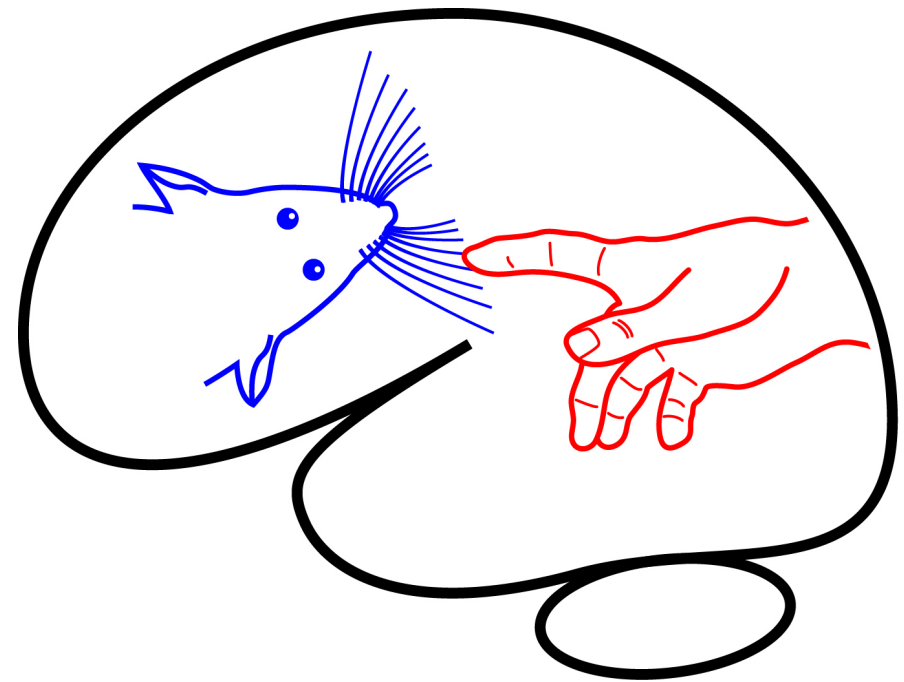# 7.1 Sensorimotor interactions

Cellular Mechanisms of Brain Function
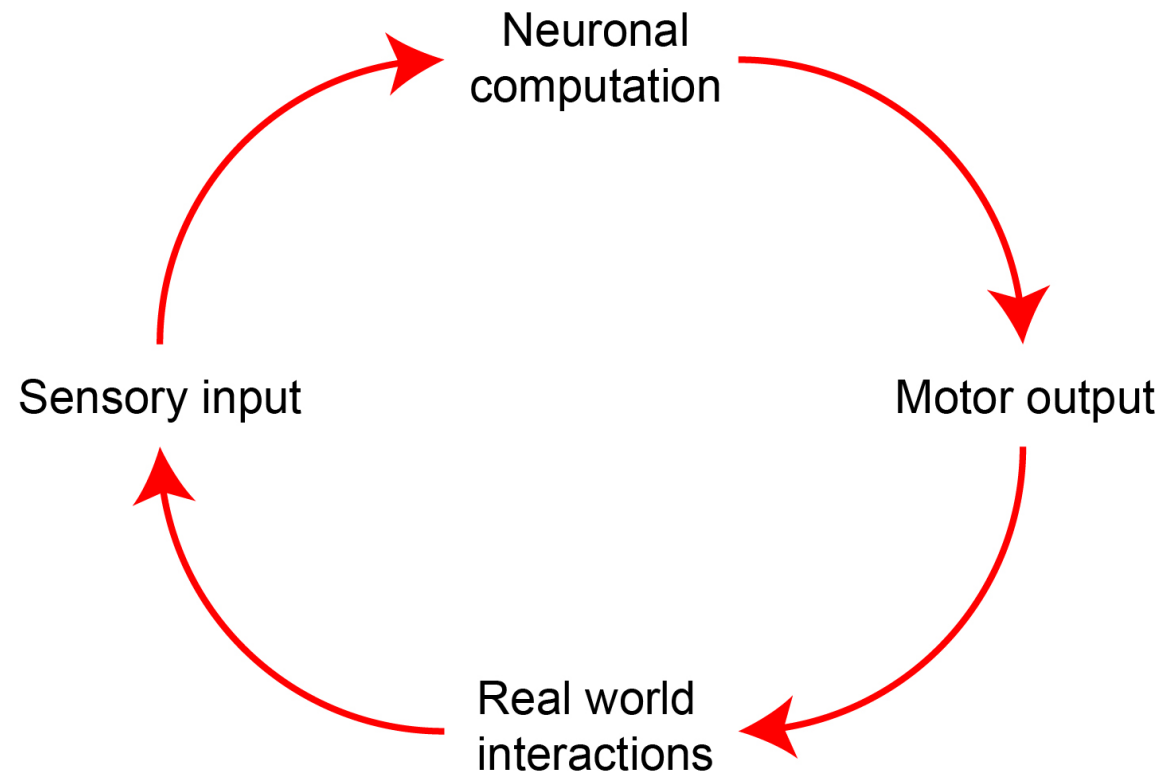
Prof. Carl Petersen

