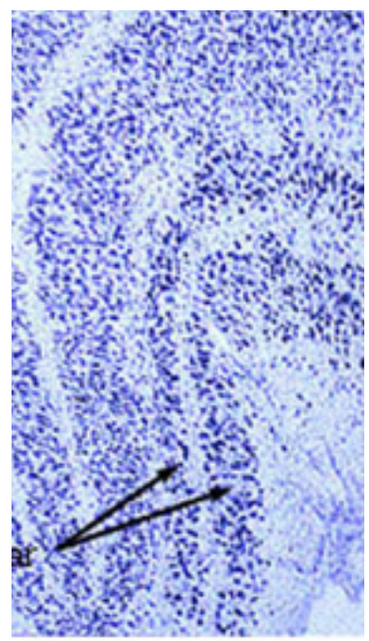
Motion Processing

Retina



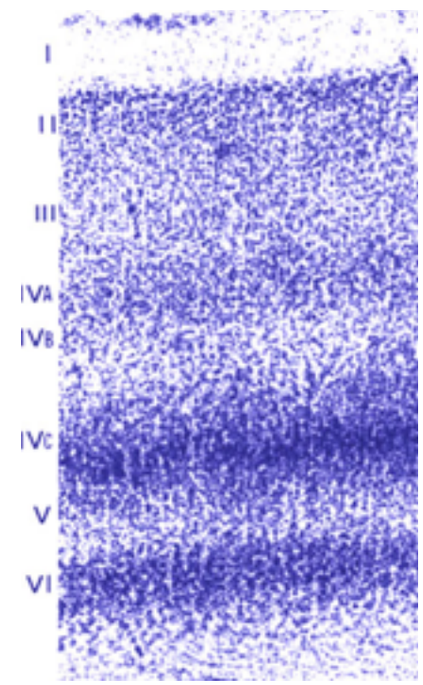
parasol

LGN



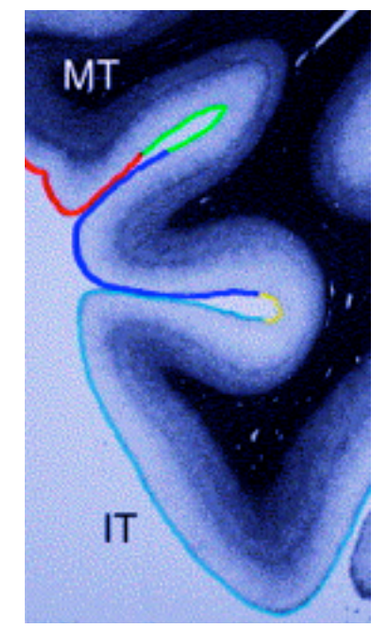
