Mean-field four-unit model can describe stimulus related adaptation in layer 2/3 of V1

UNIVERSITY OF SUSSEX

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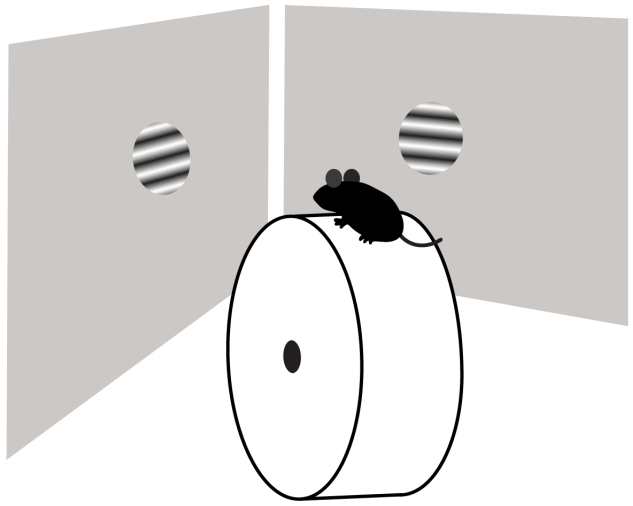
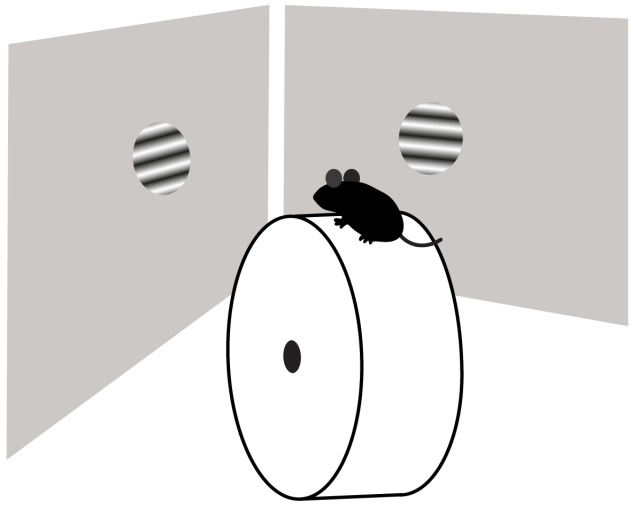
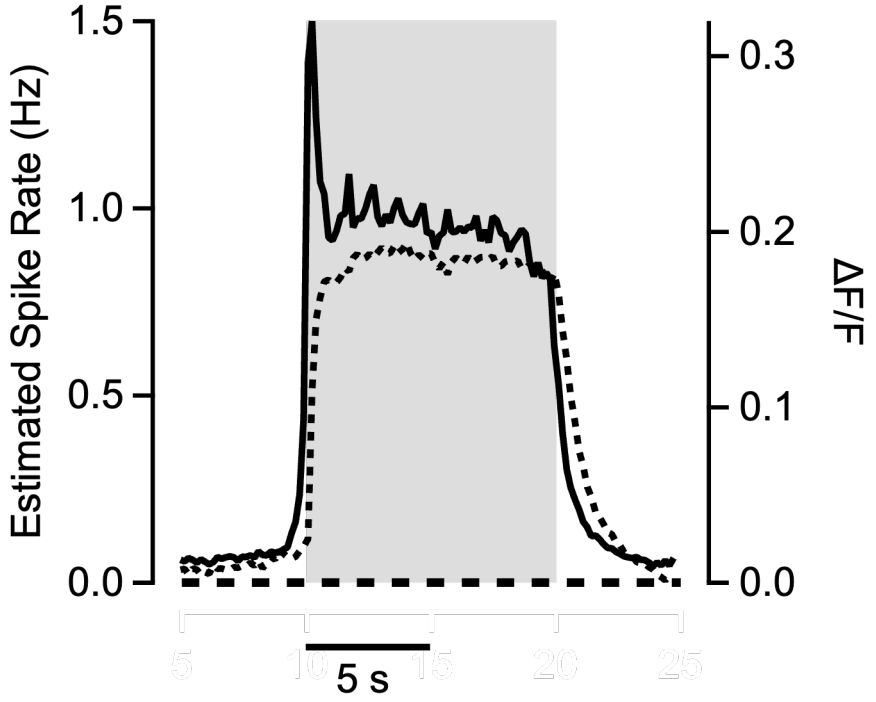
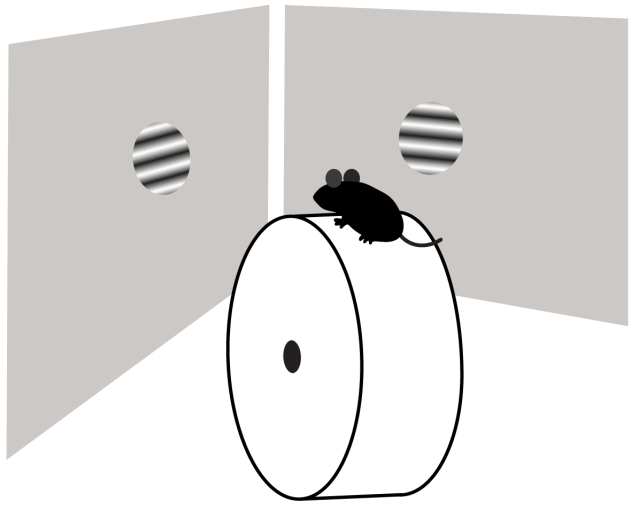
Sussex University

