# A BIOPHYSICAL NEURONAL MODEL EXPLORING ATTENTION MECHANISMS IN VISUAL CORTEX


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## ABSTRACT

Neurons in areas V2 and V4 exhibit stimulus specific tuning. When two stimuli that are differentially preferred by a V4 neuron are simultaneously presented within its receptive field, its response to the pair is intermediate between the responses to either of the two stimuli presented alone. When the animal attends to one of the two stimuli, the response shifts from the pair response towards what would be its response if the stimulus was presented alone. In addition, attention to single stimuli results in a gain increase of the neuronal responses.

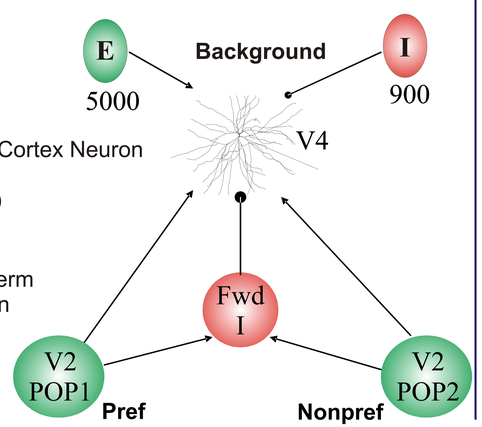
The intrinsic and network mechanisms that result in these effects are investigated here.


## METHODS

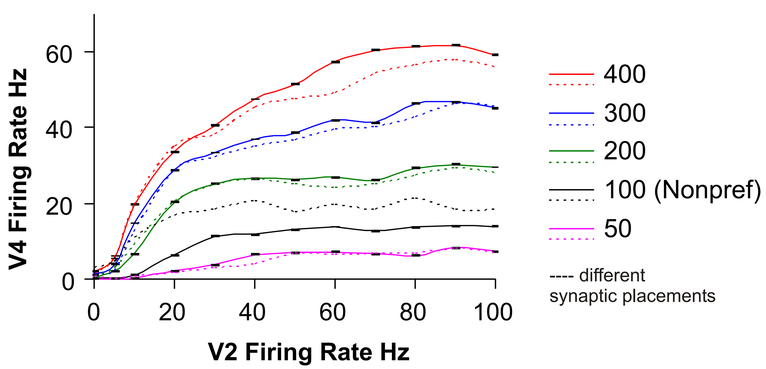
NEURON simulator

Reconstructed Cat Visual Cortex Neuron
Passive Dendrites,
Active Soma ($I_{Na}$, $I_K$, $I_M$, $I_{AHP}$)

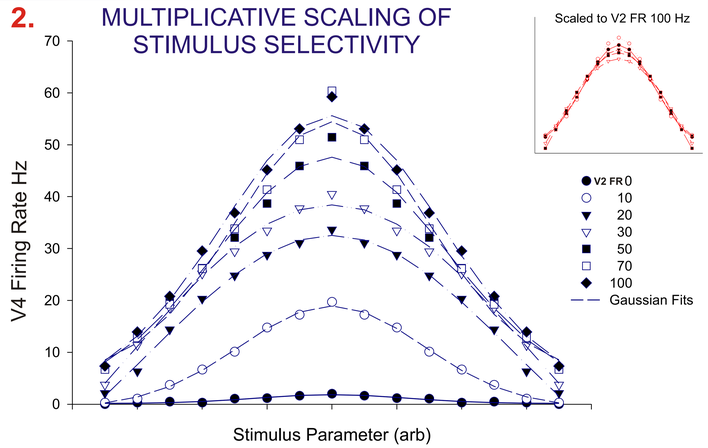
Poisson Input with Short-term Facilitation and Depression Dynamics



