

# **Sensation, movement and learning in the absence of barrel cortex**

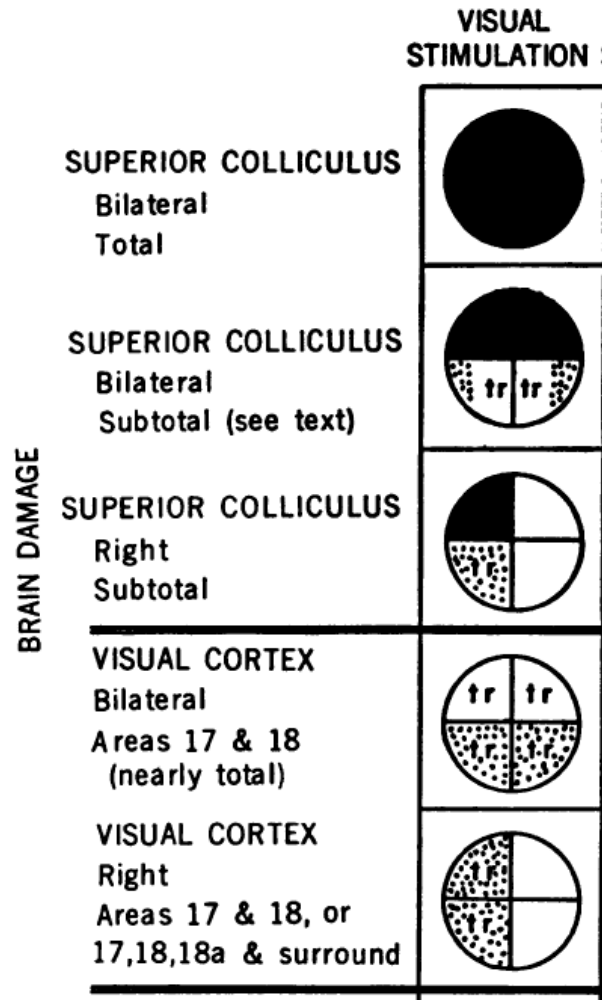
Hong et al., 2018, *Nature*  
(*Bruno lab*)