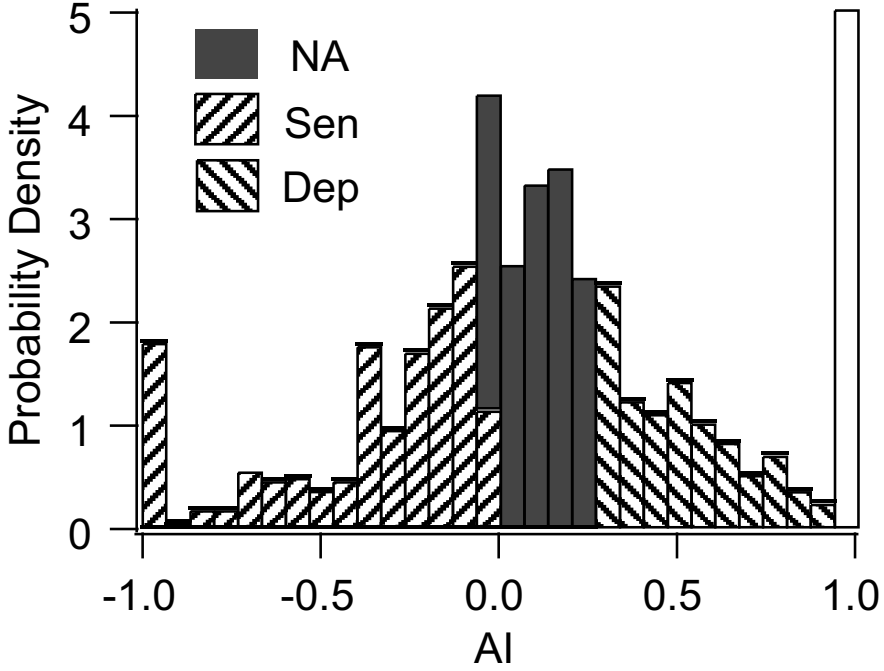
ISRC-CN3, Derry, 30/08/2024

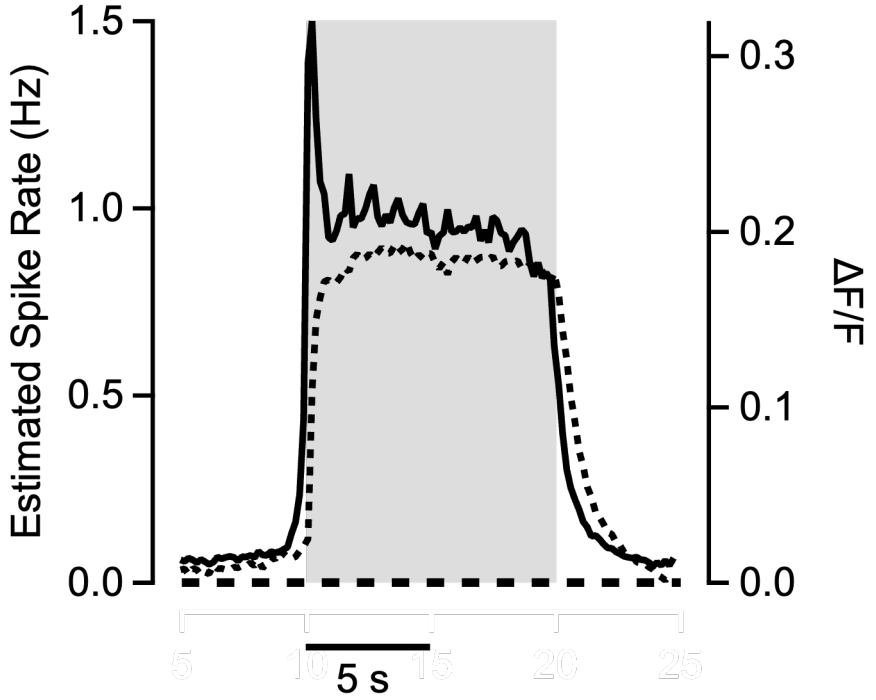


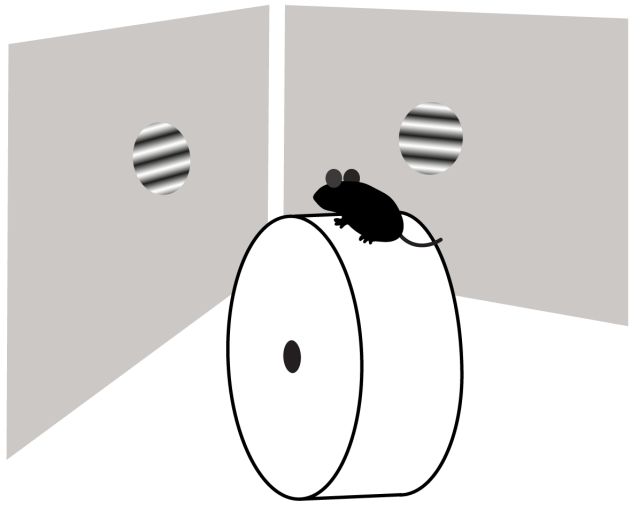


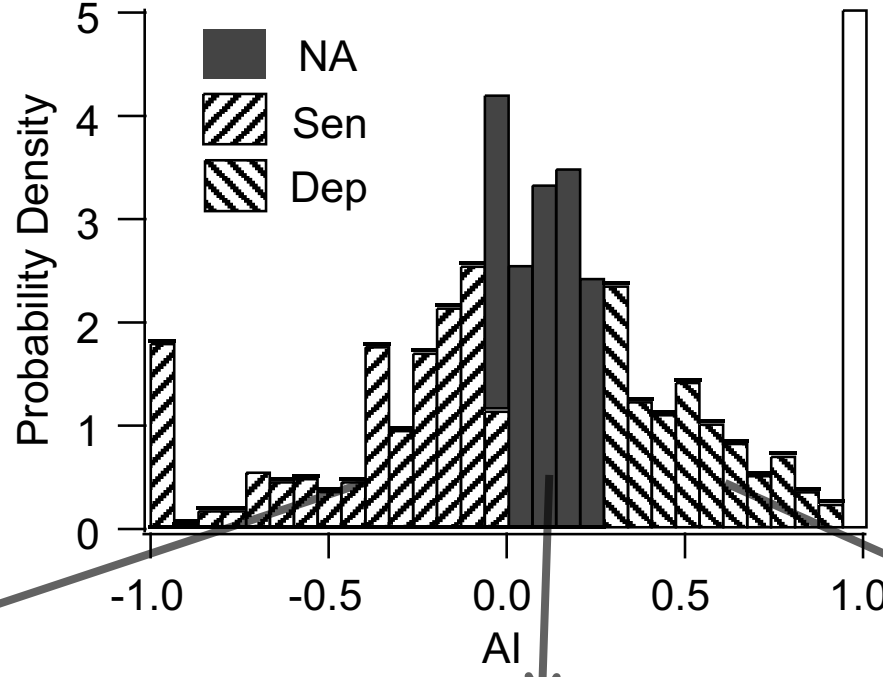

Estimated Spike Rate (Hz)
1.5
1.0
0.5
0.0
0.3
0.2
0.1
0.0
ΔF/F
5
10
15
20
25
5 s

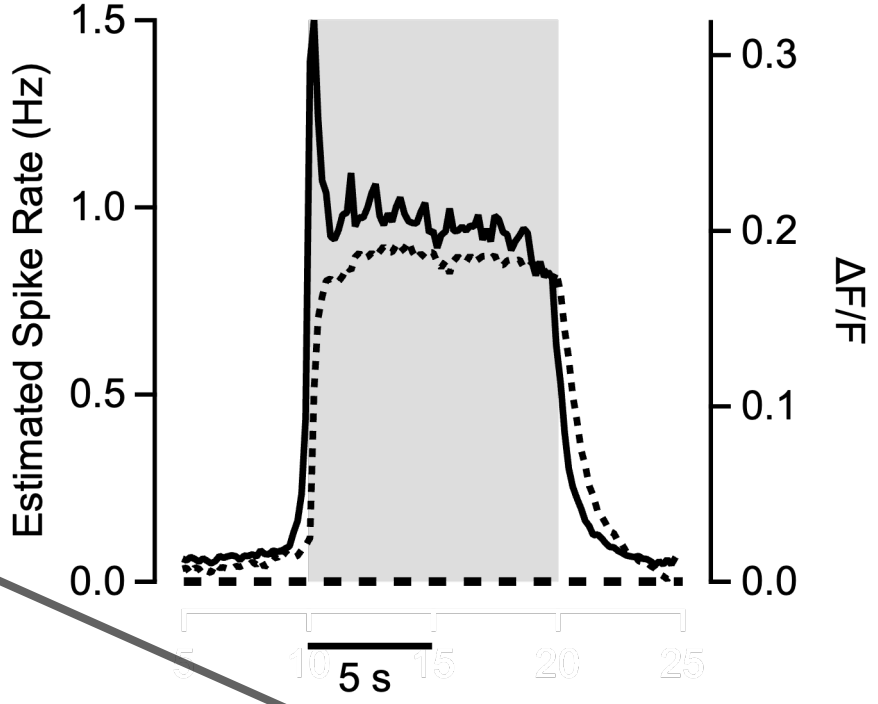


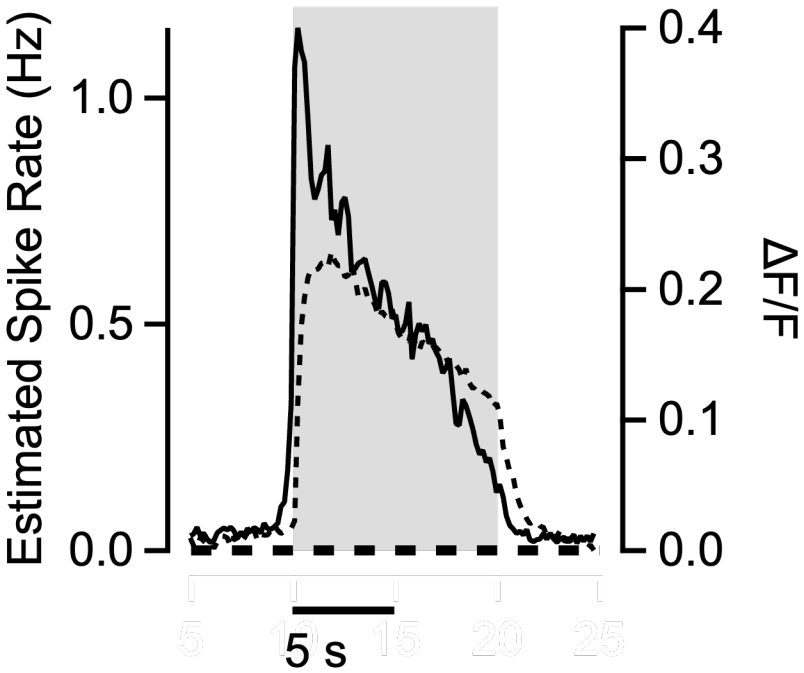

NA
Sen
Dep
Probability Density
0
1
2
3
4
5
-1.0
-0.5
0.0
0.5
1.0
AI

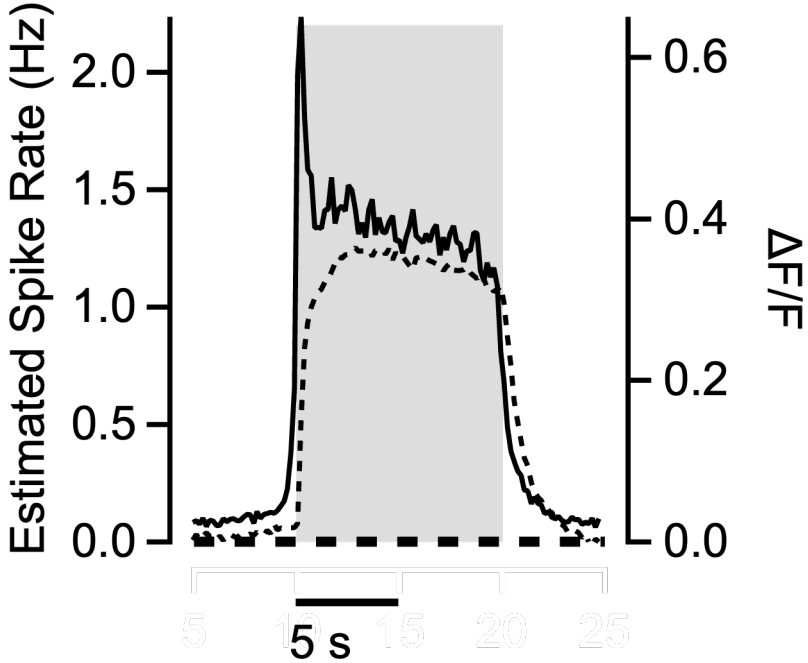

Estimated Spike Rate (Hz)
0.0
0.5
1.0
1.5
ΔF/F
0.0
0.1
0.2
0.3
5
10
15
20
25
5 s

