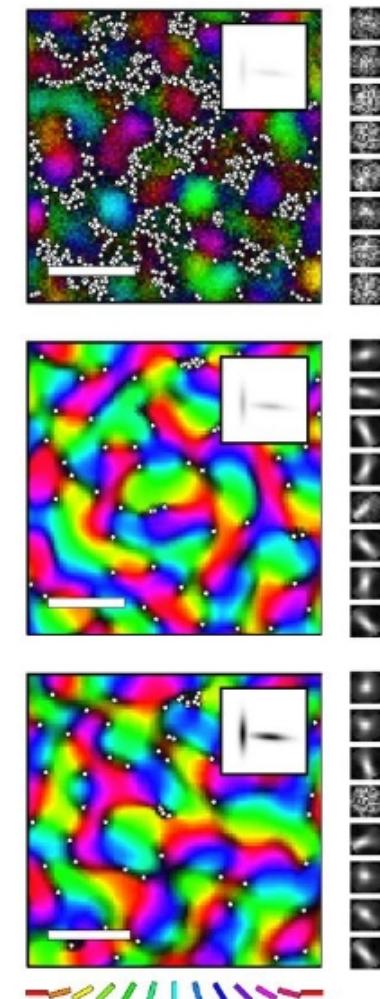
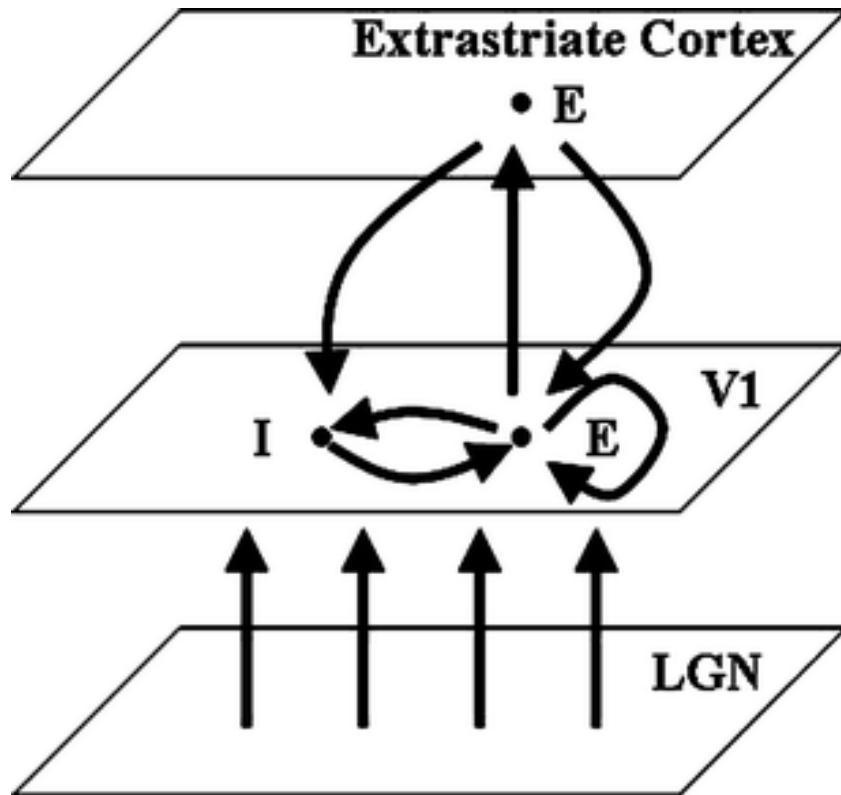


# **Dynamical models**

**AIL087**  
**Ján Antolík**  
**MFF UK, 2019**

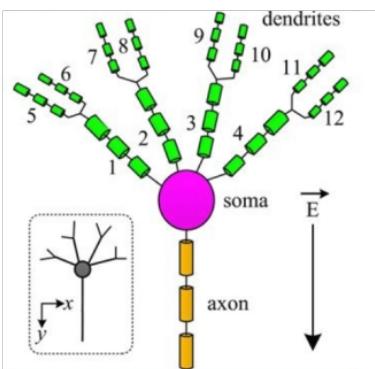
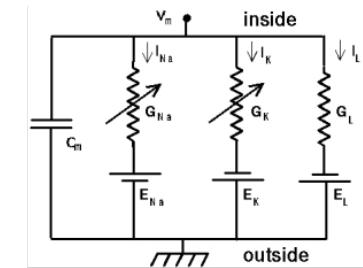
# Models of adult functions vs. models of development