Sensorimotor interactions

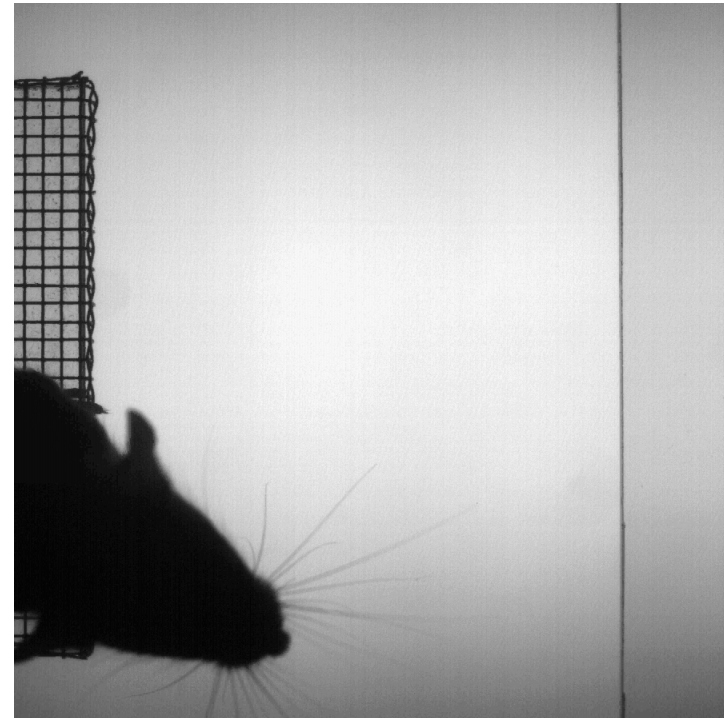# Active sensing

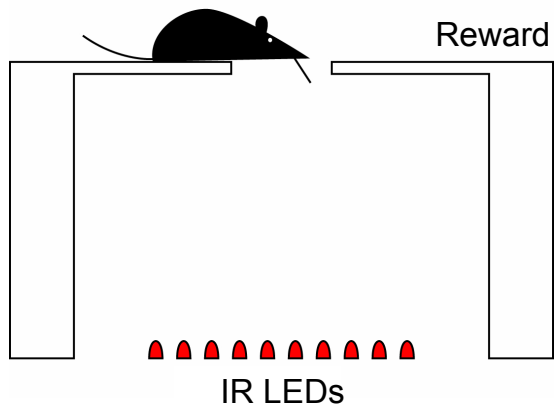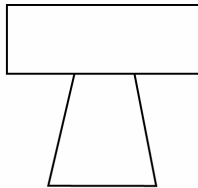**Cellular Mechanisms of Brain Function**

Sensorimotor loops

Neuronal computation

Motor output

Real world interactions

Sensory input

Active whisker sensing

Fast camera
500 Hz

Reward

IR LEDs

Petersen, 2007

Cellular Mechanisms of Brain Function

Active whisker sensing

Fast camera
500 Hz

Reward

IR LEDs
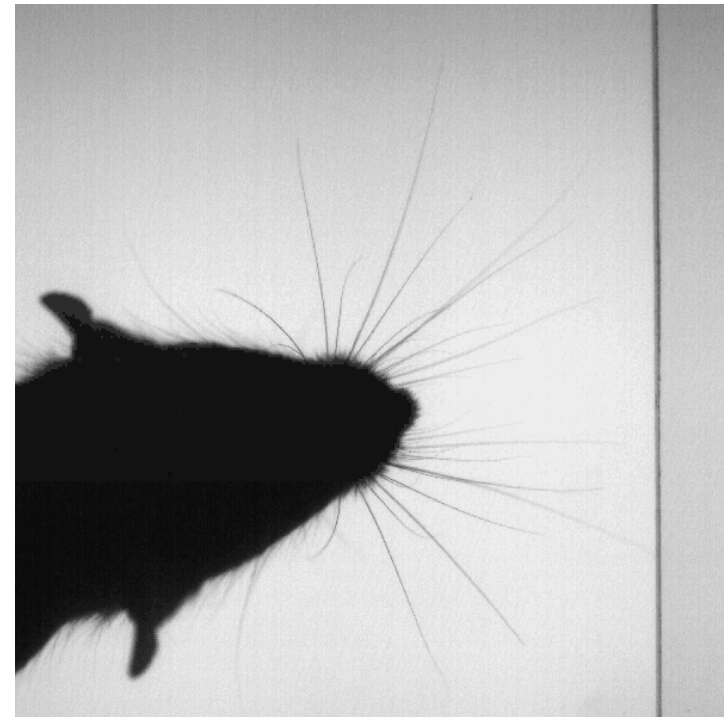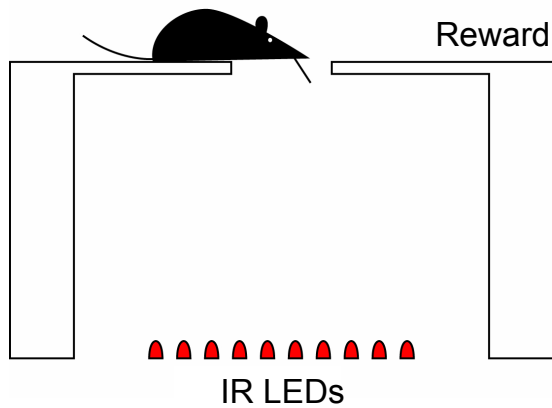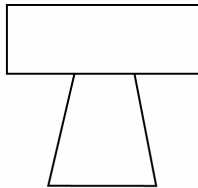
Petersen, 2007

