BioE332 Lecture 2: Decision Making

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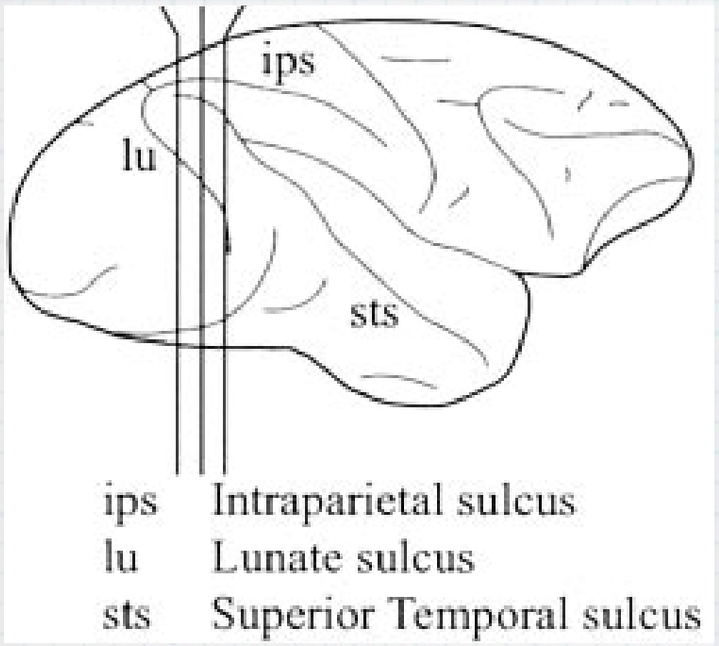
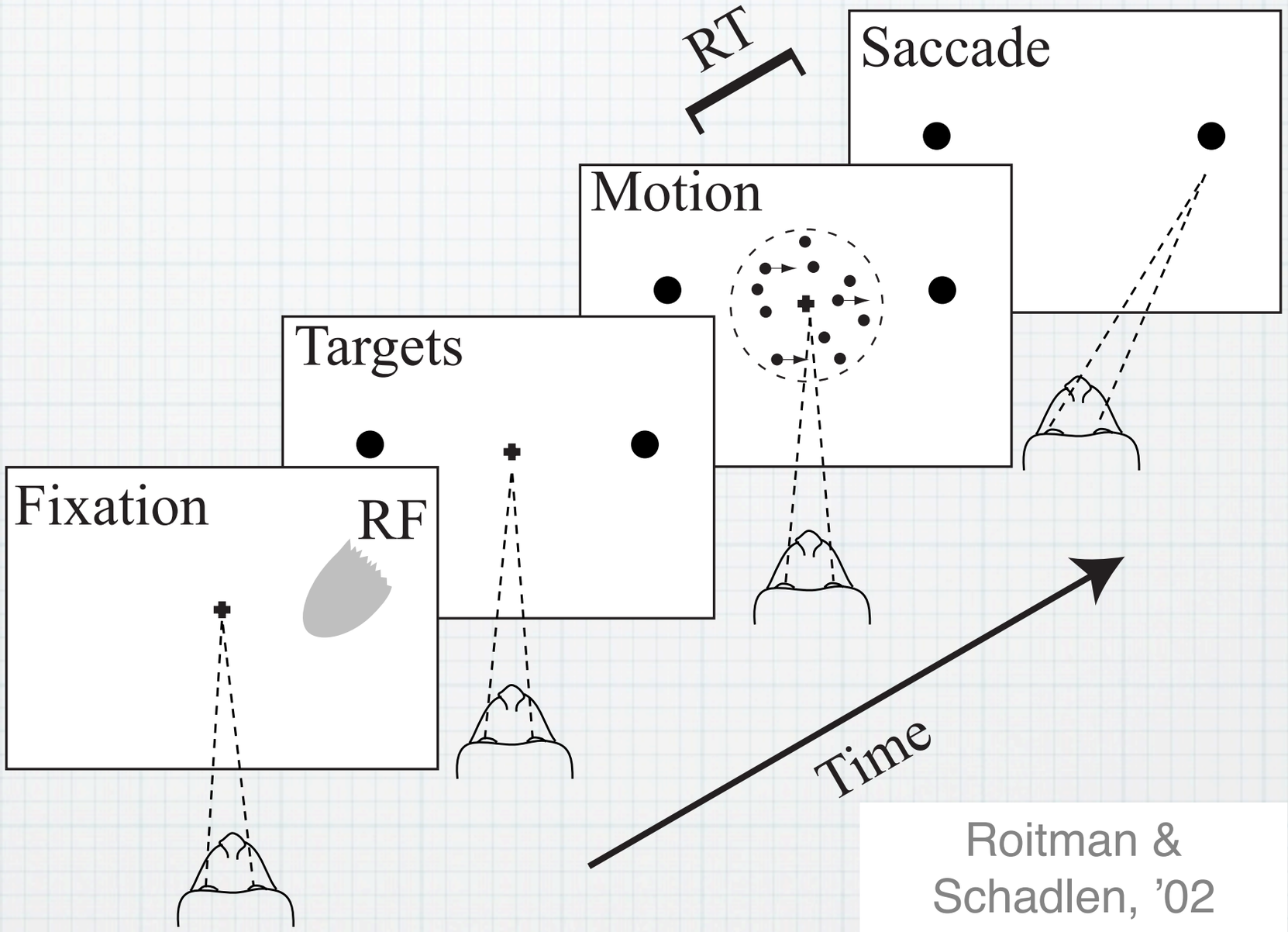
Spring 2013

Direction discrimination task



Schadlen '99

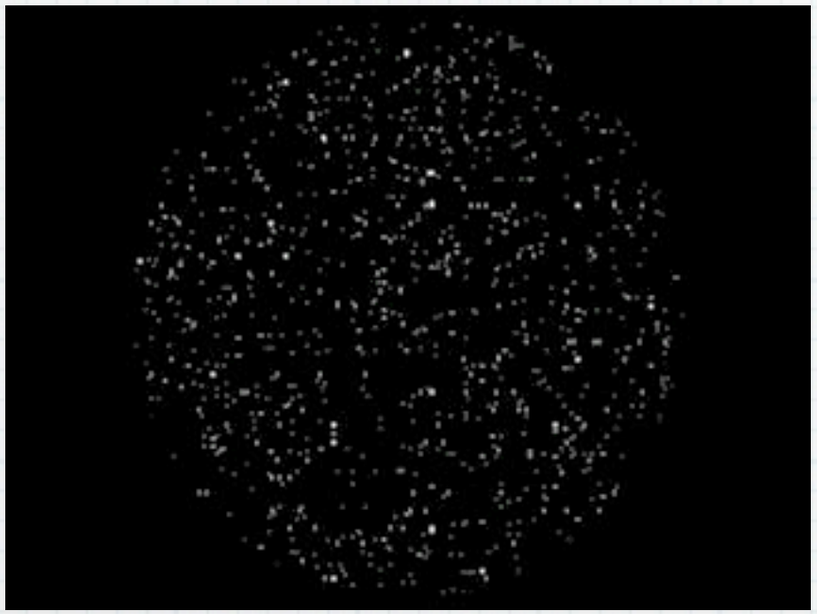


Roitman & Schadlen, '02

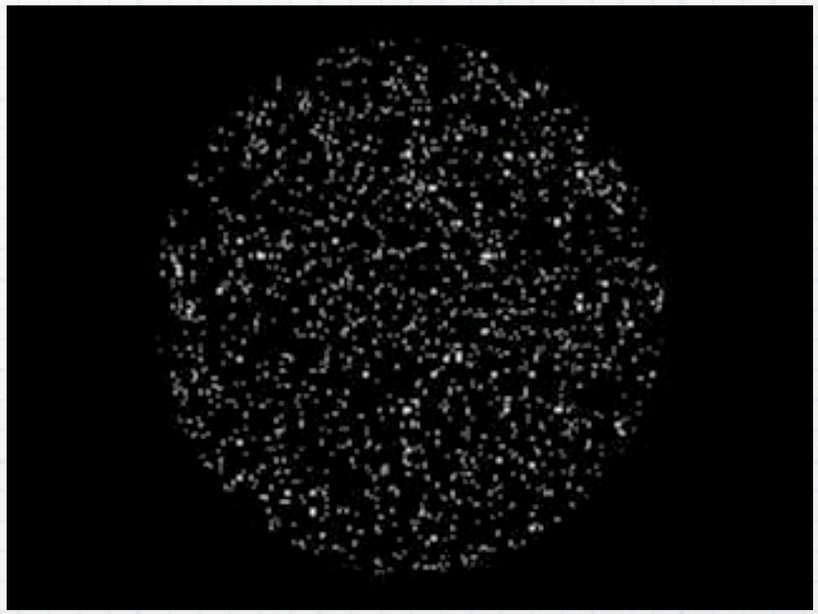
* Reaction-time task: Monkey saccades to indicate motion direction as soon as it is certain.
* Other version of task had fixed viewing duration.