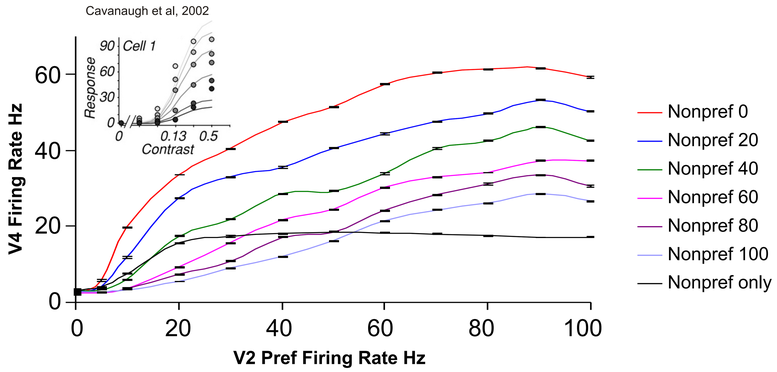

## 1. STIMULUS TUNING BY VARYING THE NUMBER OF SYNAPSES



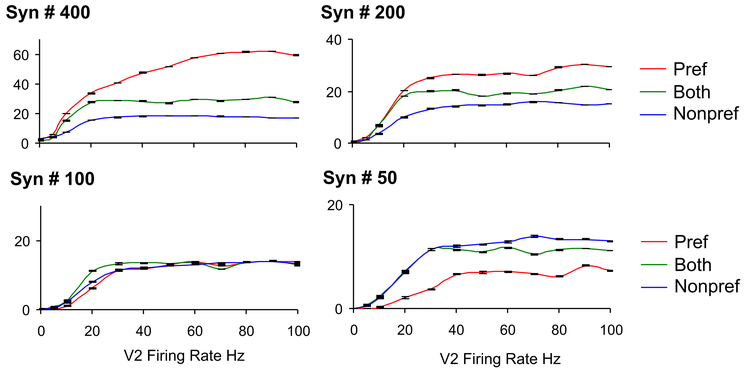

## 2. MULTIPLICATIVE SCALING OF STIMULUS SELECTIVITY



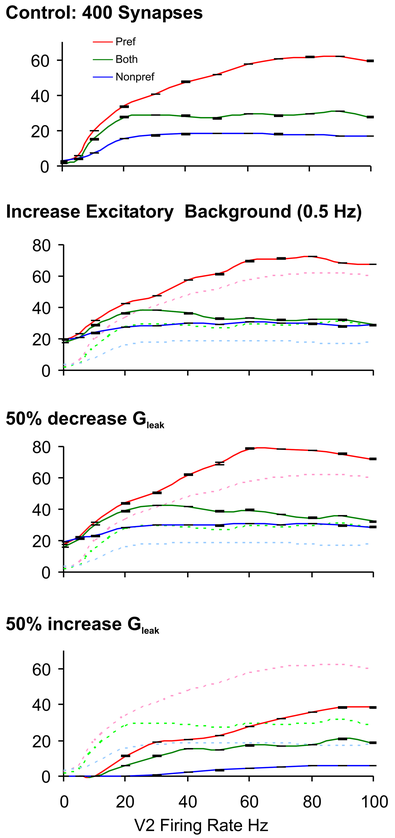

## 3. NON-PREFERRED STIMULUS SCALES DOWN RESPONSE TO PREFERRED STIMULUS




## 4. RESPONSE AVERAGING TO EQUAL 'CONTRAST' STIMULUS PAIRS

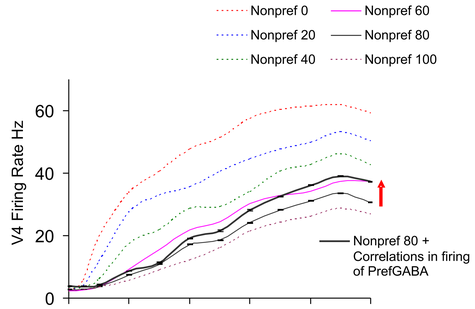



## 5. GAIN MODULATION BY BACKGROUND FIRING AND $G_{leak}$

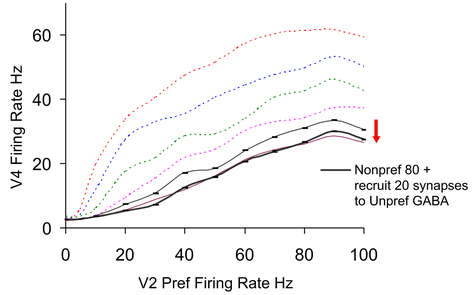



## 6. SELECTIVE ATTENTION BY CHANGES IN FEEDFORWARD INHIBITION

### A] TO PREFERRED STIMULUS USING CORRELATIONS IN FIRING




### B] TO NONPREFERRED STIMULUS USING SYNAPSE RECRUITMENT




## CONCLUSIONS

We have explored in a biophysical model V4 neuron receiving explicit stochastic synaptic inputs from V2 and from other areas that:

> Differences in numbers of projecting synapses can generate robust stimulus tuning.

> Responses to stimulus pairs can be implemented by modulation of feedforward GABA inhibition. Response averaging is robust at any stimulus preference.

> Response gain can be implemented by manipulating the mean background firing or the neuron's leak conductance.

> Changes in feedforward GABA inhibition can also mediate selective attention.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