Muscles driving whisker movements

Retraction

Protraction
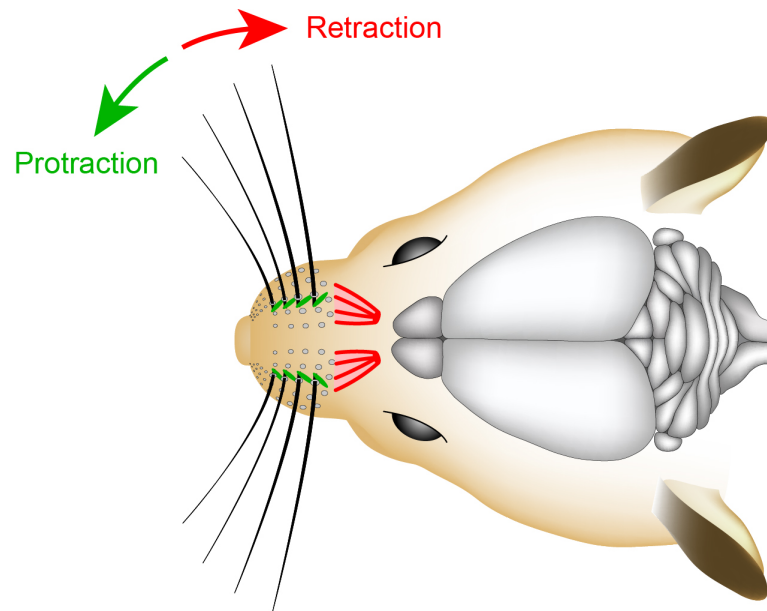
Intrinsic muscles

Extrinsic muscle *nasolabialis*

Anterior

Protraction

Retraction

Whiskers

θ

θ

θ

Follicles

Intrinsic muscle

Extrinsic muscle

Petersen, 2014

Cellular Mechanisms of Brain Function
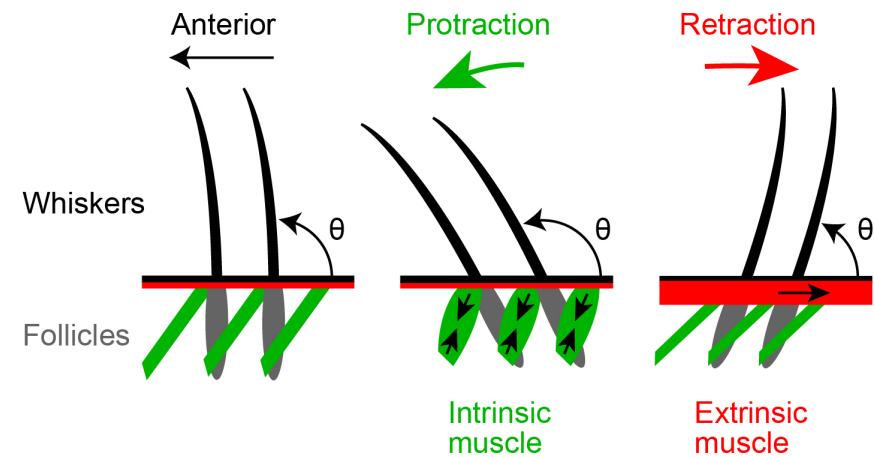
Motor neurons driving whisker movements

Rabies-ΔG-mCherry in extrinsic muscle

Nasolabialis

C3 C4
C2

Rabies-ΔG-GFP in intrinsic muscle

500 µm

C1 C2 C3

FN

Rabies-ΔG

Rabies-ΔG

Nasolabialis (extrinsic)

Follicular (intrinsic)