Random-dot display

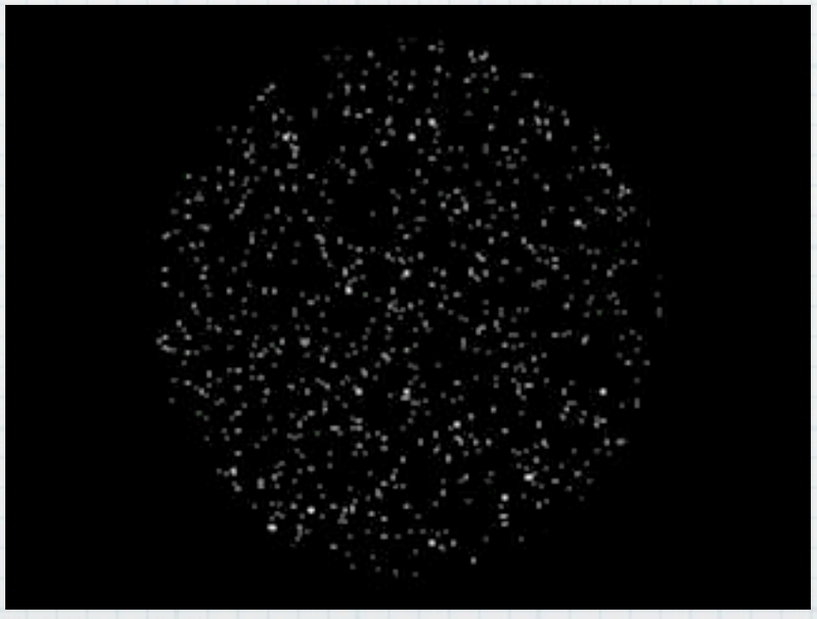
100%



30%

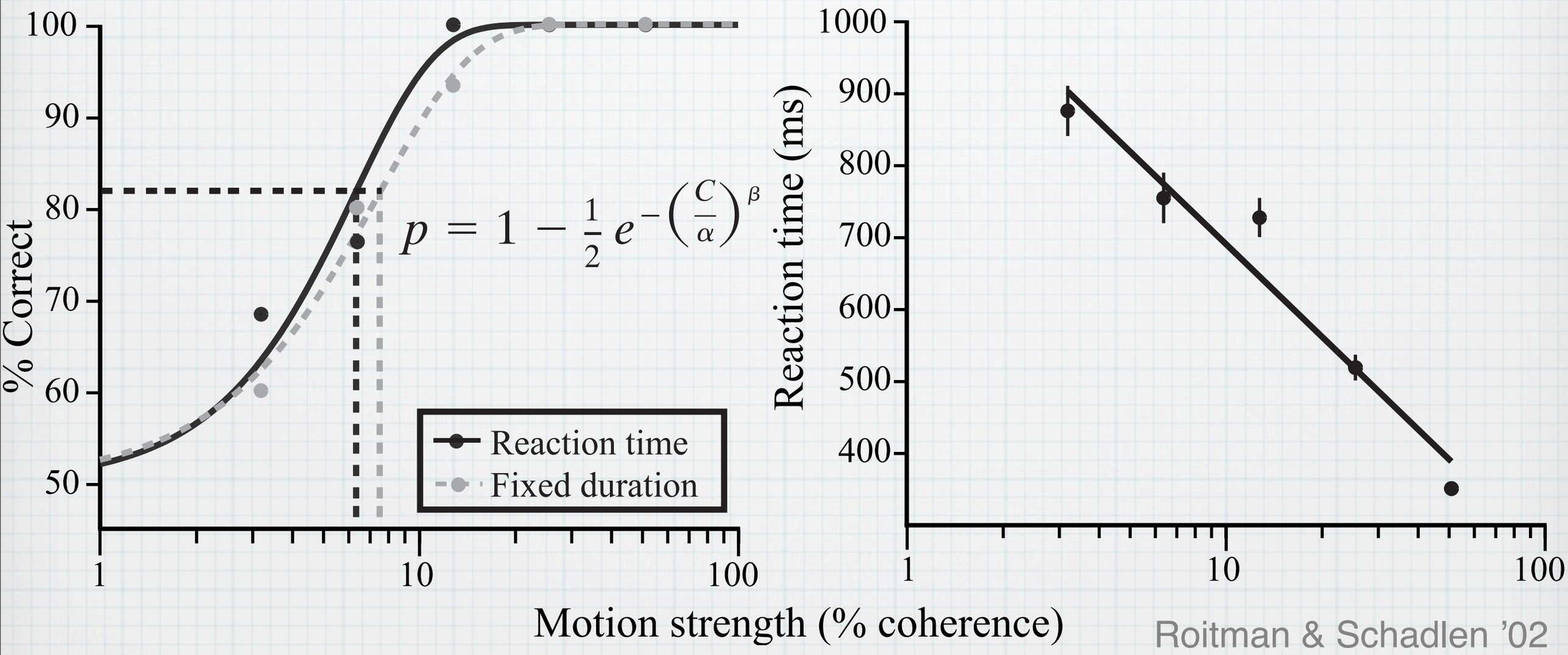


5%



0%

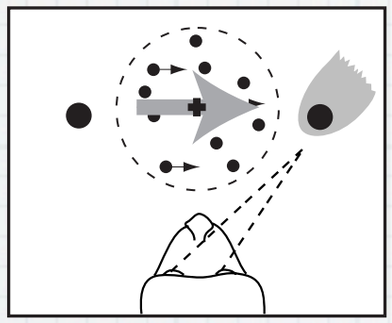
Psychophysics: Percent correct and reaction time