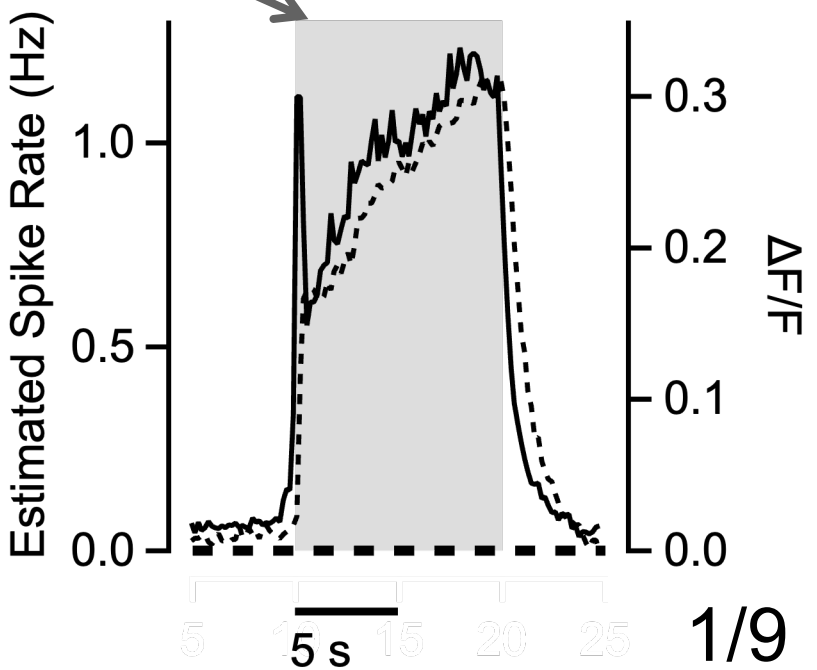


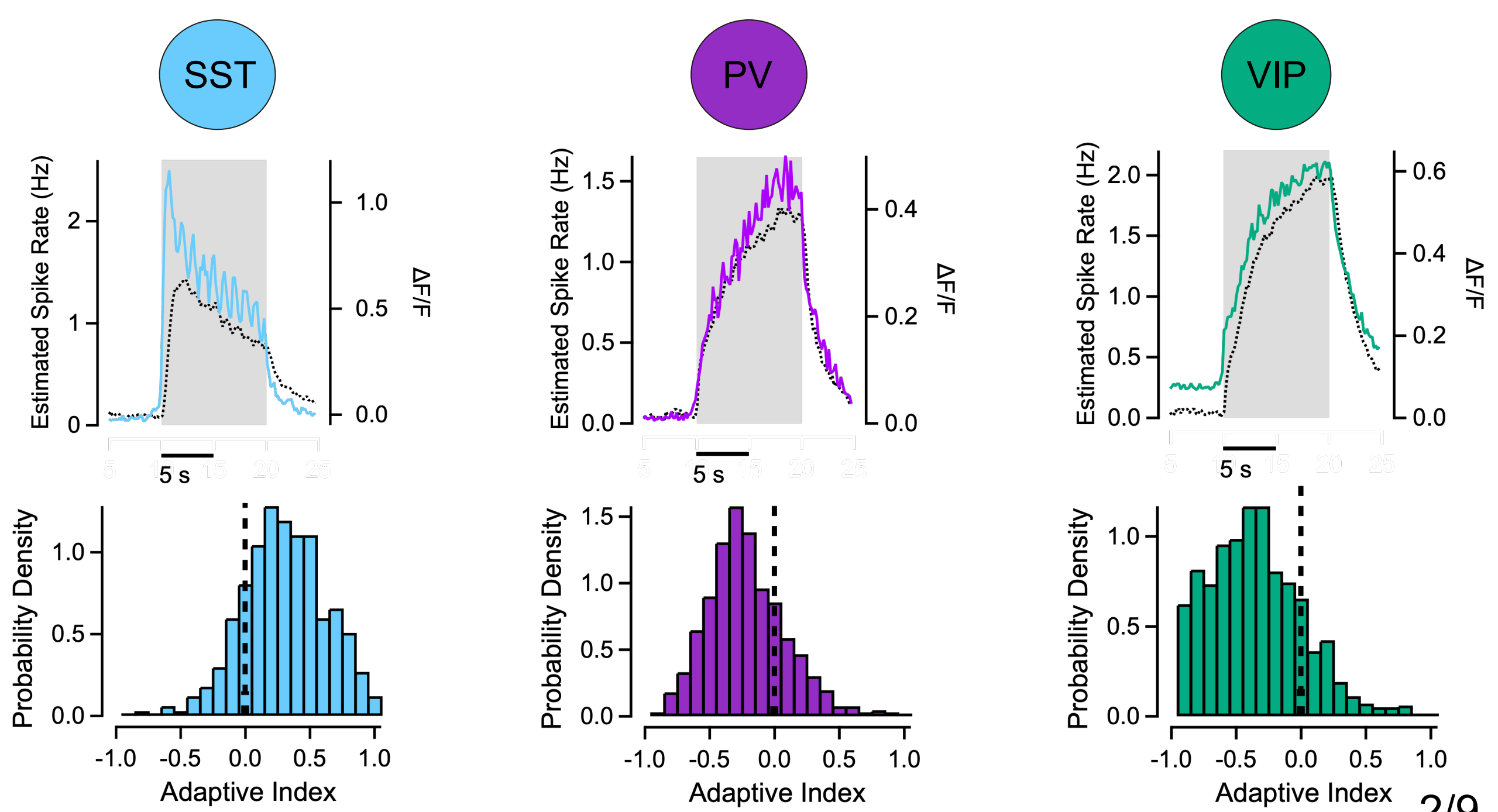

NA
Sen
Dep
Probability Density
AI

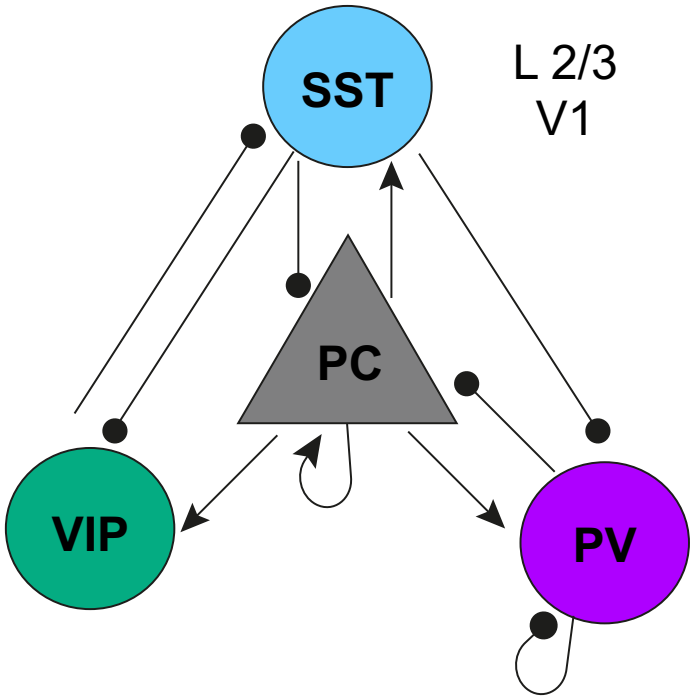

Estimated Spike Rate (Hz)
ΔF/F
5 s

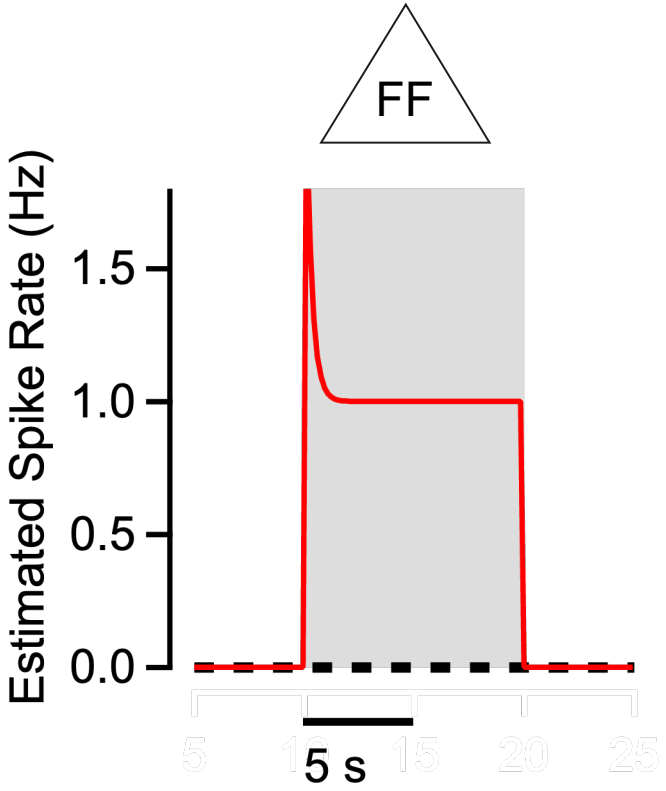

Estimated Spike Rate (Hz)
ΔF/F
5 s

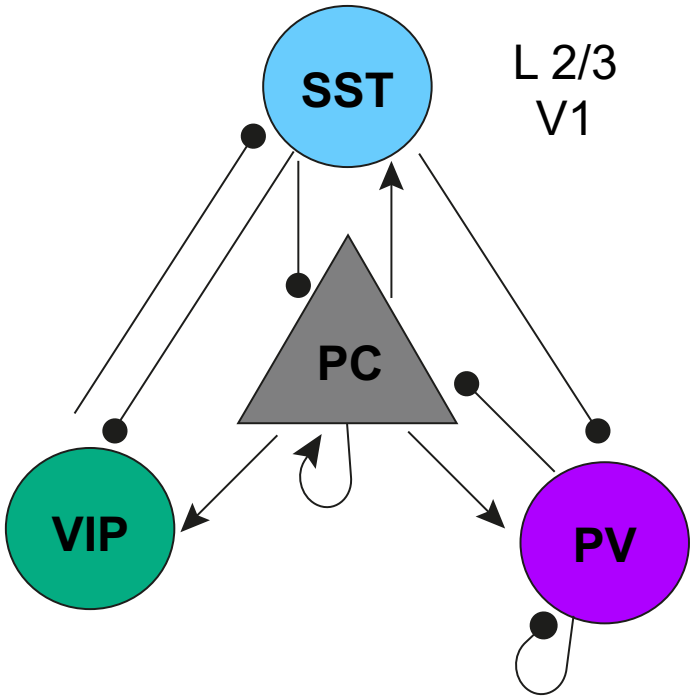

Estimated Spike Rate (Hz)
ΔF/F
5 s

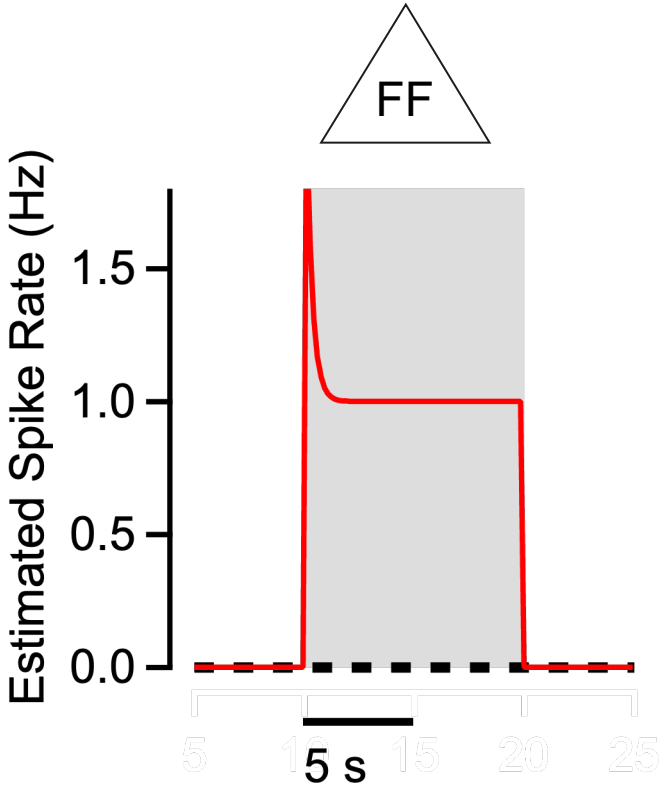

Estimated Spike Rate (Hz)
ΔF/F
5 s

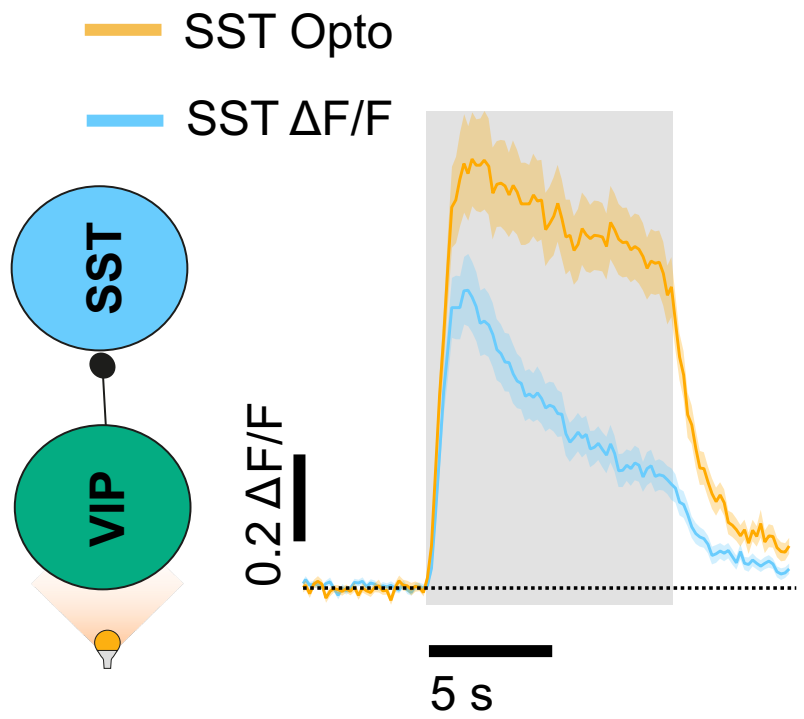

SST
PV
VIP
Estimated Spike Rate (Hz)
ΔF/F
5 s
Probability Density
Adaptive Index
-1.0
-0.5
0.0
0.5
1.0

