Developing a neuromimetic accumulator model of perceptual decisions

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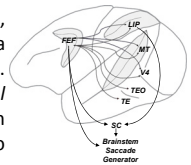
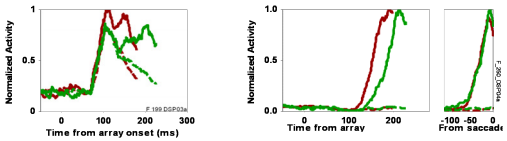
Introduction



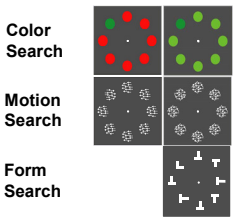
Frontal eye field (FEF) *movement neurons*, trigger a saccade when activity reaches a constant threshold (Hanes & Schall, 1996). A distinct population of FEF cells, *visual neurons*, respond to a visual stimulus in their response field. This activity evolves to differentiate the location of a target from that of distractors during presentation of a search array (Sato, Murthy, Thompson, & Schall, 2001)

Visual neuron **Movement neuron**

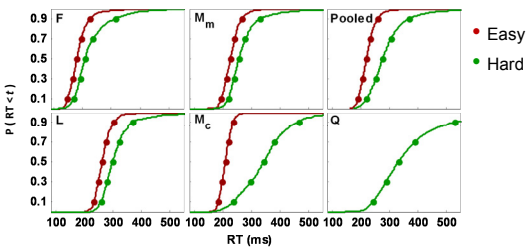


The relationship between visual and movement neurons is poorly understood. We previously reported that variability in visual neuron activity could serve as input to stochastic accumulator models that predict behavior during visual search. Here, we tested whether several simple accumulators could account for both behavior and movement neuron dynamics.

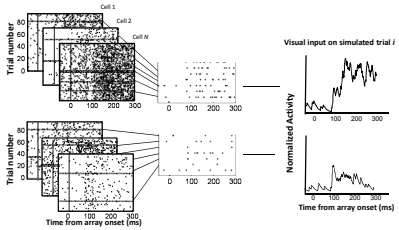
Task



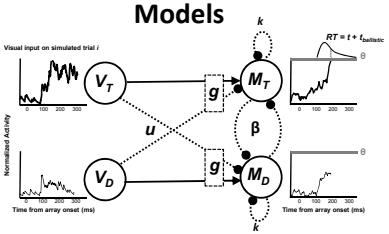
Behavioral Results



Modeling Methodology



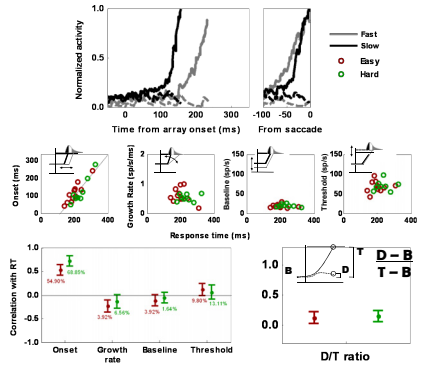
Models



Models:
Race: u = β = 0
Diffusion: u = 1, β = 0
Competitive: u = 0, β free to vary

Mechanisms:
k = leakage (free to vary)
g = gate (free to vary)

Movement neuron activity

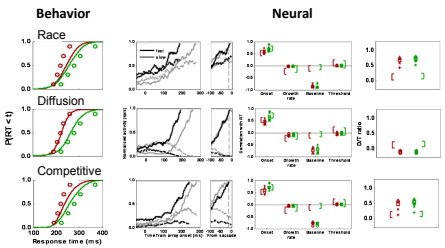


Woodman, Kang, Thompson, & Schall (2008)

Modeling Results

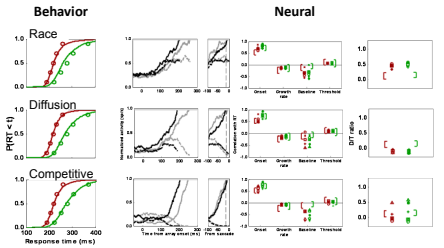
Perfect integrators

Poor account of both behavioral and neural data



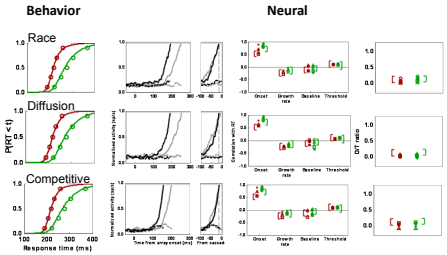
Leaky integrators

Good account of behavior, poor account of neural data



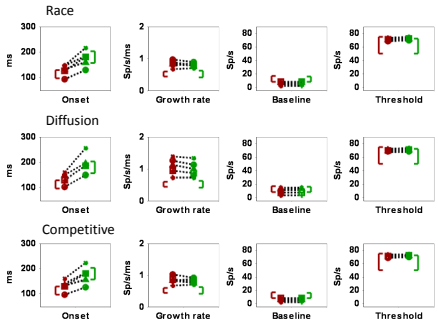
Gated integrators

Good account of both behavioral and neural data



Gated model neural predictions

All gated models provide a good account of mean onset, growth rate, baseline, and threshold



Summary:

1. Variability in visual neuron activity can be used to drive stochastic accumulator models that account for variability in response time.

2. Perfect and leaky accumulator models are sometimes able to predict observed behavior, but failed to account for known patterns of neural activity.

3. Models that included gating of visual activity prior to accumulation accounted for both behavioral and neural data.

4. There was little evidence to distinguish race, diffusion, and competitive architectures.

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Sato, T., Murthy, A., Thompson, K. G., & Schall, J. D. (2001). Search efficiency but not response interference affects visual selection in frontal eye field. *Neuron, 30*(2), 583-591.
Woodman, G. F., Kang, M. S., Thompson, K., & Schall, J. D. The Effect of Visual Search Efficiency on Response Preparation. *Psychol Sci 19: 128-136, 2008.*