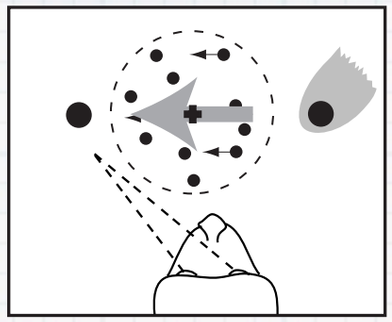


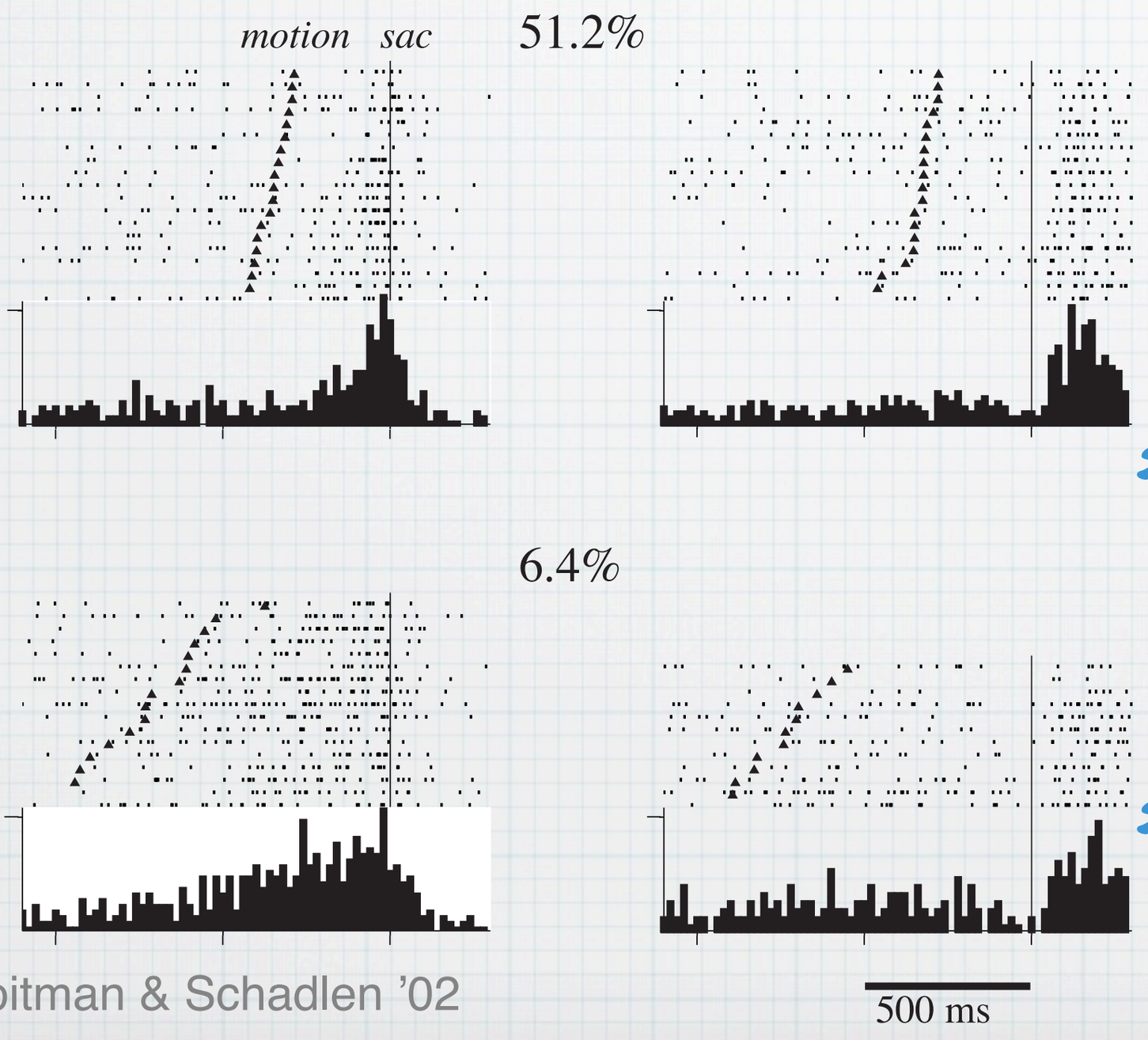
Roitman & Schadlen '02

* Weibull function fits with α=7-11 and β= 1.4-1.7

LIP neuron responses (RT)



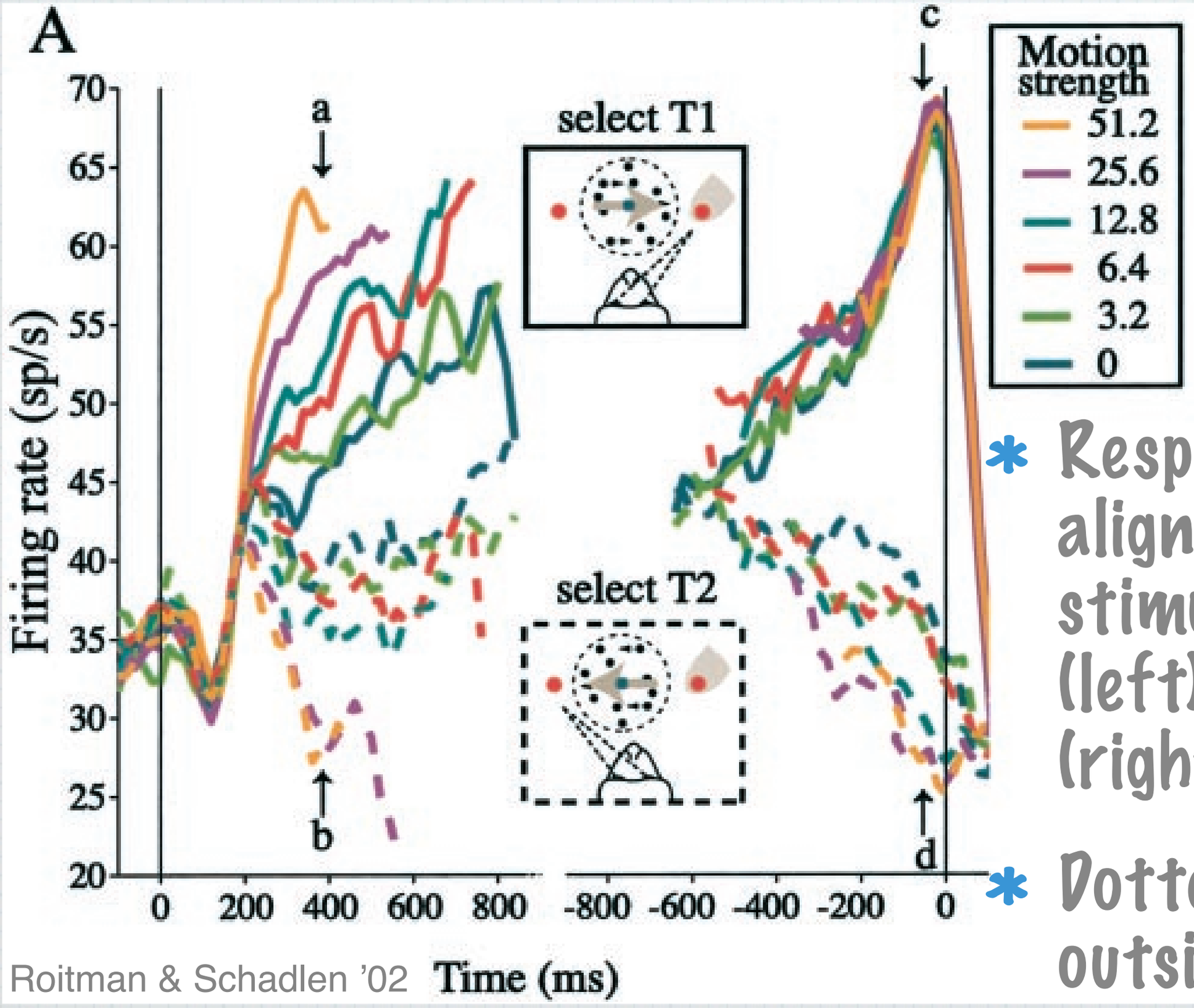




Roitman & Schadlen '02

* Spike trains aligned to saccade; stimulus onset indicated by claret; only correct choices shown
* Spike rate builds up when target is in cell's RF
* RT is longer when coherence is low