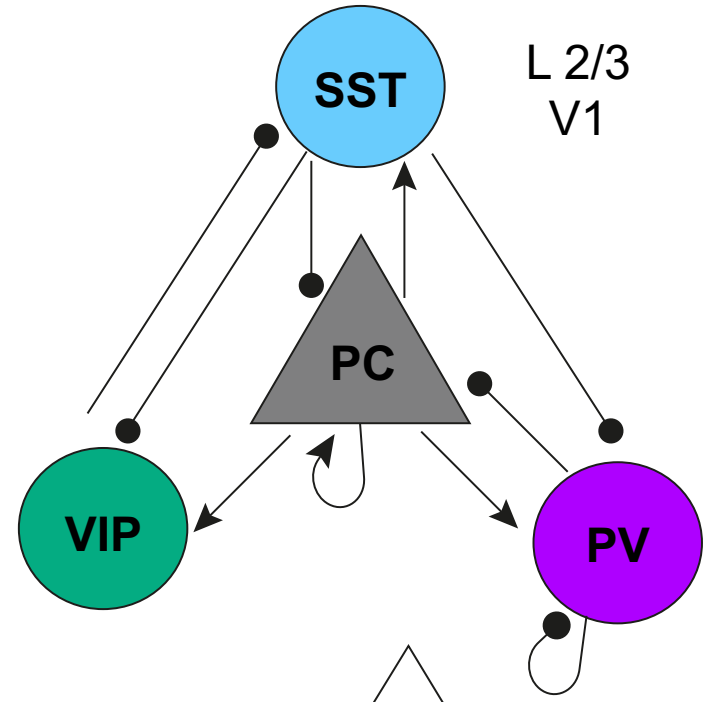

SST
L 2/3
V1
PC
VIP
PV

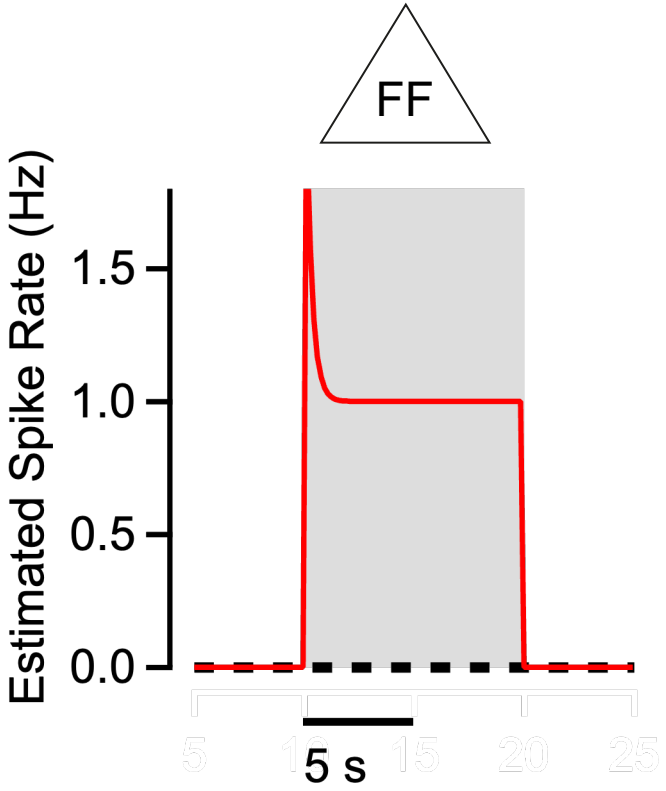

FF
Estimated Spike Rate (Hz)
1.5
1.0
0.5
0.0
5
10
15
20
25
5 s

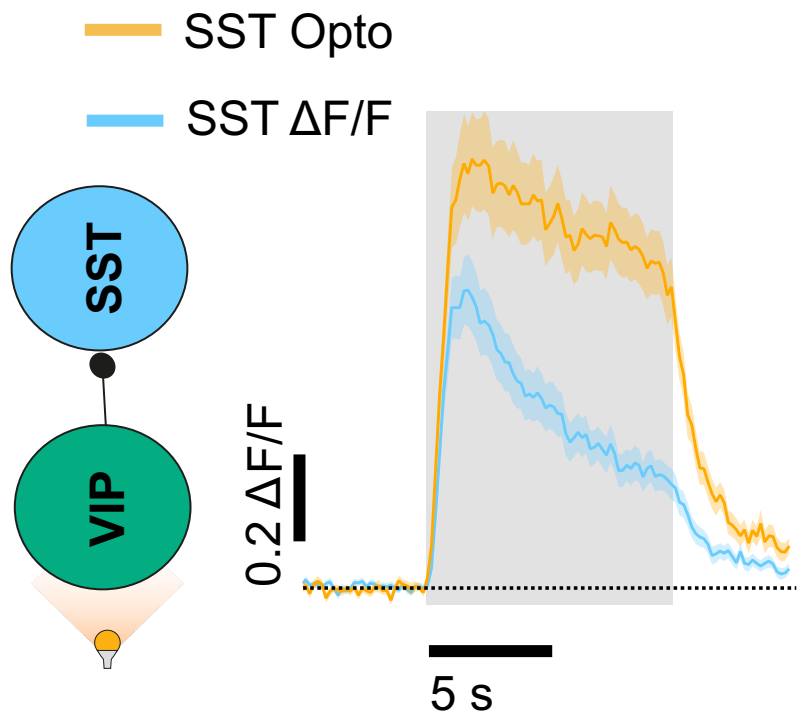

SST
L 2/3
V1
PC
VIP
PV

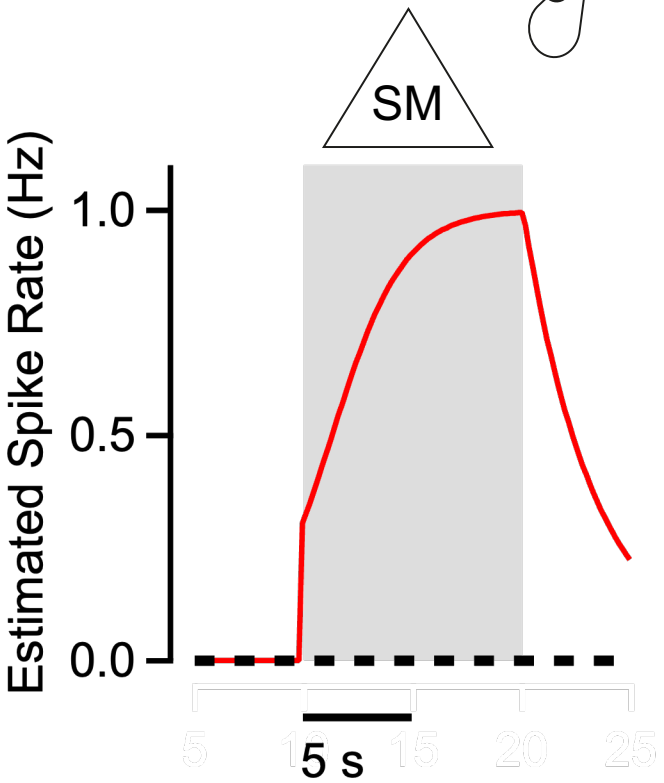

FF
Estimated Spike Rate (Hz)
1.5
1.0
0.5
0.0
5
10
15
20
25
5 s

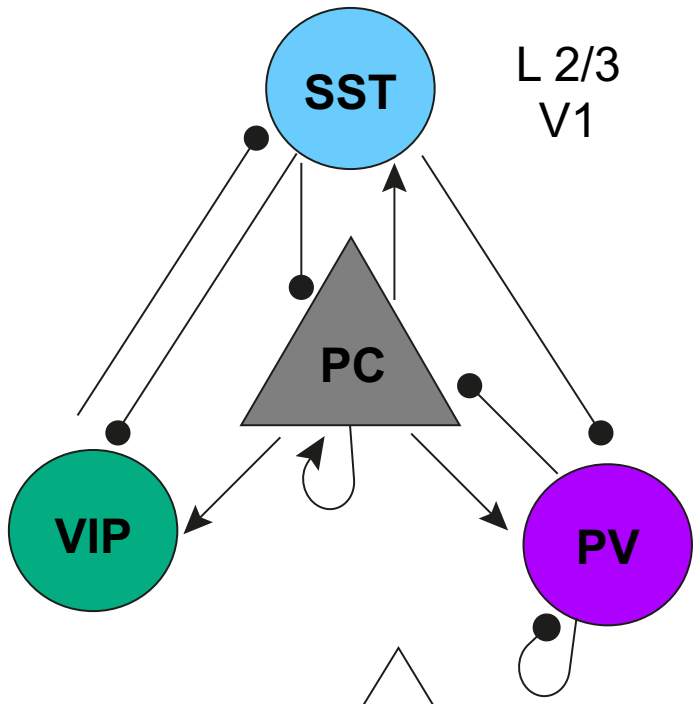

SST Opto
SST ΔF/F
SST
VIP
0.2 ΔF/F
5 s

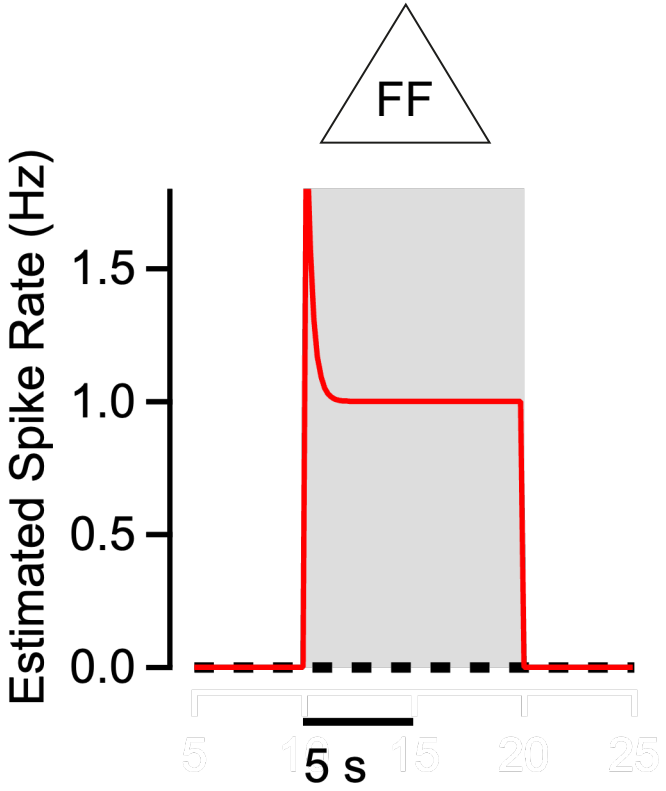

SST
L 2/3
V1
PC
VIP
PV

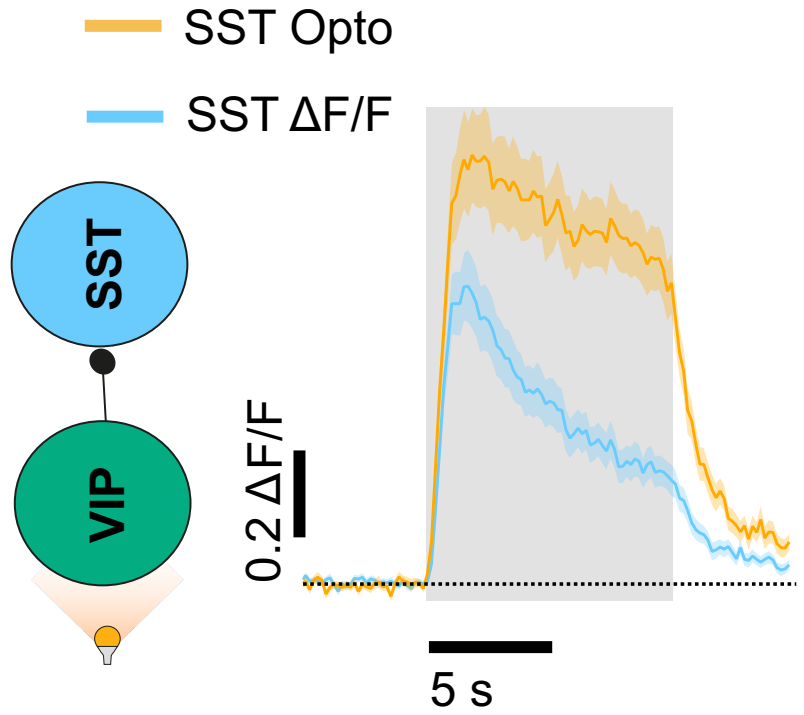

FF
Estimated Spike Rate (Hz)
1.5
1.0
0.5
0.0
5
10
15
20
25
5 s

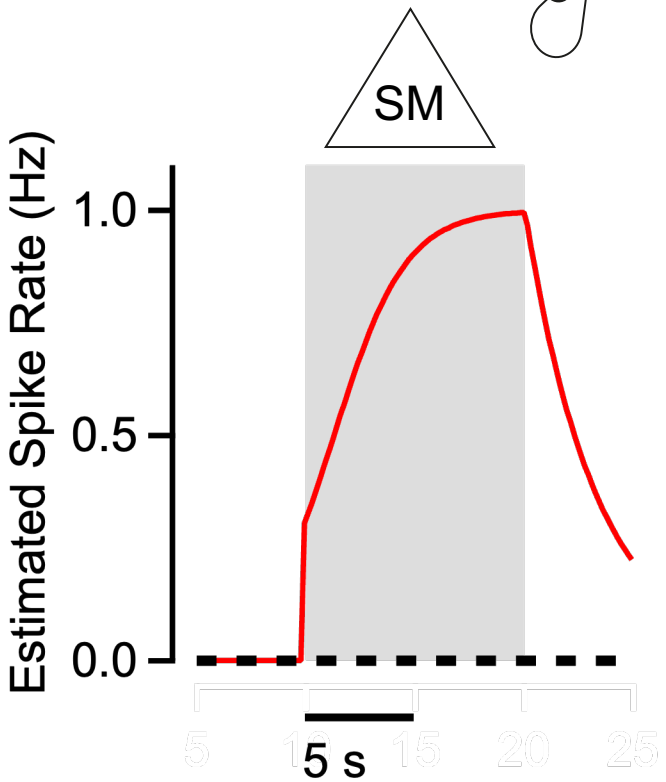

SST Opto
SST ΔF/F
SST
VIP
0.2 ΔF/F
5 s

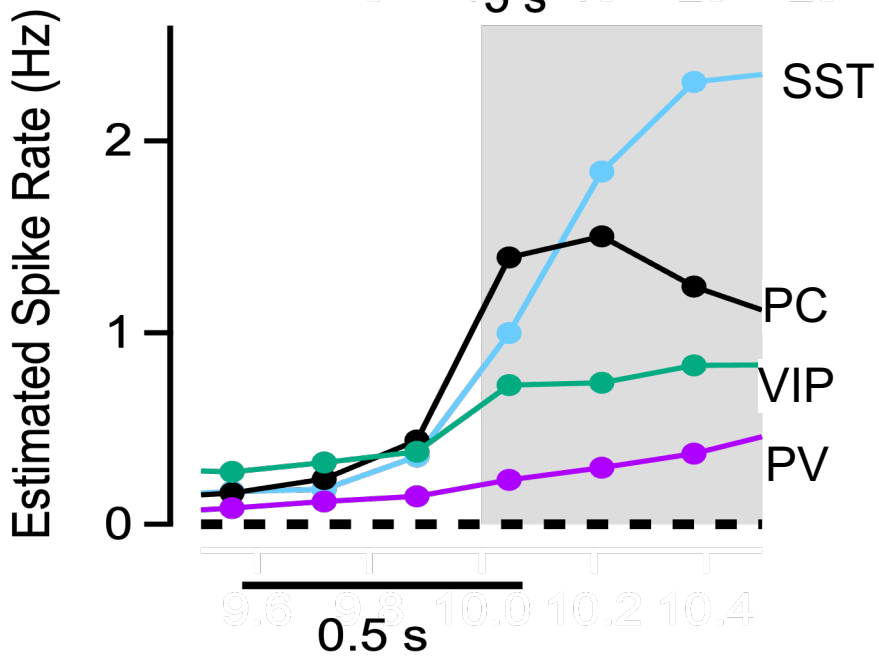

SM
Estimated Spike Rate (Hz)
1.0
0.5
0.0
5
10
15
20
25
5 s

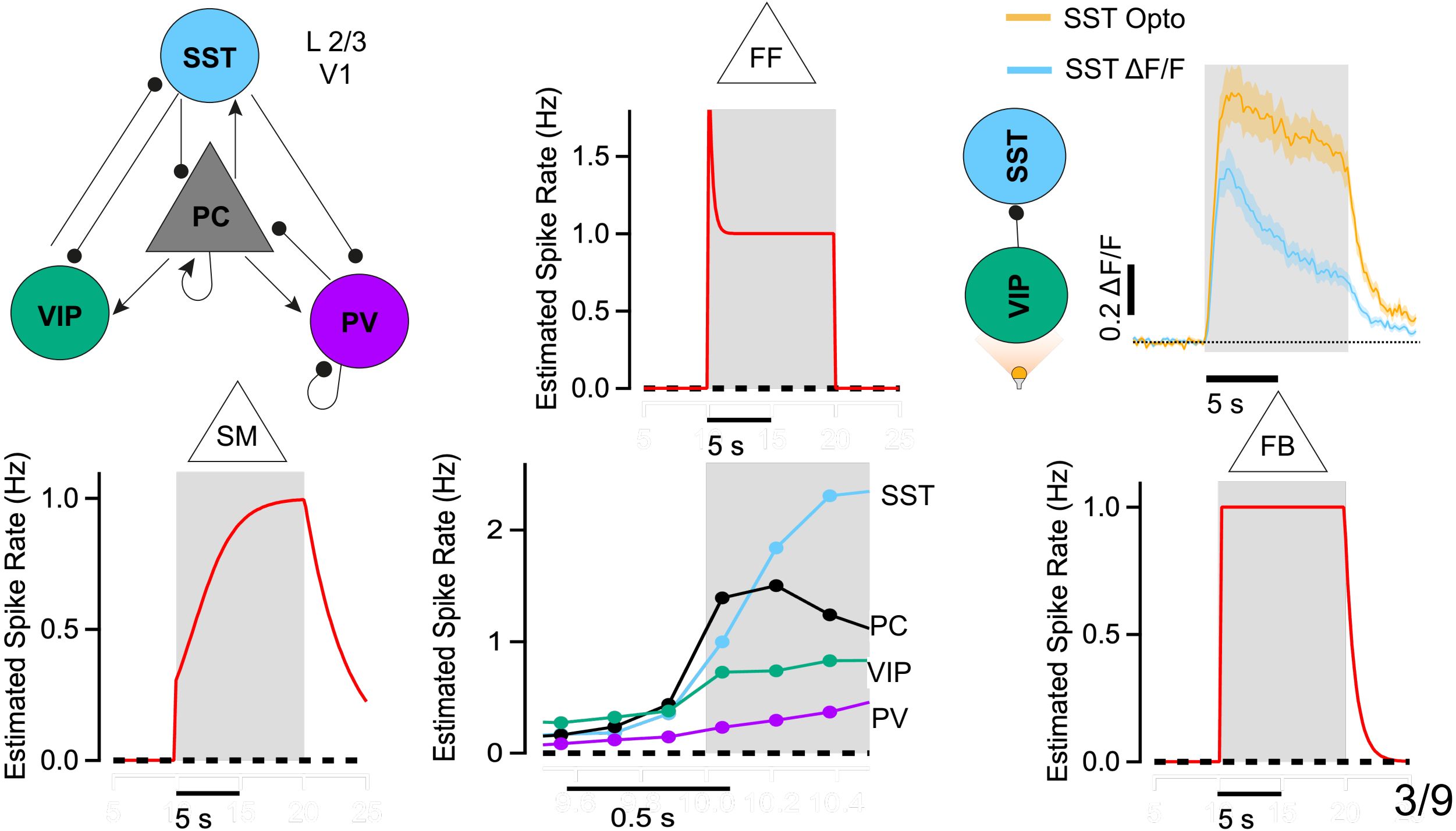

SST
L 2/3
V1
PC
VIP
PV

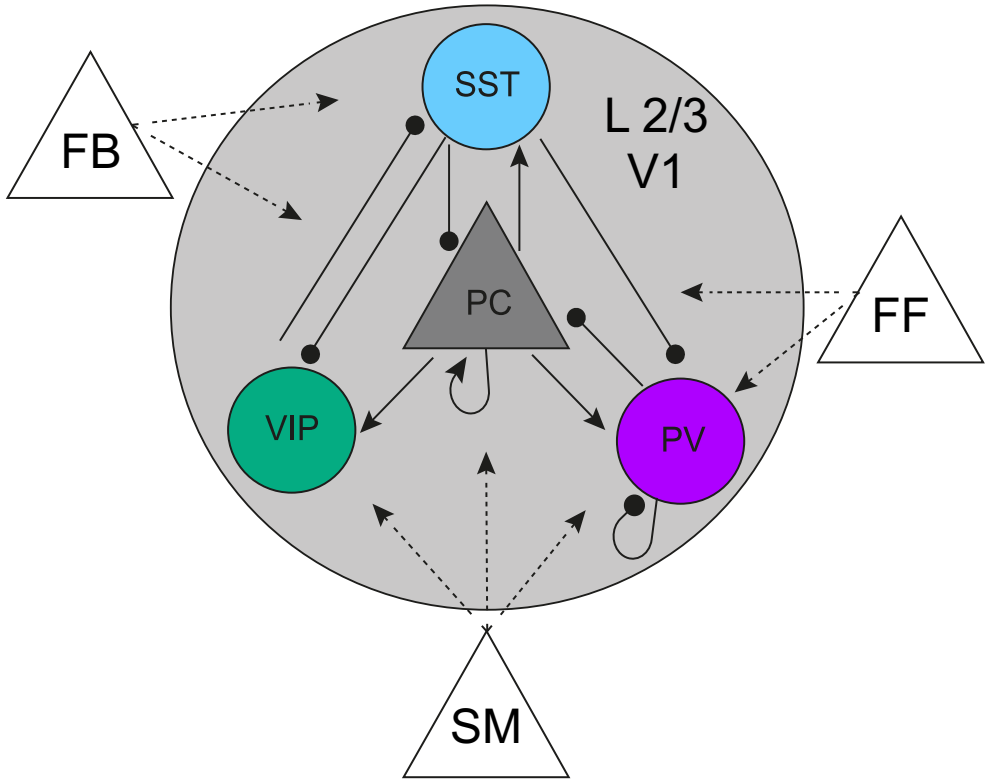