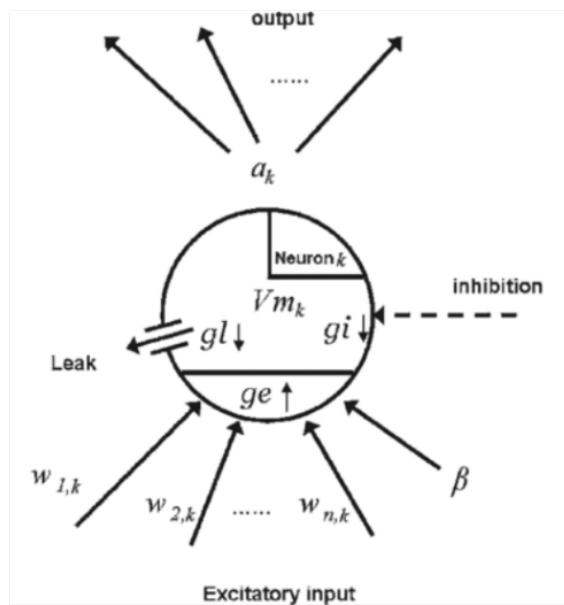
# **Biological fidelity of models**

# Neural model detail

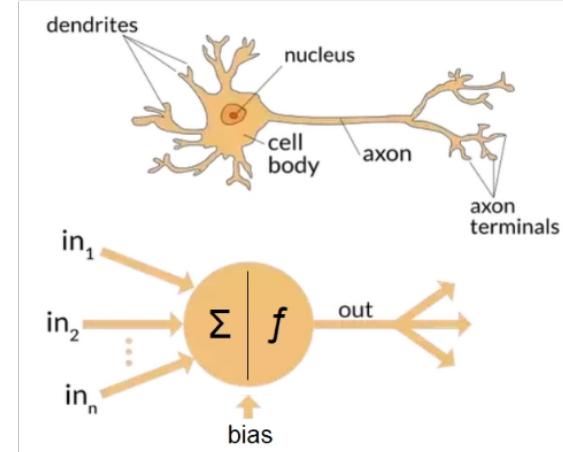
hodgkin-huxley  
neural model



point  
neuron



firing-rate  
neuron

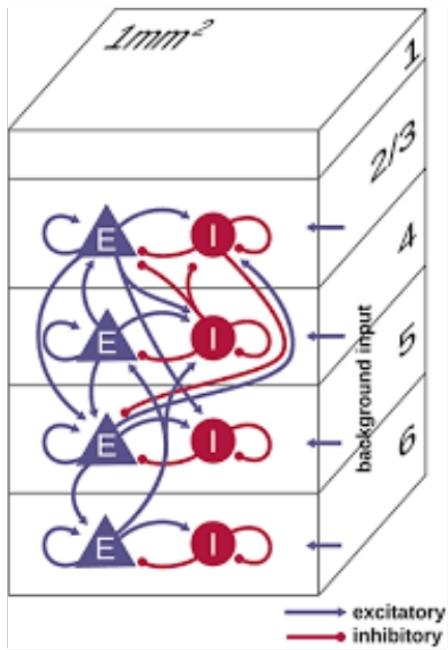


DETAILED

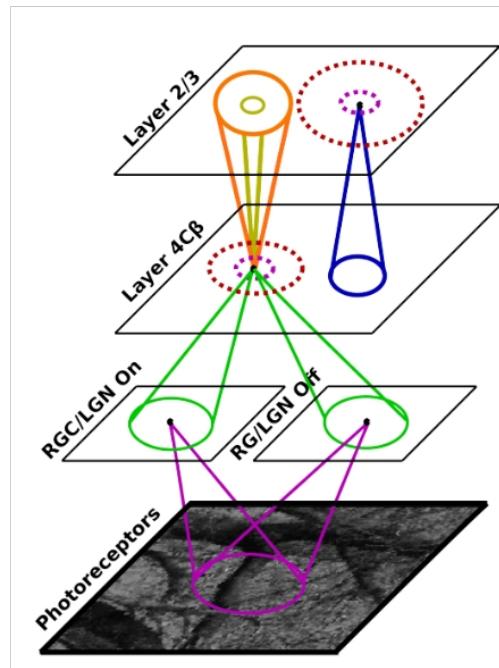
ABSTRACT

# Model scope

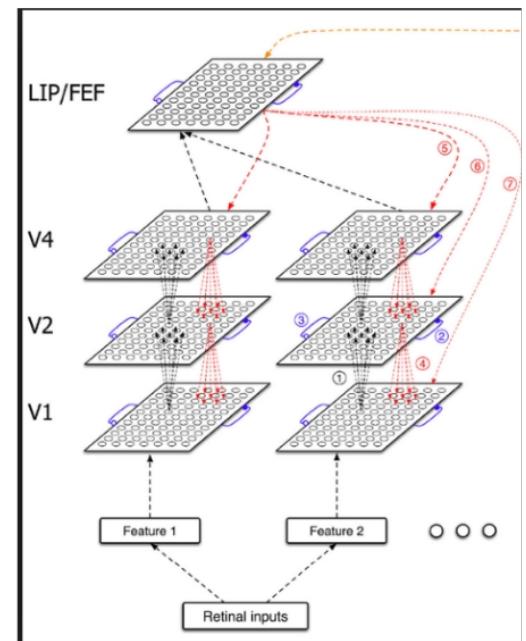
Single column



Single-area



Multi-area

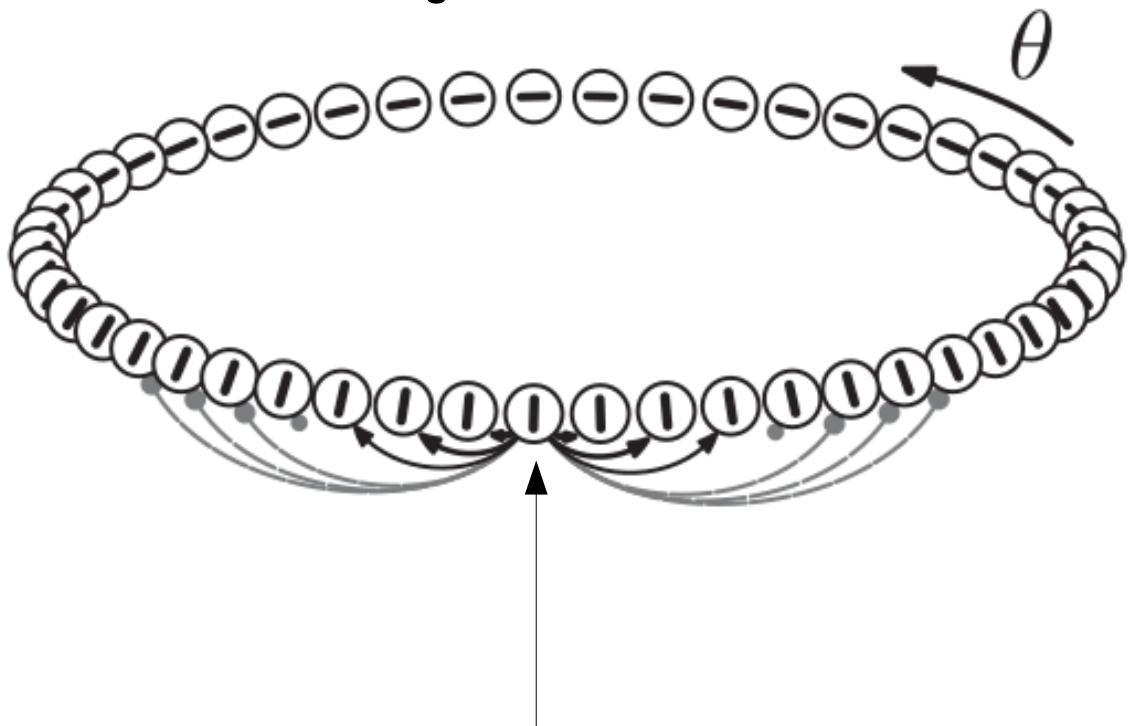


NARROW

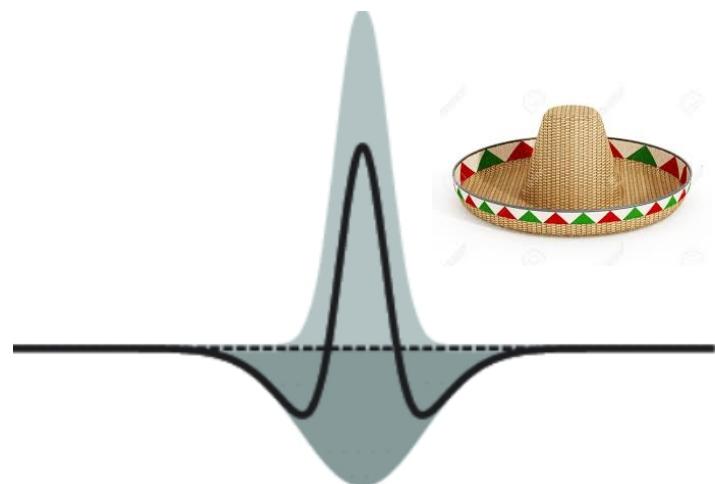
BROAD

# Ring attractor model of orientation tuning

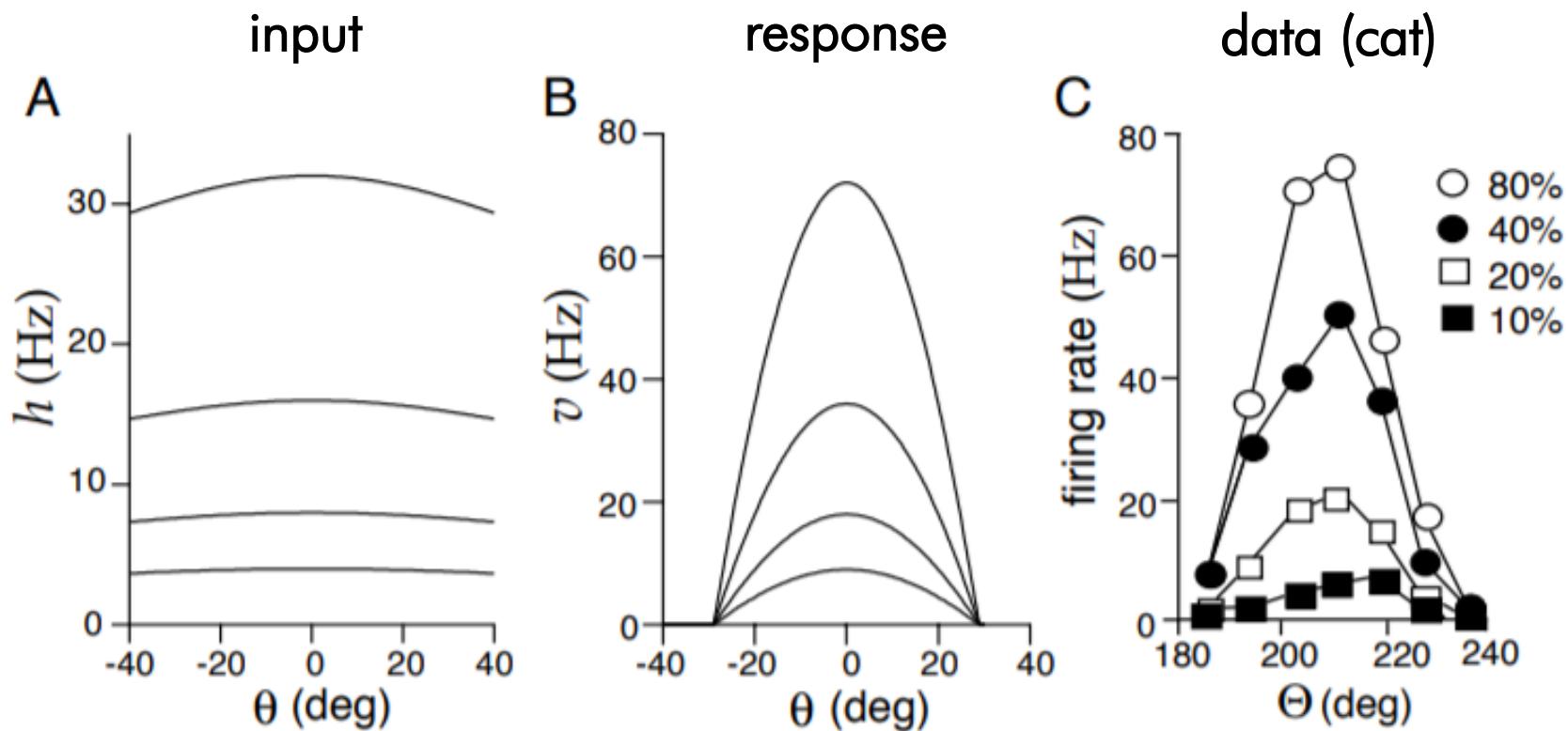
Ring neural model



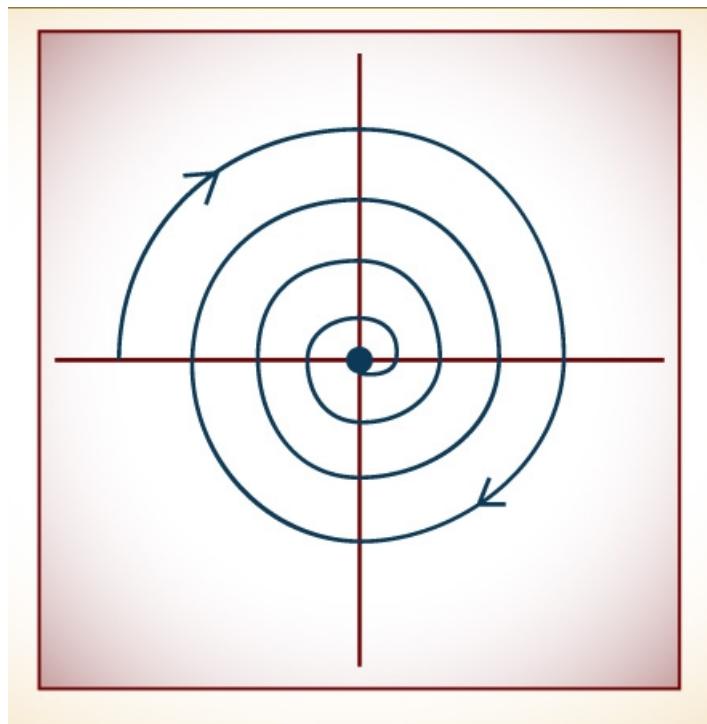
Mexican-hat  
Lateral connectivity  
profile



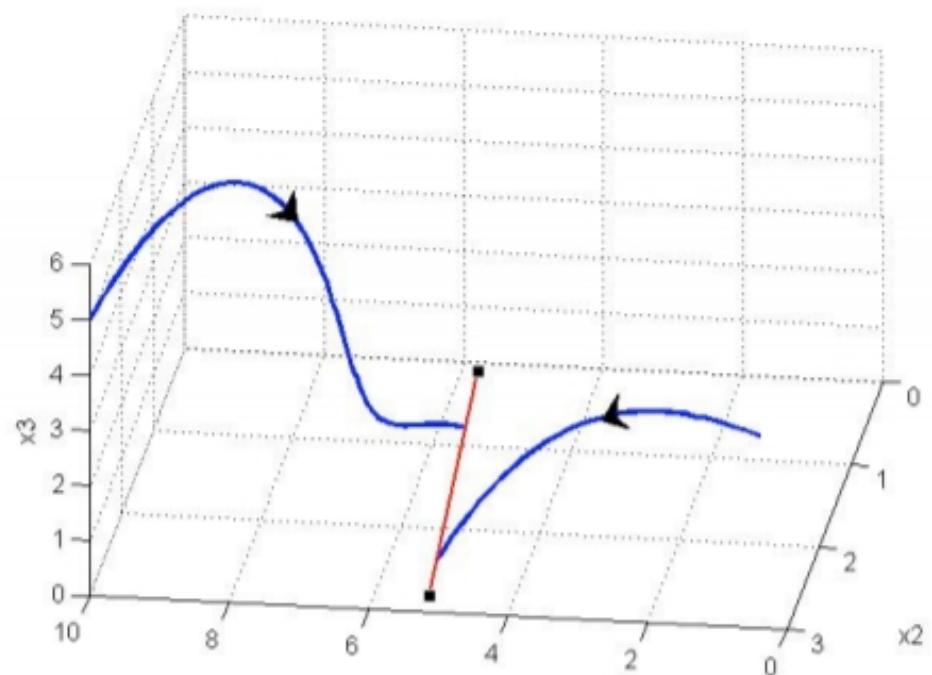
# Ring model: results



# Ring model as attractor network



POINT ATTRACTOR



LINE ATTRACTOR

# Problems?

- Ben-Yishai et al. - long-range broadly tuned inhibition
- Brain - short-range tuned inhibition
- Solution ? Troyer et al. model