Time course of activity

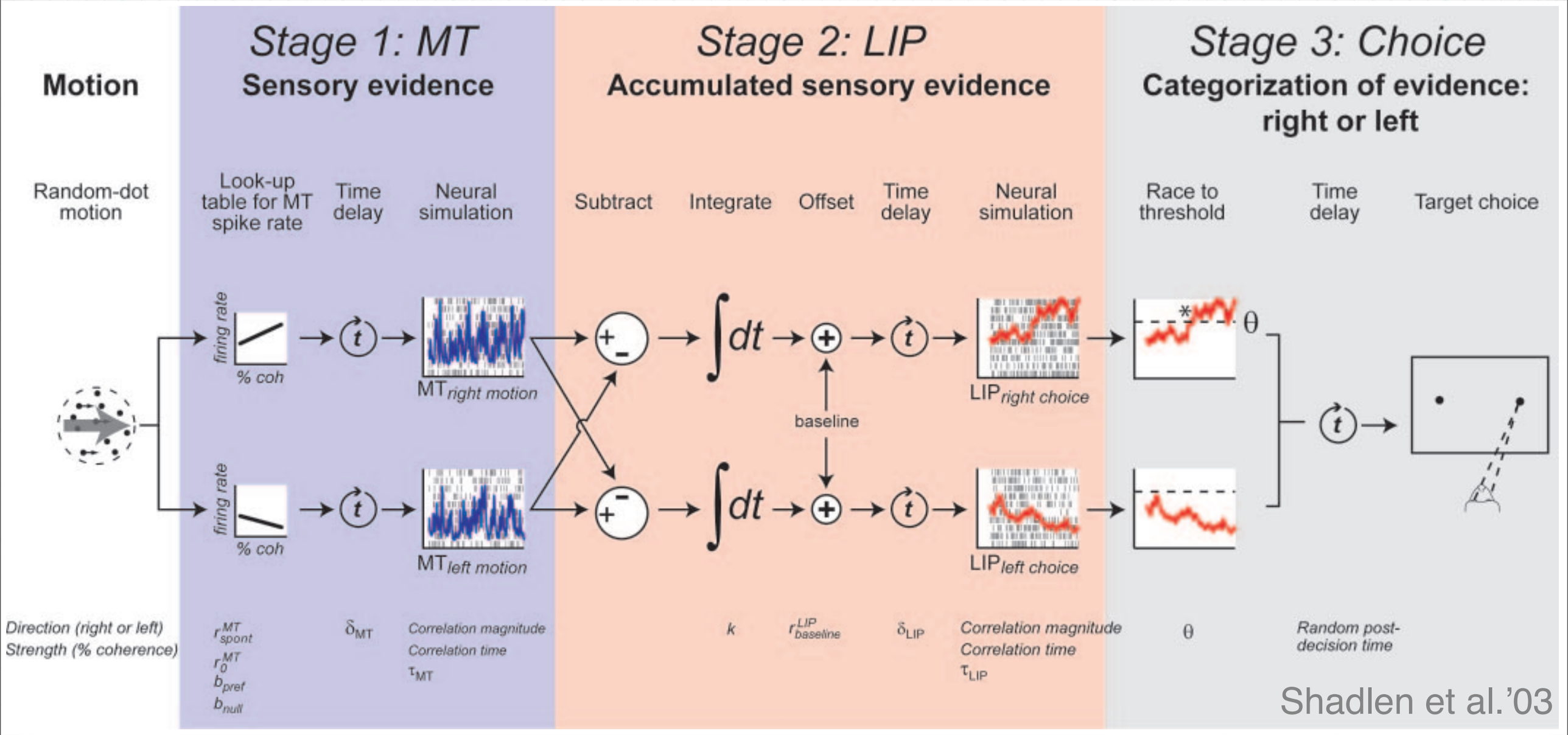


Roitman & Schadlen '02

* Responses are aligned to stimulus onset (left) or saccade (right).

* Dotted lines are outside RF

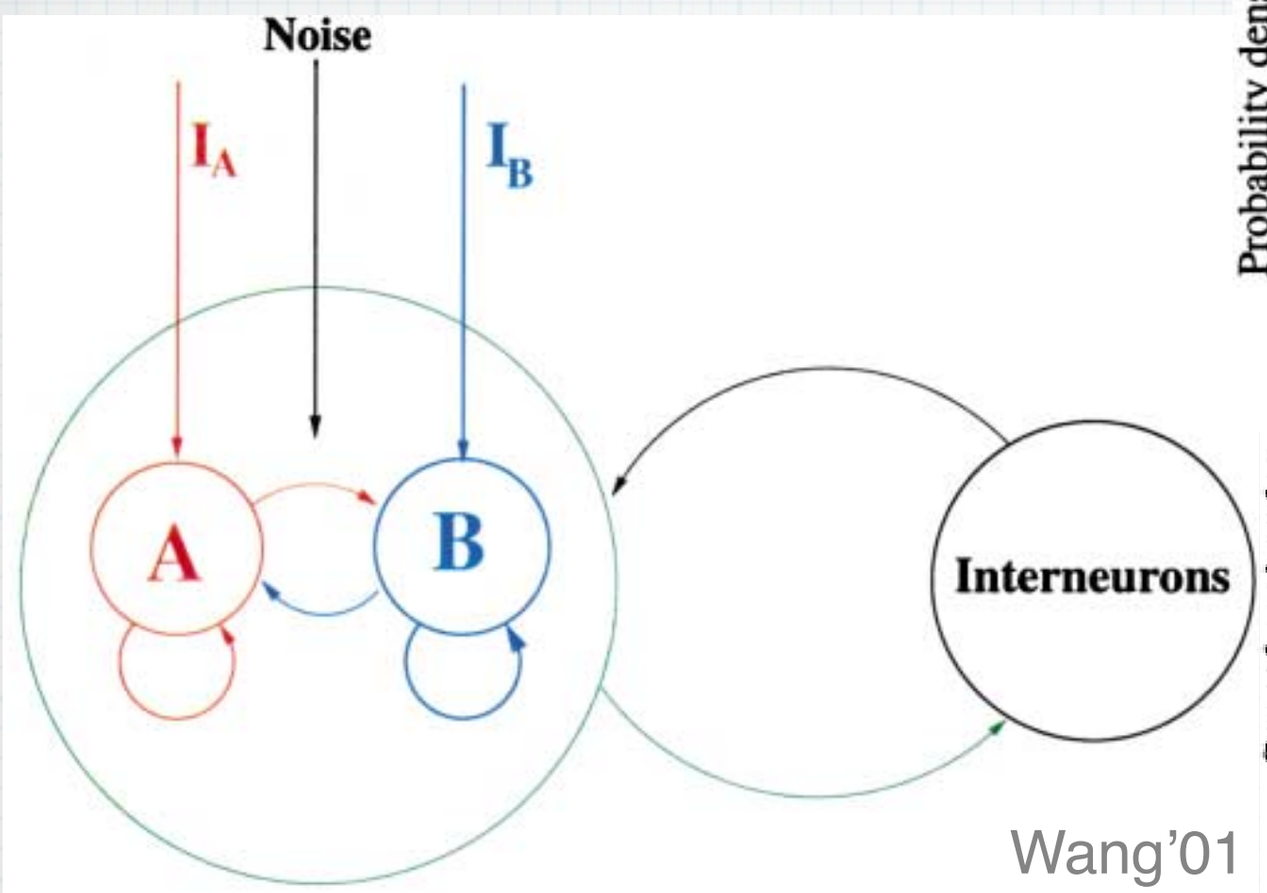
Abstract model



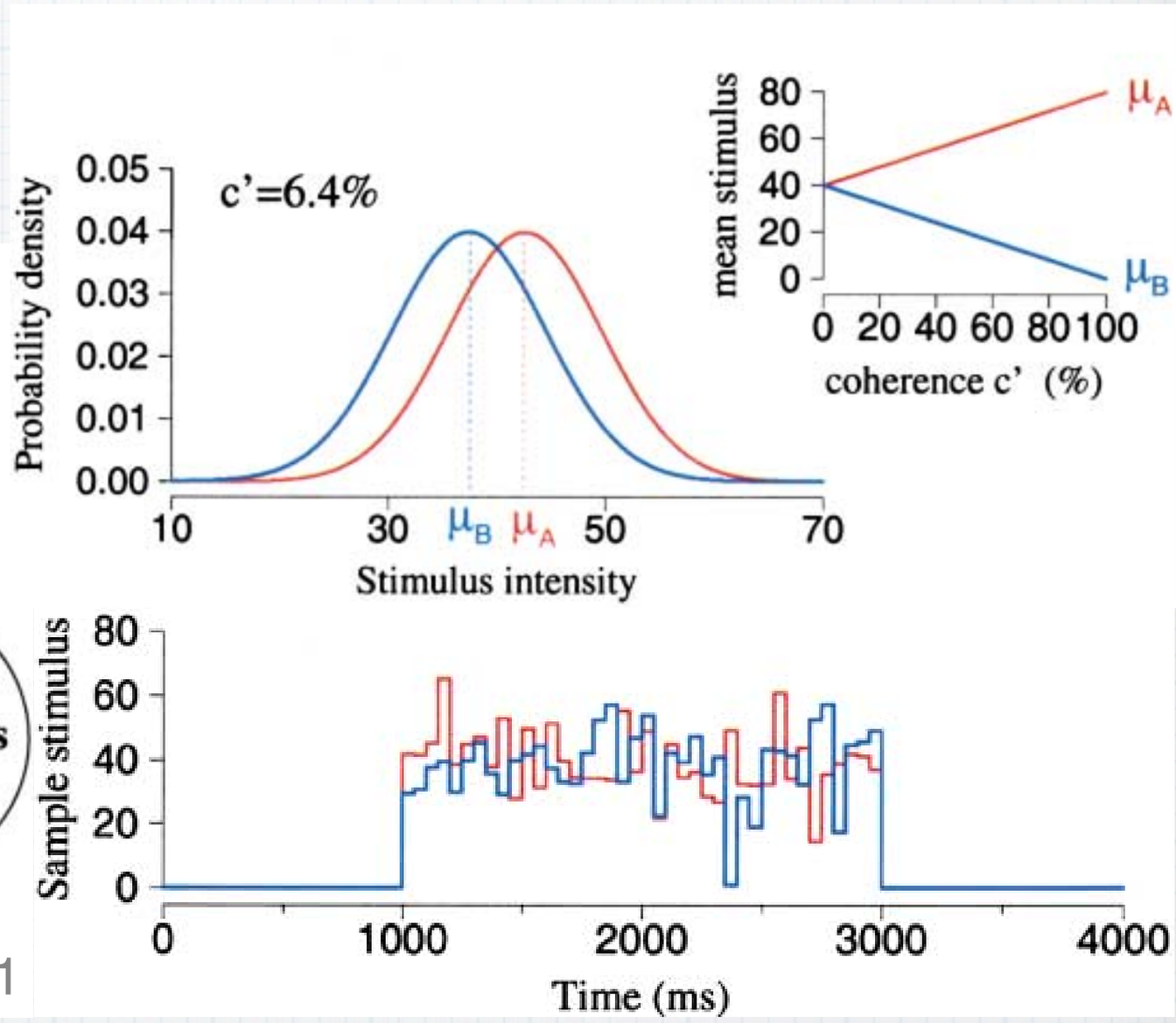
Shadlen et al.'03

* Doesn't specify how neurons achieve the key computations: difference, integration, and threshold.