magno

V1



4Ca, 4B

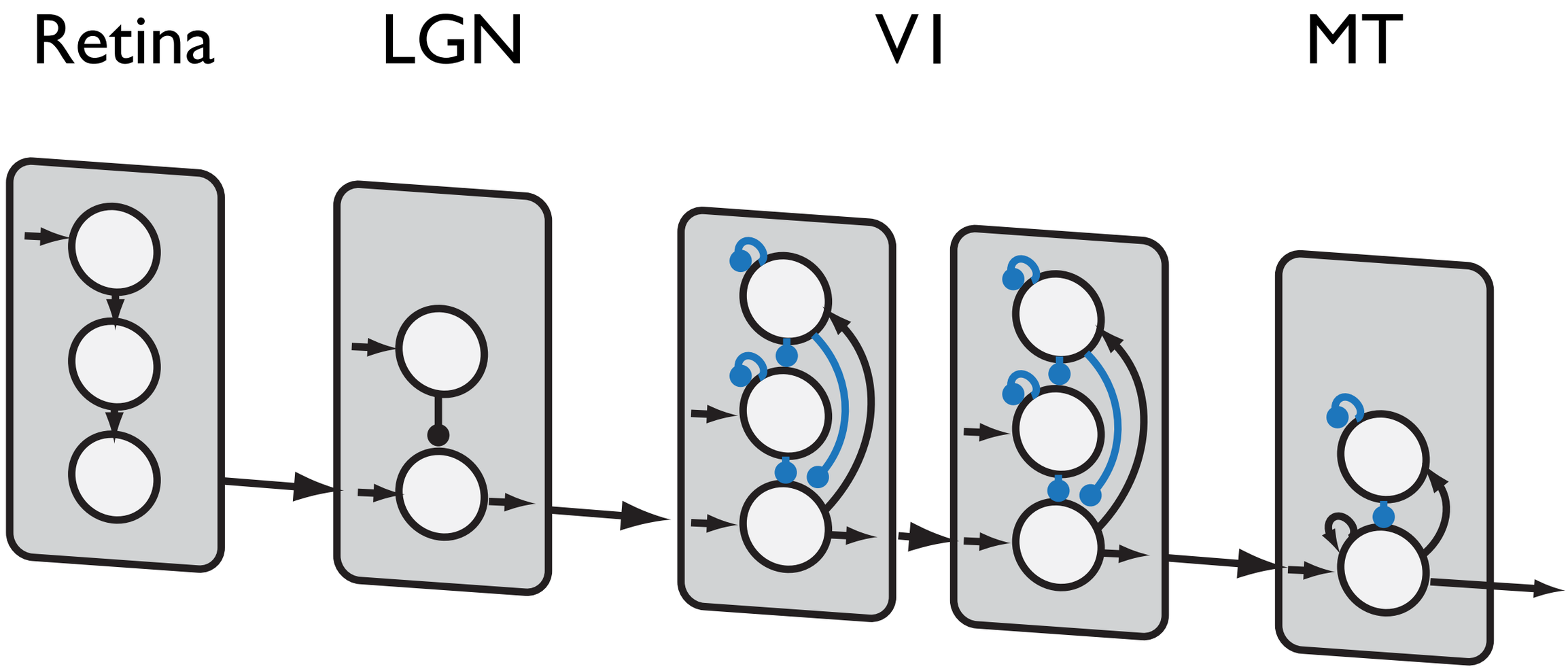
MT



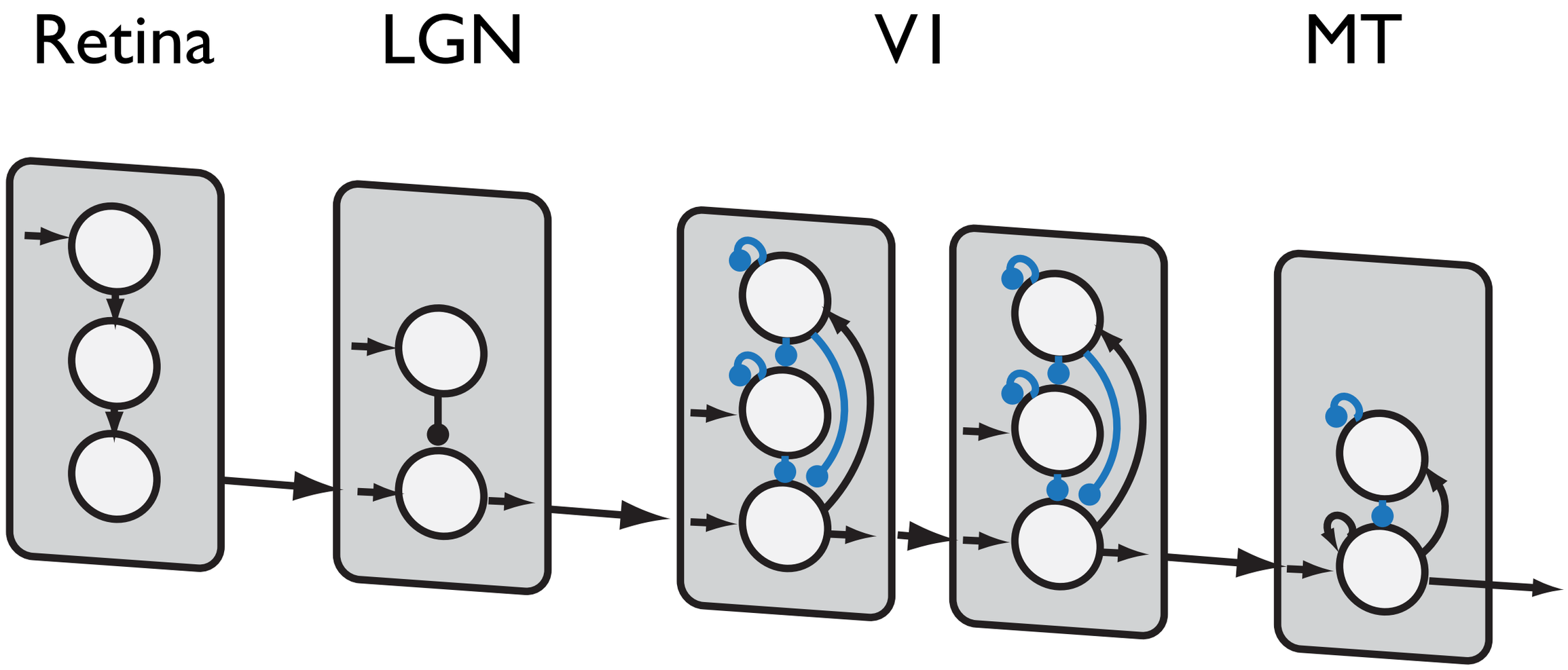
L4

Lang, et al, 2009