# Troyer et al. – afferent input

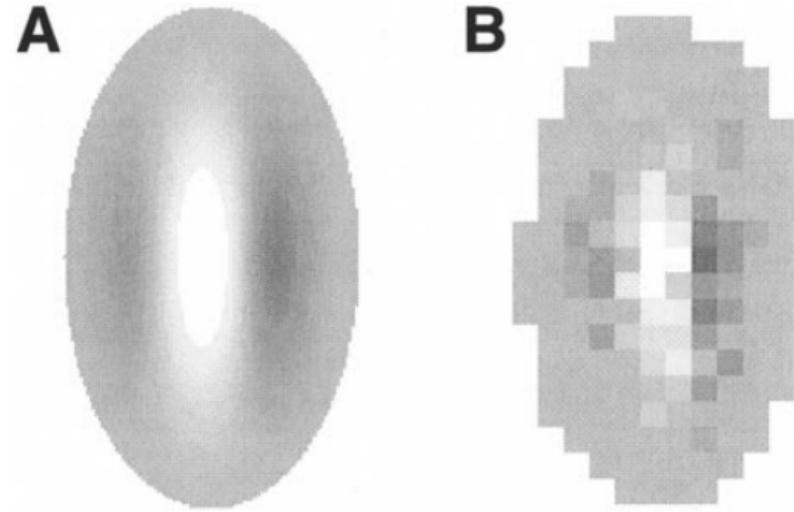
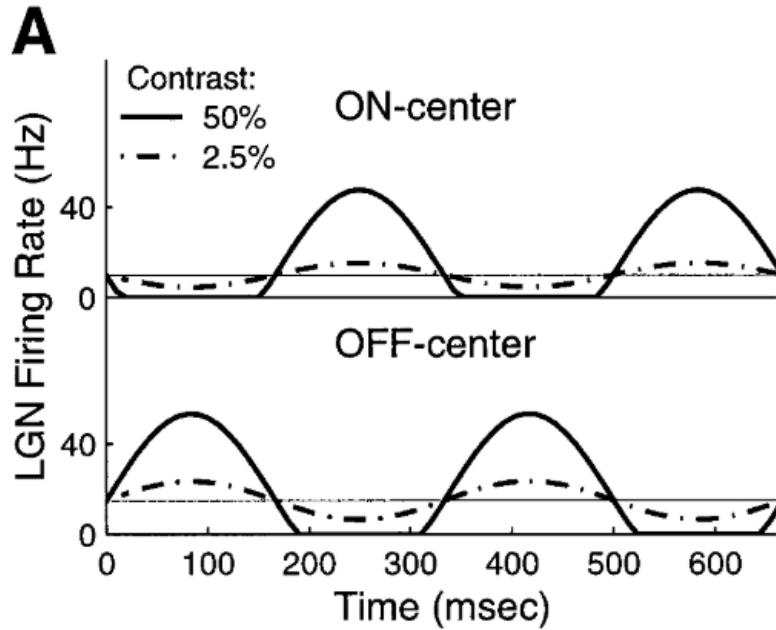
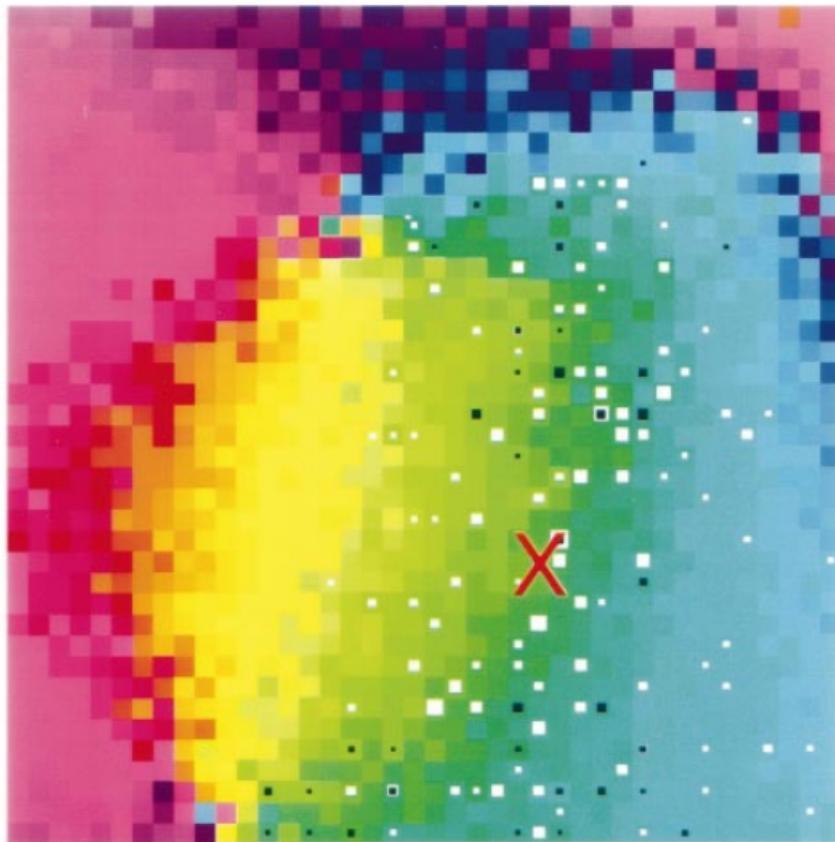


Figure 2. Gabor-shaped cortical RFs. Lighter grays to white indicate positive values of Gabor function, corresponding to weights of ON-center LGN cells with centers at corresponding spatial positions; darker grays to

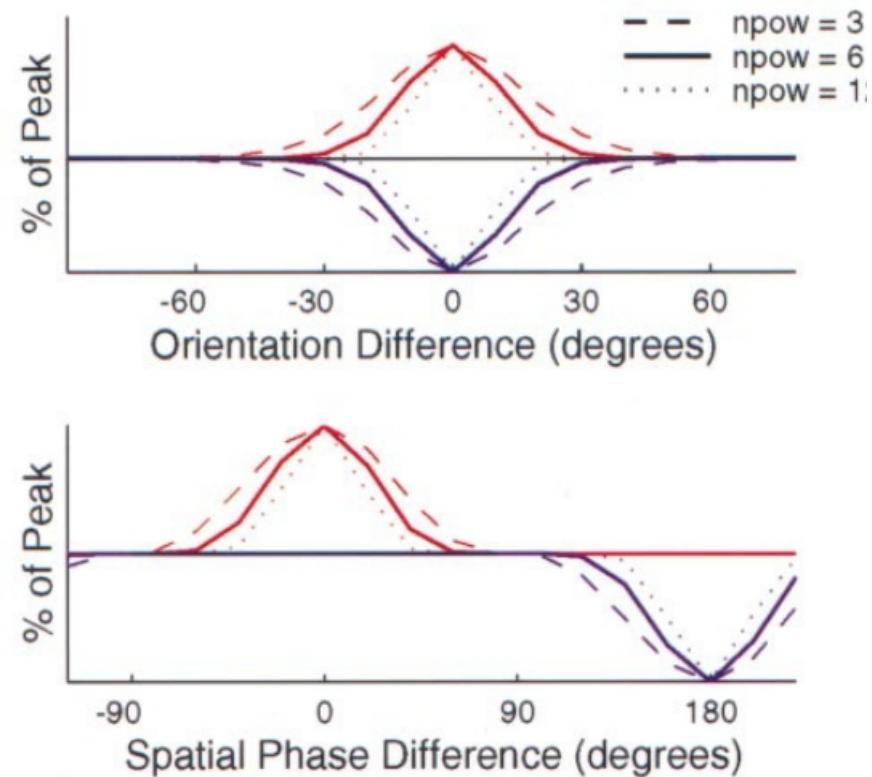
# Troyer et al. – connectivity

A

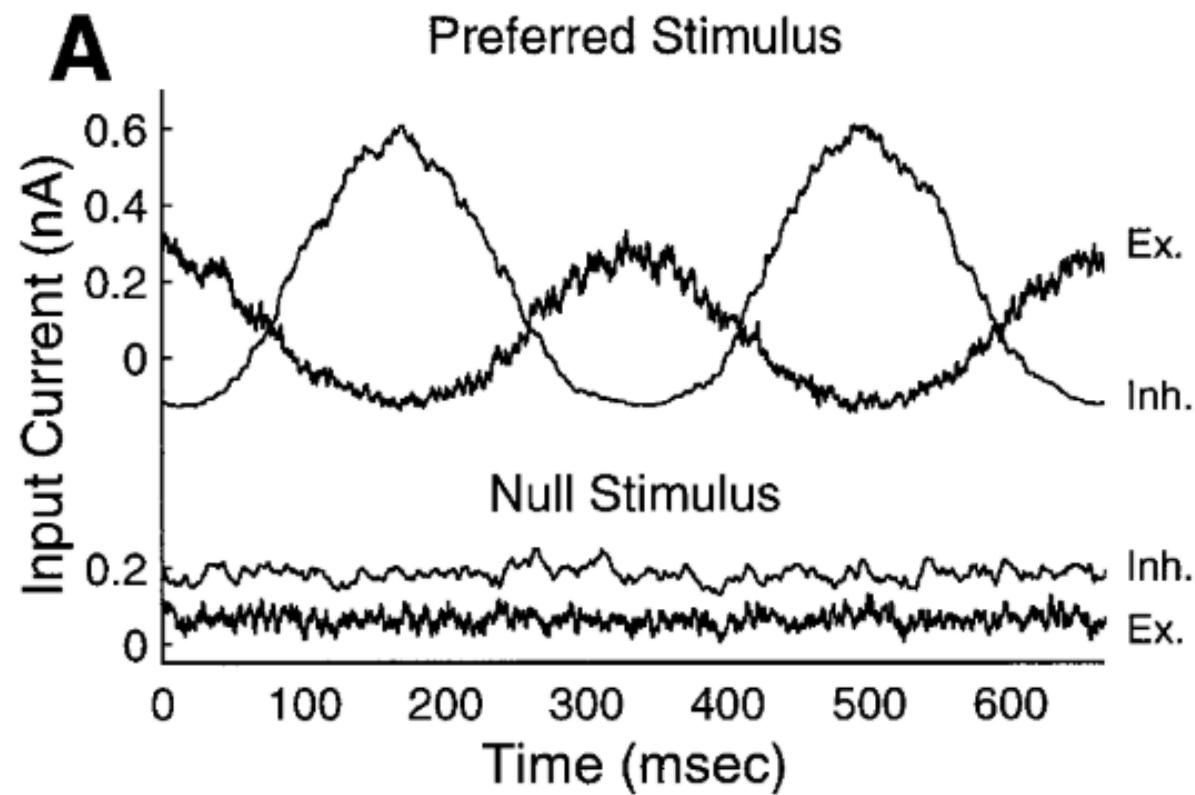


Connections to cell at **X**:    □ Excitatory  
                                  ■ Inhibitory

