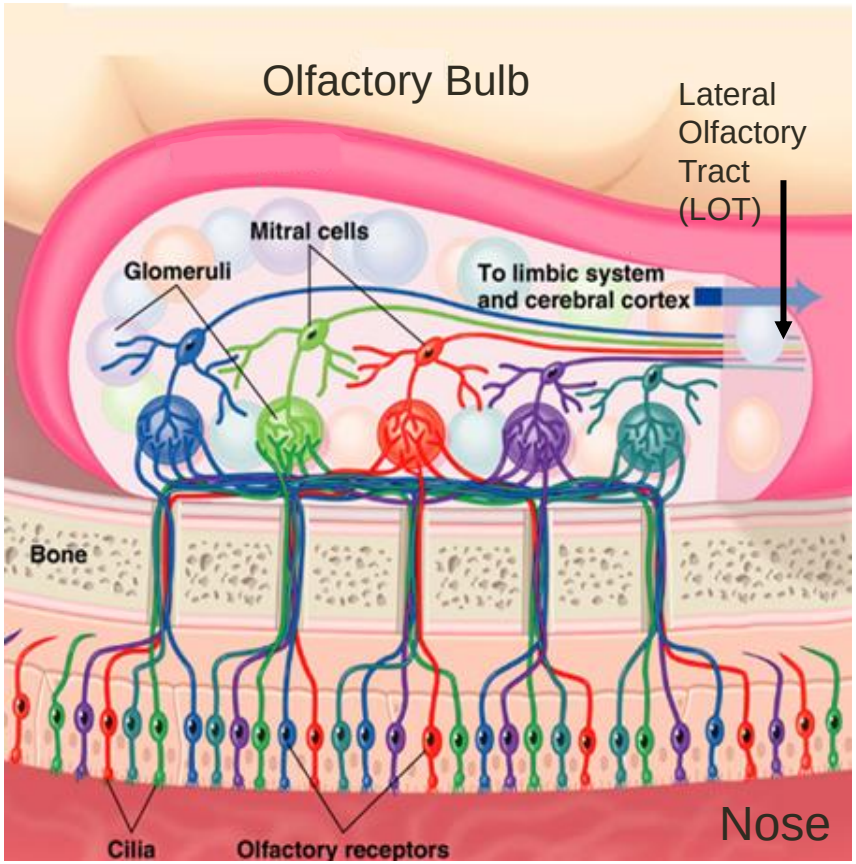
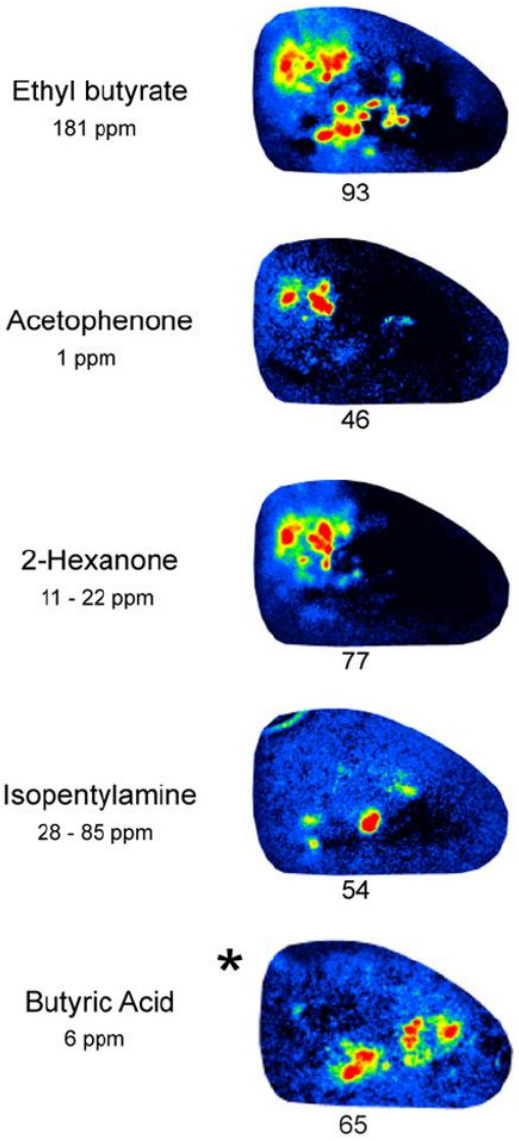
Spatial profiles of inhibition in piriform cortex

Anne-Marie Oswald
Department of Neuroscience, University of Pittsburgh
amoswald@pitt.edu

Spatial representation of odors



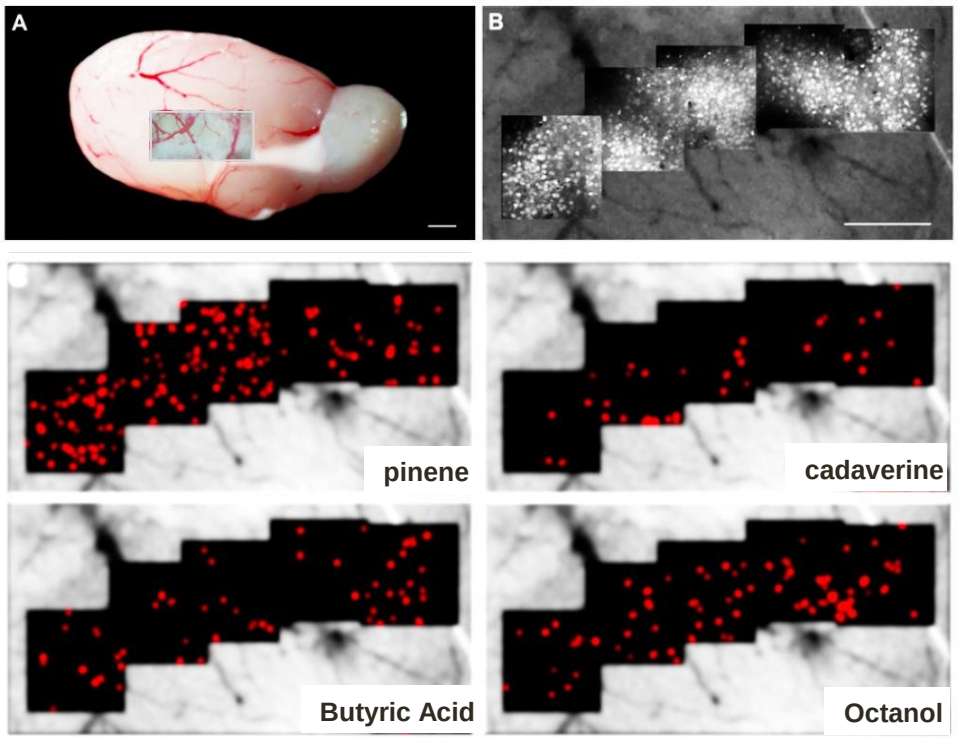
Olfactory Bulb Odor Maps



Wachowiak et al., 2013

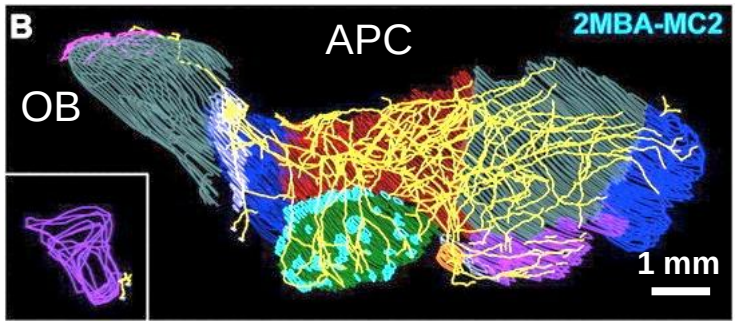
Non-topographic odor responses in piriform cortex are supported by excitatory circuitry