Bregma: -6 mm

FN

500 µm
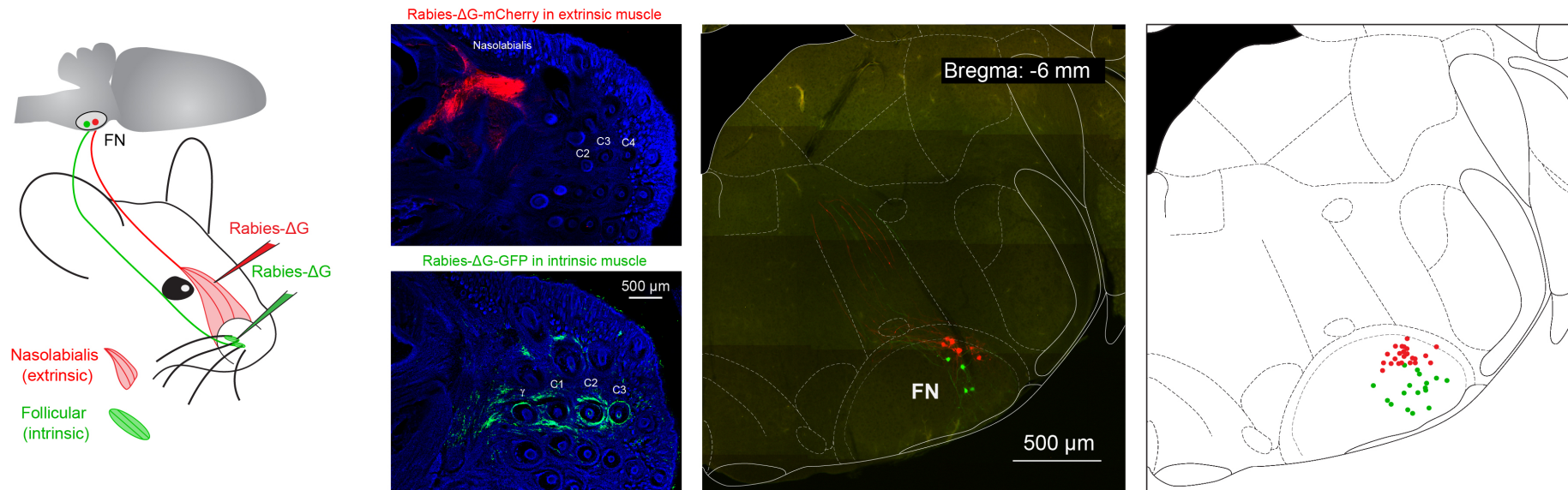
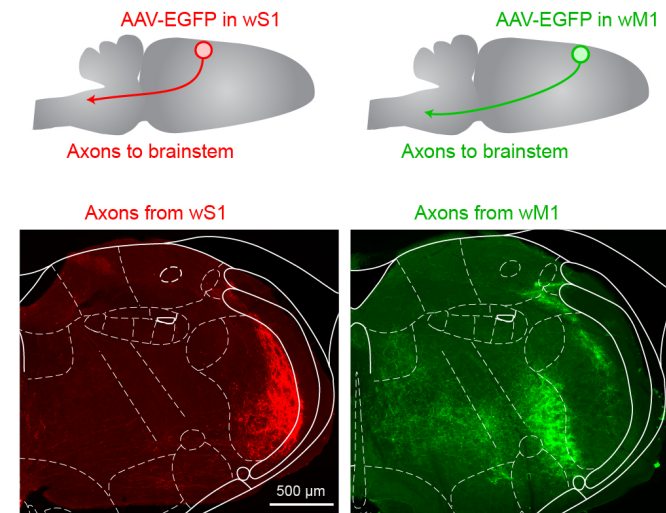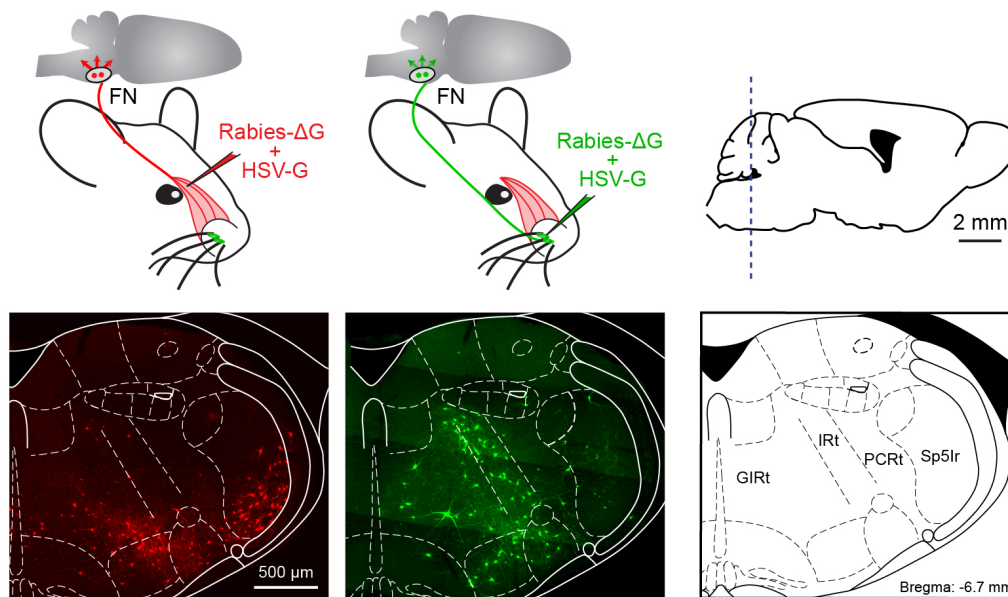*Sreenivasan, Karmakar, Rijli and Petersen, 2015*