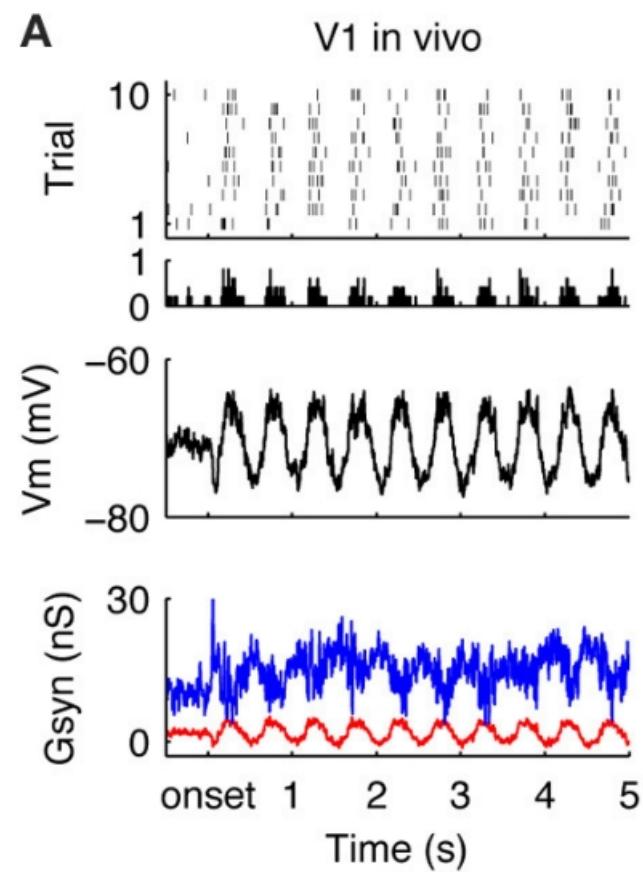
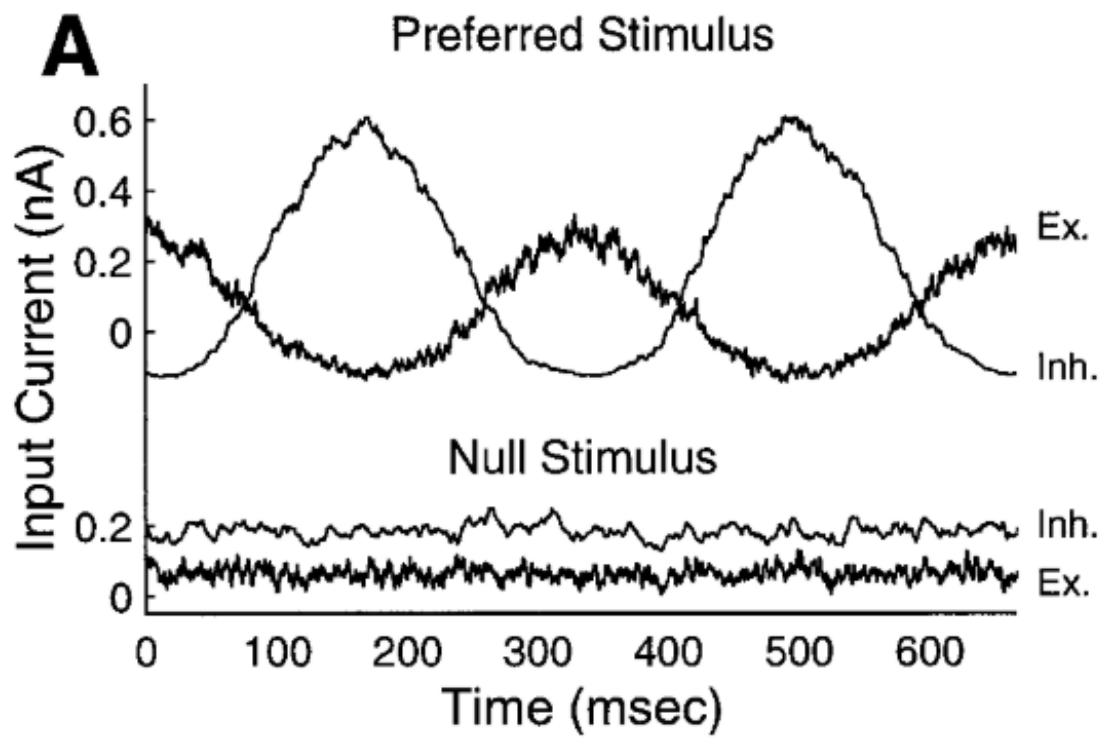
B



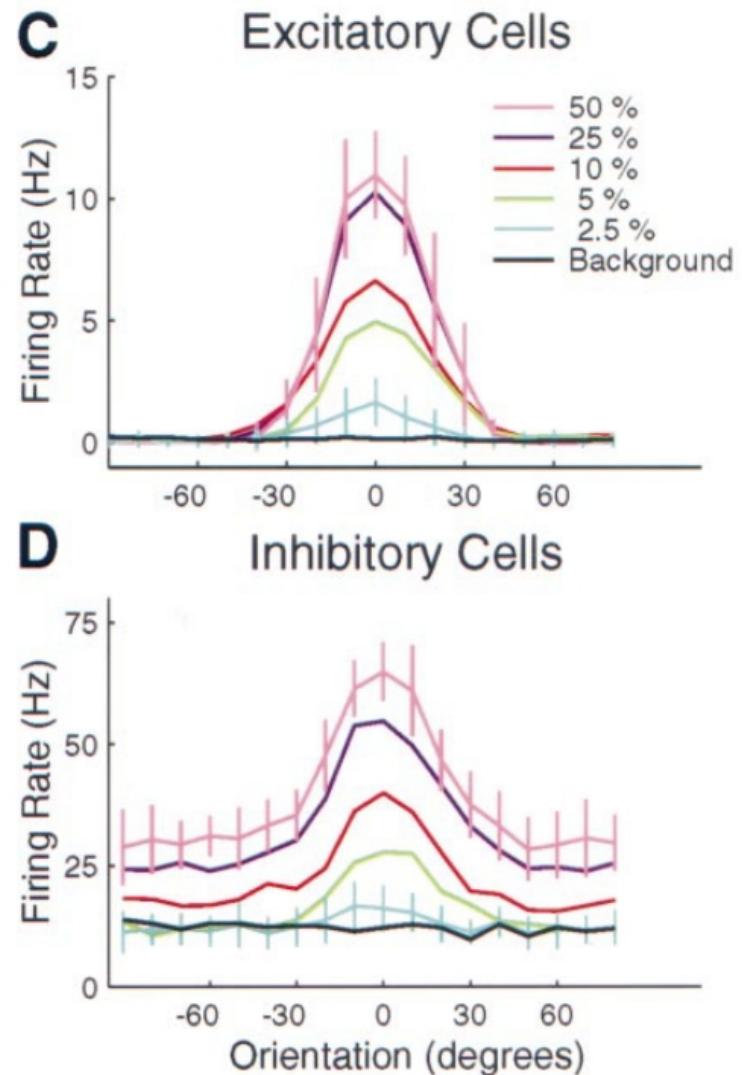
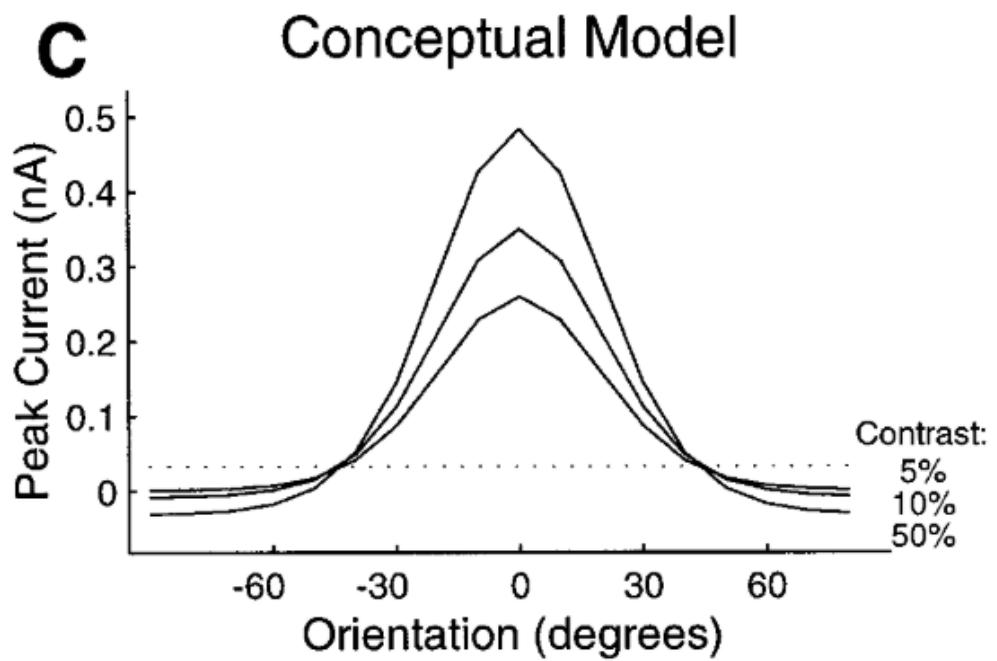
# Troyer et al. – key insight