Piriform Cortex



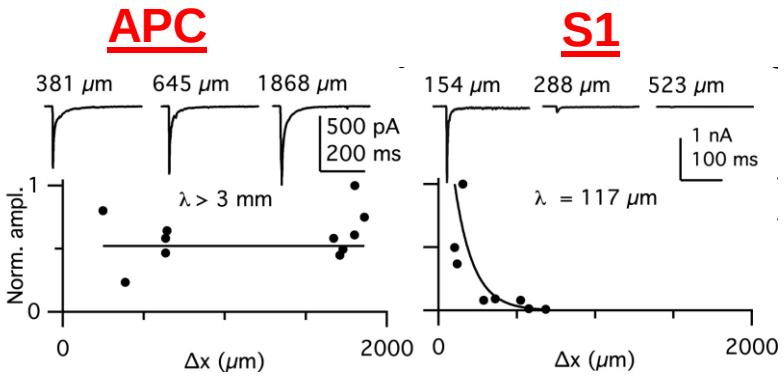
Stettler and Axel, 2009

Axonal projection of a mitral cell



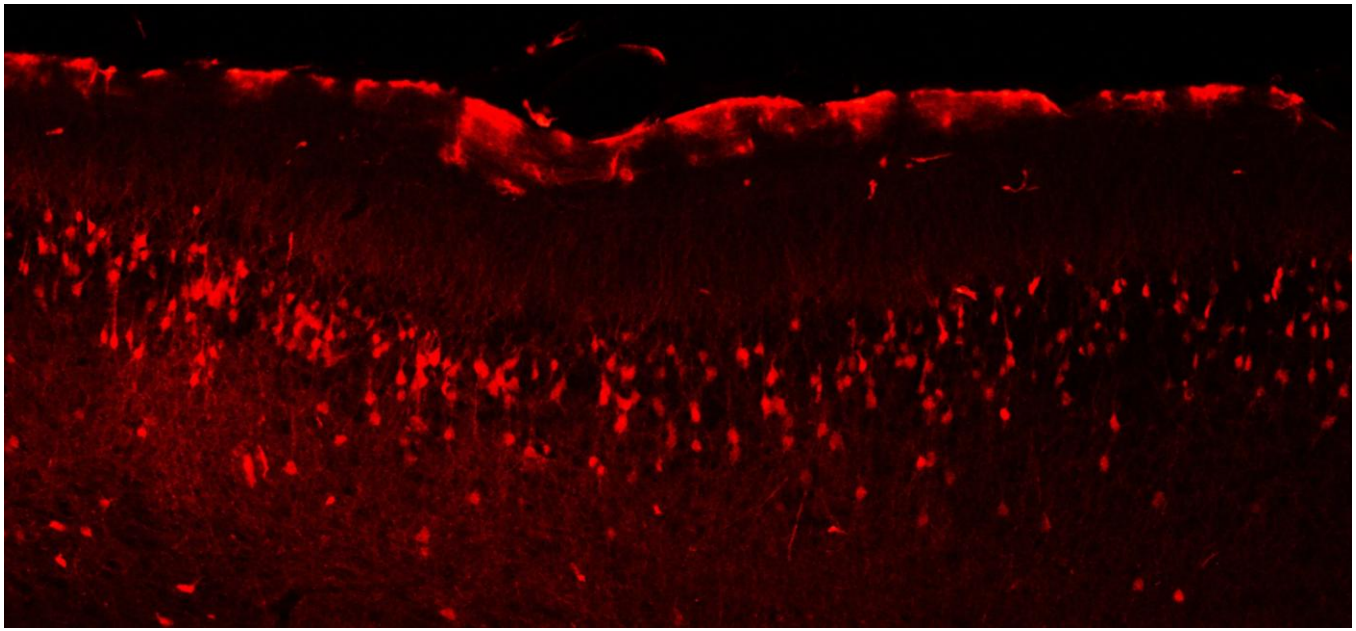
Igarashi et al. 2012

Uniform Intracortical Excitatory Connections



Franks et al., 2011

Distributed cortical activity

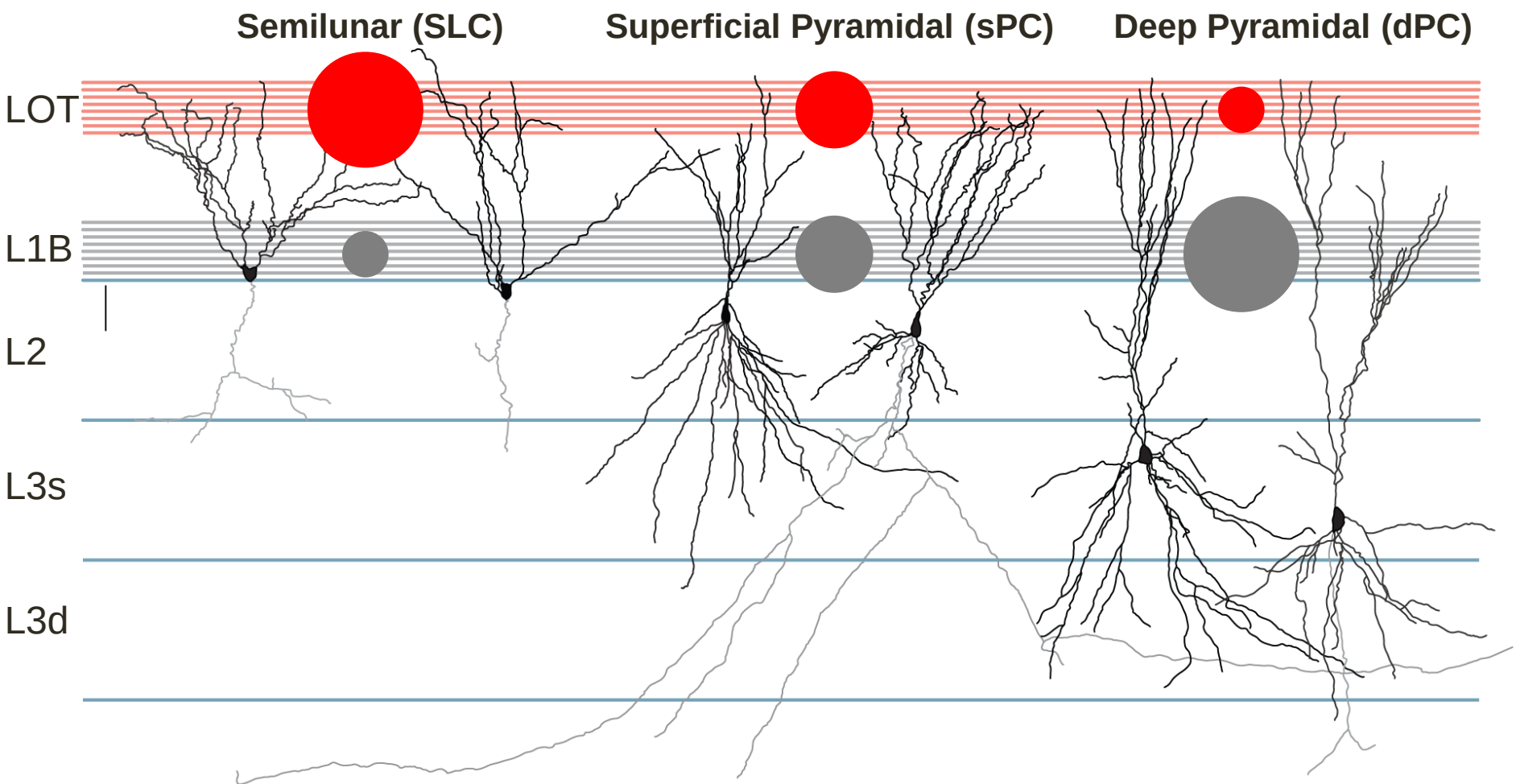


Sagittal slice of APC

TRAP- “Targeted recombination in activated neurons” during exploration in a novel environment (fos-creER^{T2}::tdTom mice)

Guenthner et al., 2013

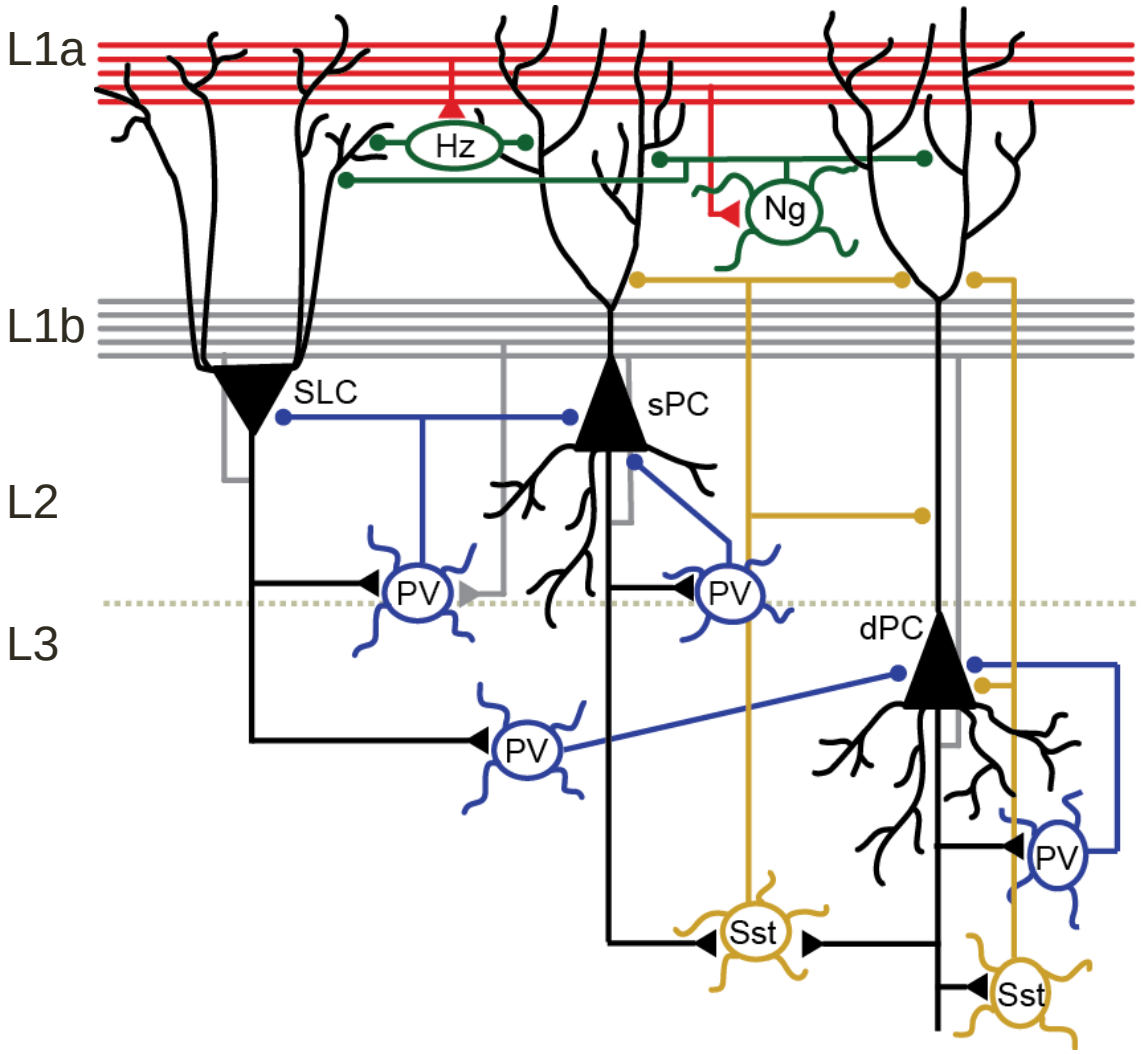
Excitation in Piriform Cortex



Class specific differences intrinsic properties, afferent and intracortical excitation