webvison.med.utah
Annese, et al. 2004

Motion Model



Motion Model

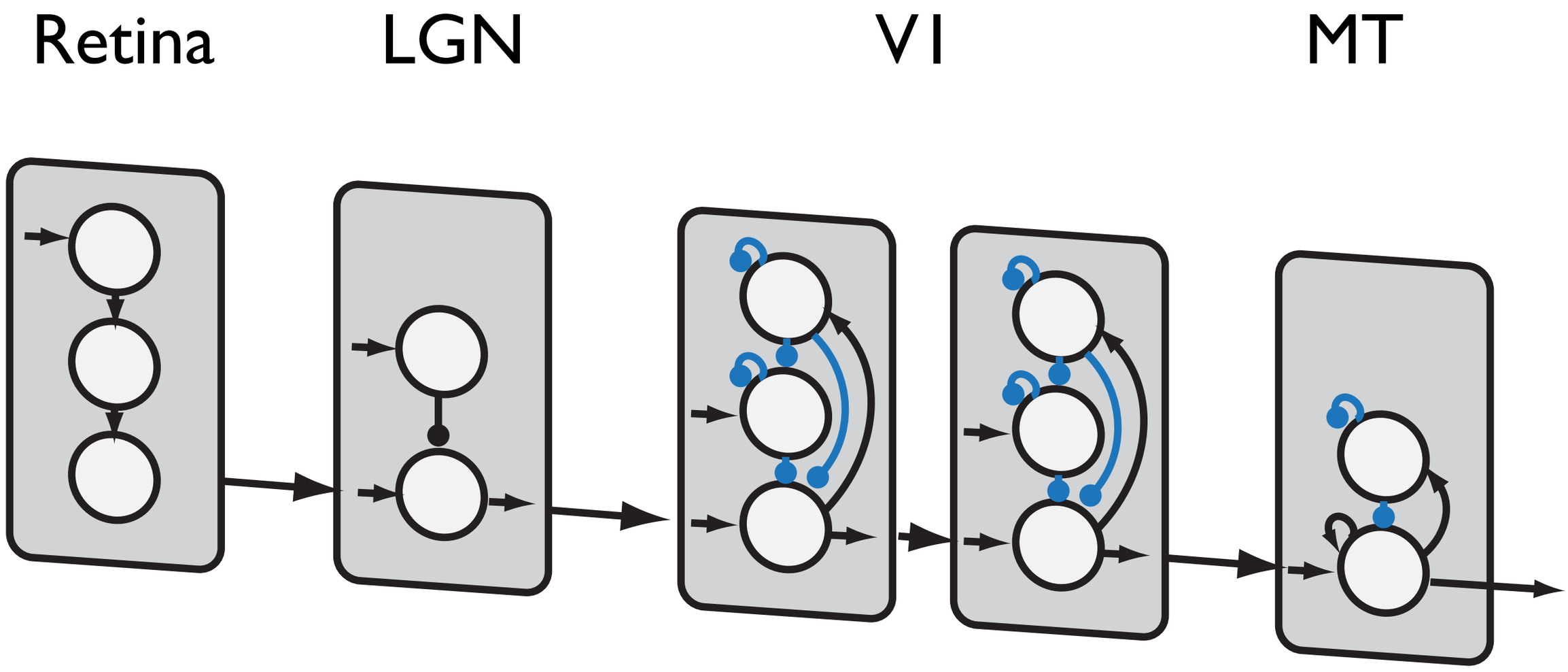


24 channels

Qualitative Response