# Troyer et al. – key insight

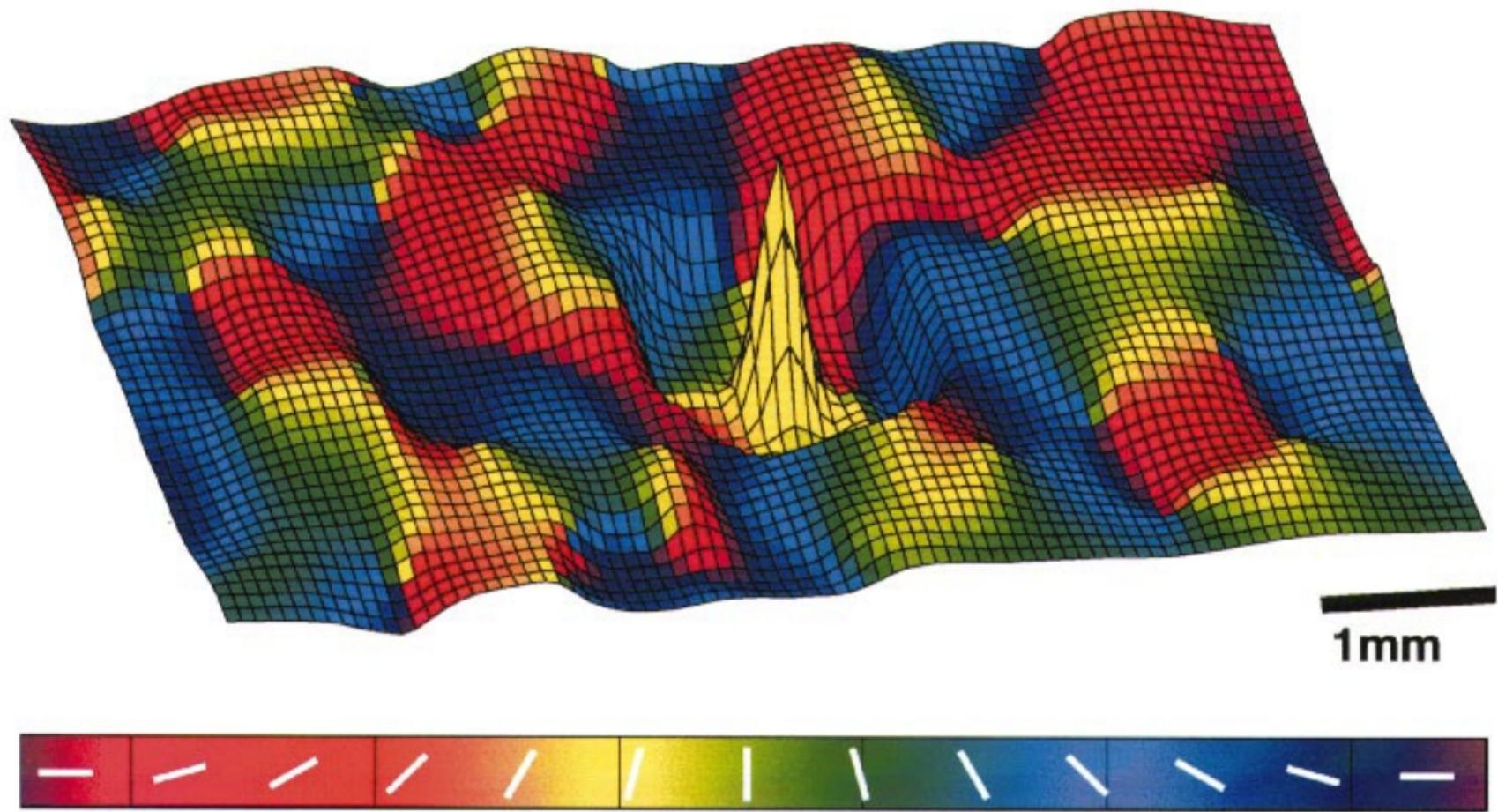


# Troyer et al. – result

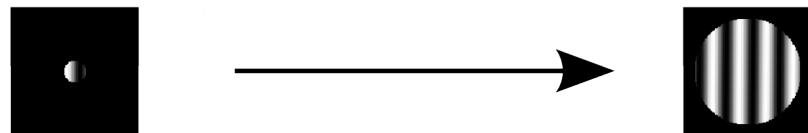
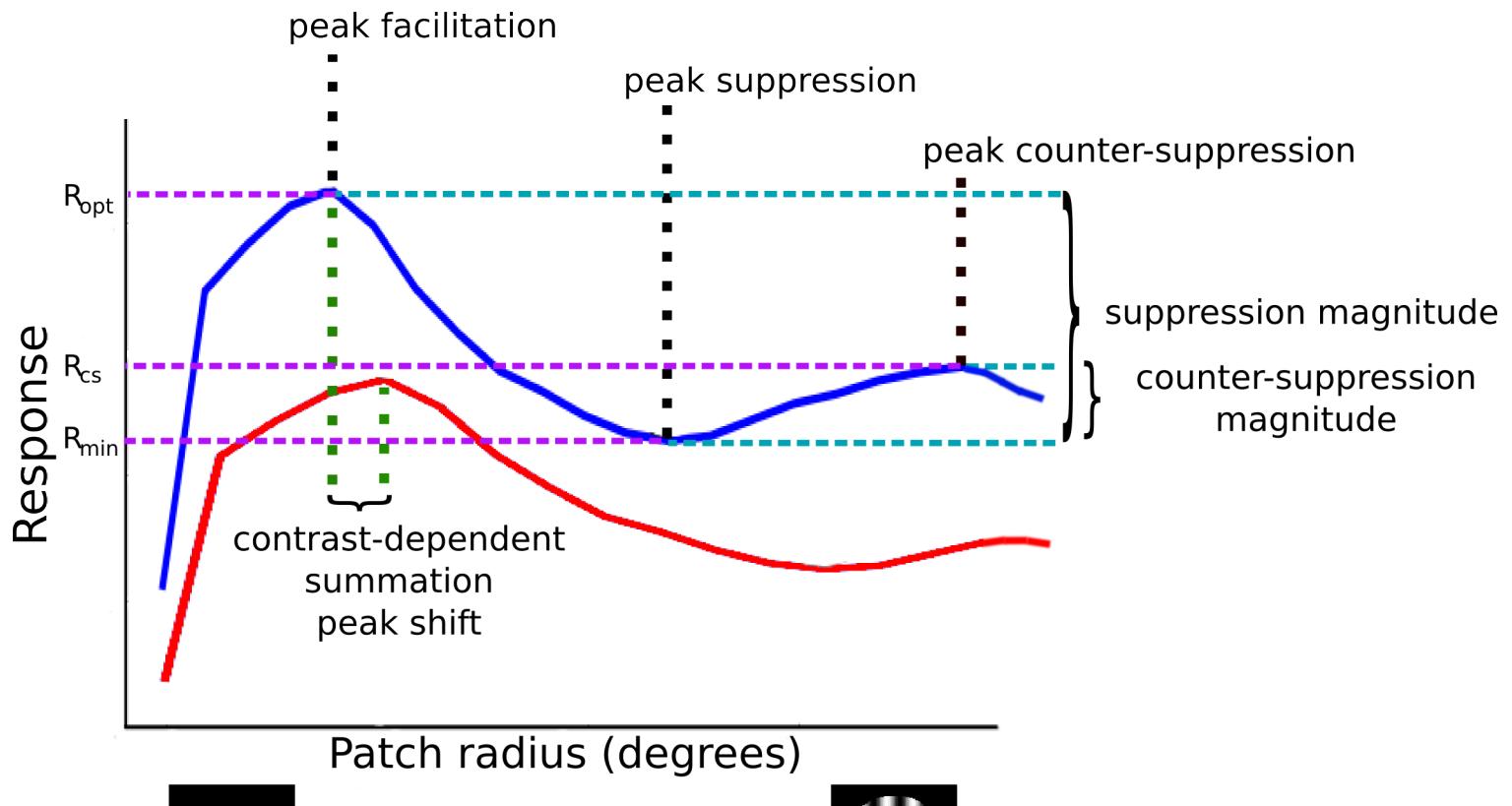


**Let's broaden scope**

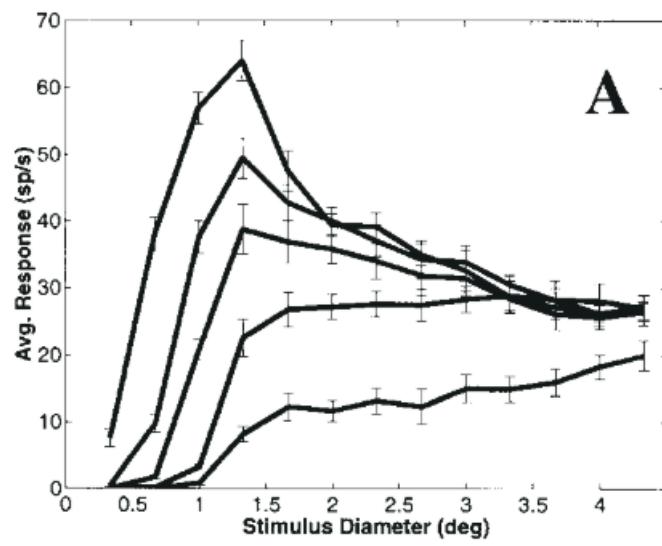
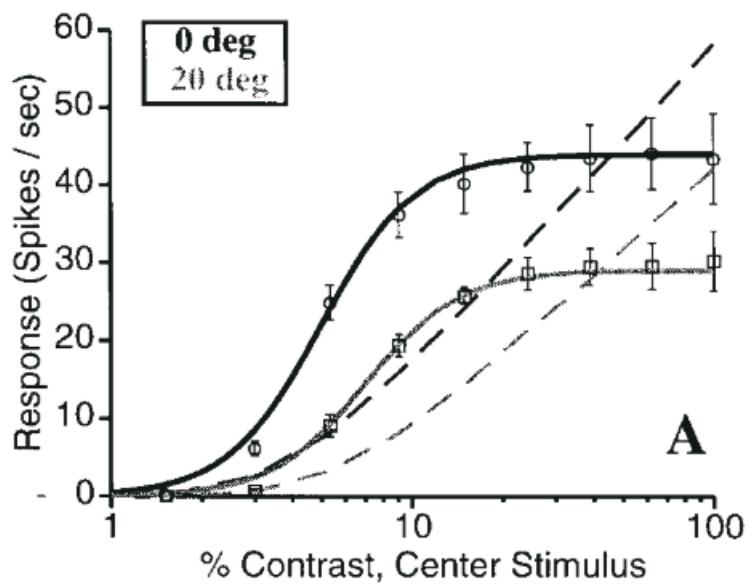
# Somers et al – Connectivity