Suzuki and Bekkers 2006,2011, Wiegand et al.,2011

Laminar Distributions of Interneuron Classes



Feed forward inhibition

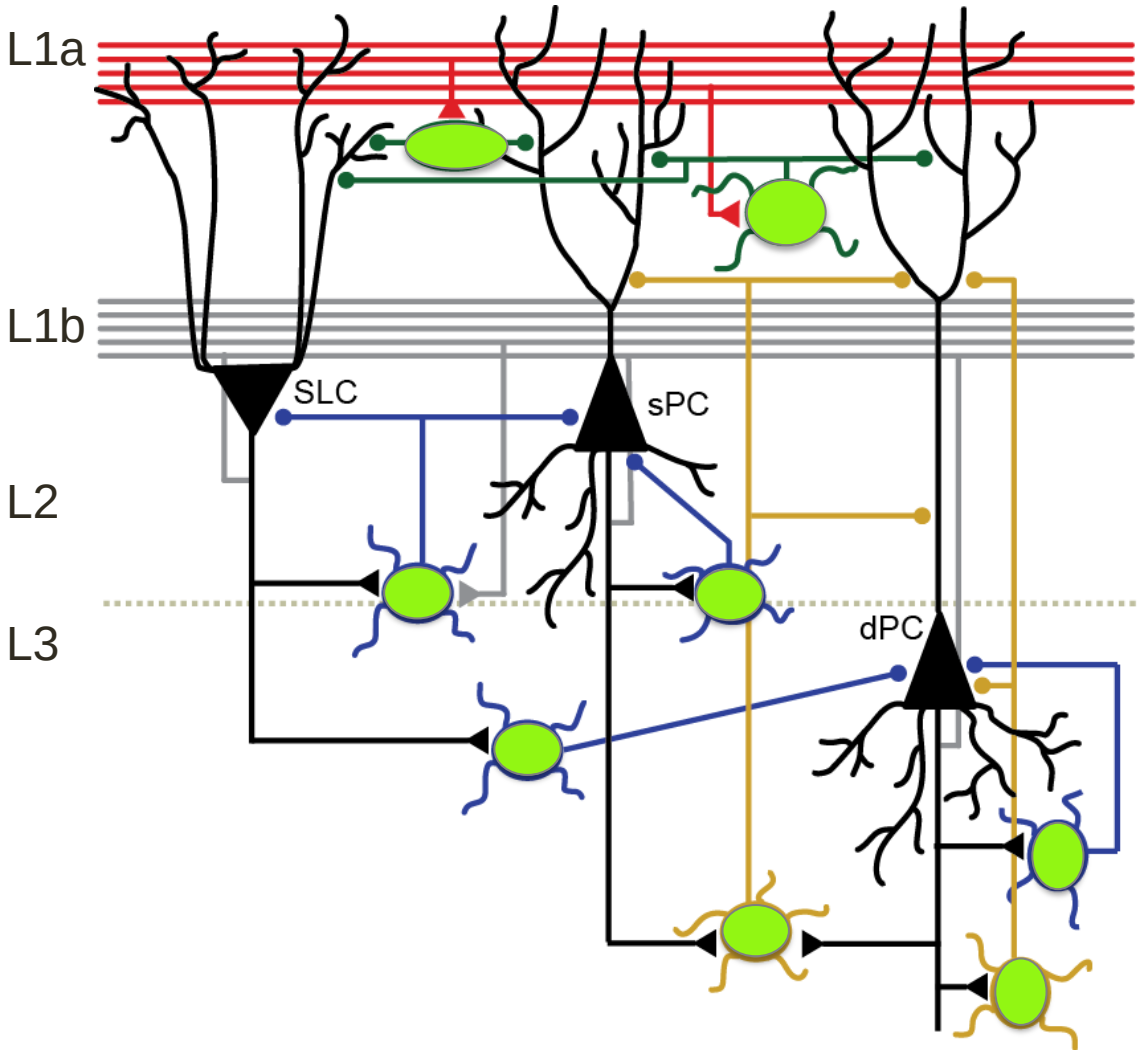
- Strongest excitation from L1a
- Dendritic
- L1 interneurons
- Horizontal and Neurogliaform

Feedback/Recurrent inhibition

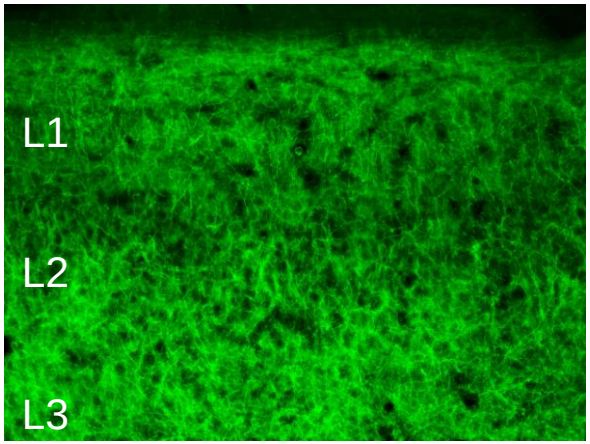
- Excitation from L1b, L3
- Somatic
- L2/3 interneurons
- Parvalbumin (fMP)
- Somatostatin (rMP)

Suzuki and Bekkers, 2010 a,b; 2012

Laminar Profile of inhibition

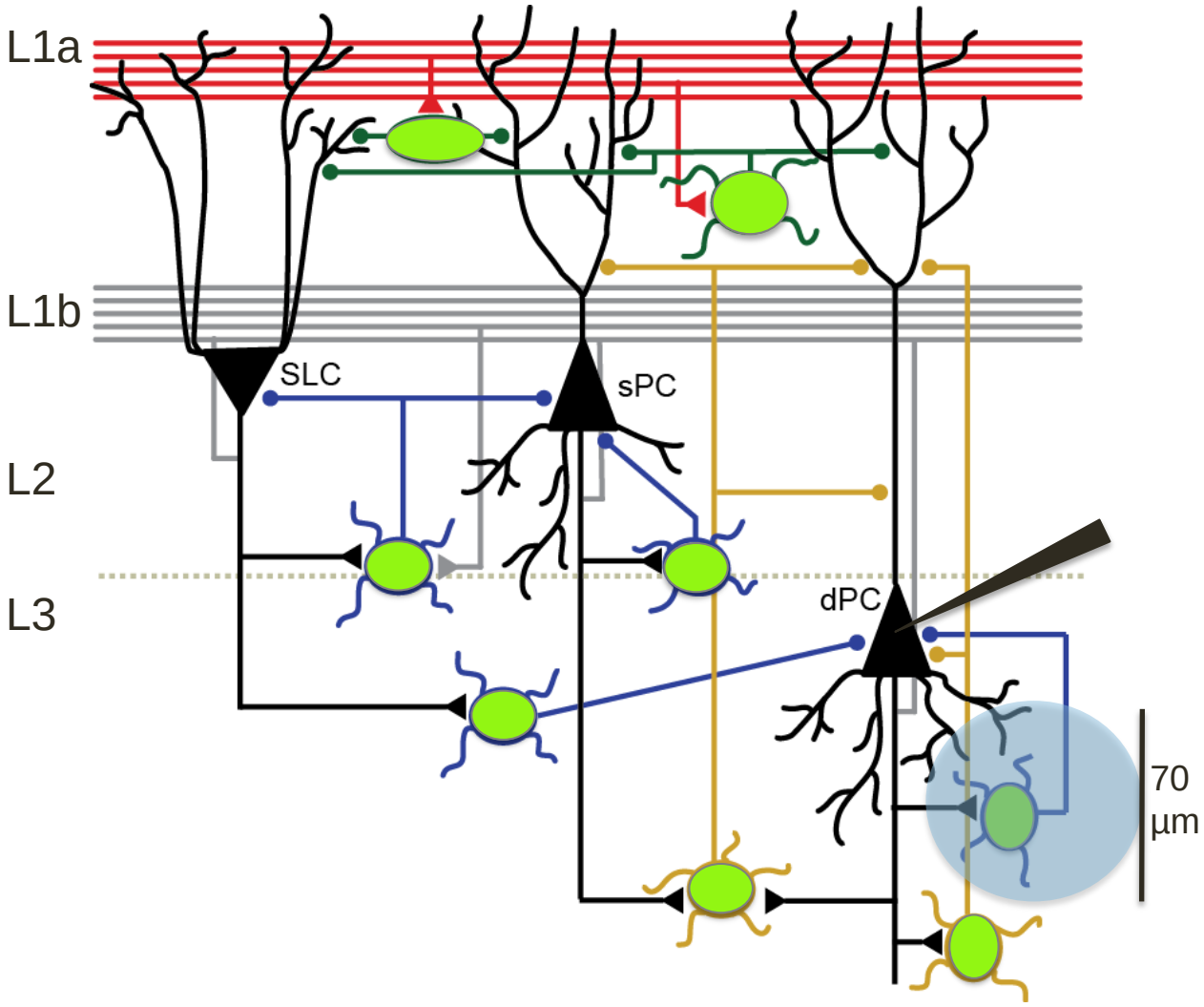


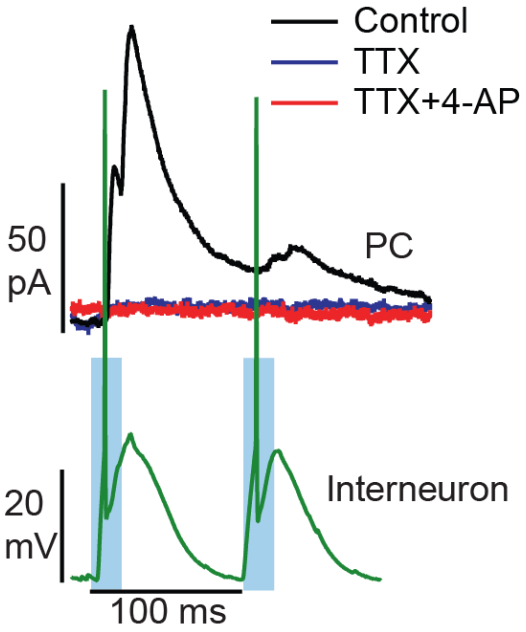
Optogenetic activation of interneurons in vGAT-ChR2 mice