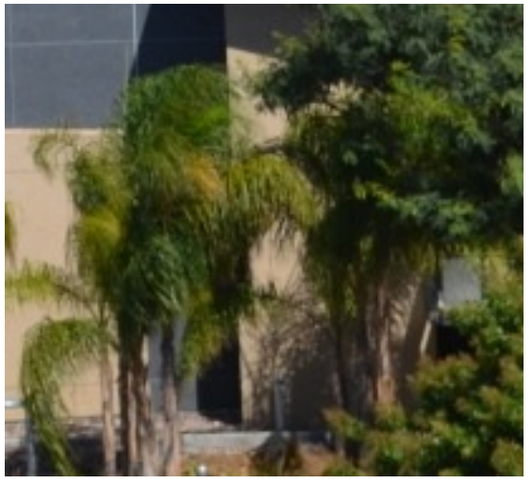
In Slow Motion

Motion Model

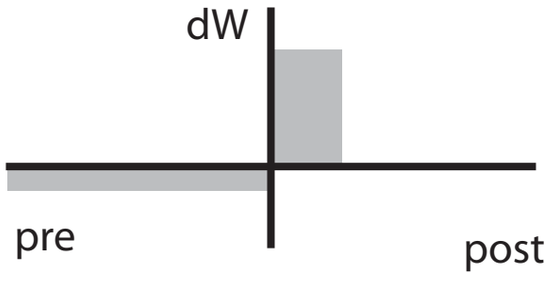


How do you fit all the synaptic weights?