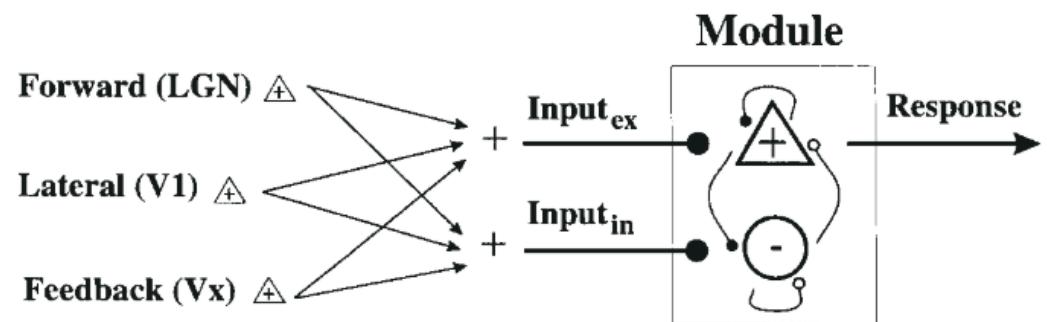
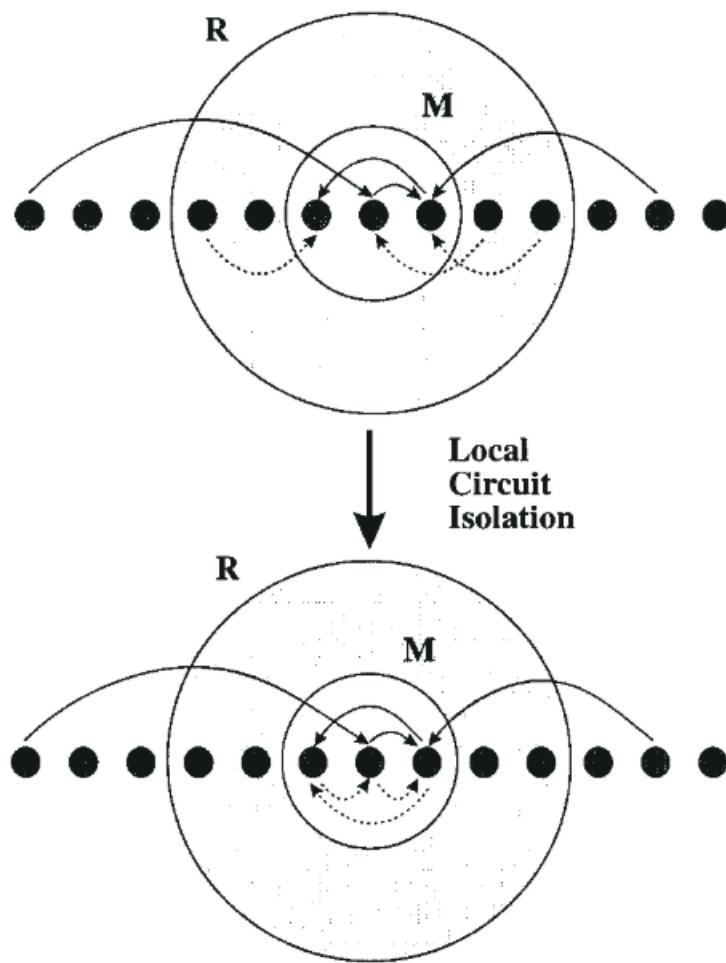
# Size tuning in V1



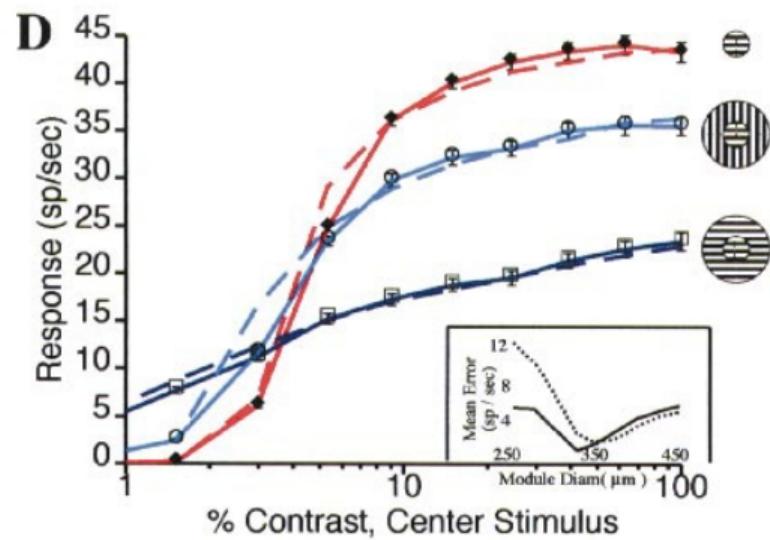
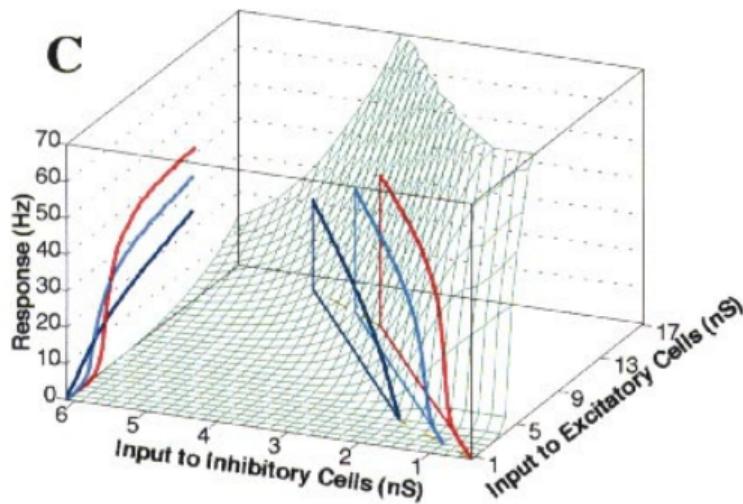
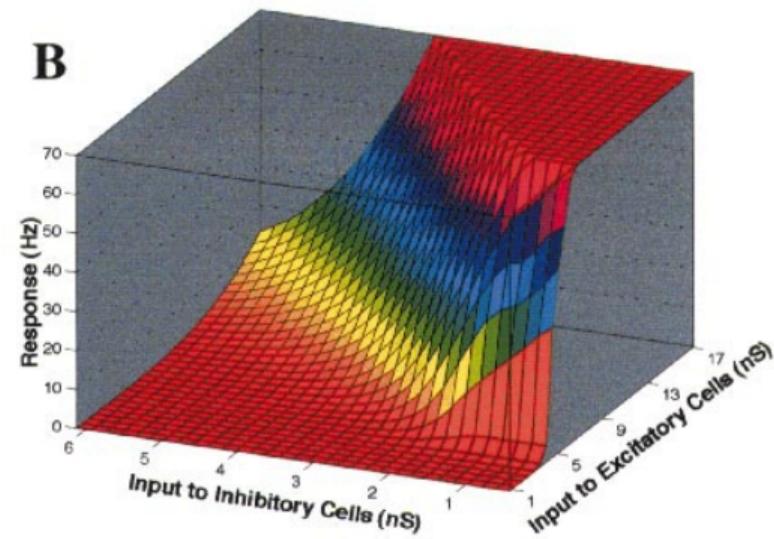
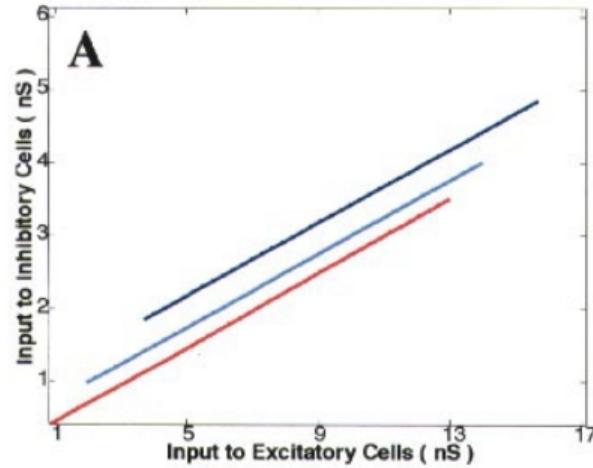
# Model cell responses