FF
Estimated Spike Rate (Hz)
1.5
1.0
0.5
0.0
5
10
15
20
25
5 s

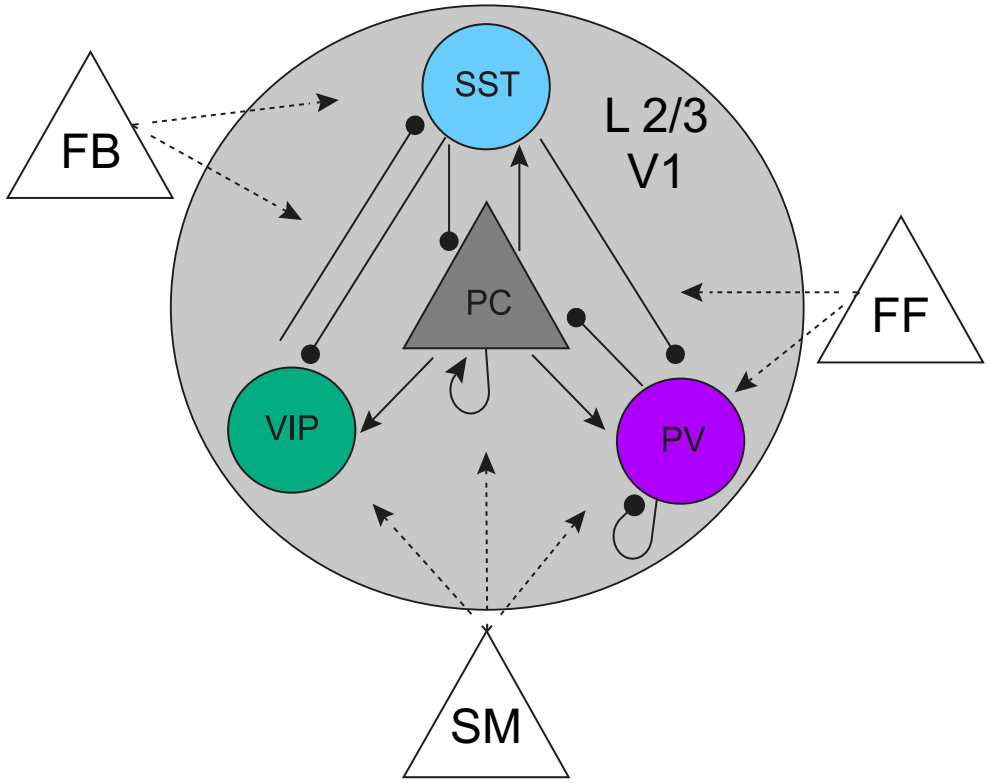

SST Opto
SST ΔF/F
SST
VIP
0.2 ΔF/F
5 s


SM
Estimated Spike Rate (Hz)
1.0
0.5
0.0
5
10
15
20
25
5 s

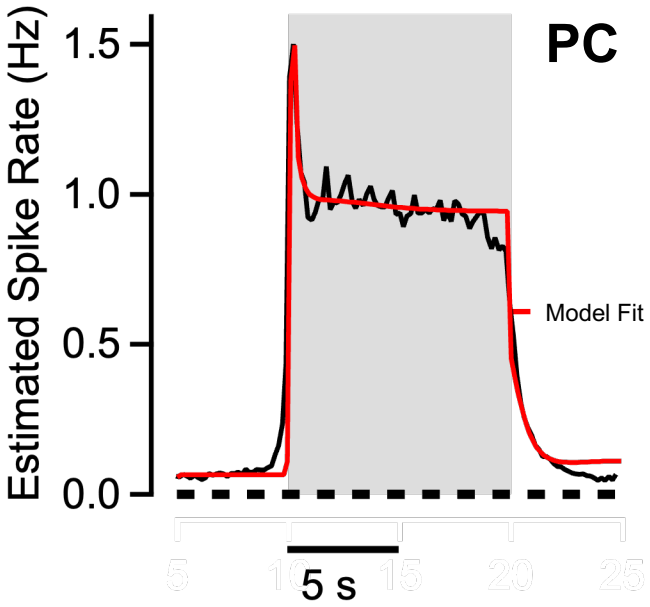

Estimated Spike Rate (Hz)
2
1
0
SST
PC
VIP
PV
9.6
9.8
10.0
10.2
10.4
0.5 s

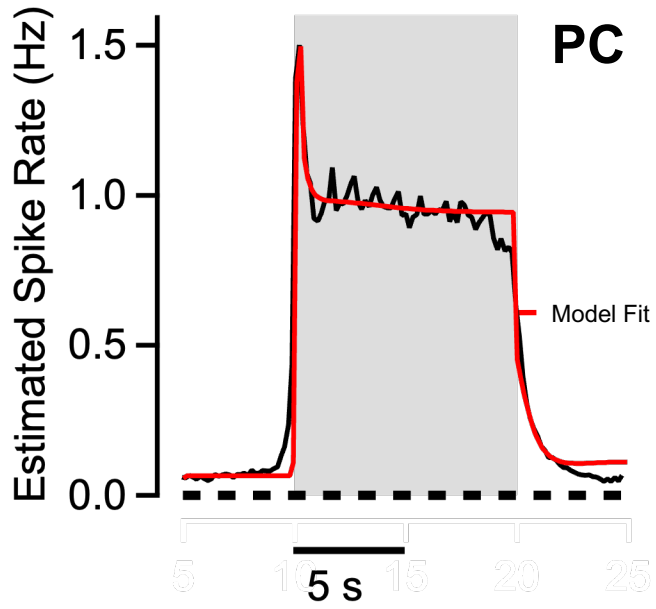

SST
L 2/3
V1
PC
VIP
PV
FF
Estimated Spike Rate (Hz)
1.5
1.0
0.5
0.0
5 s
SST Opto
SST ΔF/F
SST
VIP
0.2 ΔF/F
5 s
SM
Estimated Spike Rate (Hz)
1.0
0.5
0.0
5 s
Estimated Spike Rate (Hz)
2
1
0
SST
PC
VIP
PV
0.5 s
FB
Estimated Spike Rate (Hz)
1.0
0.5
0.0
5 s

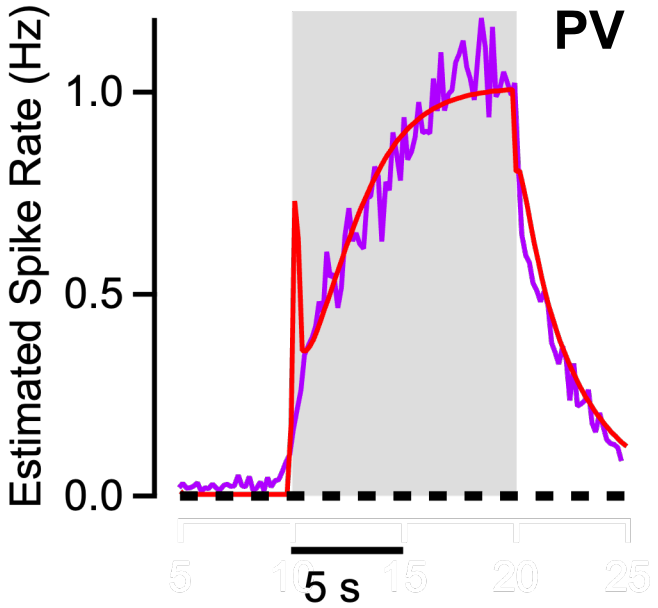

FB
SST
L 2/3
V1
PC
FF
VIP
PV
SM

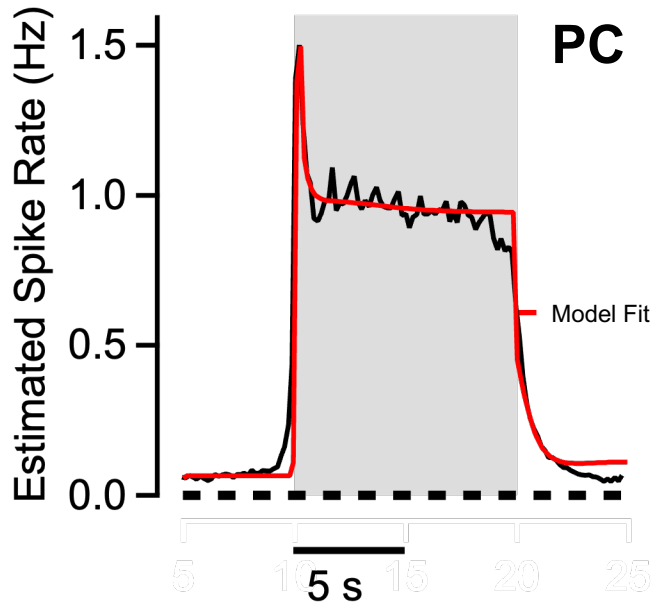


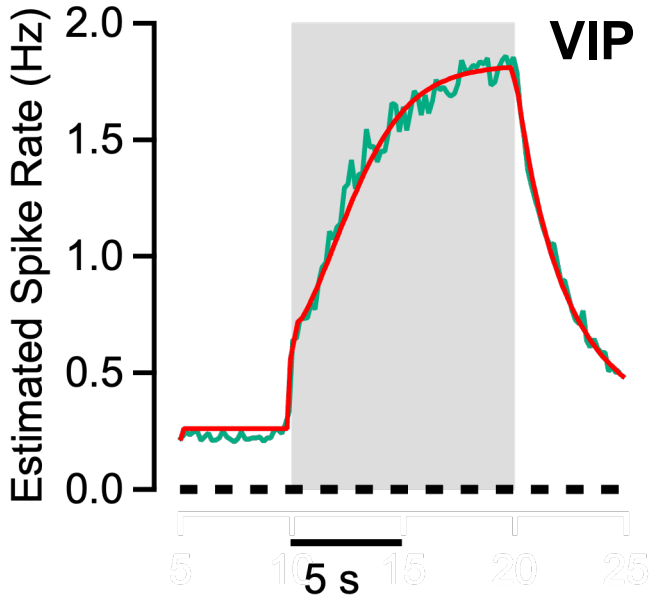
$$\tau_i \frac{dr_i}{dt} = -r_i + f\left(\sum_j w_{ji} r_j + w_{in} In + b_i\right)$$