Circuit model

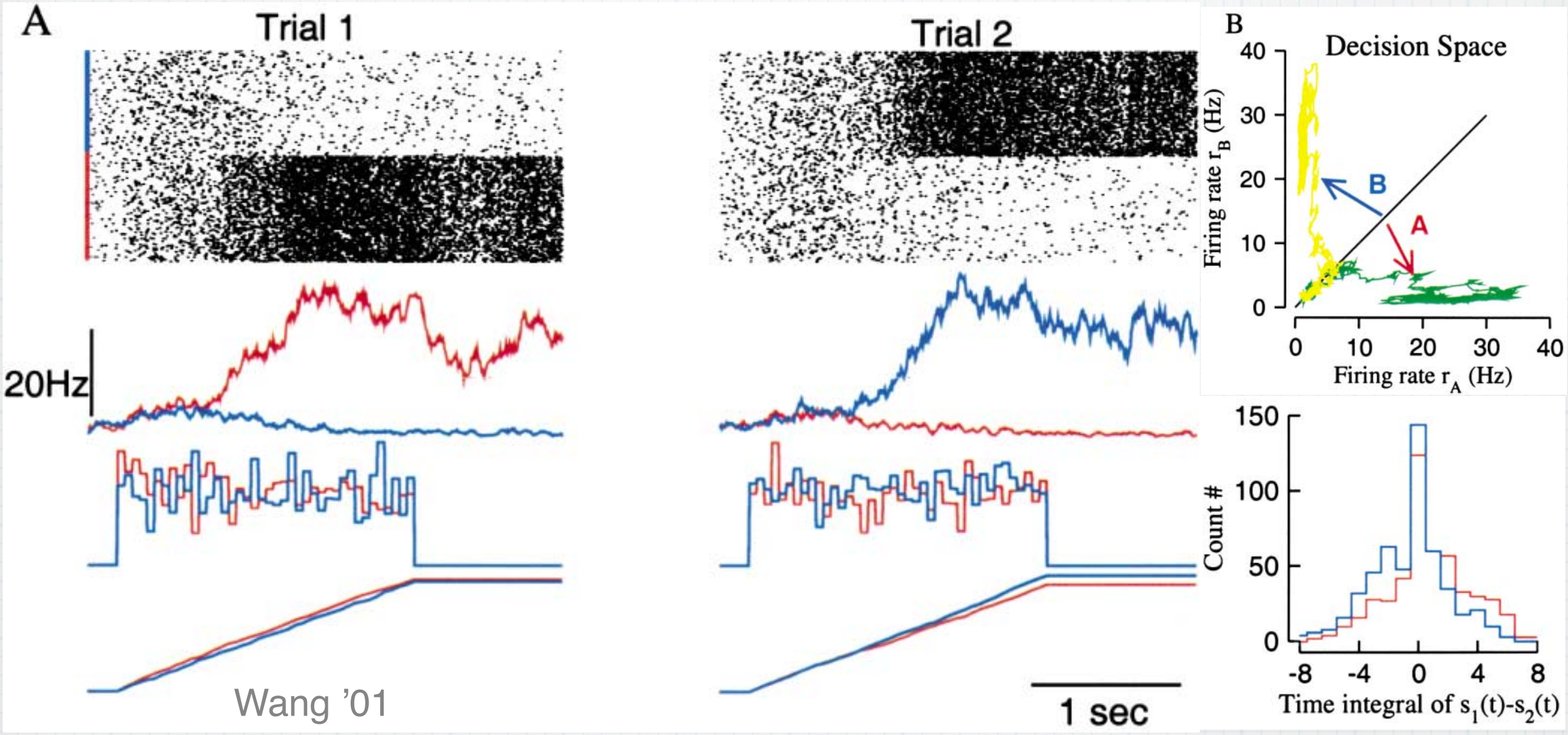


Wang'01



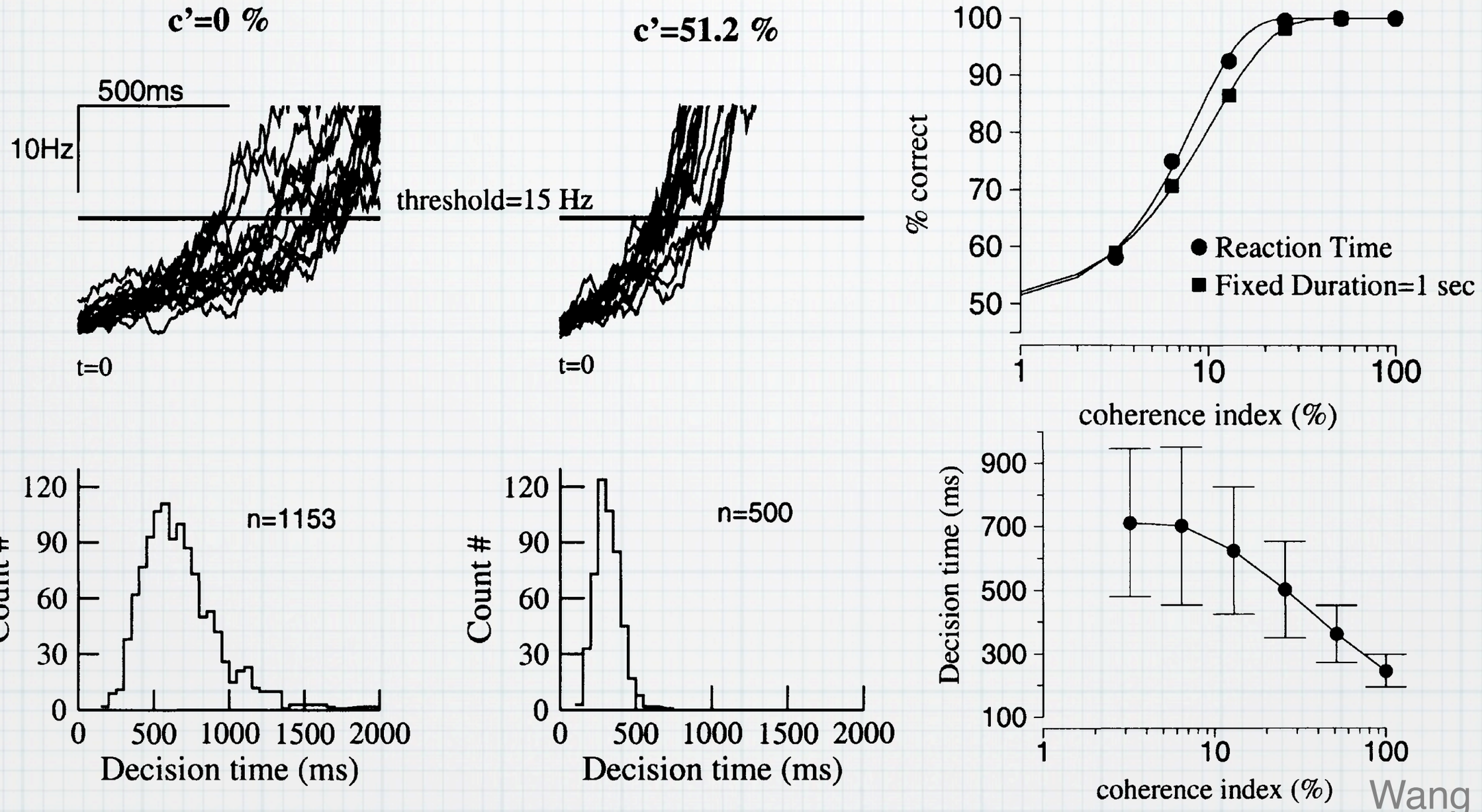
* There are two pyramidal cell populations (groups A and B) with strong recurrent excitatory connections that compete through feedback inhibition from interneurons

Coin-tossing with neurons



* At zero-coherence, either group could win, depending on random fluctuations in input strength as well as added noise.