Sur lab Journal Club, 03/28/19

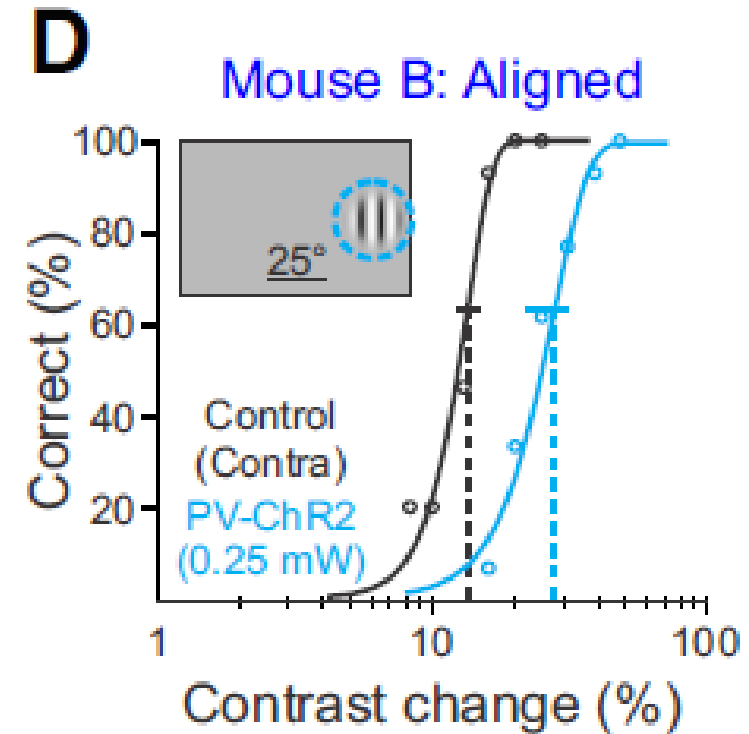
***What is the role of cortex?***

# What is the role of cortex?

## Vision



Schneider, 1969



Glickfield et al, 2013

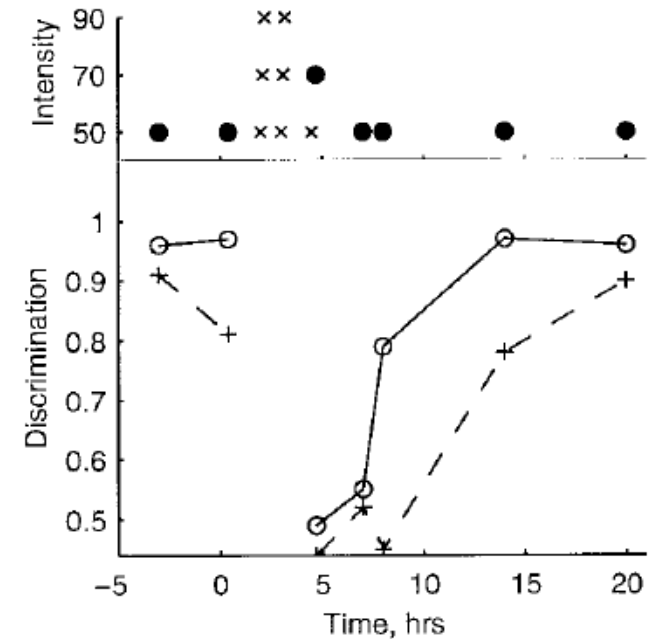
# What is the role of cortex?

## Audition

### Ablation

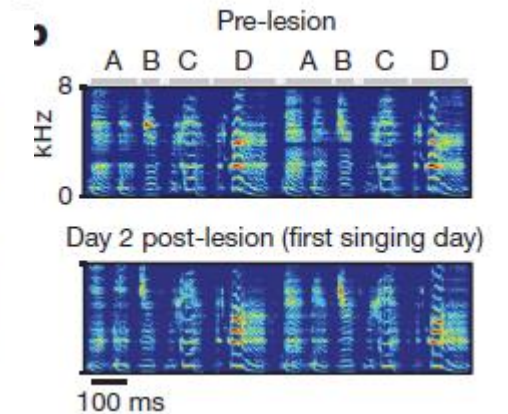
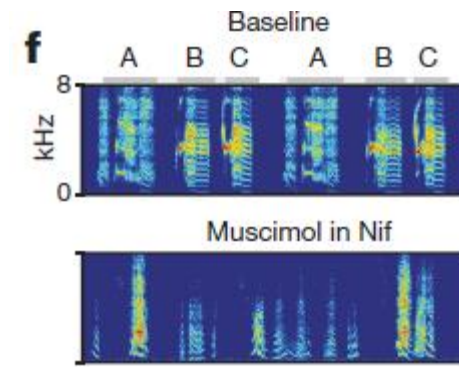
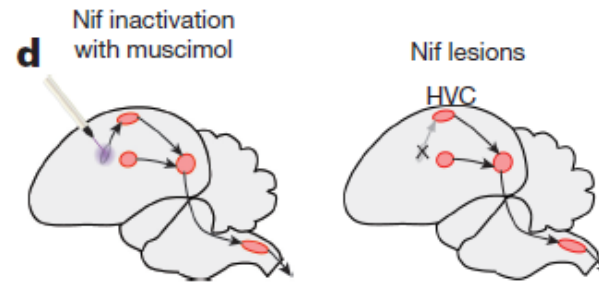
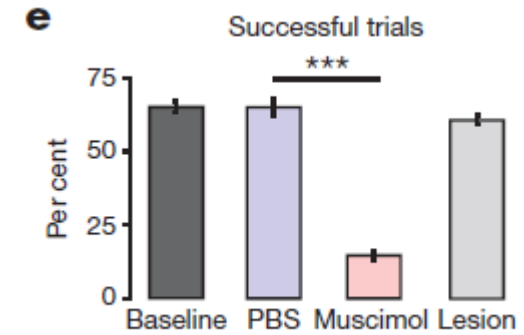
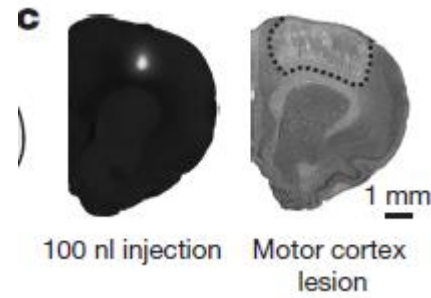
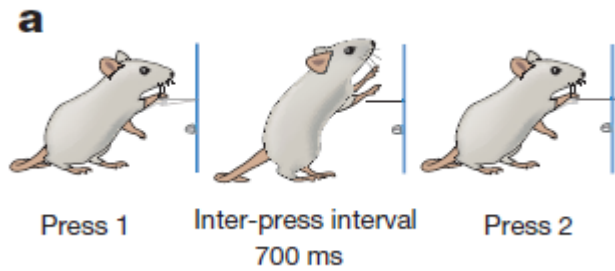
- **Simple pitch discriminations** not affected by bilateral auditory ablations.
- **Sound detection:** none in many species, moderate deficit in primates and humans