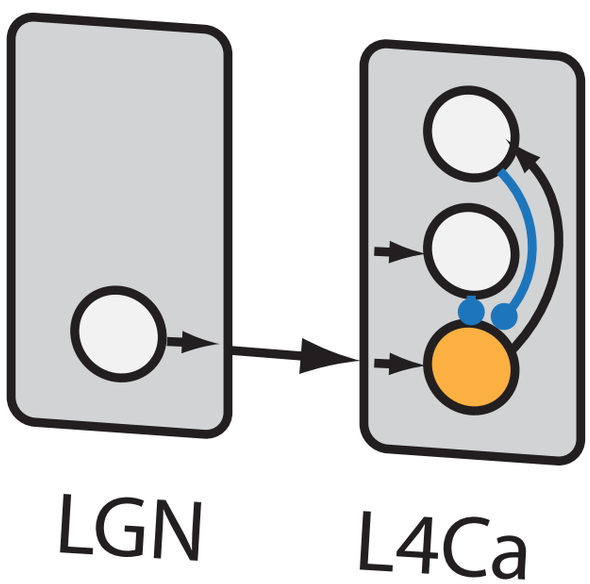
Spike Timing Dependent Plasticity



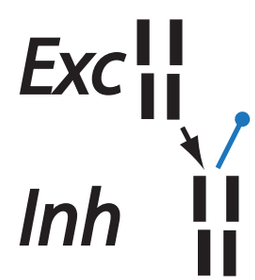
Inh STDP



A problem: synchronous onset

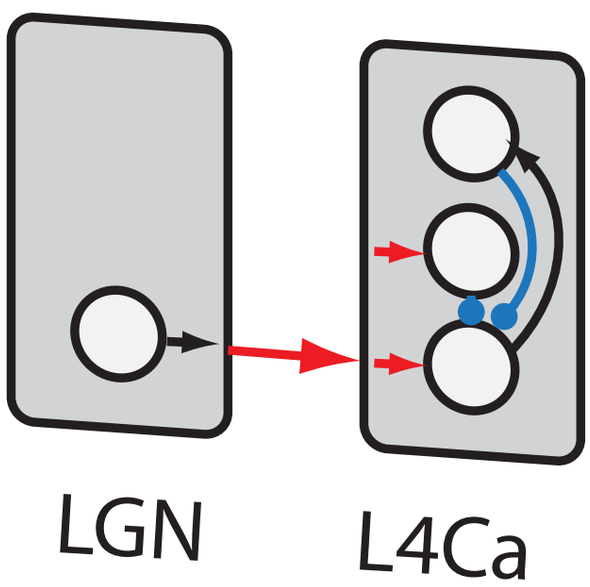


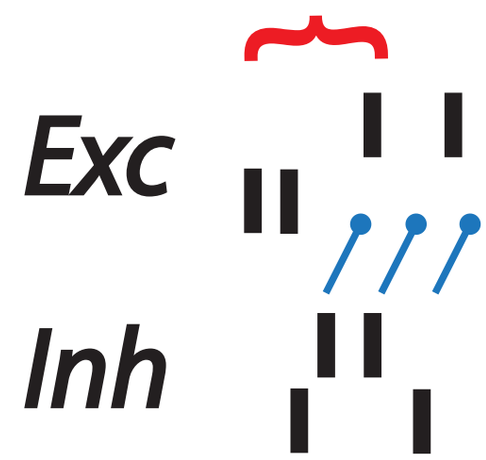
lateral



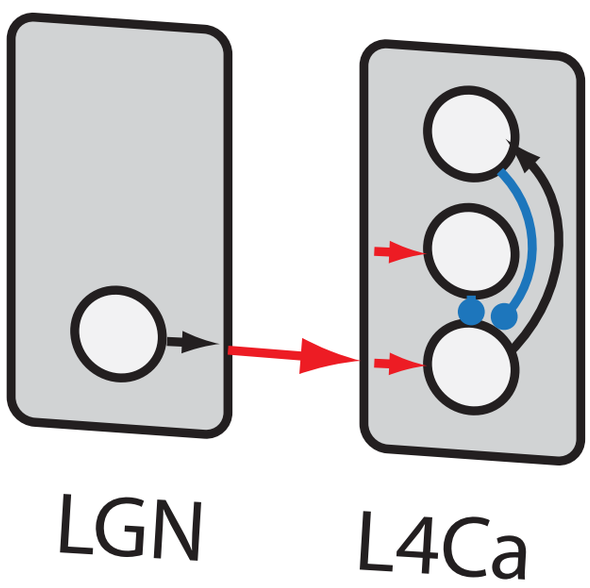