Mapping premotor neurons
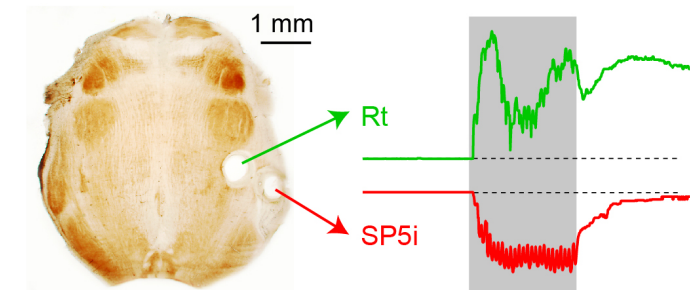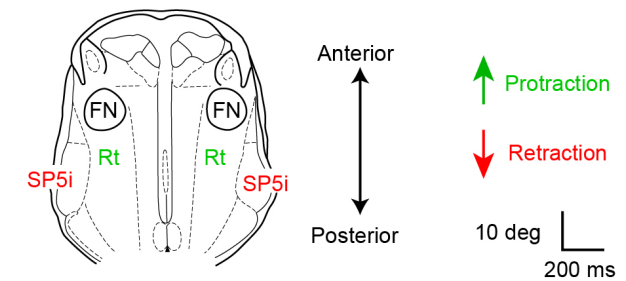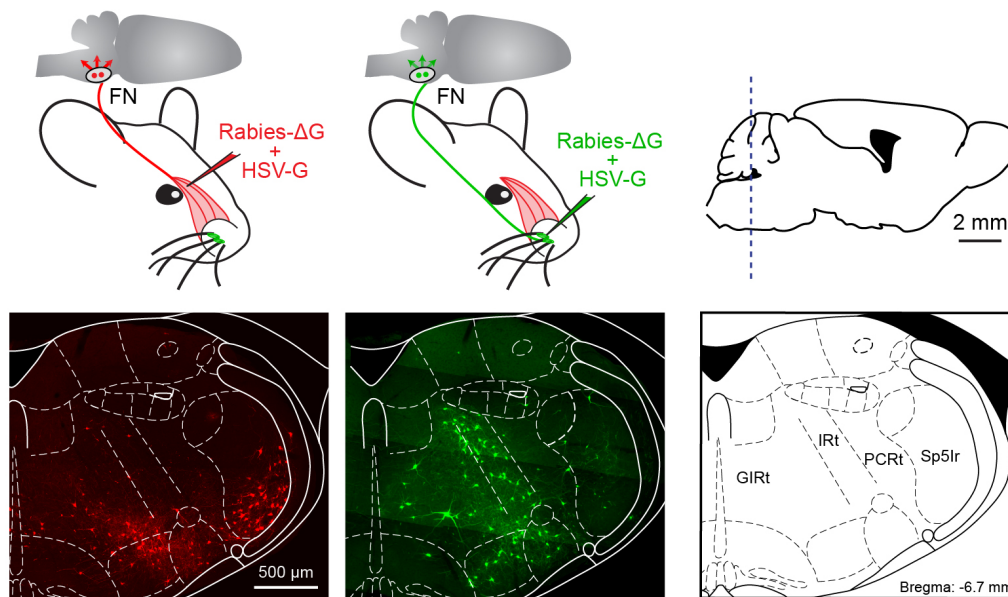
Sreenivasan, Karmakar, Rijli and Petersen, 2015
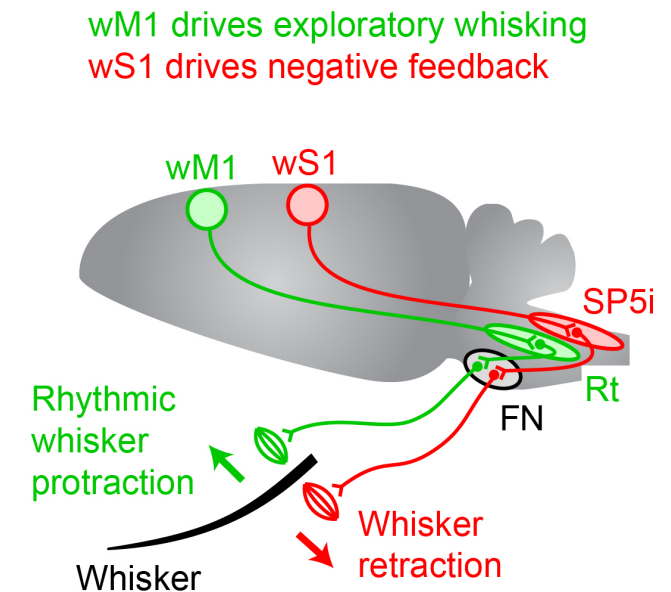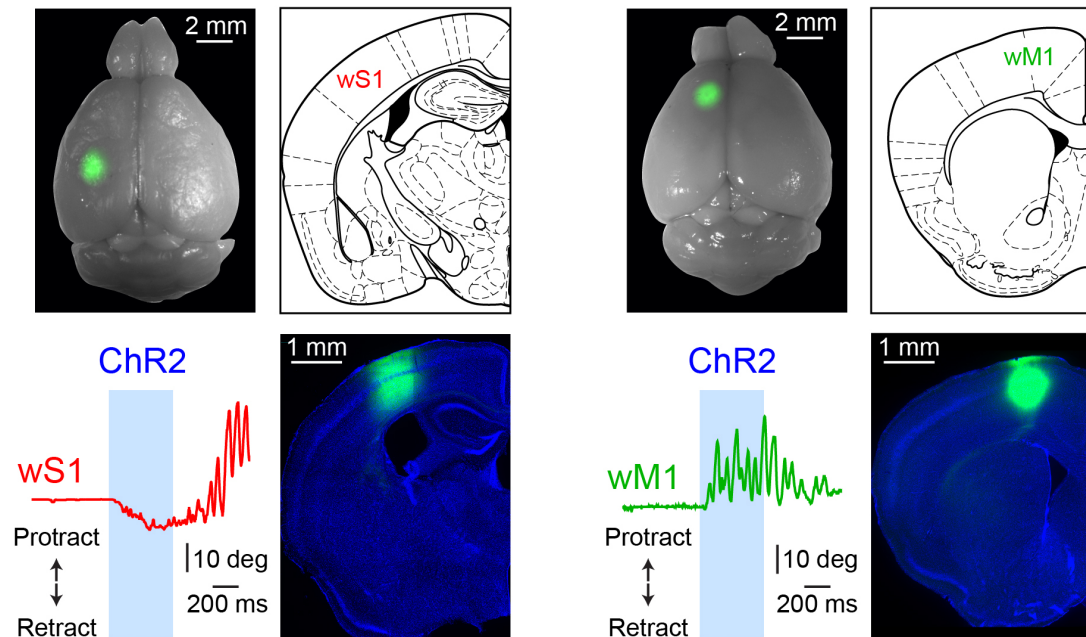Matyas, Sreenivasan, Marbach, Wacongne, Barsy, Mateo, Aronoff and Petersen, 2010