### Muscimol inactivation



# What is the role of cortex?

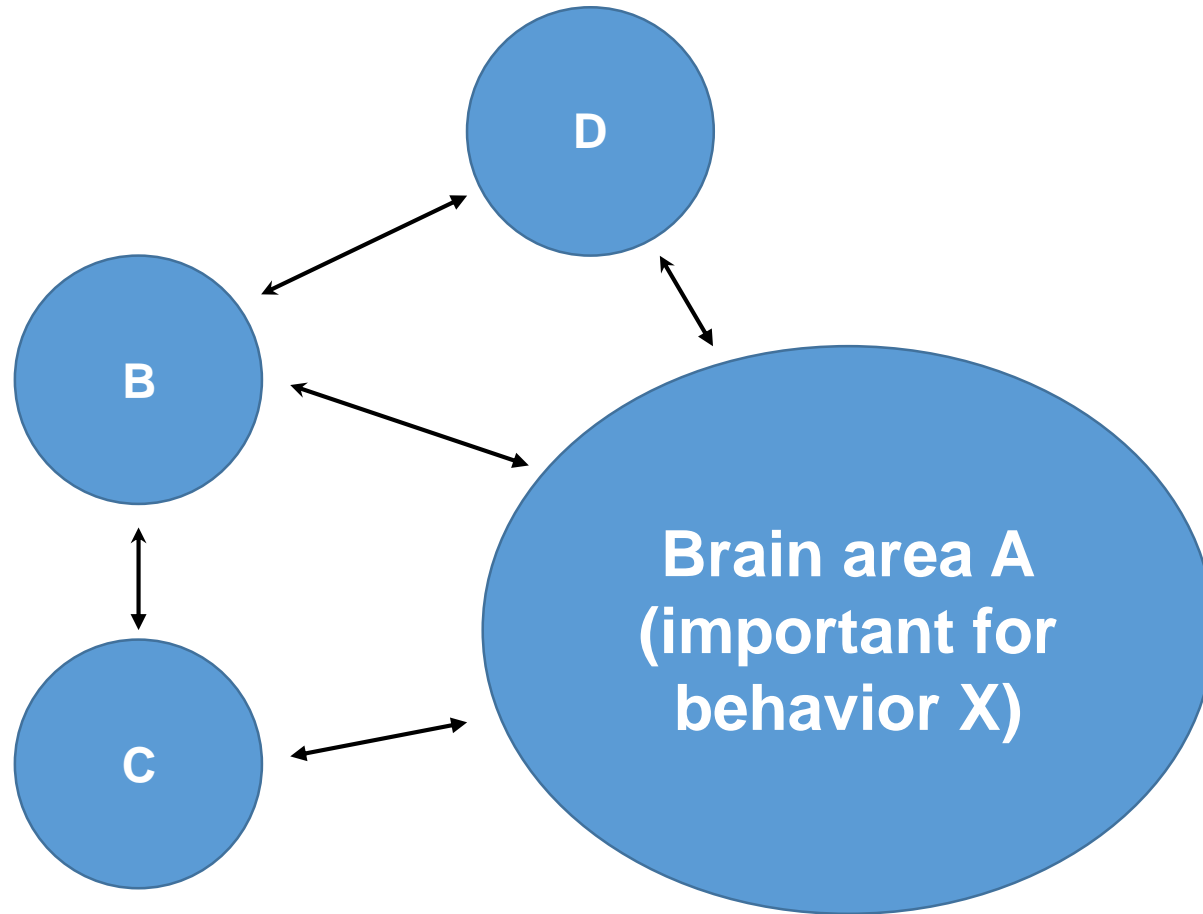
## Motor



# Possible causes of these conflicting results