feed fwd

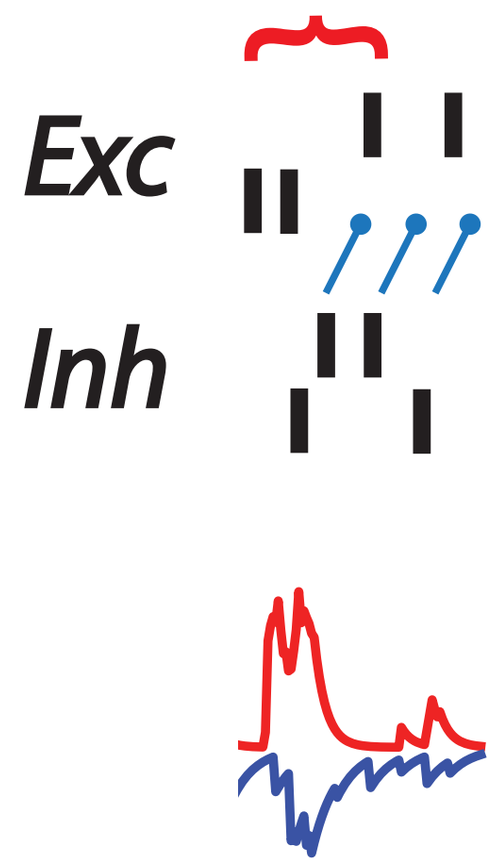
A solution: variable onset latency



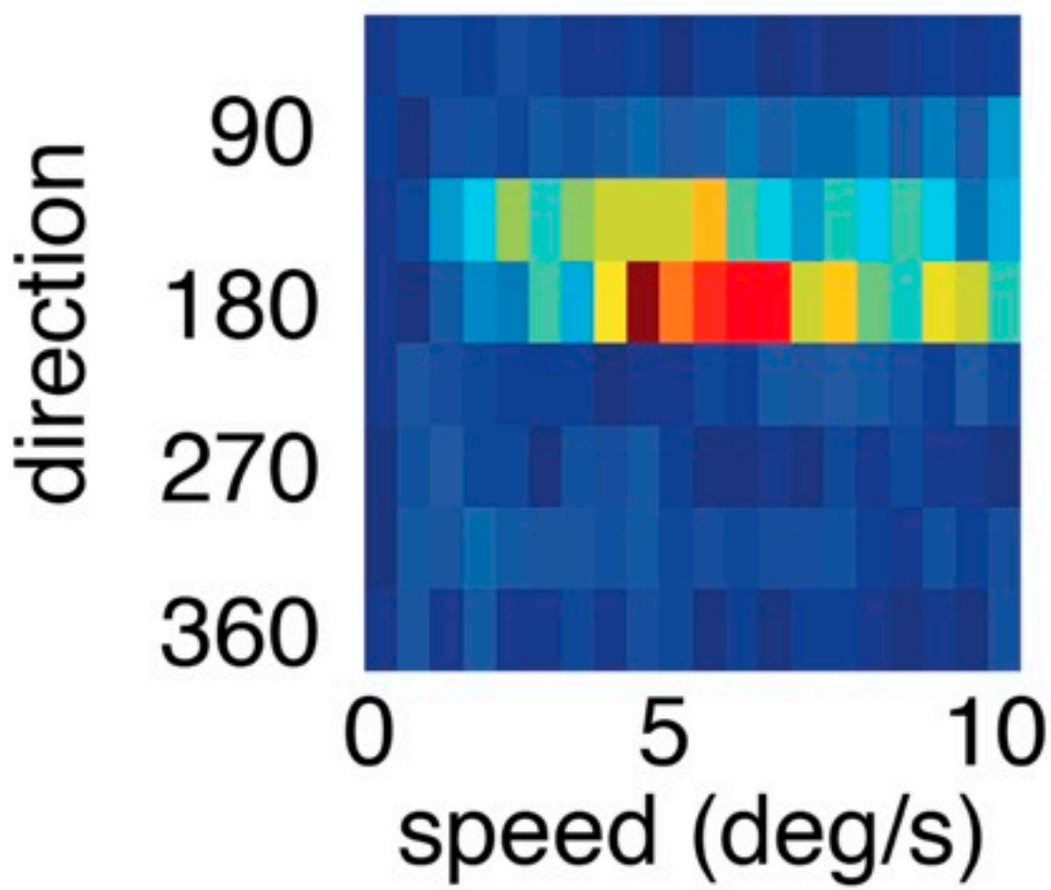


A solution: variable onset latency



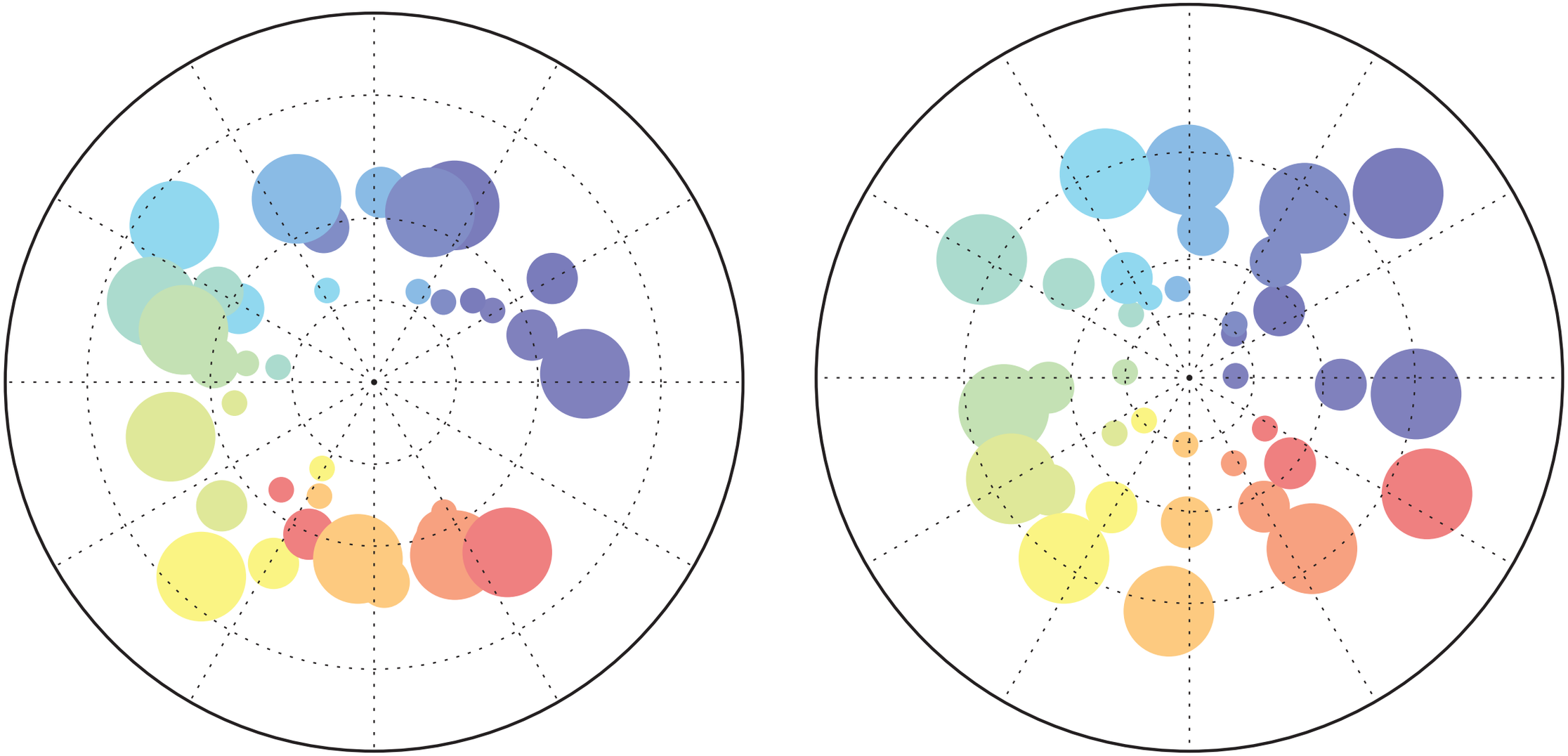


MT population tuning



Speed 2
Direction 180

Direction decoding



no STDP **jittered**

120 msec, 3 frames

Summary

- Design principles from systems neuroscience
- Spiking implementation of Motion Energy
- Inhibitory STDP automatically balances
- Linear decoding

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