Cortical projections to brainstem

FN

Rabies-ΔG + HSV-G

FN

Rabies-ΔG + HSV-G

2 mm

GIRt   IRt   PCRt   Sp5Ir

Bregma: -6.7 mm

500 µm

AAV-EGFP in wS1

Axons to brainstem

AAV-EGFP in wM1

Axons to brainstem

Axons from wS1

Axons from wM1

500 µm

Sreenivasan, Karmakar, Rijli and Petersen, 2015

Cellular Mechanisms of Brain Function

Cortical control of whisker movement

ChR2

wS1

Protract

Retract

|10 deg
200 ms

ChR2

wM1

Protract

Retract

|10 deg
200 ms

wM1 drives exploratory whisking
wS1 drives negative feedback

wM1   wS1

SP5i

Rhythmic
whisker
protraction

Rt

FN

Whisker
retraction
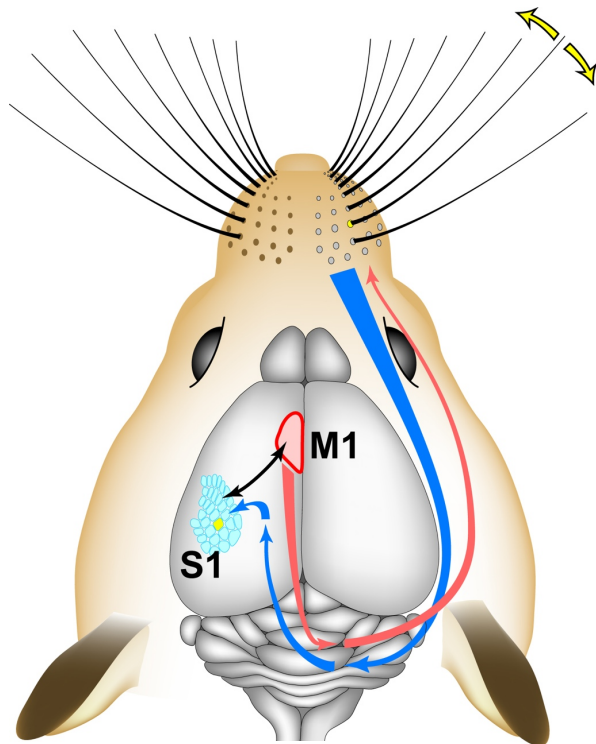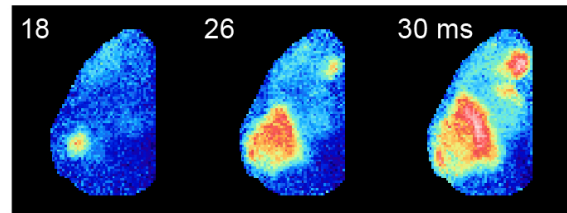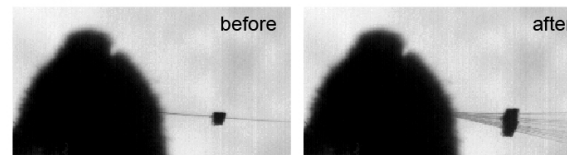
Whisker