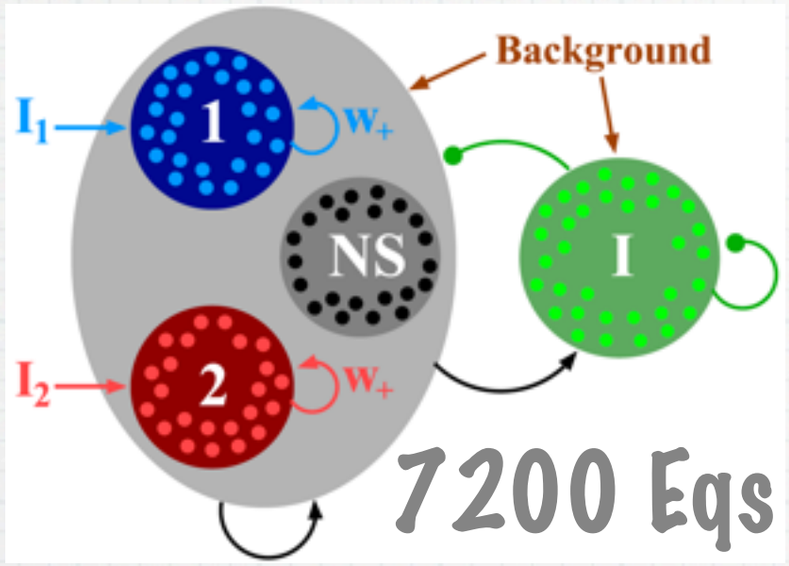
Matches RT and % correct



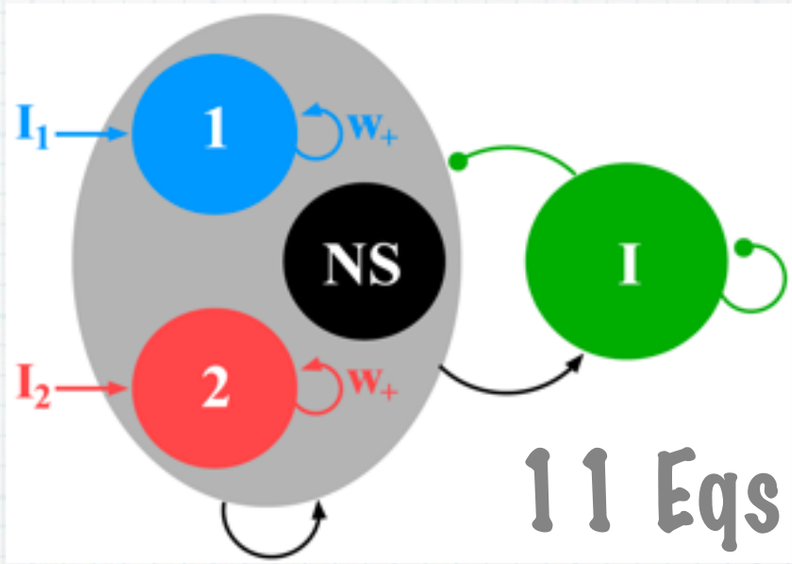
Wang '01

* RT is longer and more variable when coherence is low. Neurometric threshold is 8.4 or 10.4% coherence for RT and 1s delay, respectively.

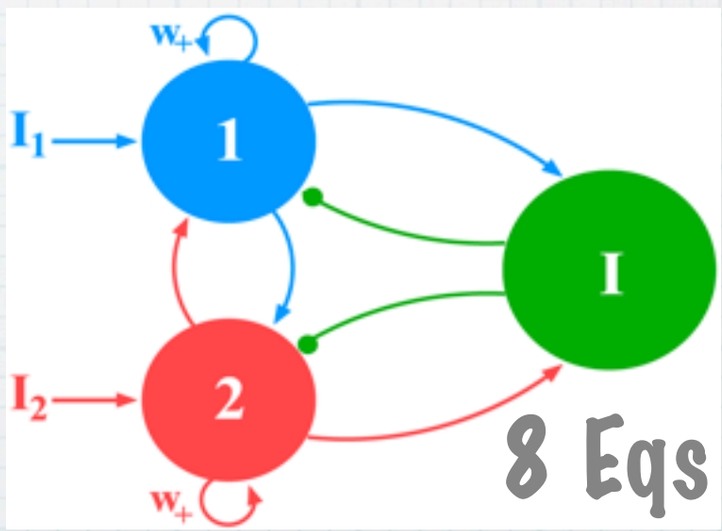
Mean-field reduction



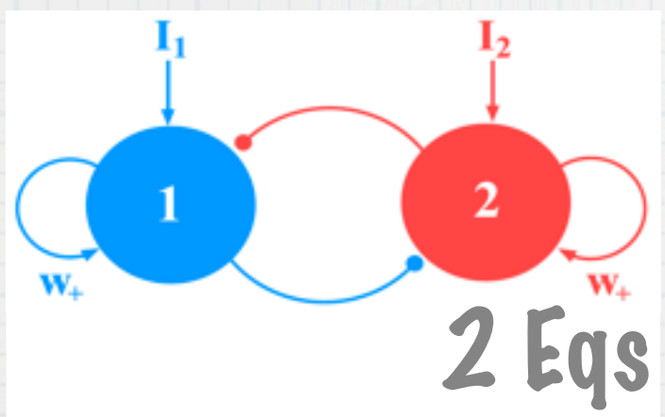
Mean-field approach



Simplified FI curves and constant NS cells



Only NMDA dynamics



Wong & Wang '06

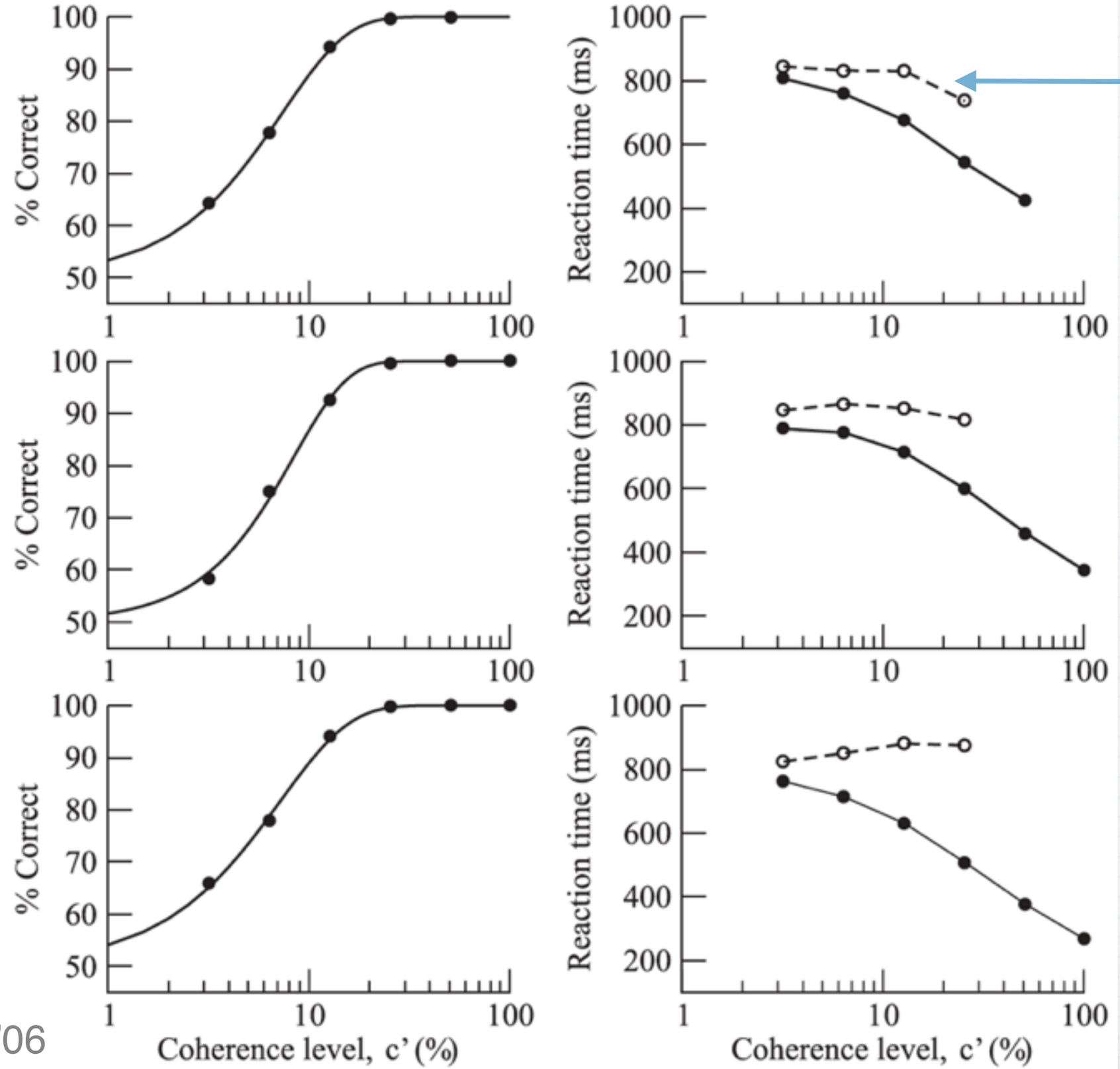
* Results in two-variable model amenable to analysis