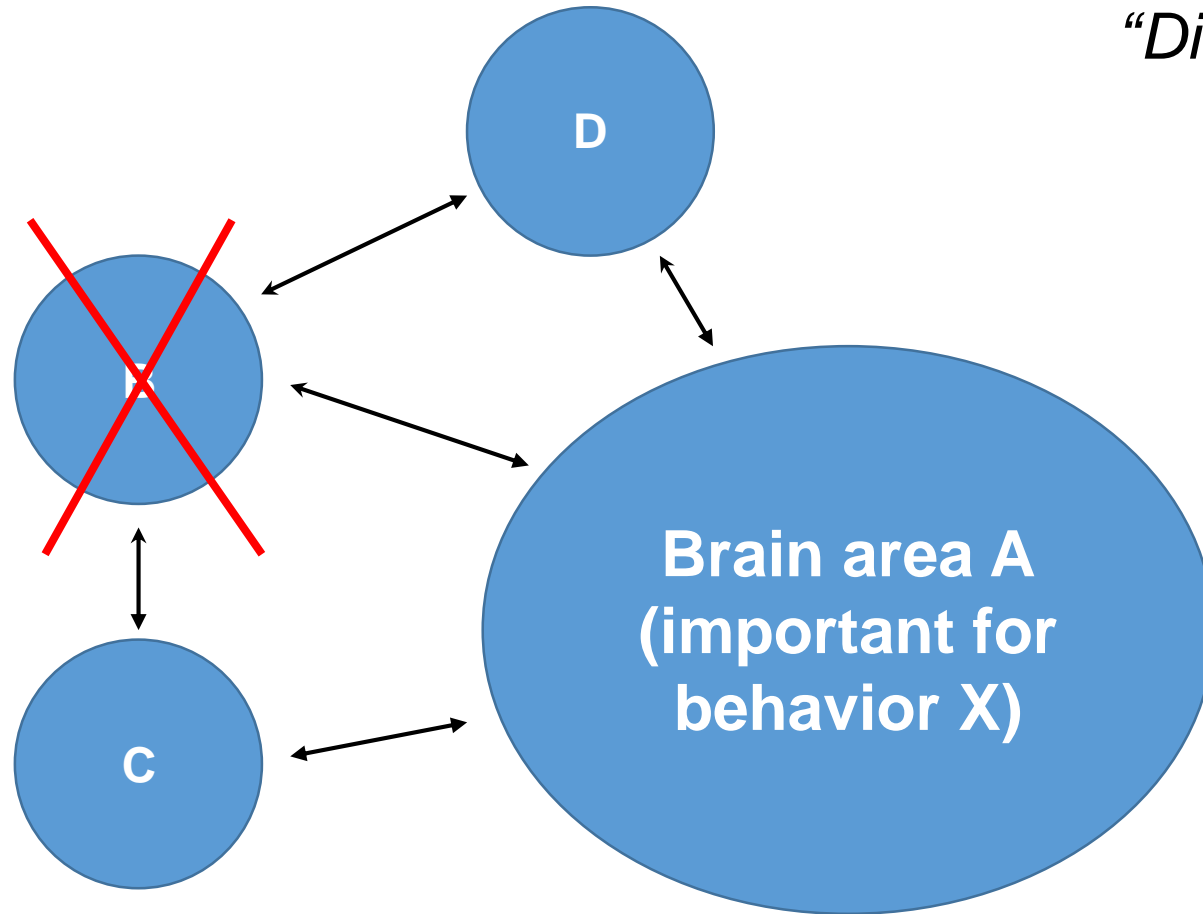
1. Redundancy / Compensatory learning or rewiring
2. Off-target disruption of important brain areas for the task