Sreenivasan, Karmakar, Rijli and Petersen, 2015
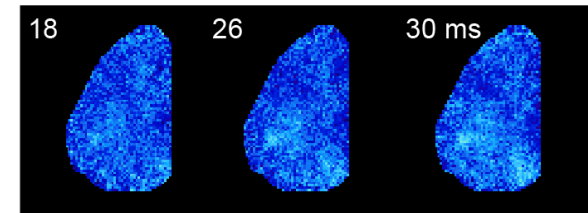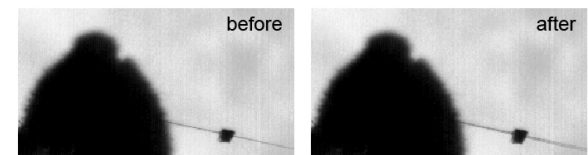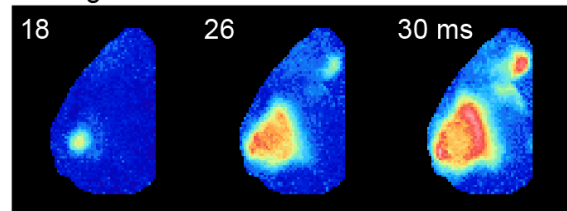*Matyas, Sreenivasan, Marbach, Wacongne, Barsy, Mateo, Aronoff and Petersen, 2010*

Cellular Mechanisms of Brain Function

A cortical sensorimotor loop

Single trial

before   after

18   26   30 ms

Averaged trials

18   26   30 ms

Single trial

before   after

18   26   30 ms

Averaged trials

18   26   30 ms
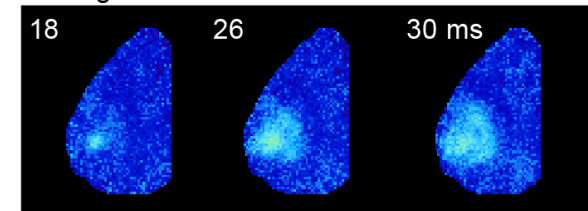
Ferezou, Haiss, Gentet, Aronoff, Weber and Petersen, 2007

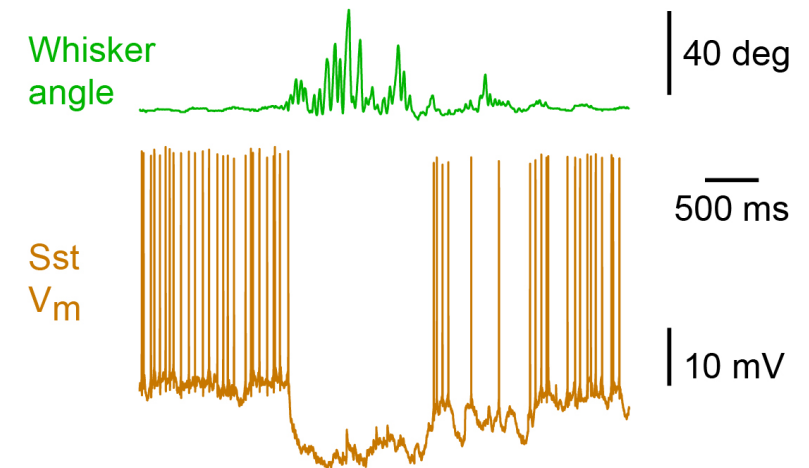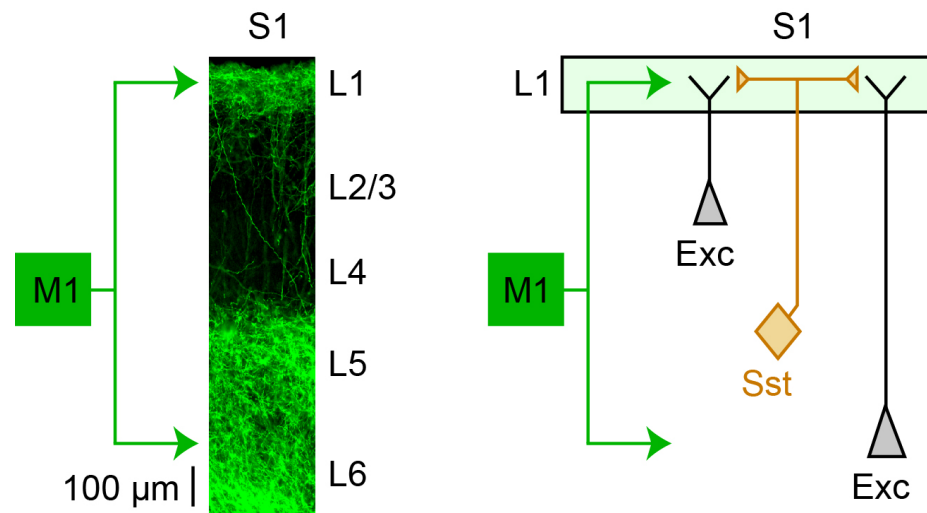**Cellular Mechanisms of Brain Function**