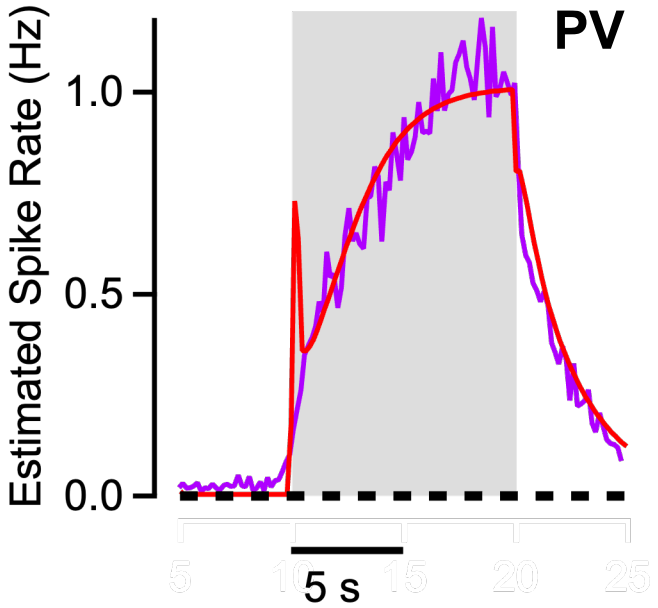

PC
Estimated Spike Rate (Hz)
1.5
1.0
0.5
0.0
Model Fit
5 s
5
15
20
25

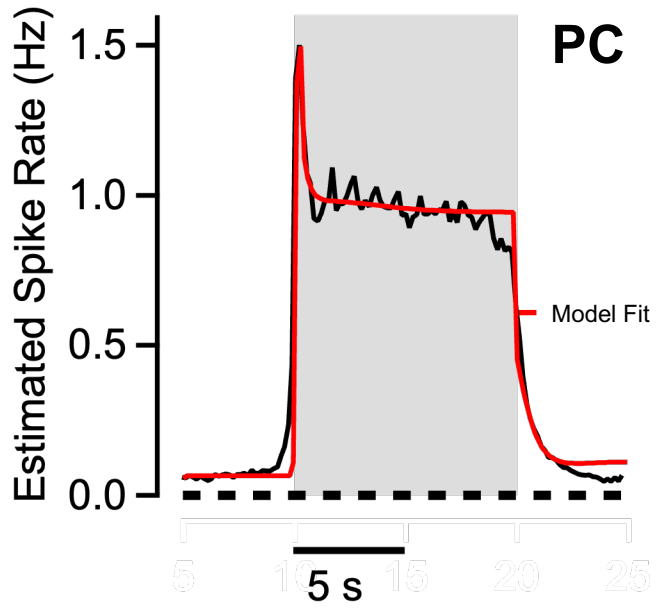

PC
Estimated Spike Rate (Hz)
1.5
1.0
0.5
0.0
Model Fit
5 s
5
15
20
25

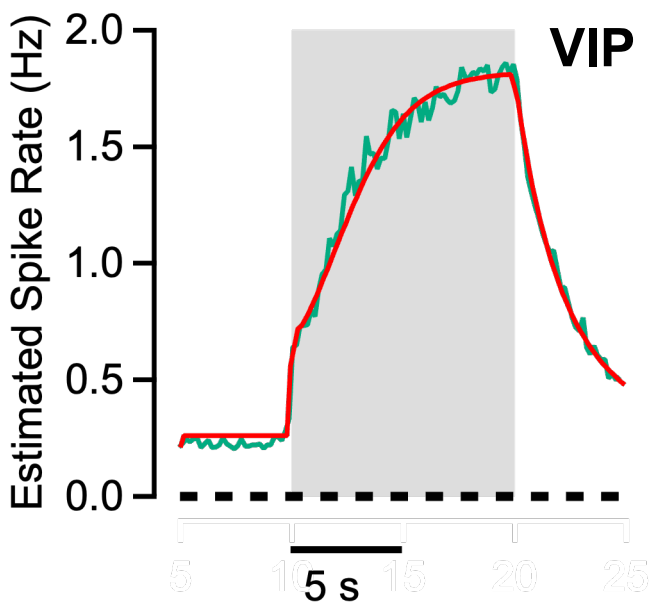

PV
Estimated Spike Rate (Hz)
1.0
0.5
0.0
5 s
5
15
20
25

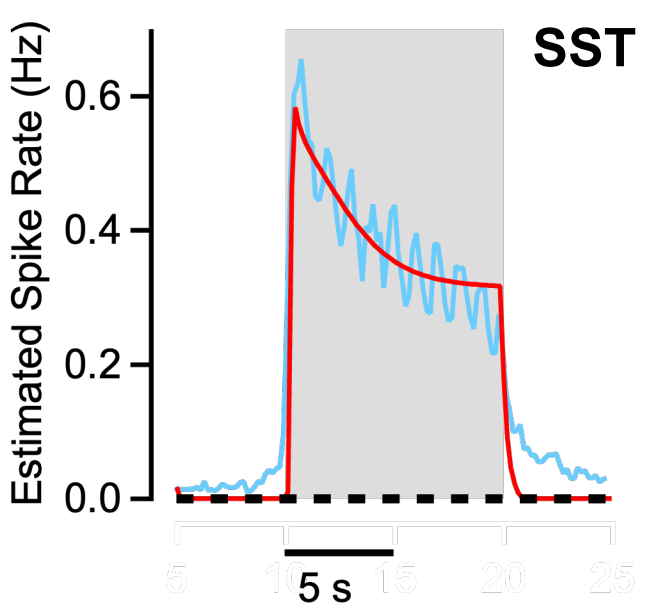

PC
Estimated Spike Rate (Hz)
1.5
1.0
0.5
0.0
Model Fit
5 s
5
15
20
25

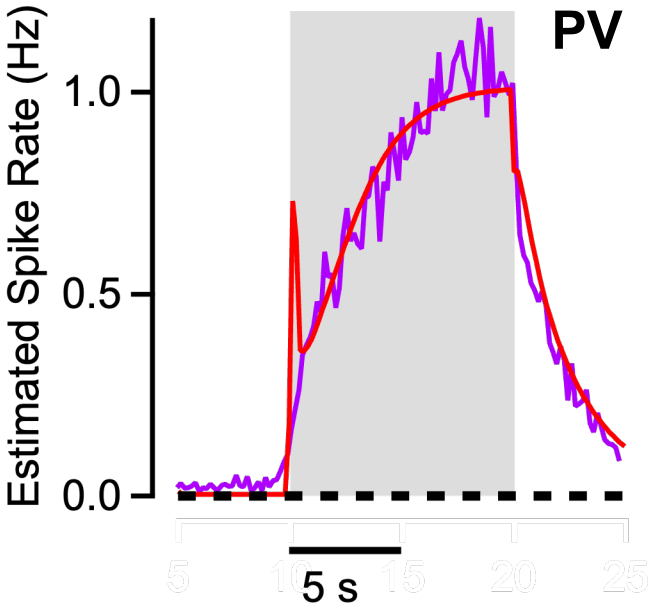

VIP
Estimated Spike Rate (Hz)
2.0
1.5
1.0
0.5
0.0
5 s
5
15
20
25

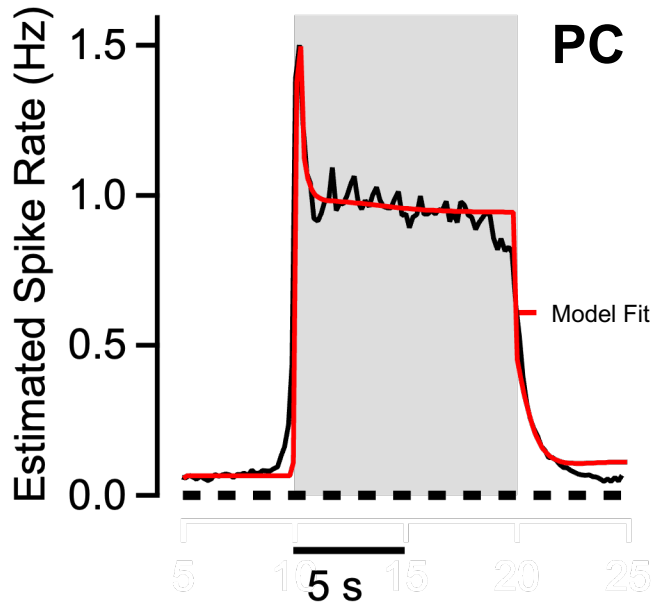

PV
Estimated Spike Rate (Hz)
1.0
0.5
0.0
5 s
5
15
20
25

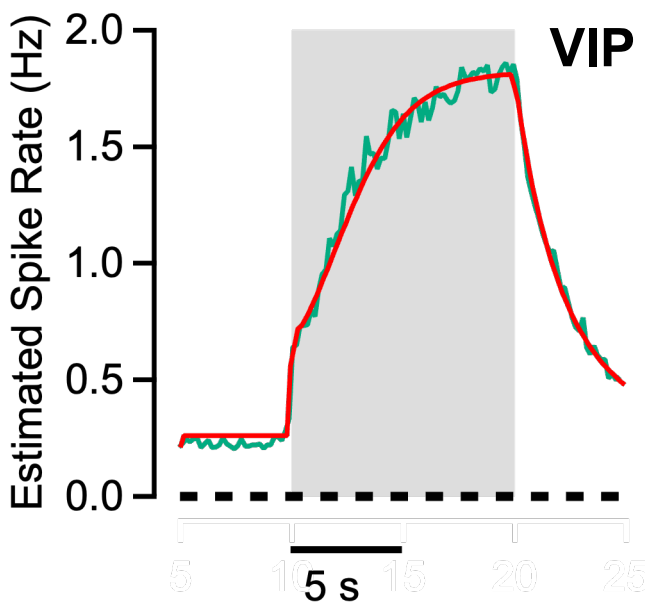

PC
Estimated Spike Rate (Hz)
1.5
1.0
0.5
0.0
Model Fit
5 s
5
15
20
25

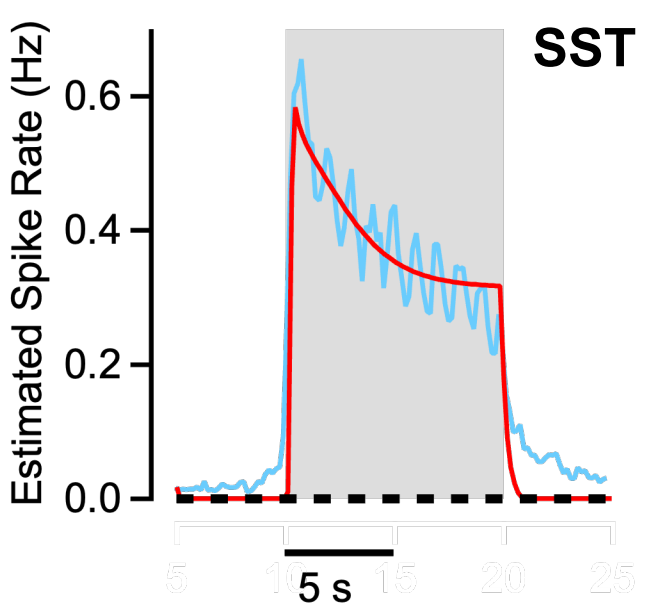

VIP
Estimated Spike Rate (Hz)
2.0
1.5
1.0
0.5
0.0
5 s
5
15
20
25

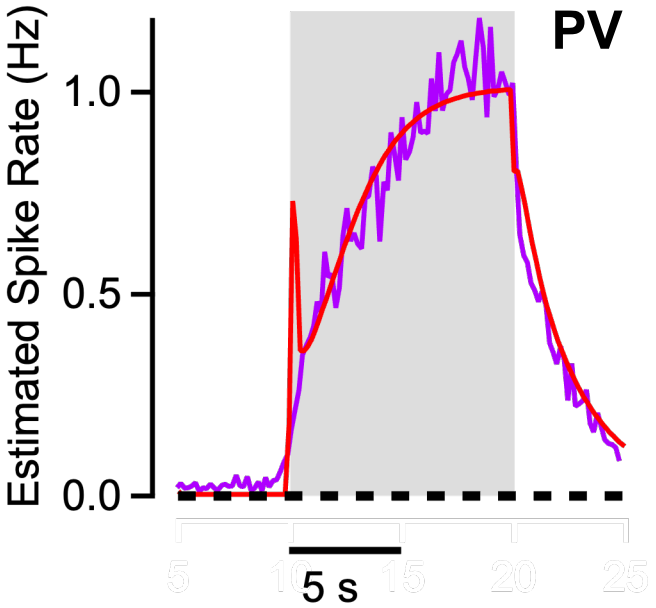

SST