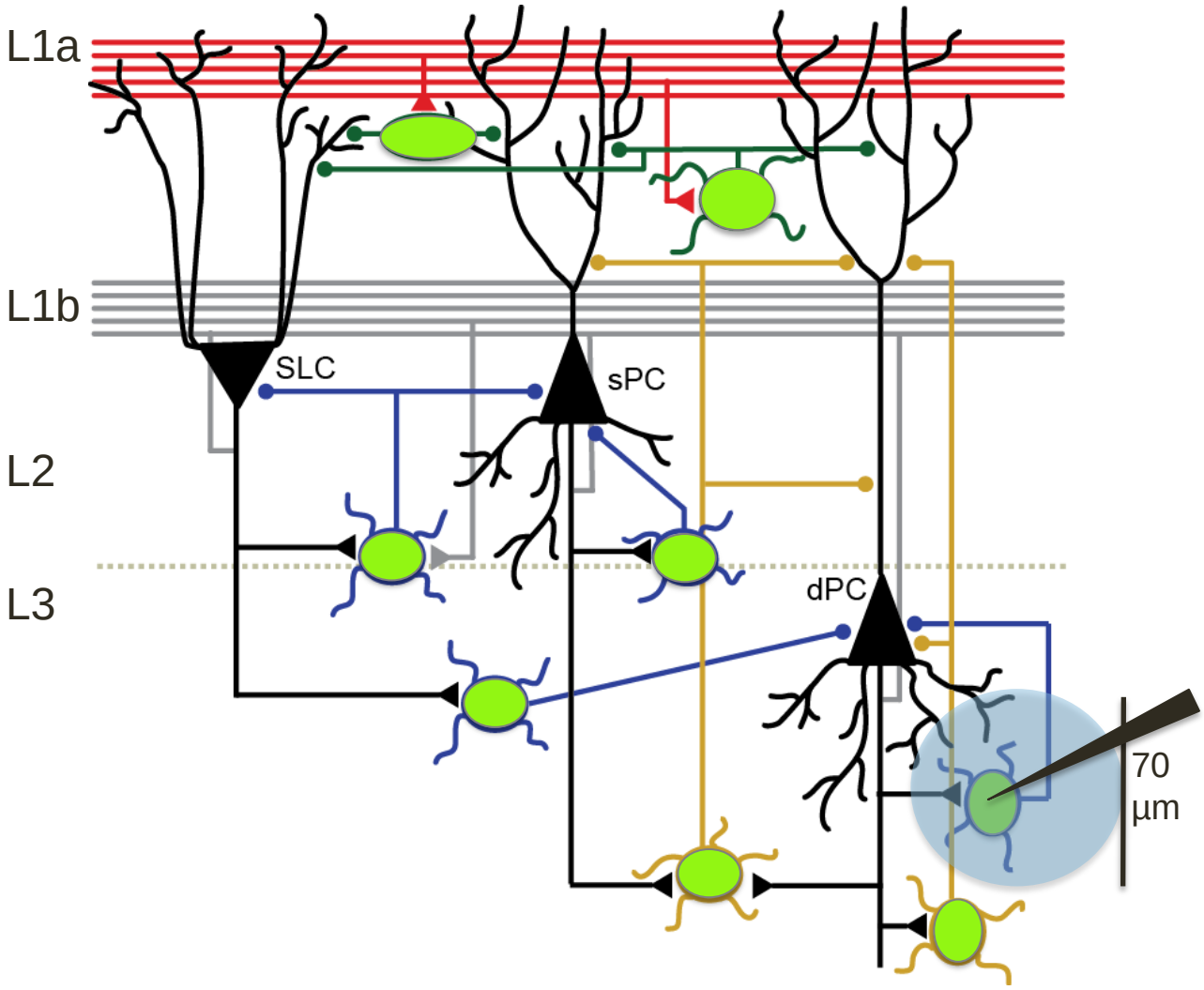
Zhao et al, 2011

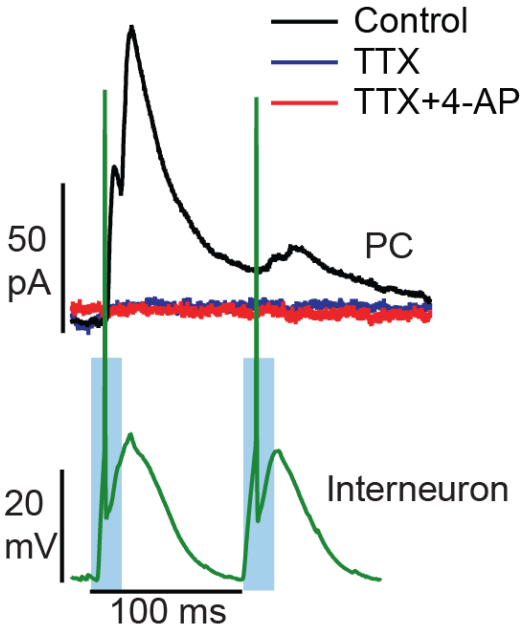
Laminar Profile of inhibition

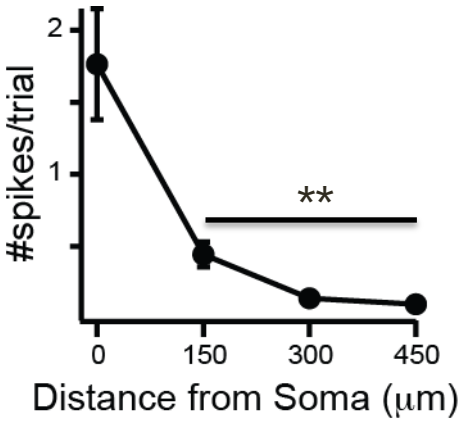




Laminar Profile of inhibition

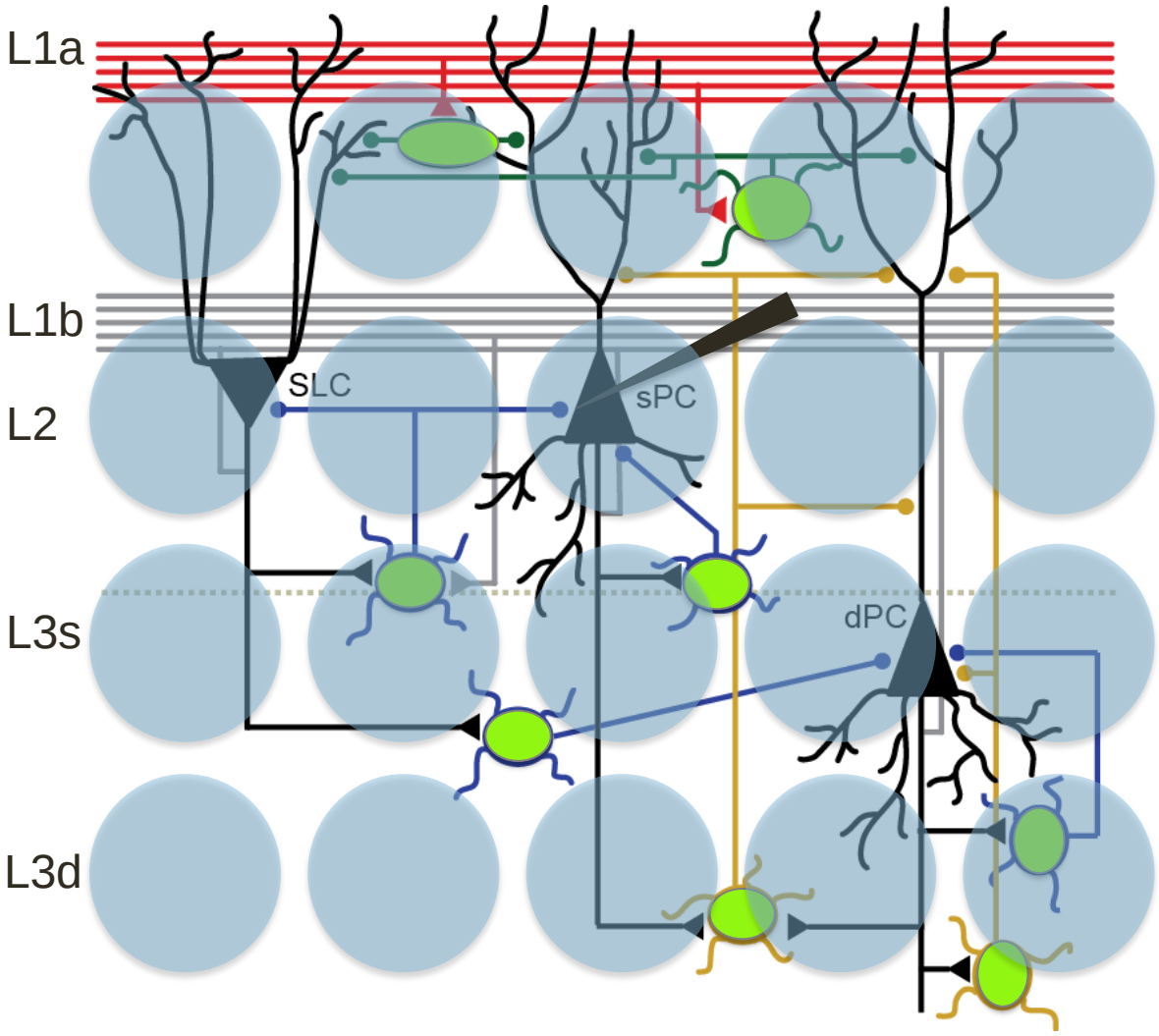


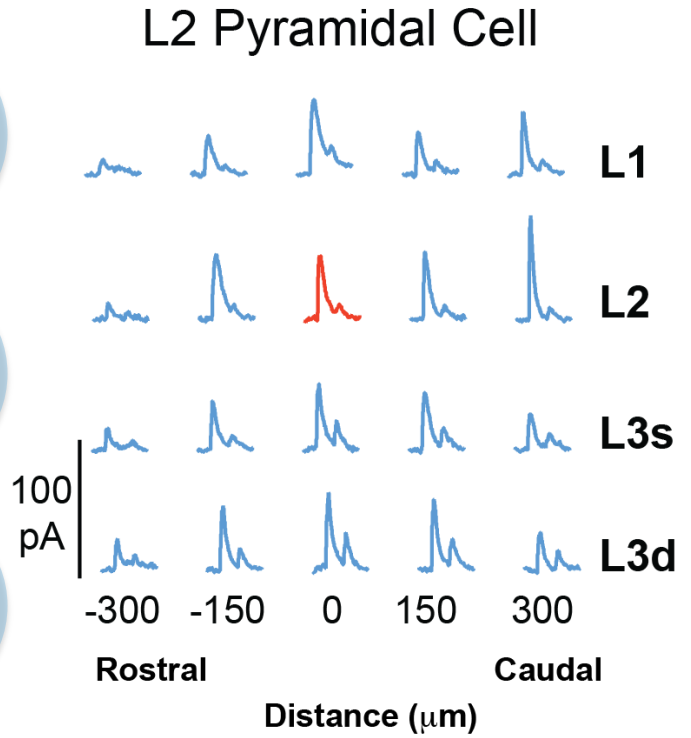




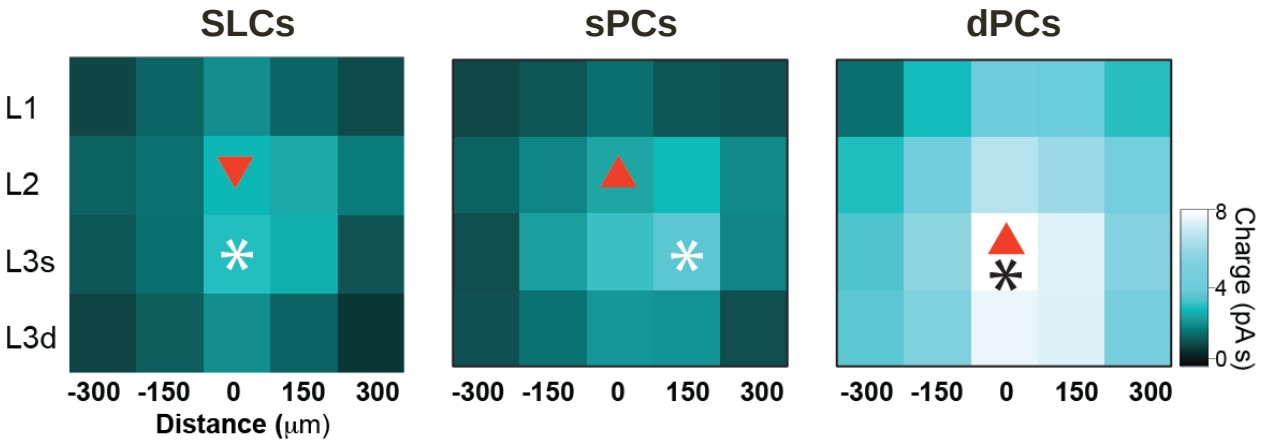
n=14 interneurons

Laminar Profile of inhibition

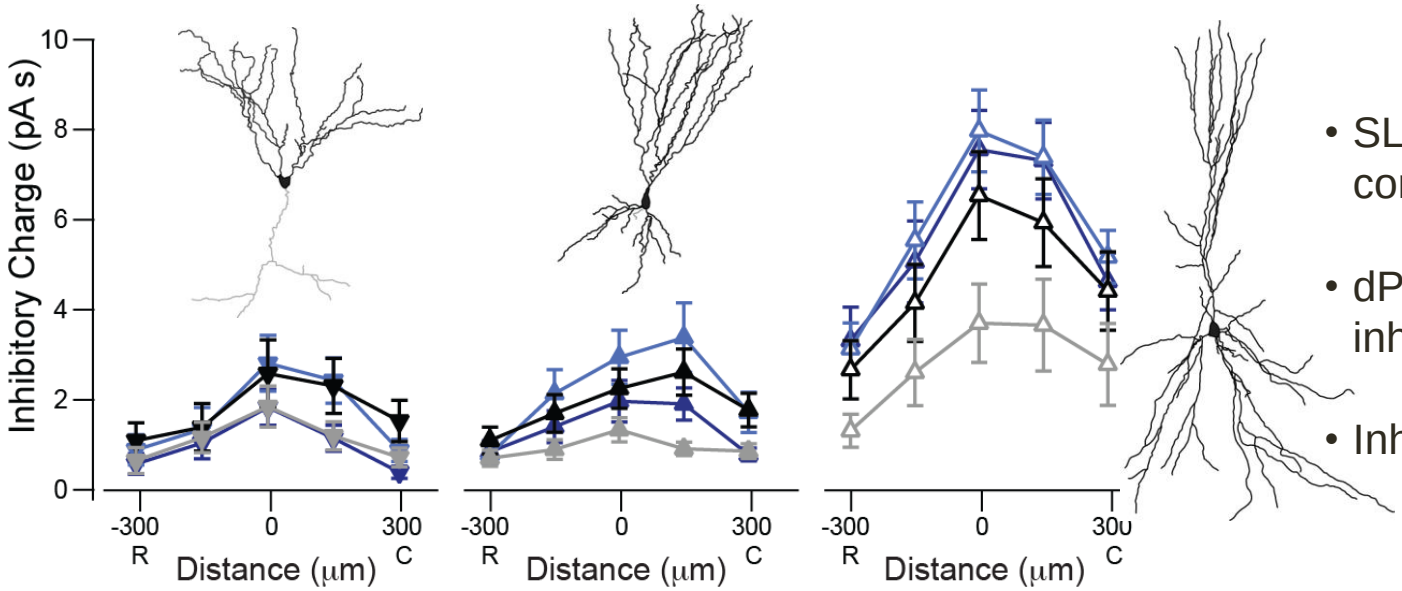