2D model fits the data

Experimental data

Spiking neuronal network model

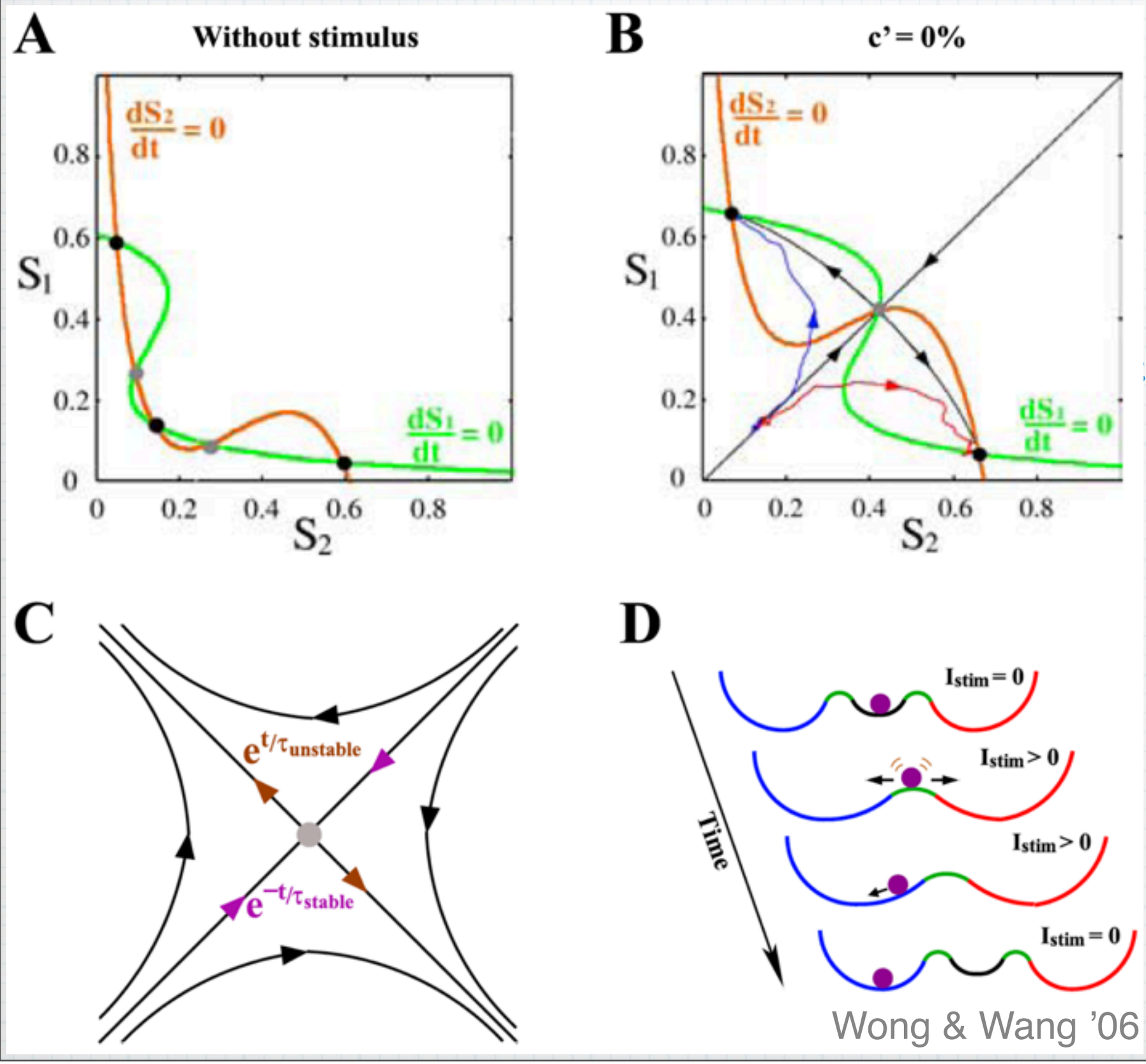
Reduced two–variable model



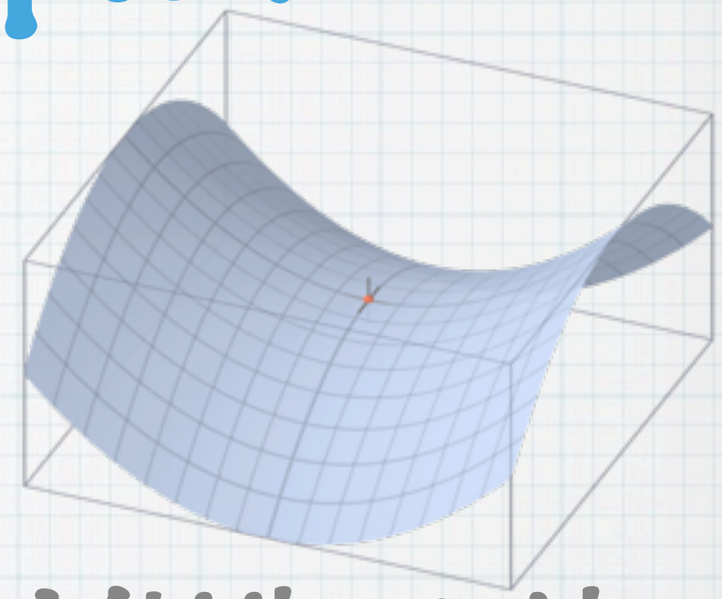
Error trials

Wong & Wang '06

2D model's phase-plane

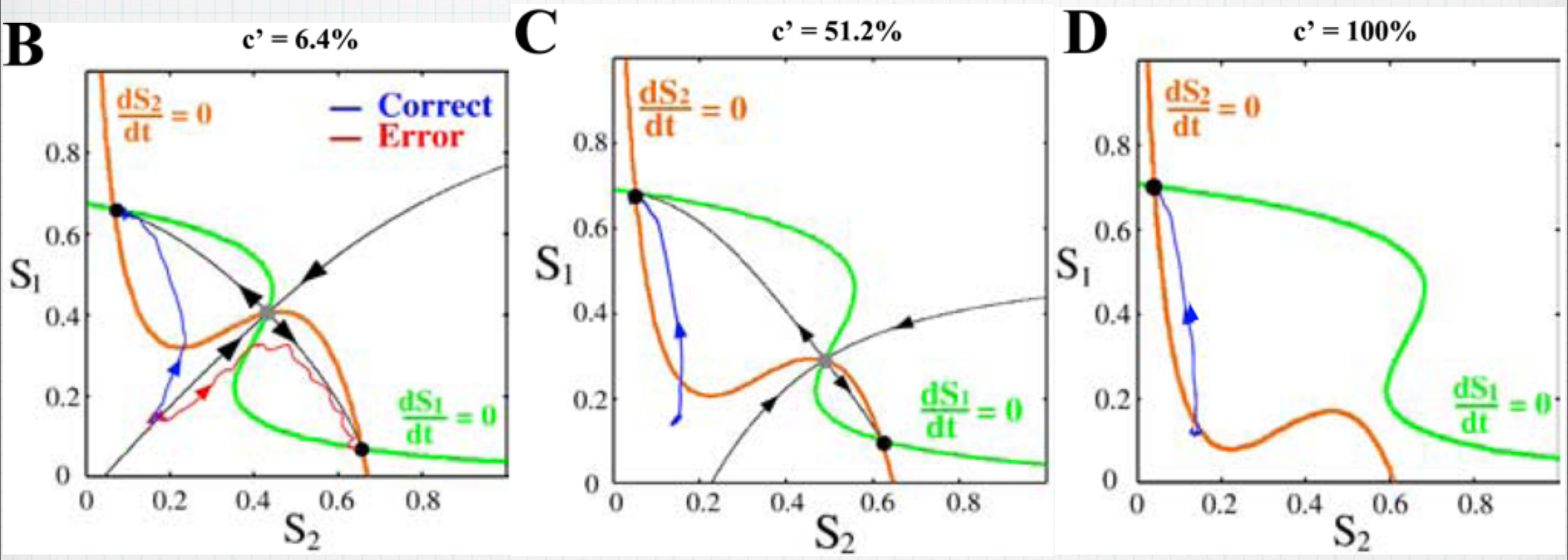


Wong & Wang '06



Middle stable point becomes a saddle-point, which defines a boundary between two other stable points' basins of attraction.