# Model Analysis



# Model Analysis





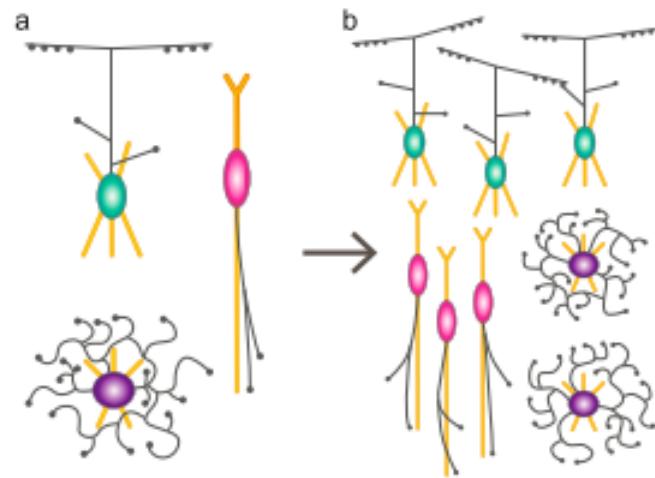
**Ultra-detailed  
models**

**Two players:**

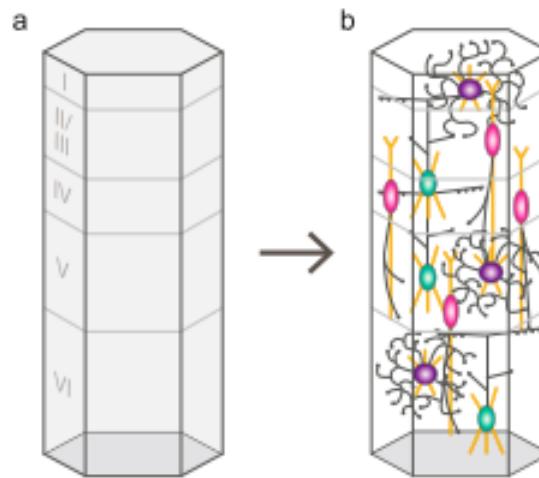
**Blue Brain Project**

**Allen Institute**

**A** Morphological diversity of neurons:  
(a) m-types, (b) cloning



**B** Microcircuit anatomy: (a) Microcircuit dimensions,  
(b) m-type distribution, and morphology selection

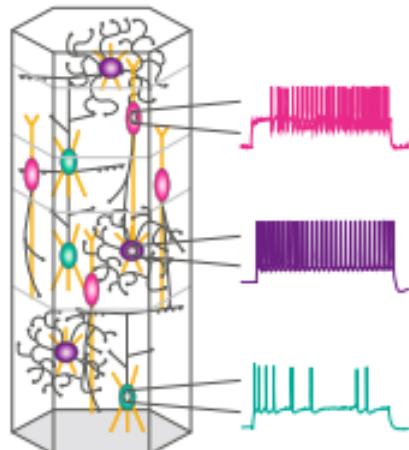


**C** Reconstructing  
microcircuit connectivity

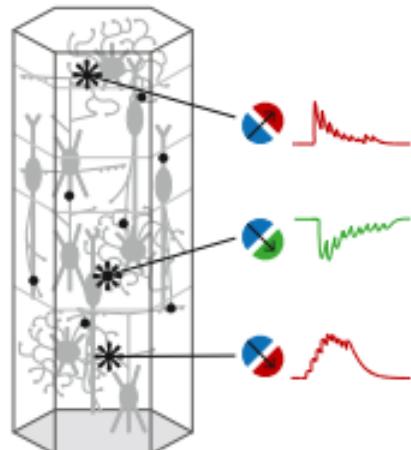


A N A T O M Y  
P H Y S I O L O G Y

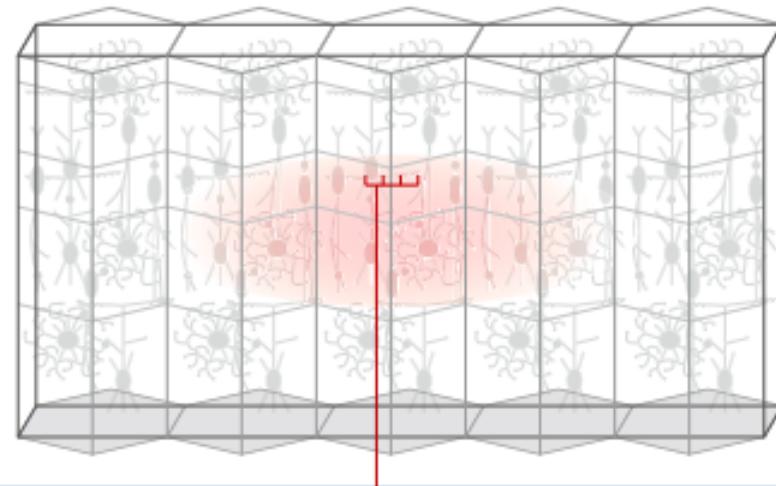
**D** Electrical diversity of neurons:  
e-types