Spatial profile of inhibition in piriform cortex

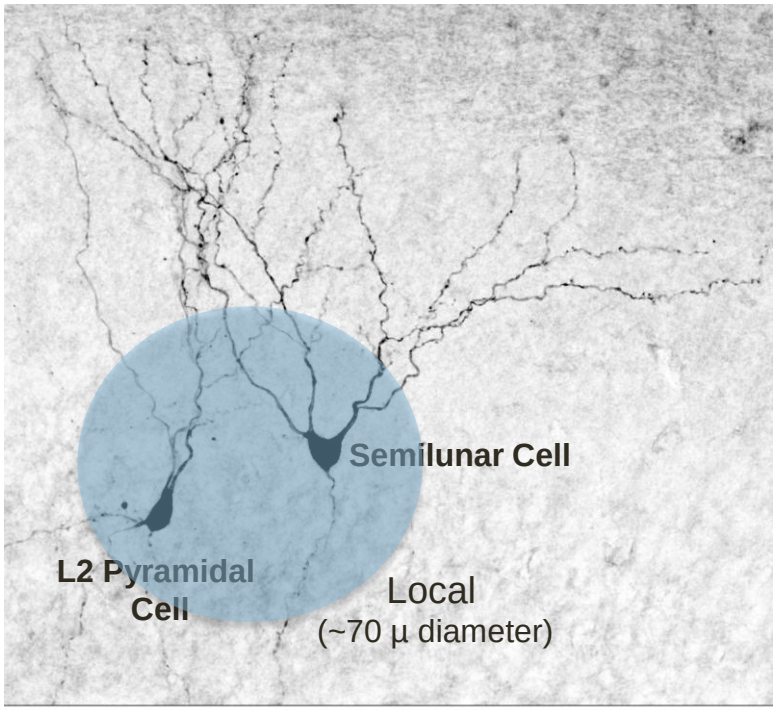


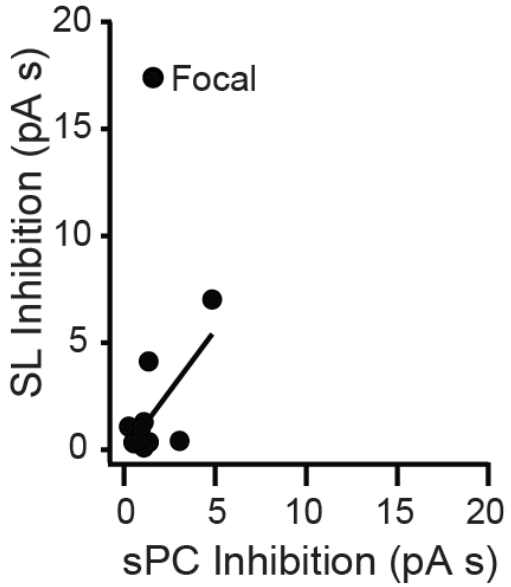
- Weak inhibition from L1
- Strong inhibition from L3

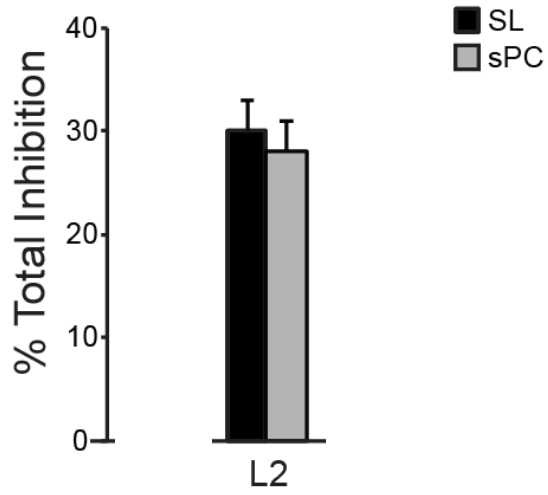


- SLCs and sPCs receive comparable inhibition
- dPCs receive strongest inhibition from all layers
- Inhibition is asymmetric

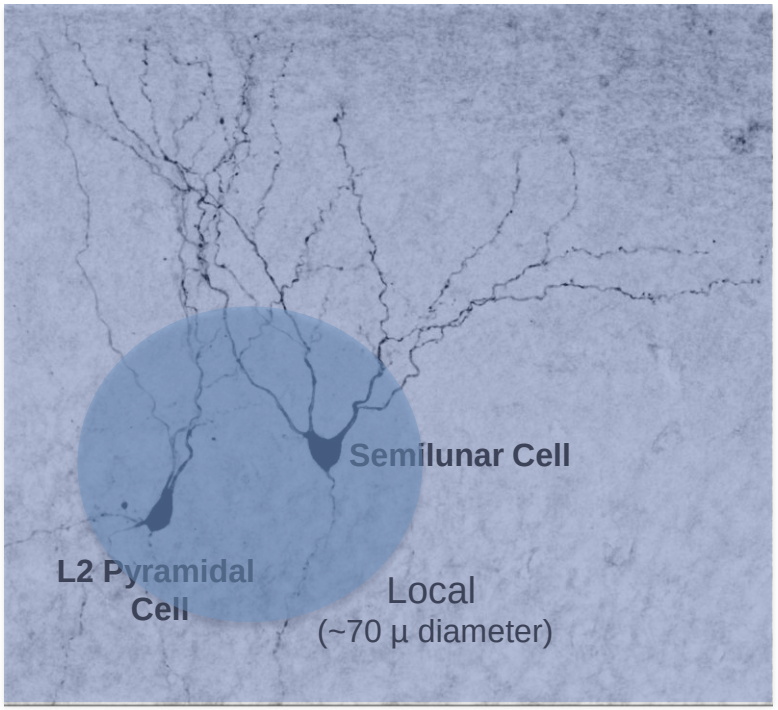
Differential inhibition of SLCs and sPCs