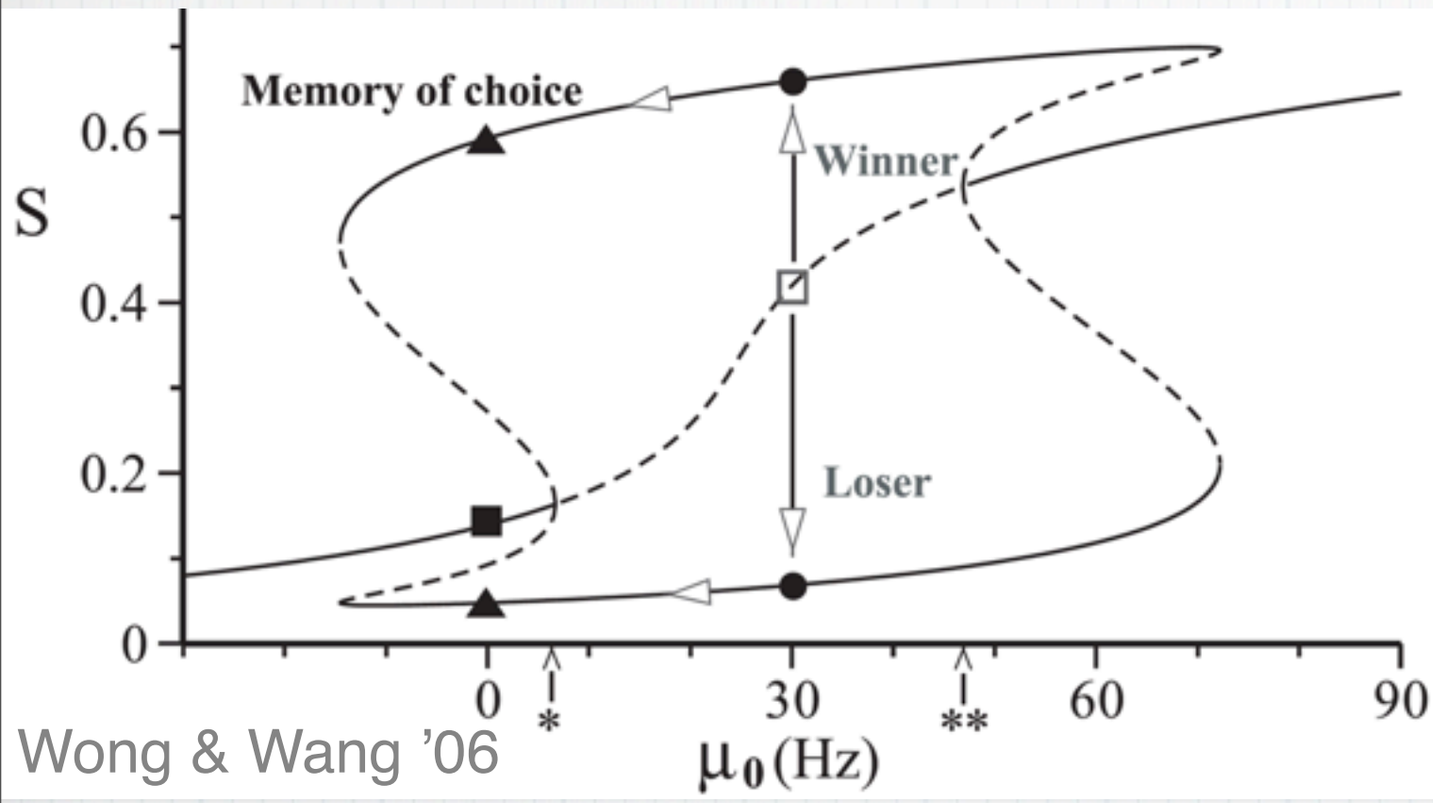
Role of increasing coherence



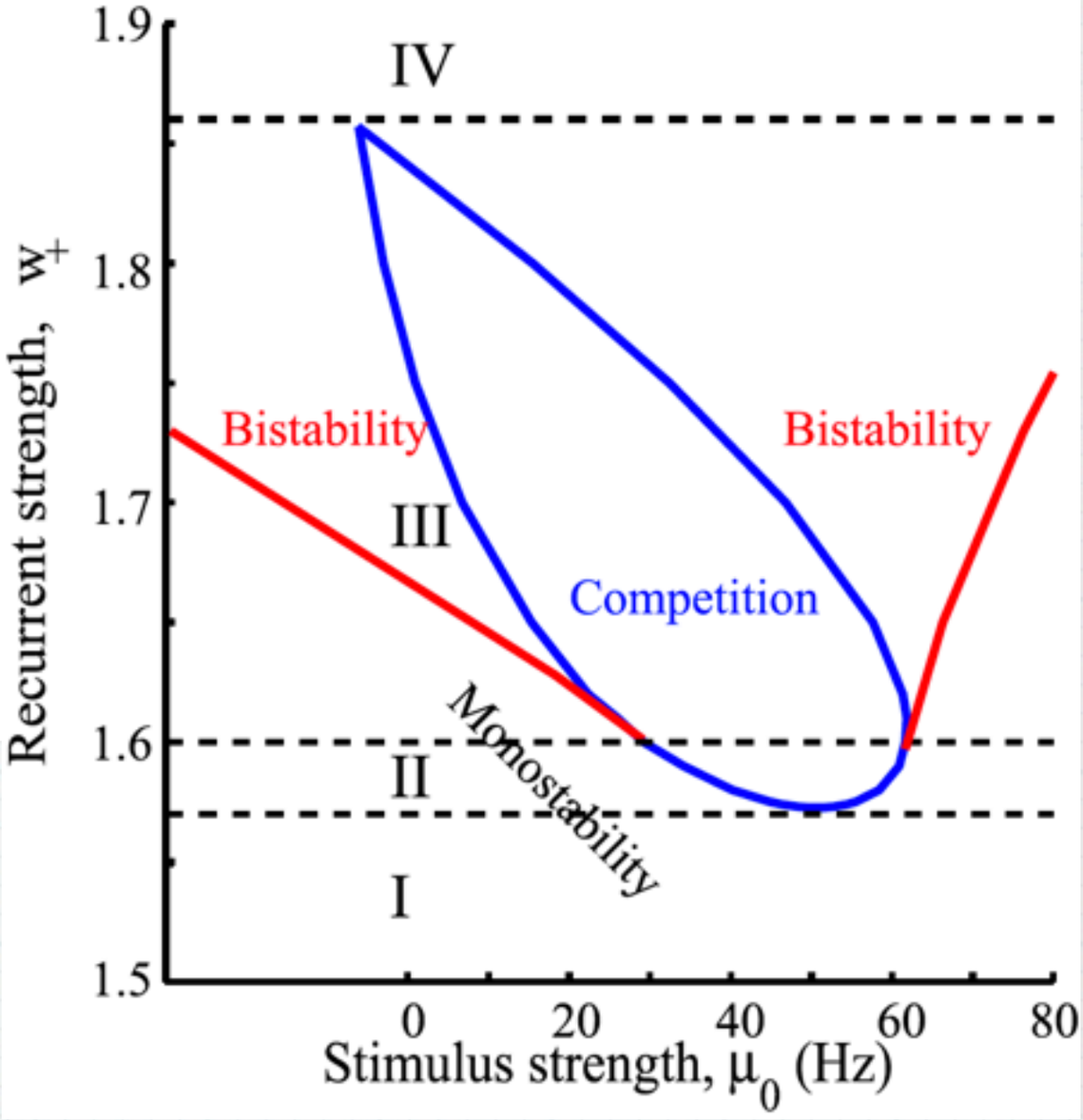
Wong & Wang '06

- At sufficiently high coherence, the trajectory always goes to the favored attractor.
- At even higher coherences, the unfavored attractor disappears.

Bifurcation diagram



Wong & Wang '06



* Monostable: 1 stable point
* Bistable: 2 stable points
* Competition: No hysteresis

Next week

* Balanced networks