Estimated Spike Rate (Hz)
0.6
0.4
0.2
0.0
5 s
5
15
20
25

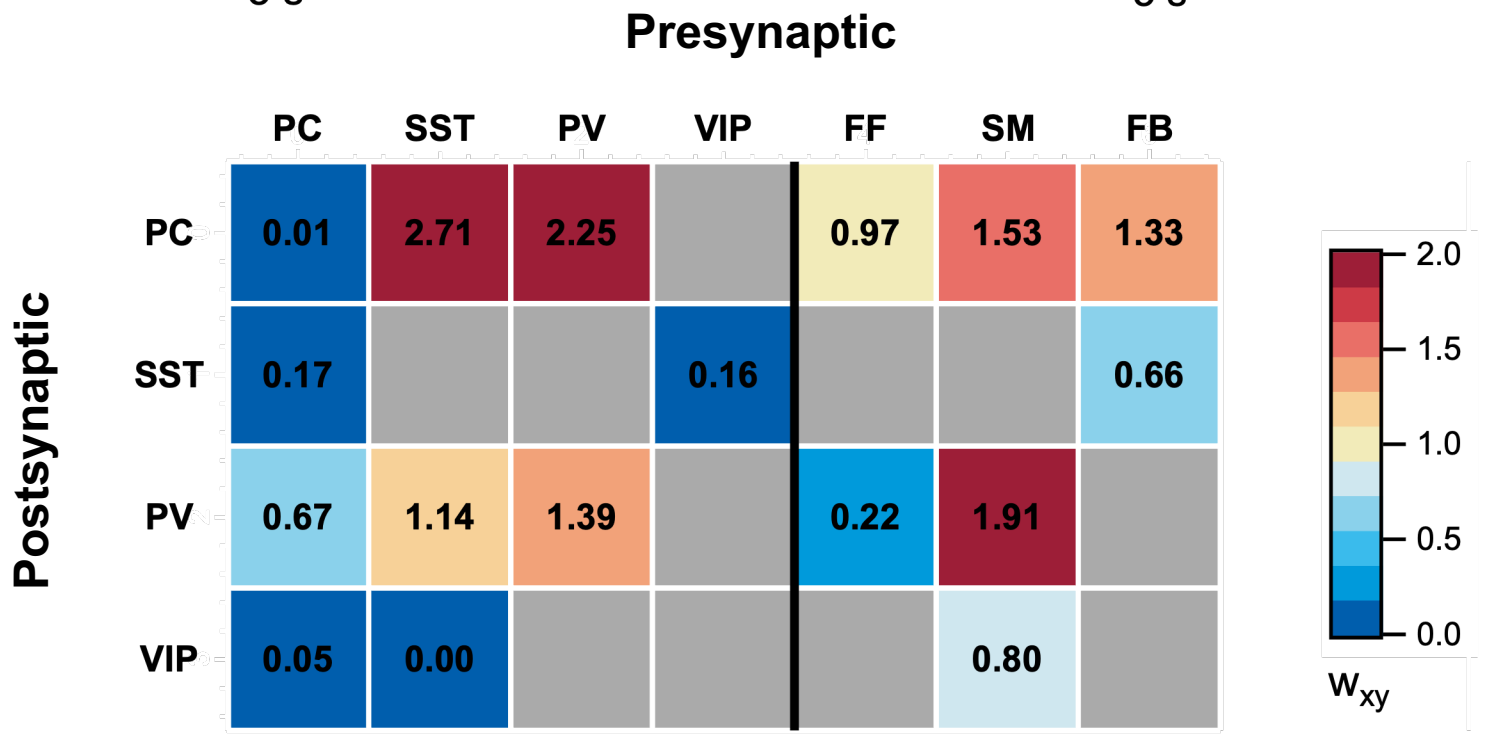

PV
Estimated Spike Rate (Hz)
1.0
0.5
0.0
5 s
5
15
20
25

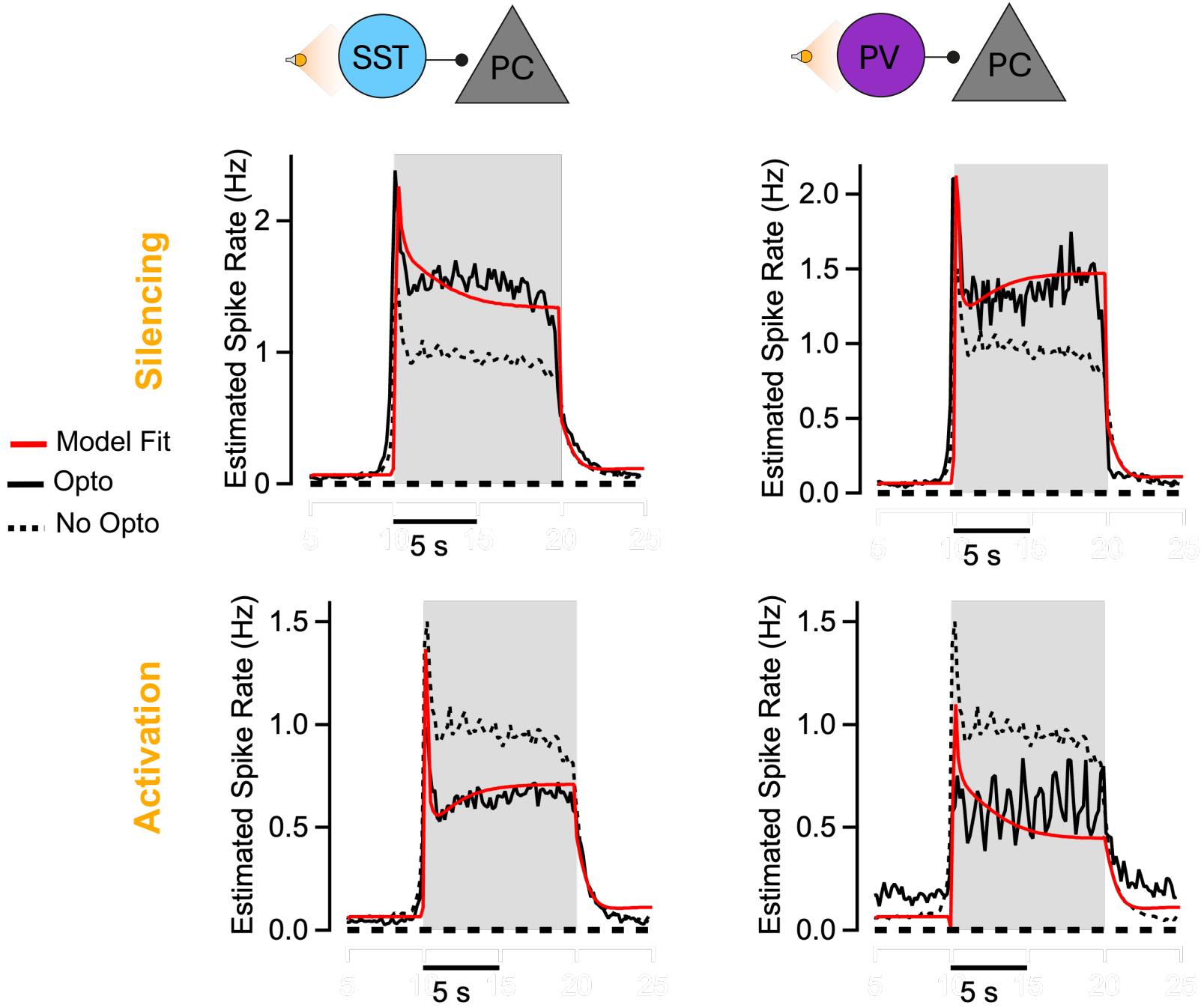

PC
Estimated Spike Rate (Hz)
1.5
1.0
0.5
0.0
Model Fit
5 s
5
15
20
25

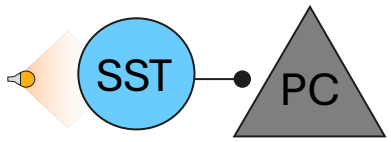

VIP
Estimated Spike Rate (Hz)
2.0
1.5
1.0
0.5
0.0
5 s
5
15
20
25

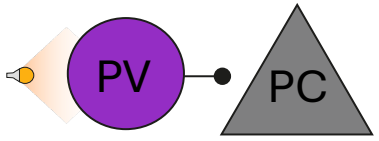

SST
Estimated Spike Rate (Hz)
0.6
0.4
0.2
0.0
5 s
5
15
20
25

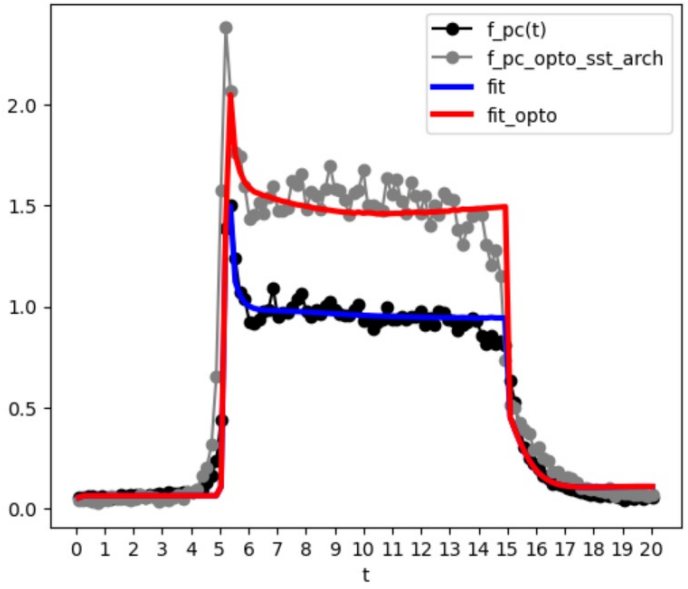

PV
Estimated Spike Rate (Hz)
1.0
0.5
0.0
5 s
5
15
20
25

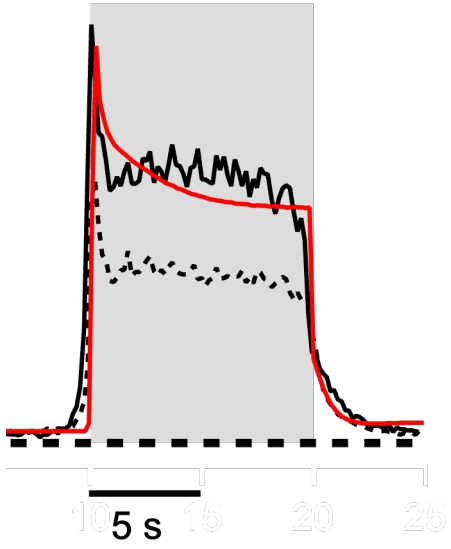

Presynaptic
Postsynaptic
PC
SST
PV
VIP
FF
SM
FB
PC
SST
PV
VIP
0.01
2.71
2.25
0.97
1.53
1.33
0.17
0.16
0.66
0.67
1.14
1.39
0.22
1.91
0.05
0.00
0.80
2.0
1.5
1.0
0.5
0.0
Wxy

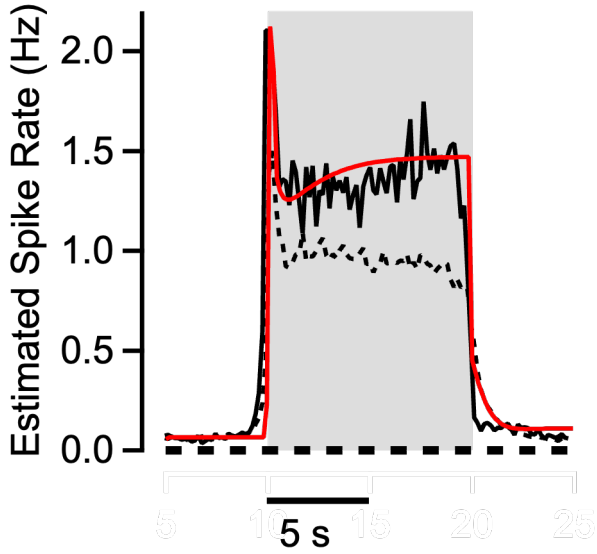

SST
PC
PV
PC
Silencing
Activation
Model Fit
Opto
No Opto
Estimated Spike Rate (Hz)
5 s