# Off-target disruption



*Normal behavior*

# Off-target disruption



*“Diaschisis”*

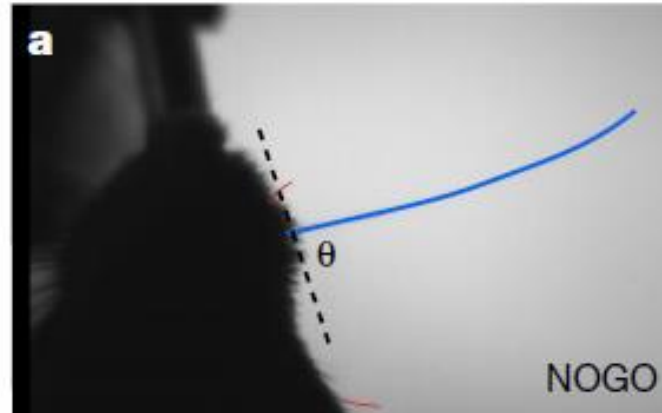
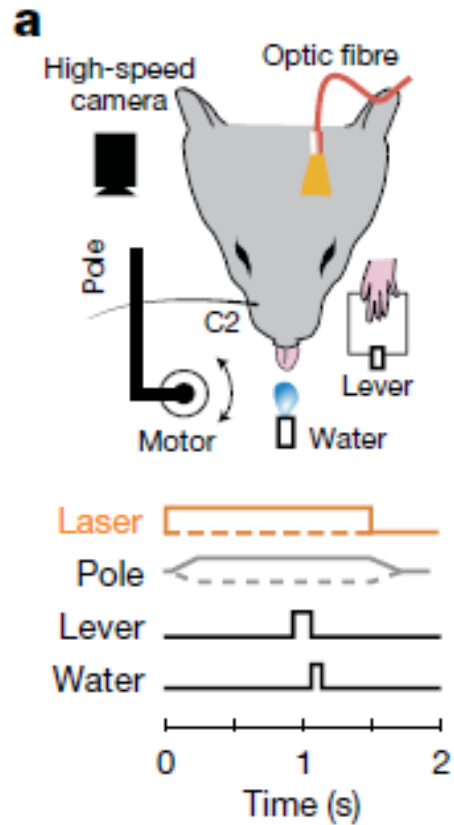
*Disrupted behavior*



# Main claims

1. Transient optogenetic inactivation of barrel cortex impairs whisker-mediated detection.
  - Impairment is caused by decreased whisker movement and increased detection threshold.
2. Lesion of barrel cortex initially impairs performance, but performance quickly recovers.
3. Barrel cortex is not required for learning the task.