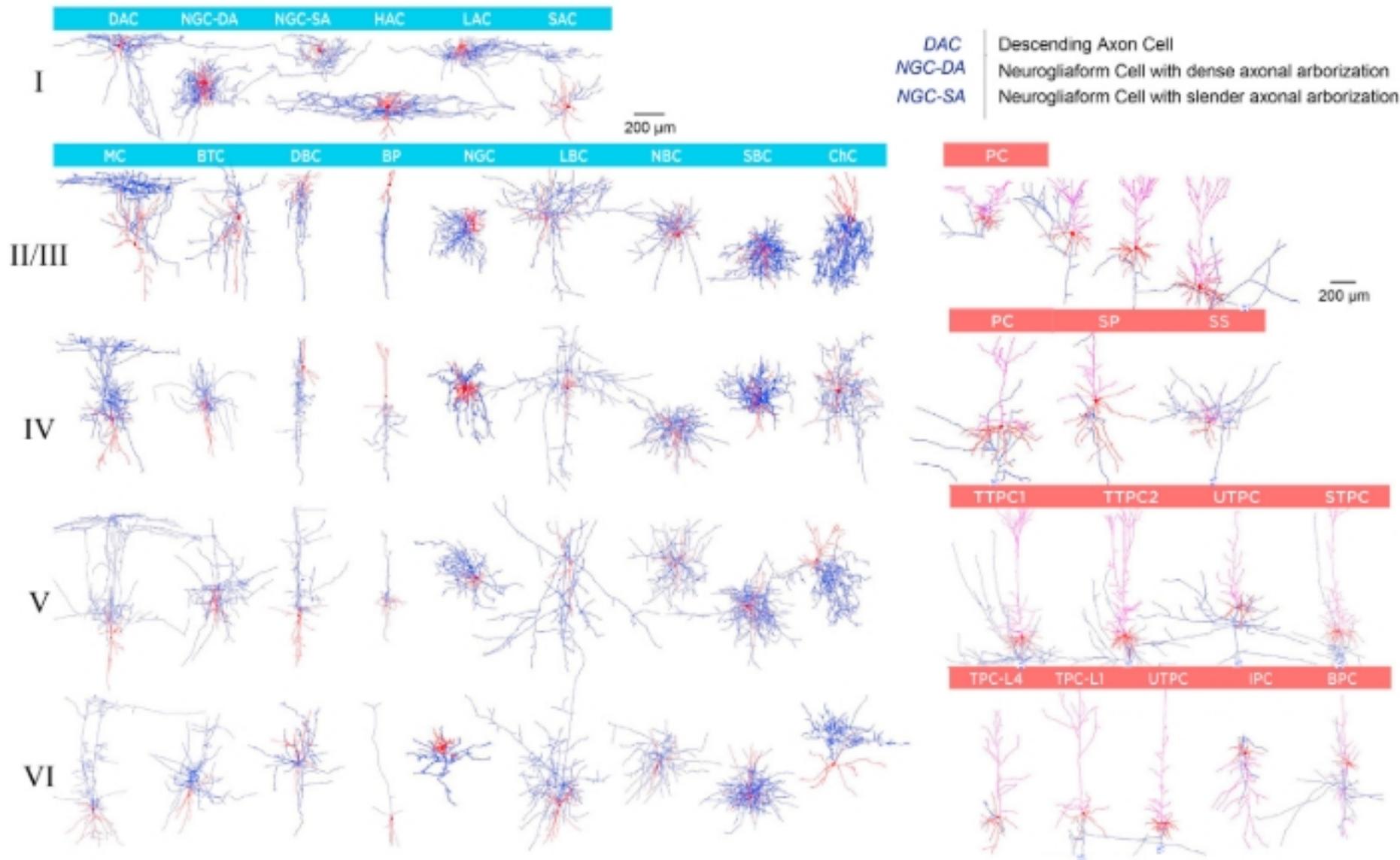


**E** Synaptic diversity:  
s-types

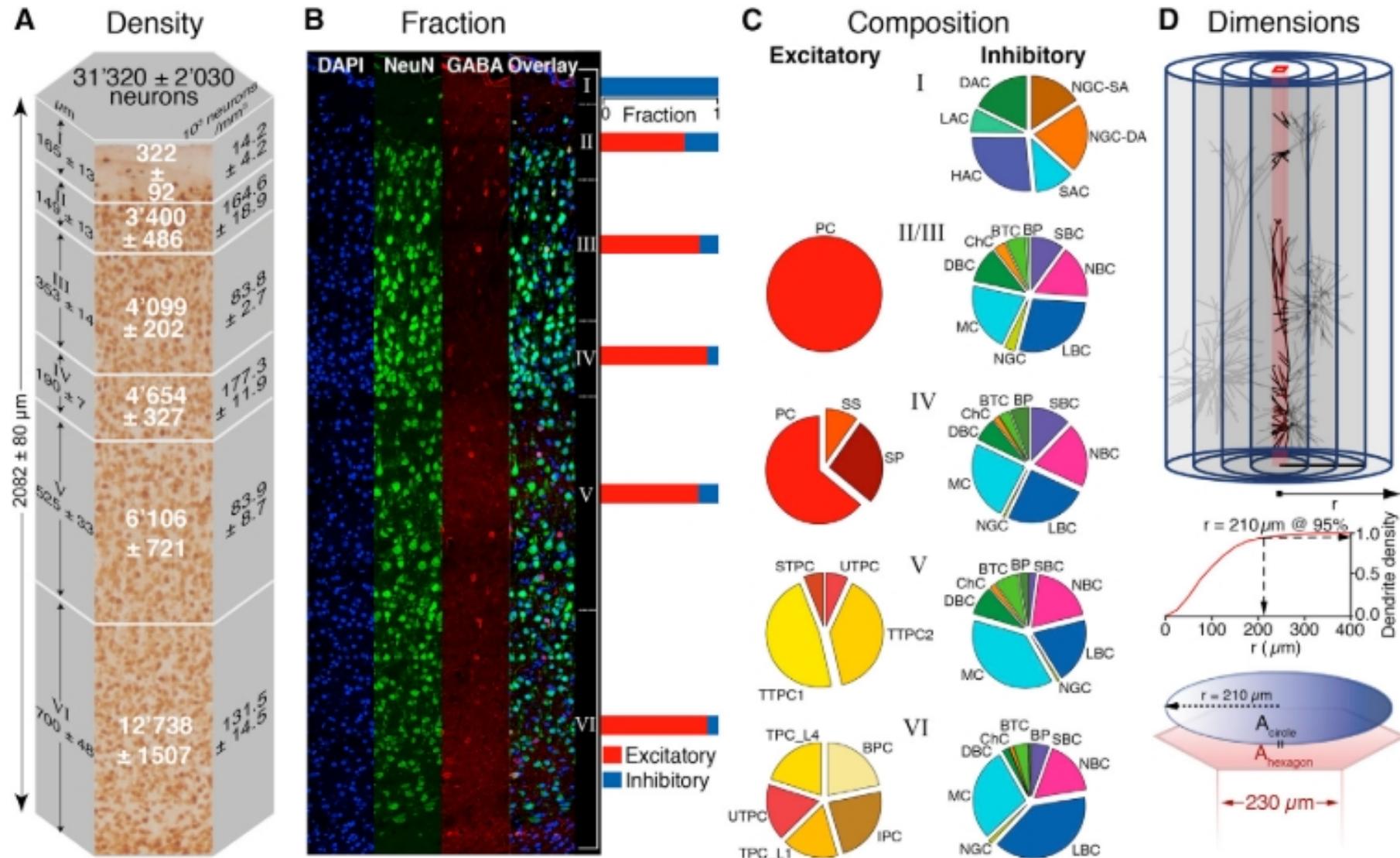


**F** Reconstructing virtual tissue volumes for  
*in silico* experimentation

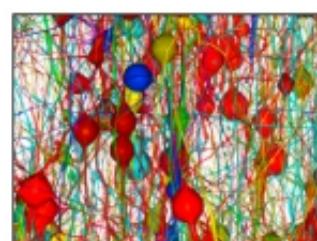
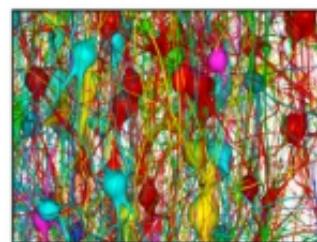
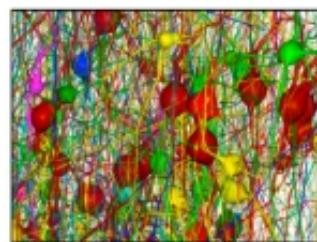
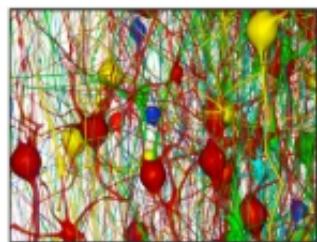




**DAC** Descending Axon Cell  
**NGC-DA** Neurogliaform Cell with dense axonal arborization  
**NGC-SA** Neurogliaform Cell with slender axonal arborization



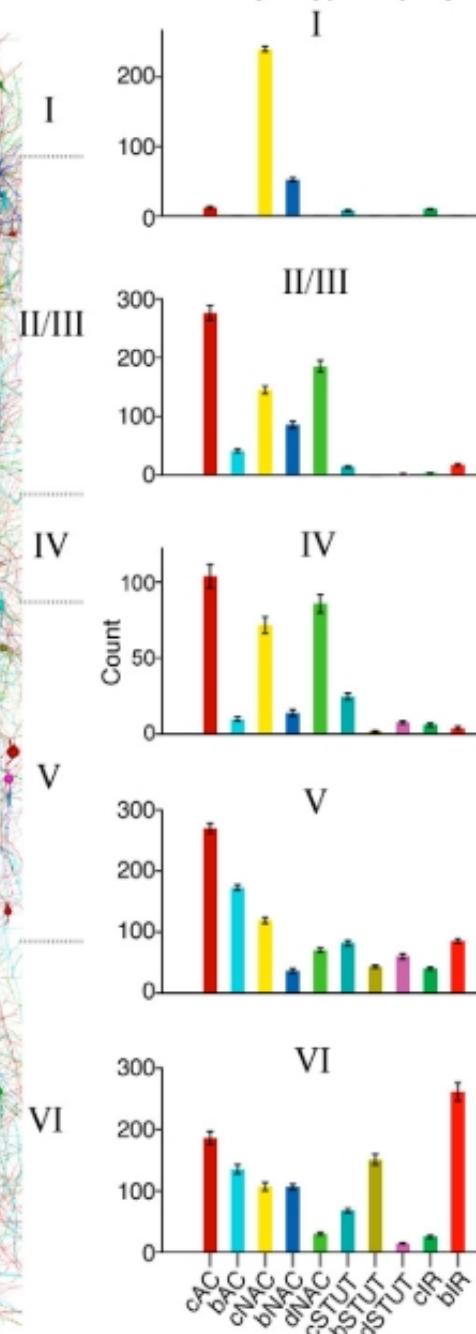
**A** *In silico* stain of inhibitory e-types

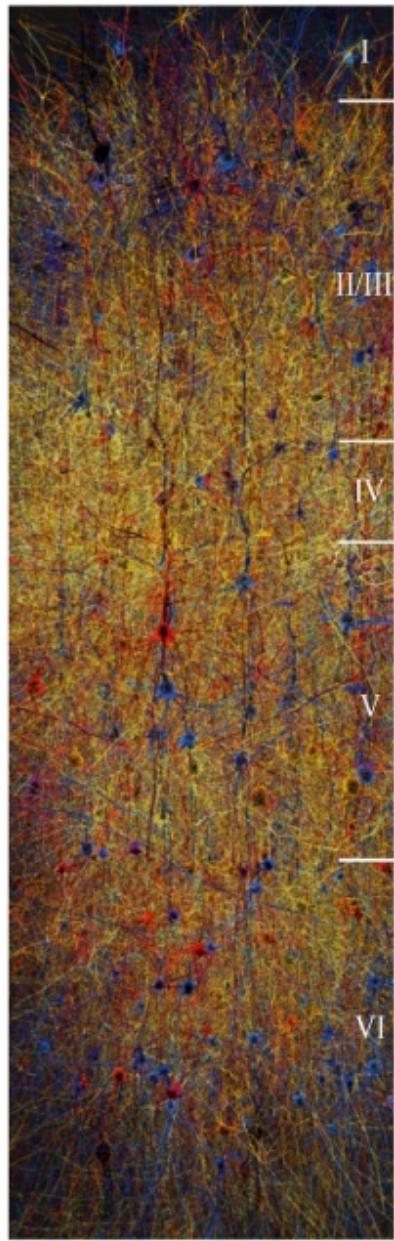
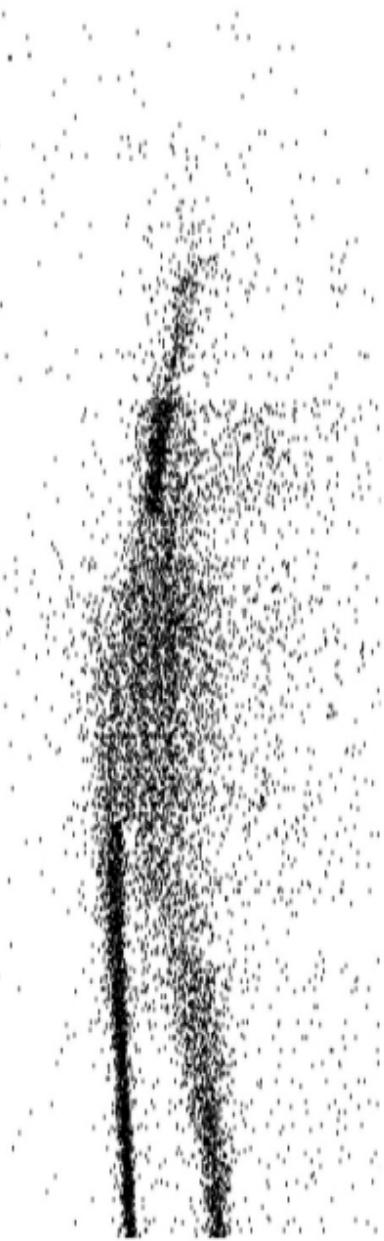
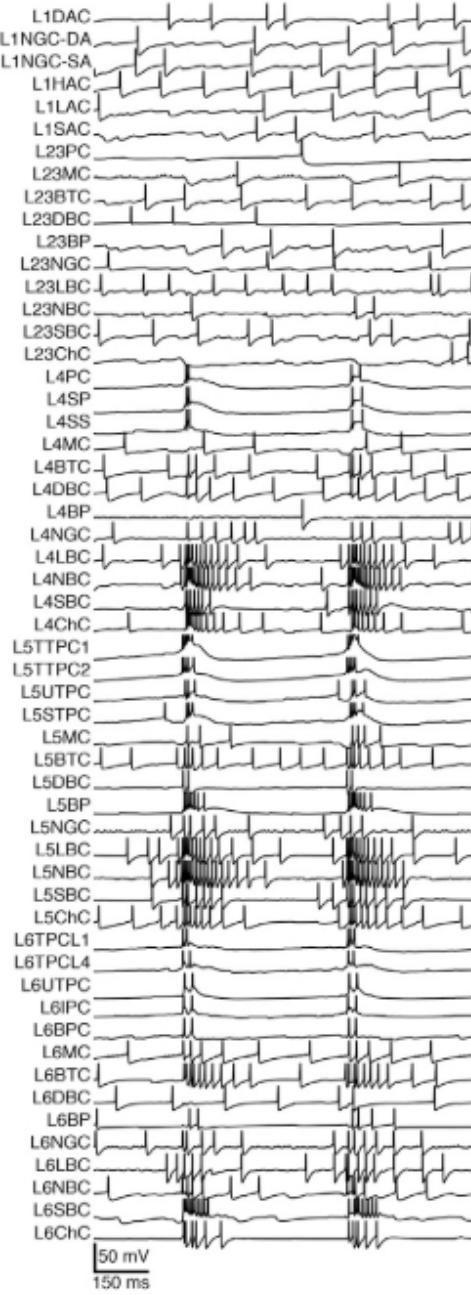


- cAC
- bAC
- cNAC
- dNAC
- cSTUT
- bSTUT
- dSTUT
- cIR
- bIR

100  $\mu\text{m}$

**B** Inhibitory e-types by layer



**A****B****C****D**