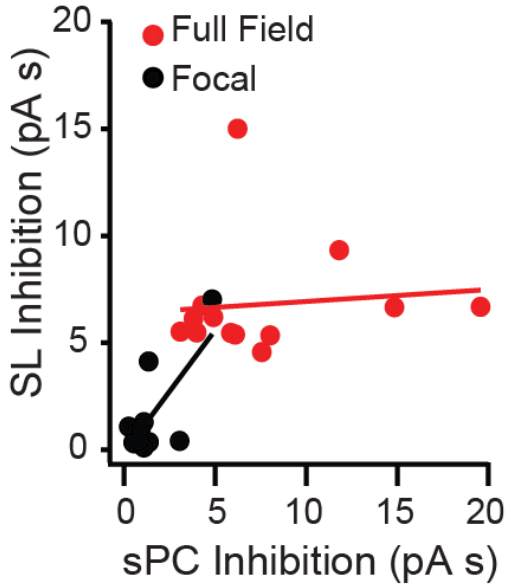


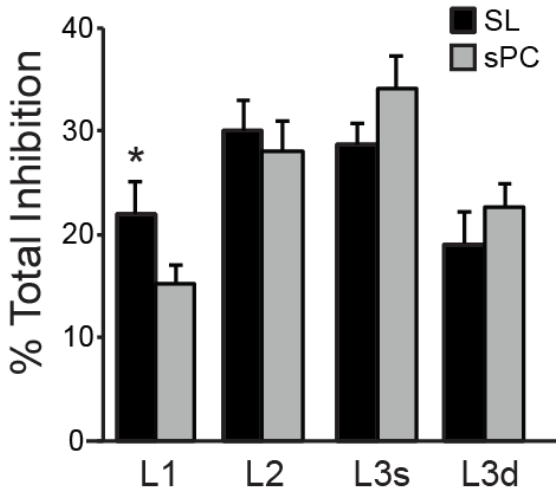


Differential inhibition of SLCs and sPCs

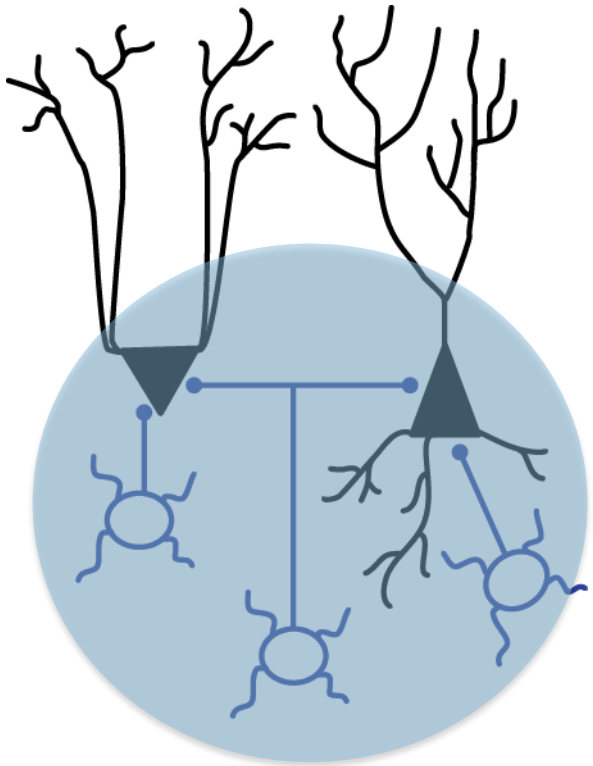


Global (full field)



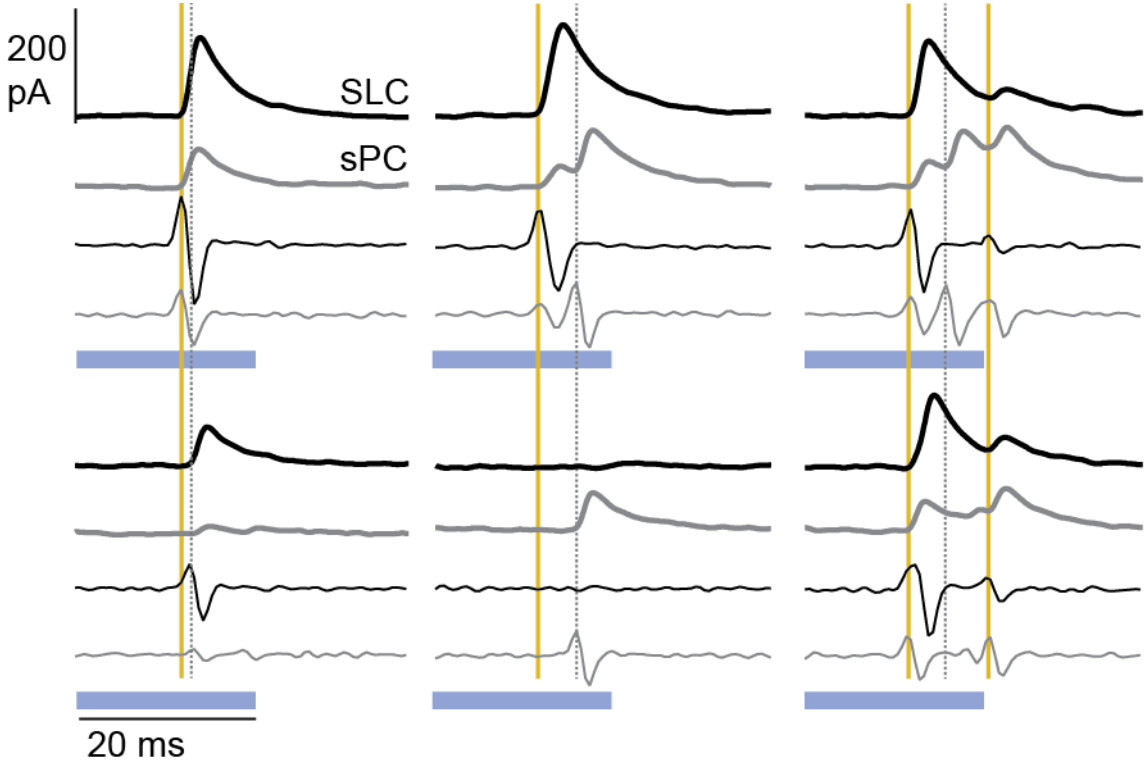


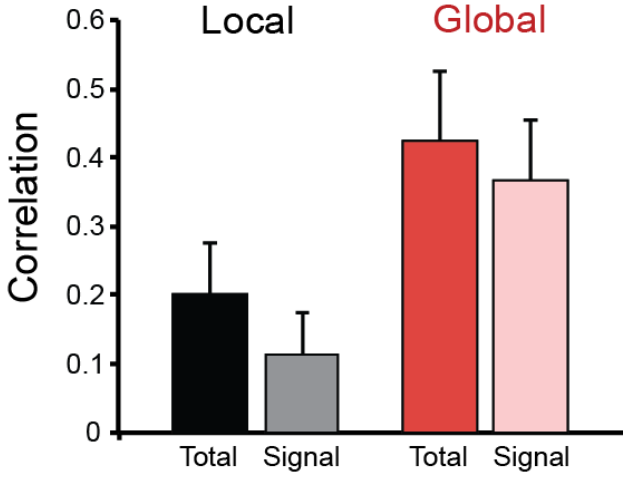
Sources of correlation



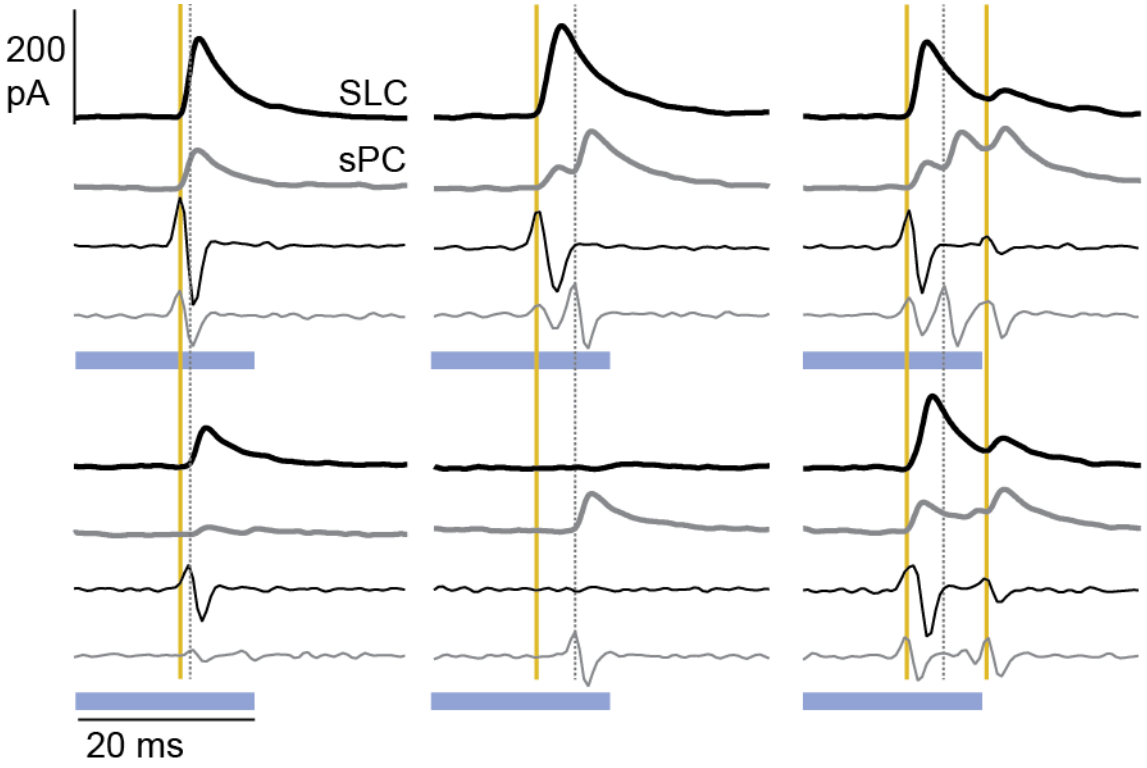
- Shared presynaptic neuron
  - Within trial correlations
  - “Noise Correlations”
  - Total correlation - signal correlation
- Simultaneously activated presynaptic pool
  - Across trial correlations
  - “Signal Correlations”