Active touch
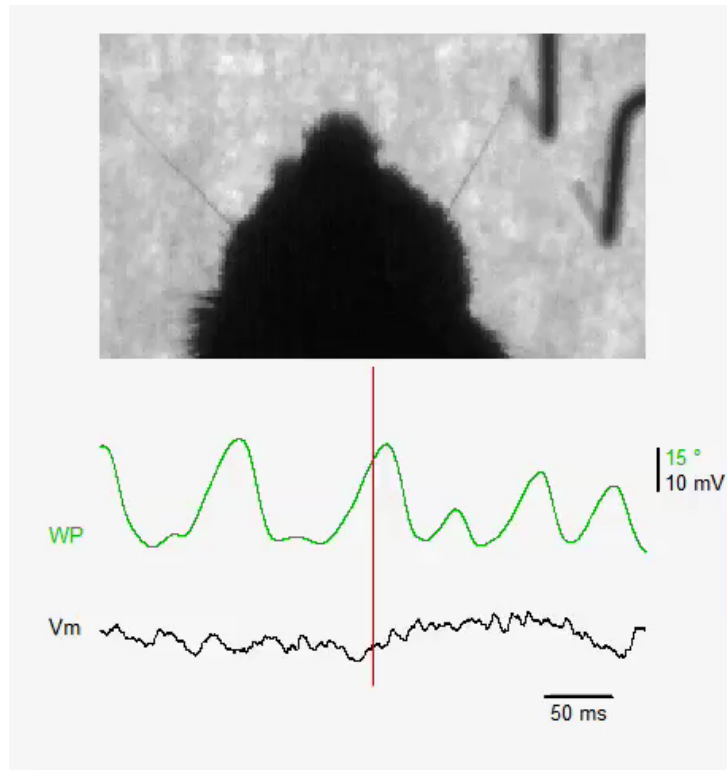
Crochet, Poulet, Kremer and Petersen, 2011
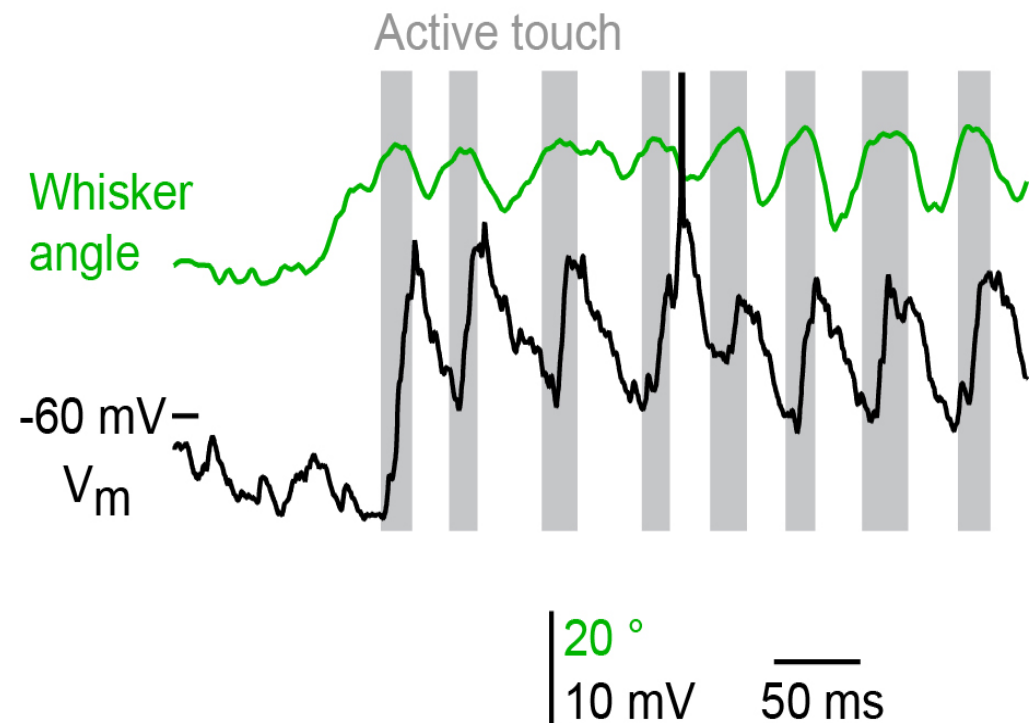
Cortical sensorimotor integration

Gentet, Kremer, Taniguchi, Huang, Staiger and Petersen, 2012

Cellular Mechanisms of Brain Function

Sensorimotor interactions

- Understanding motor control is fundamental to understanding any form of behavior.

- Sensory information is essential for guiding motor commands, and sensory stimuli can initiate sensorimotor loops.

- Sensory information is often actively and selectively acquired.