SST
PC

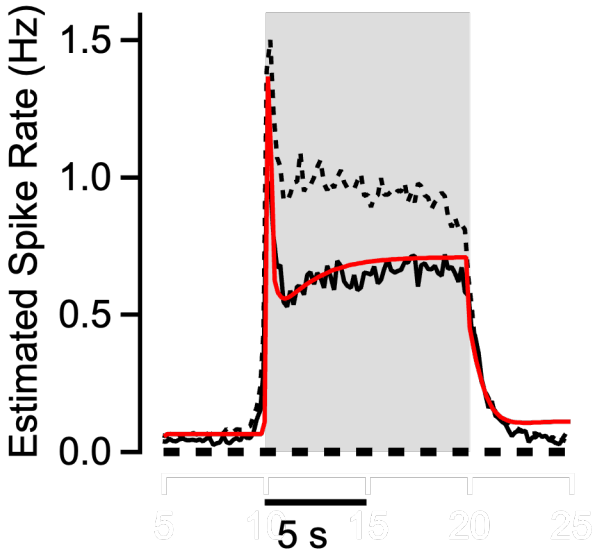

PV
PC

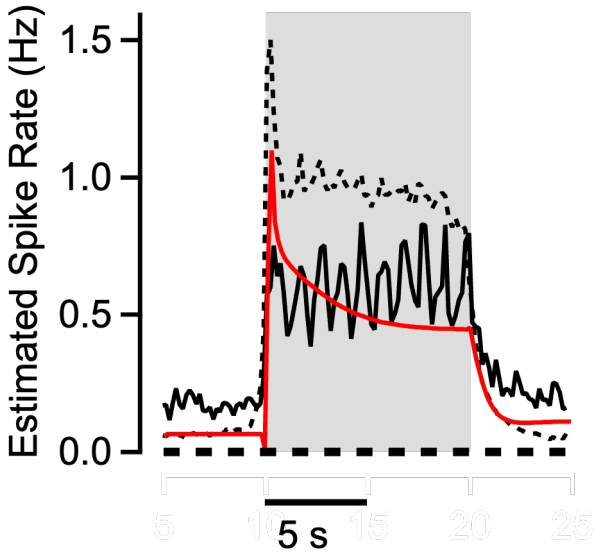

f_pc(t)
f_pc_opto_sst_arch
fit
fit_opto
t

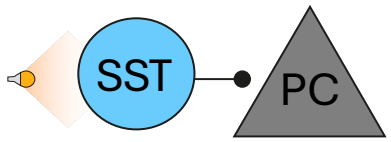

5 s

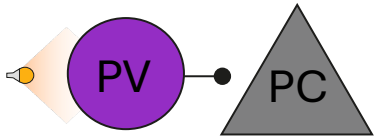

Estimated Spike Rate (Hz)
5 s

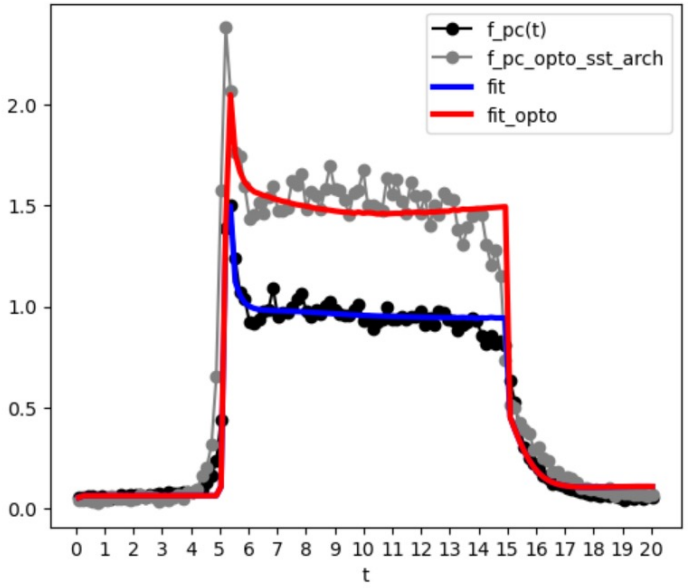
Activation

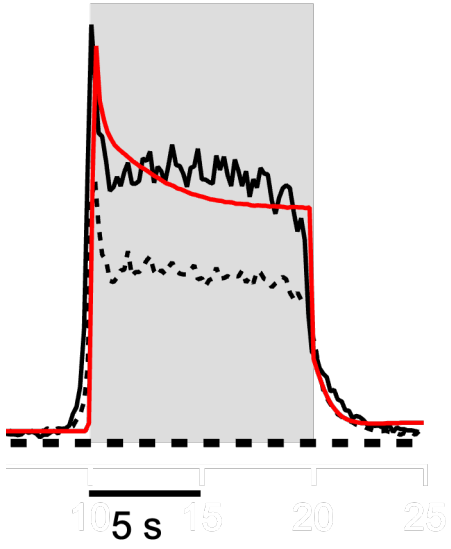

Estimated Spike Rate (Hz)
5 s

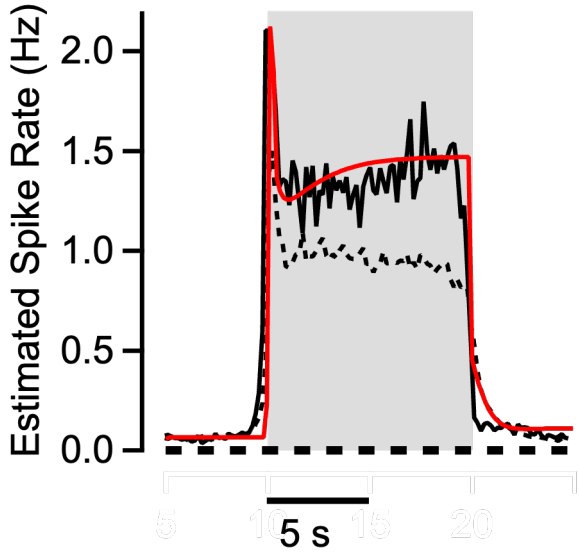

Estimated Spike Rate (Hz)
5 s


SST
PC

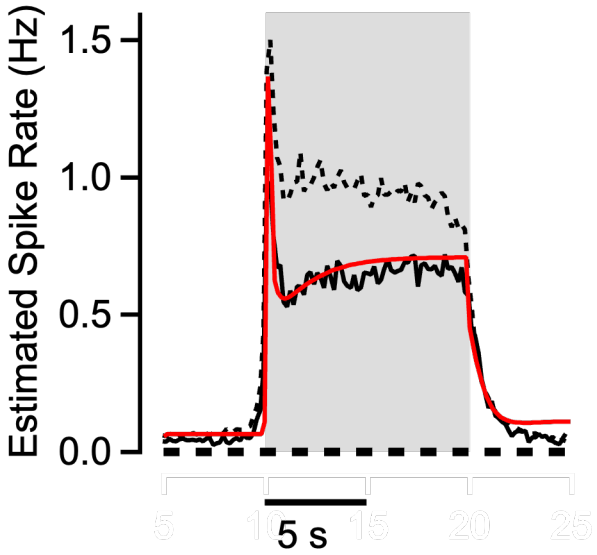

PV
PC

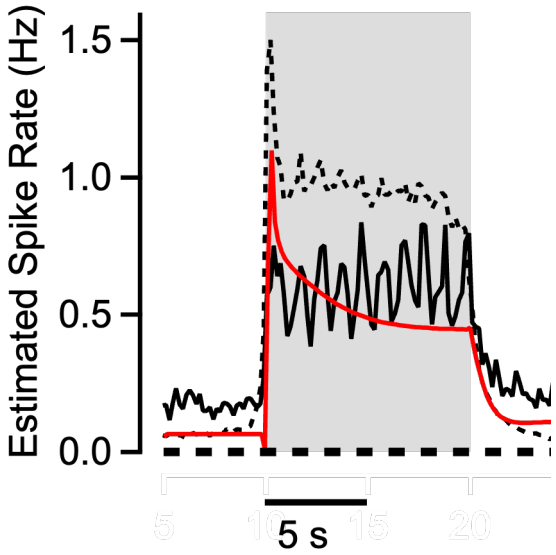

f_pc(t)
f_pc_opto_sst_arch
fit
fit_opto
t

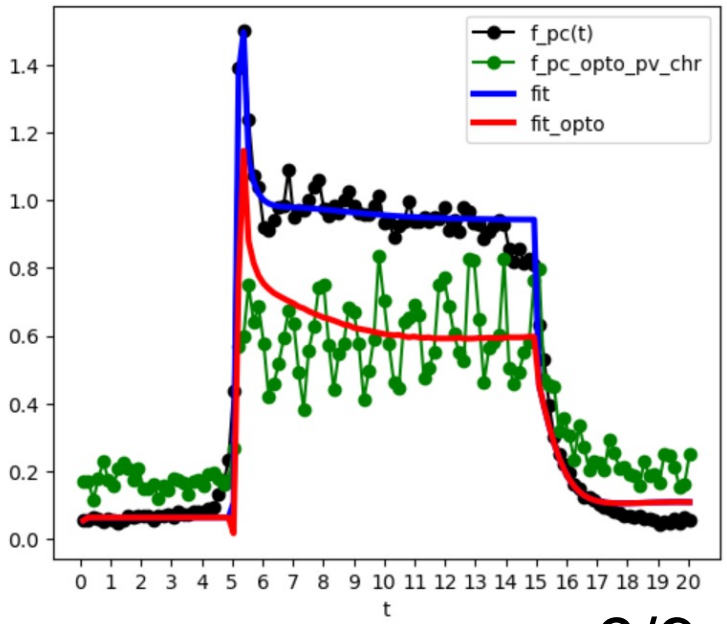

5 s

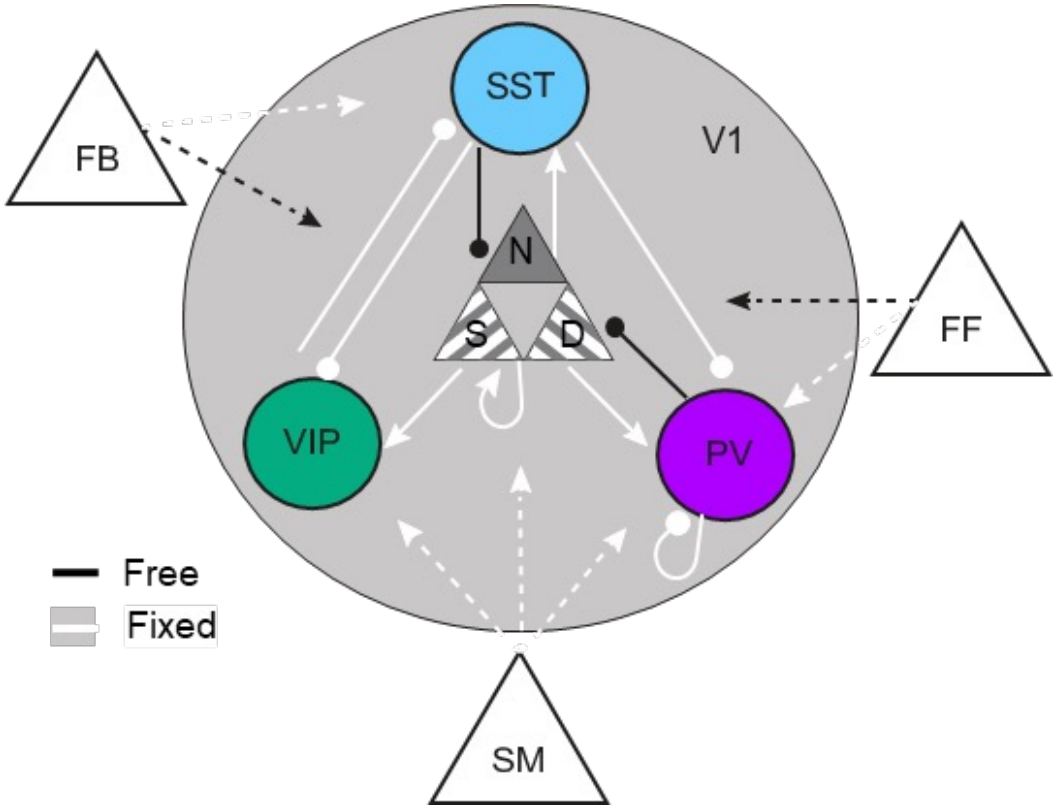

Estimated Spike Rate (Hz)
5 s

Activation


Estimated Spike Rate (Hz)
5 s


Estimated Spike Rate (Hz)
5 s


f_pc(t)
f_pc_opto_pv_chr
fit
fit_opto
t



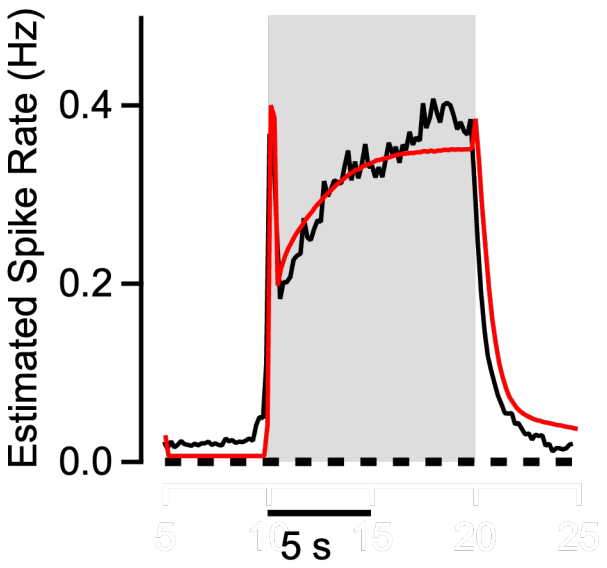
Presynaptic

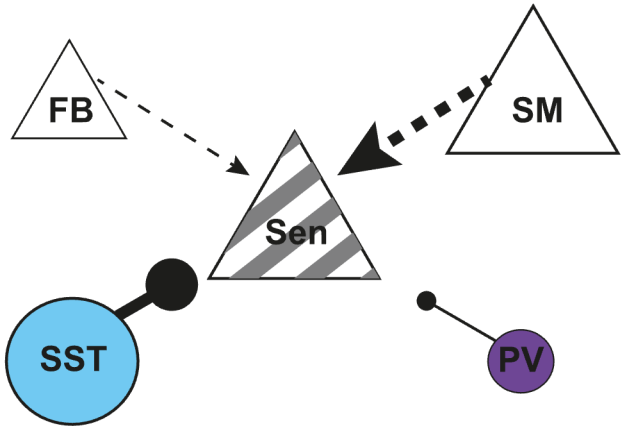
Postsynaptic	SST	PV	FF	FB	SM
Dep (PC)	2.61	2.35	0.71	1.41	1.34
NA (PC)	2.68	2.27	0.84	1.34	1.52
Sen(PC)	2.78	2.20	0.65	1.30	1.65

W_{xy}

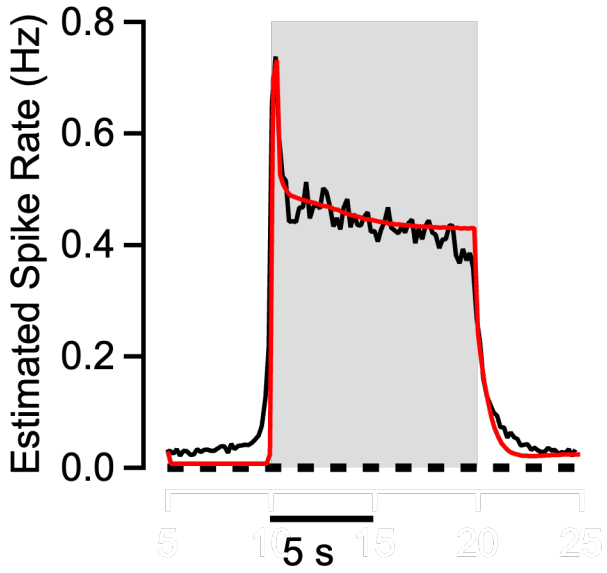
0.5 1.0 1.5 2.0 2.5 3.0

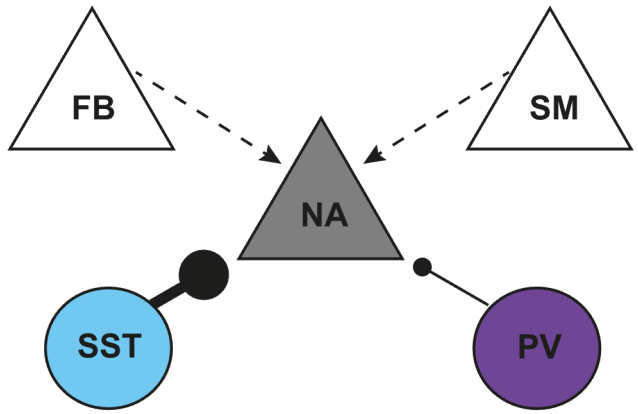
Sensitizers



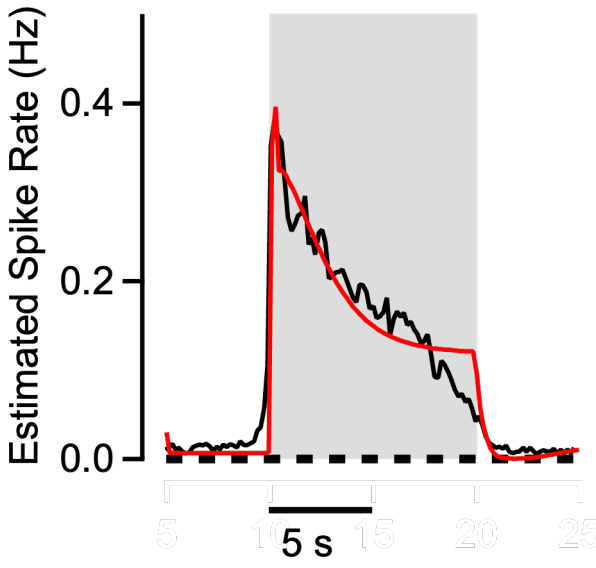


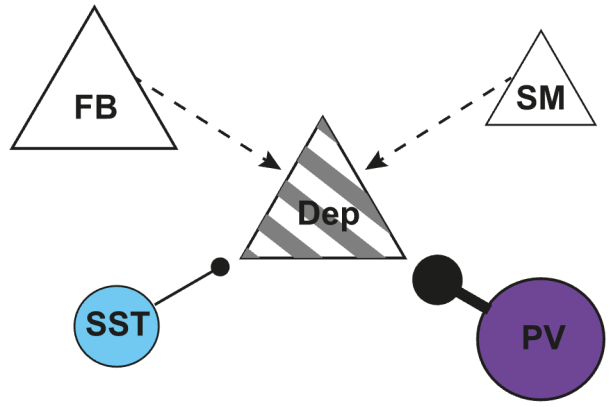
Non-adaptors





Depressors





Summary:

- Model able to describe adaptation
- Model predicts optogenetic manipulation
- Synaptic plasticity matters, but happening outside of network

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Next steps:

- Habituation
- Reward

Acknowledgements

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cara

a lifeline to academics at risk

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