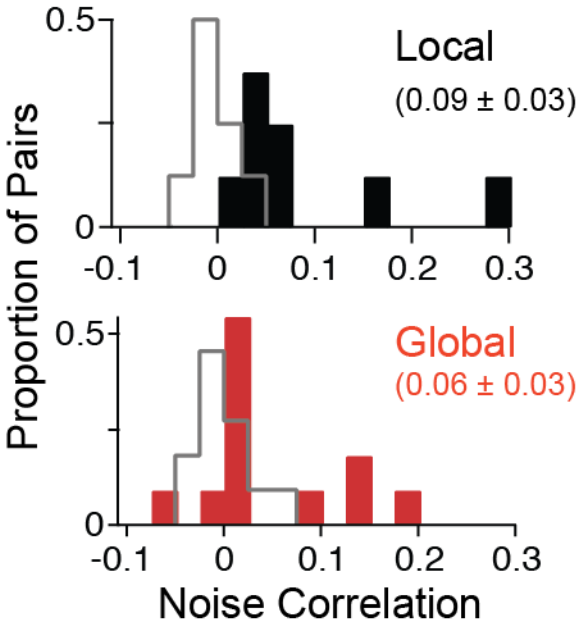
Trial-by-trial correlations in IPSC onsets in SLC-sPC pairs





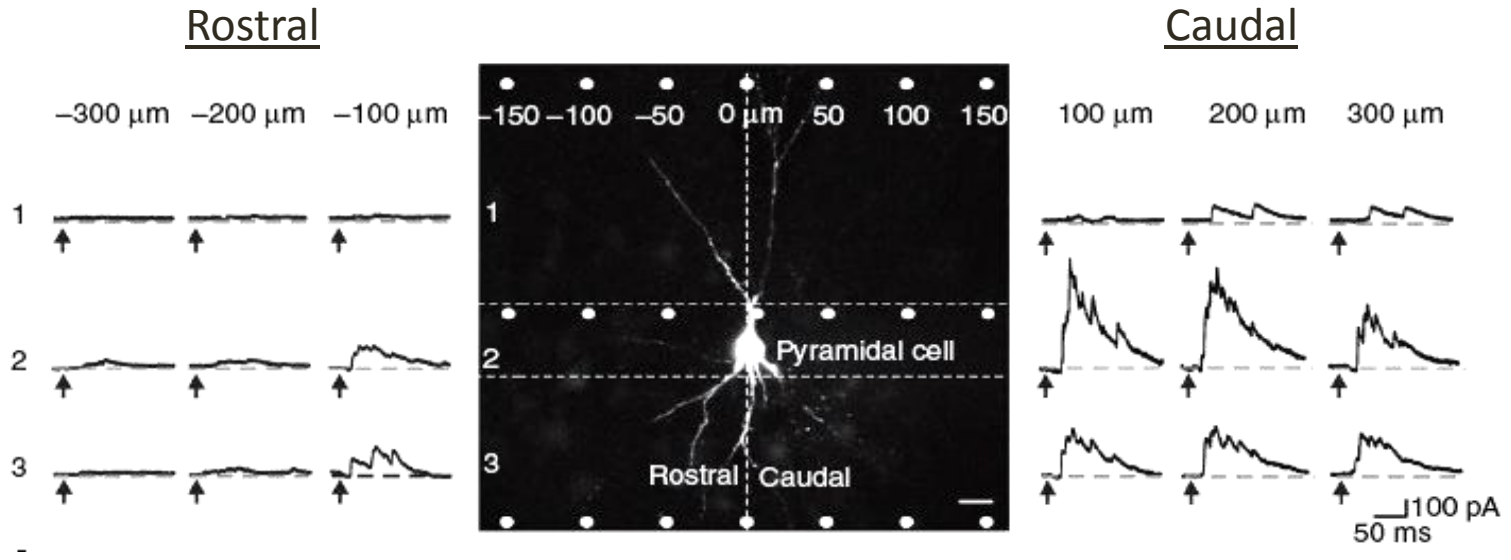
SLCs and sPCs receive inhibition from overlapping but distinct interneuron populations





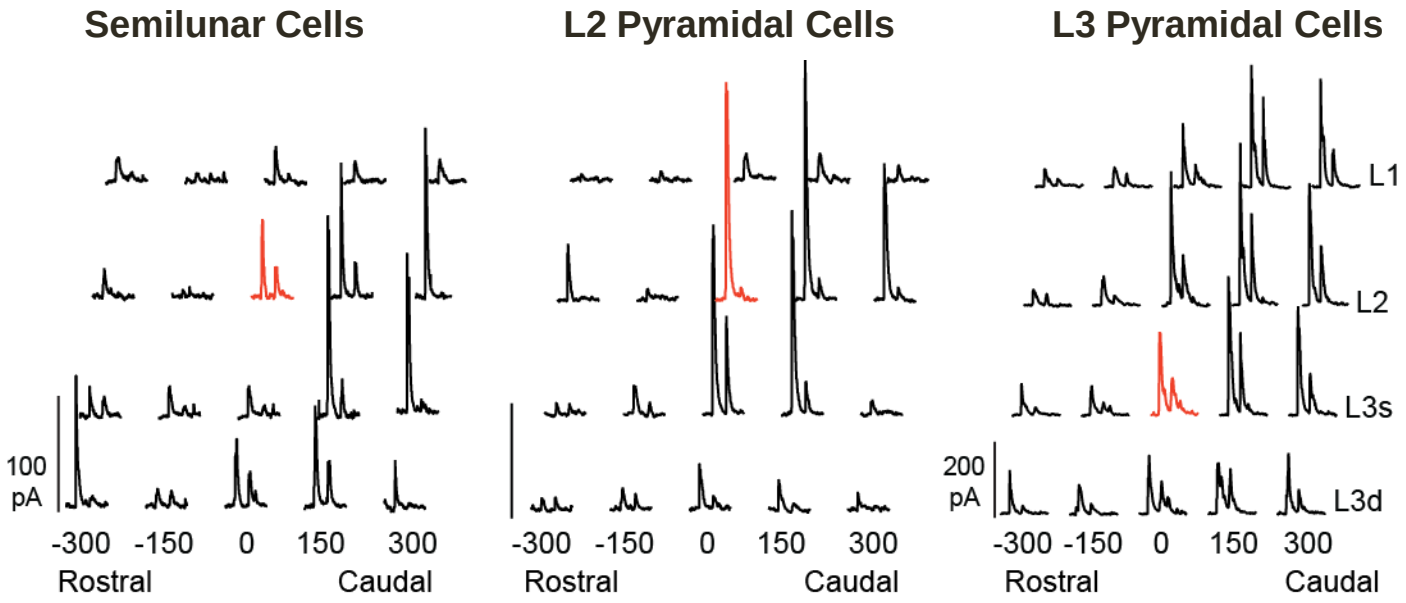
Asymmetric spatial profile of Inhibition in APC

L2 Pyramidal cells receive more inhibition from ***caudal*** stimulation sites

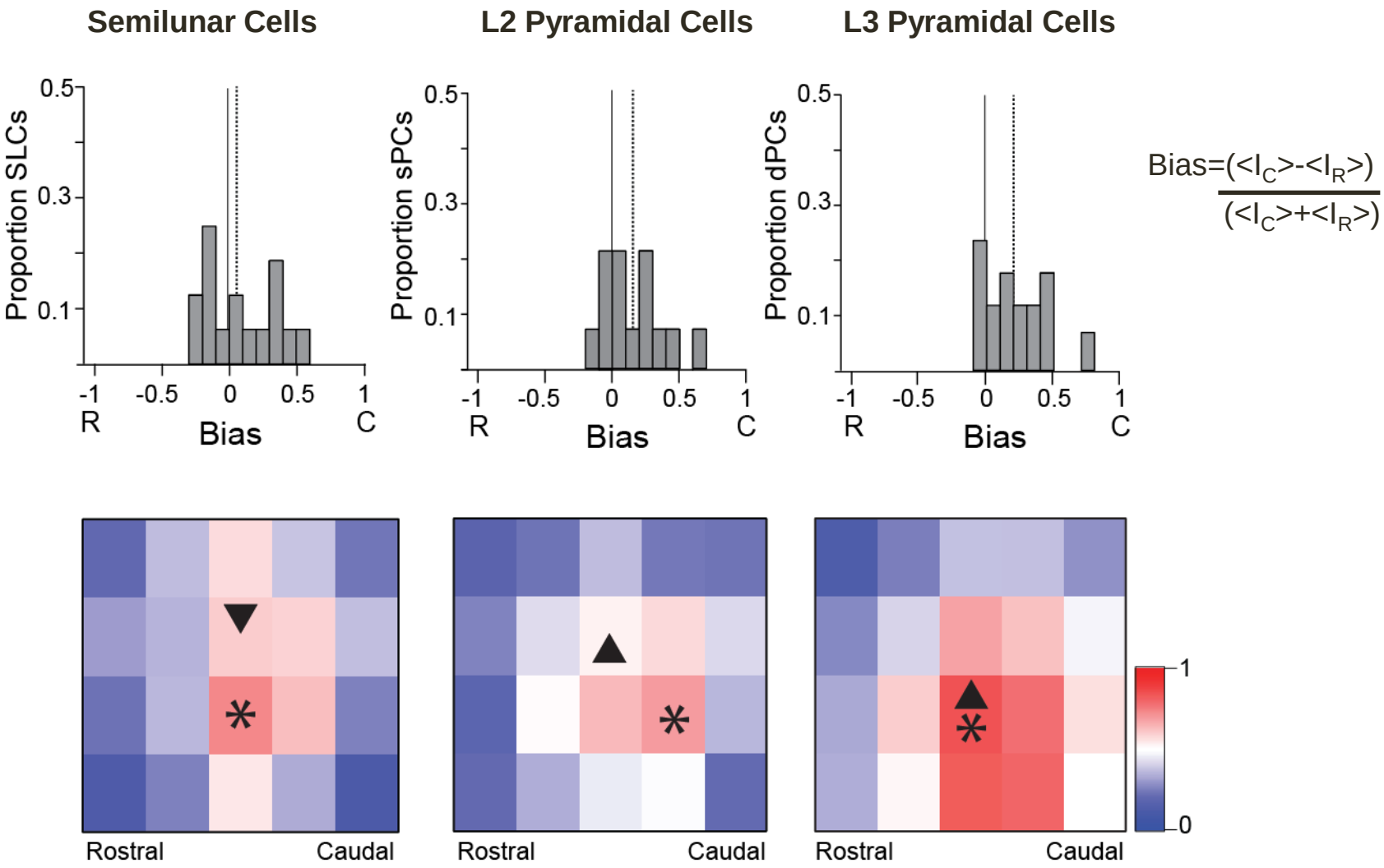


Luna & Petit, 2010

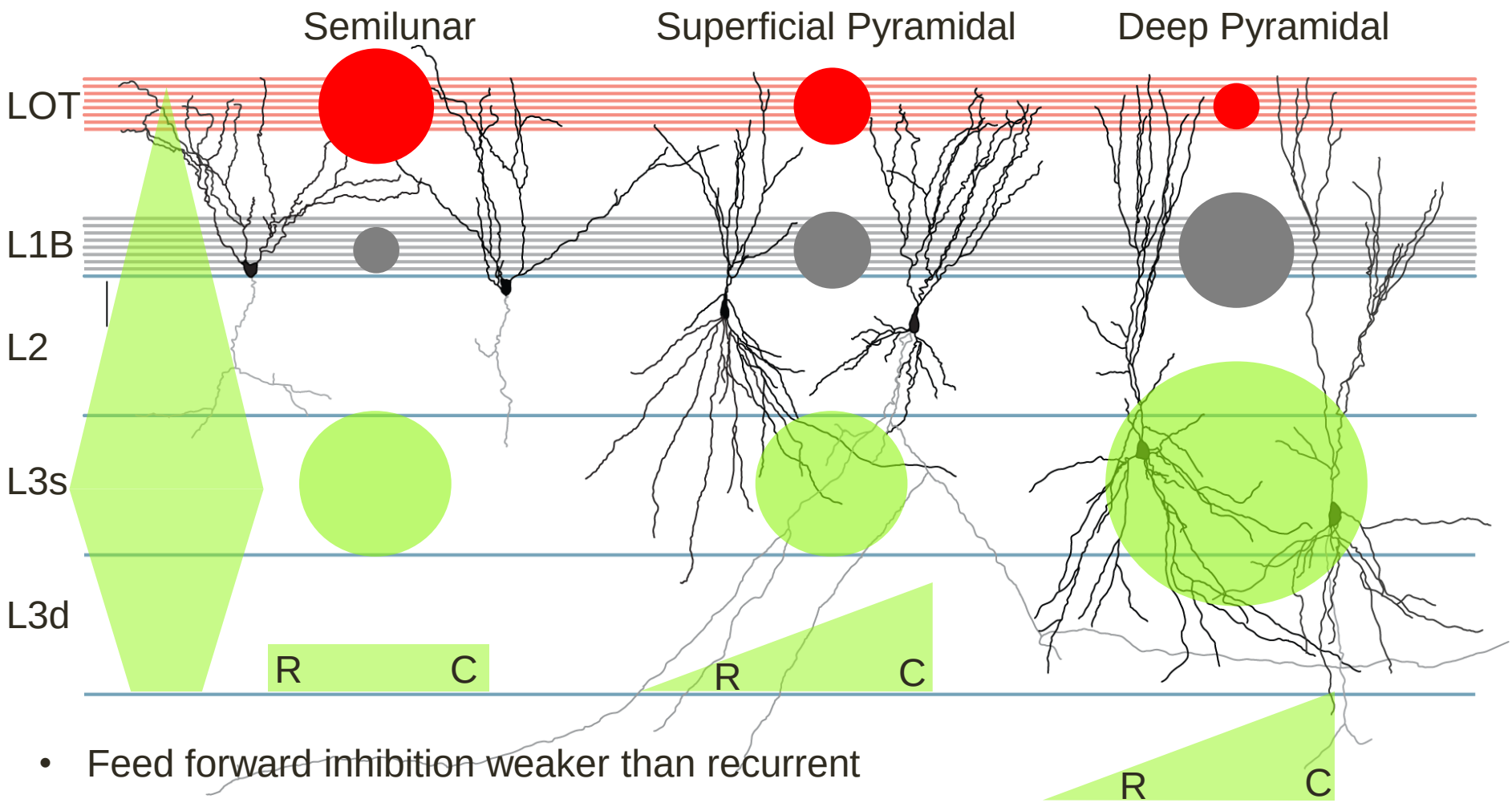
Rostral-caudal inhibitory asymmetry



Asymmetric inhibition in PCs but not SLCs



Inhibition in Piriform Cortex



- Feed forward inhibition weaker than recurrent
- SLCs highly distinct patterns of excitation/inhibition
- sPCs and dPCs show comparable patterns but differing magnitudes

How do spatial patterns of inhibition arise?

1) More inhibition in L3 neurons than L2

- More interneurons in Layer 3 than in Layers 1 and 2.

Densities (mm^{-3}) — Interneuron classes in Piriform Cortex

	CB	CR	PV	CCK	NPY	SOM	
Ia	490 ± 276	114 ± 66	238 ± 168	0	0	84 ± 55	L1: 1840
Ib	107 ± 85	644 ± 192	50 ± 50	26 ± 26	87 ± 87	0	
IIa	315 ± 195	3838 ± 1134	475 ± 283	362 ± 185	88 ± 88	194 ± 90	L2: 20839
IIb	5505 ± 1138	3940 ± 585	2921 ± 943	1369 ± 322	68 ± 68	1046 ± 329	
III	12280 ± 1637	1855 ± 184	4723 ± 317	602 ± 141	541 ± 68	6143 ± 912	L3: 52827
En	9260 ± 340	2273 ± 463	2277 ± 646	506 ± 89	1105 ± 309	11262 ± 587	

Suzuki and Bekkers, 2010

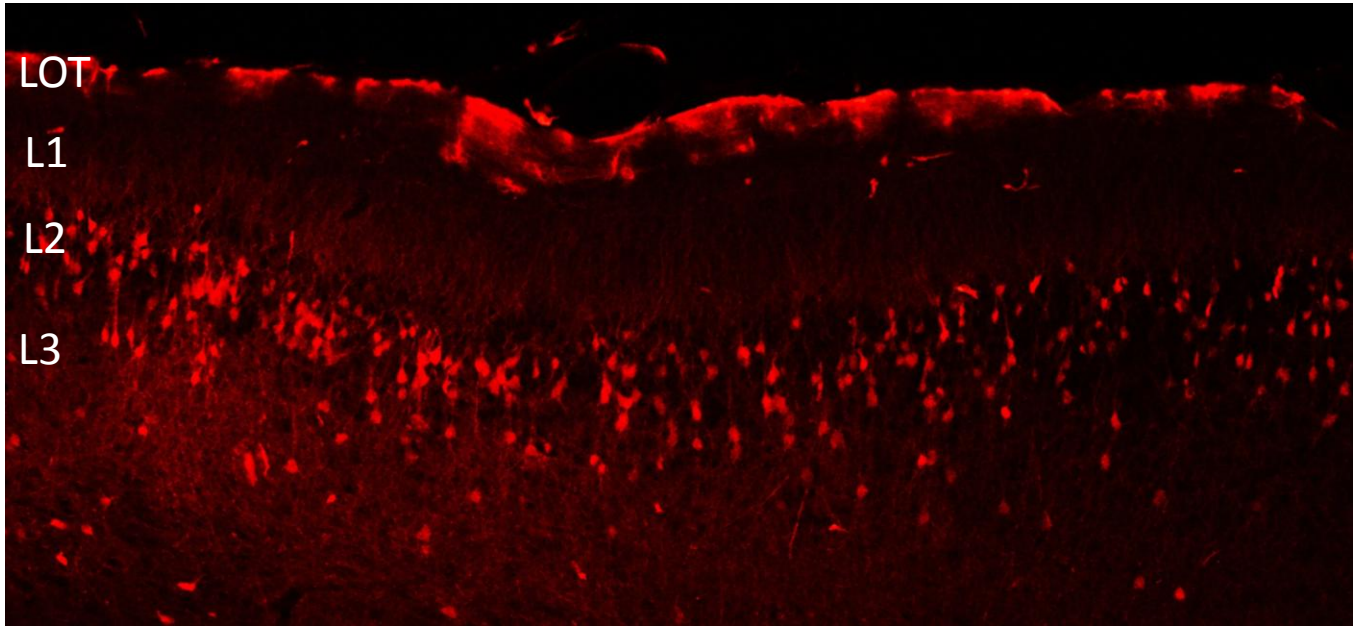
2) Asymmetric inhibition (ongoing)

- ✗ Number of interneurons increase along rostral-caudal axis
- ✗ The strength of unitary inhibitory connections increases along R-C axis
- ✓ Disinhibitory circuitry (See Poster 12)

Speculations….

cFos Activation Novel Environment

Rostral



Caudal

- Superficial to deep activity gradients
- Rostral-Caudal activity gradients
- Semilunar cells?

Acknowledgements

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