# Behavioral task



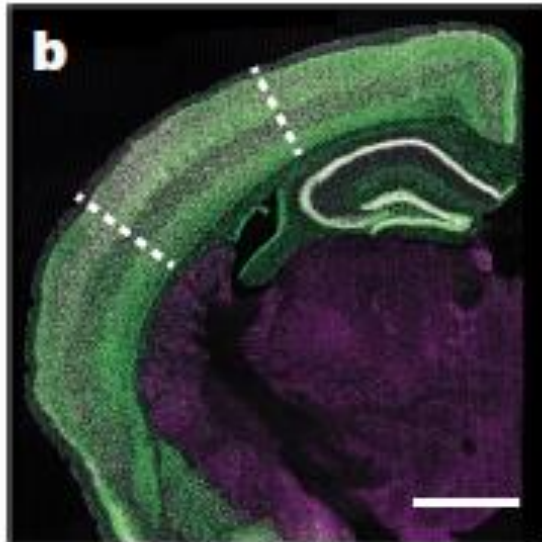
Pole not detected → **NOGO**



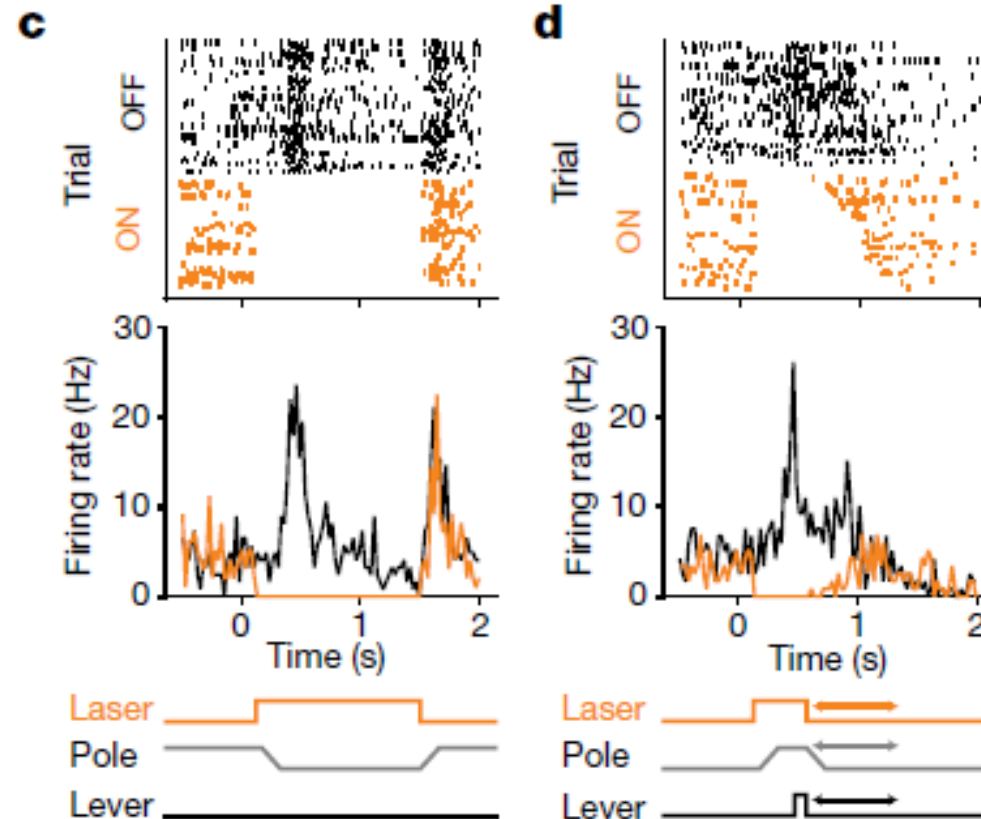
Pole detected → **GO**

# 1. Transient inactivation of barrel cortex

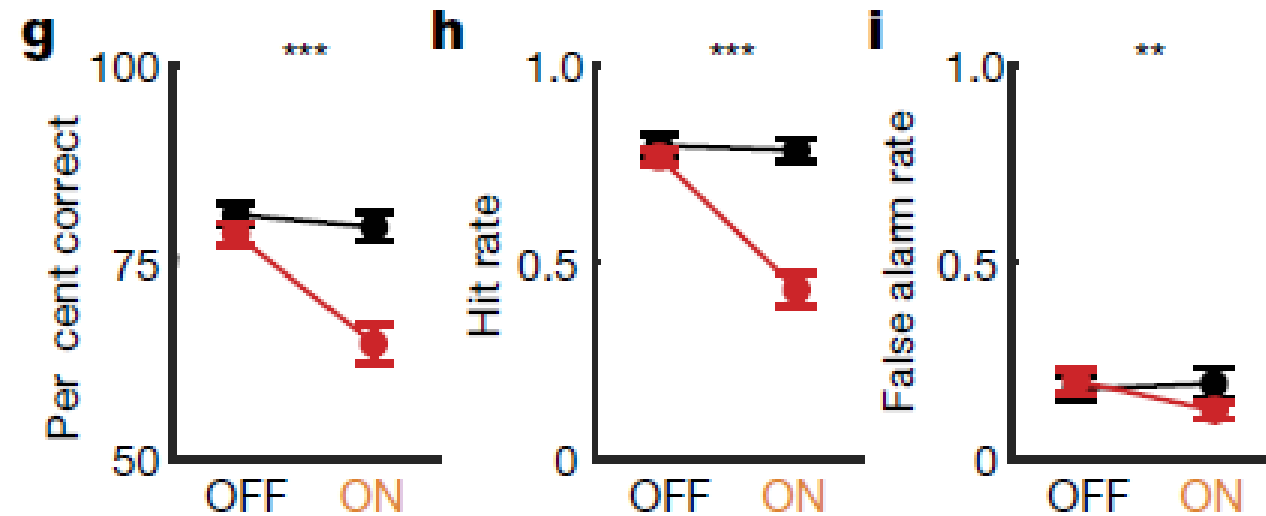
**Method:** express Halo in cortical excitatory neurons



Emx1-GFP mouse brain



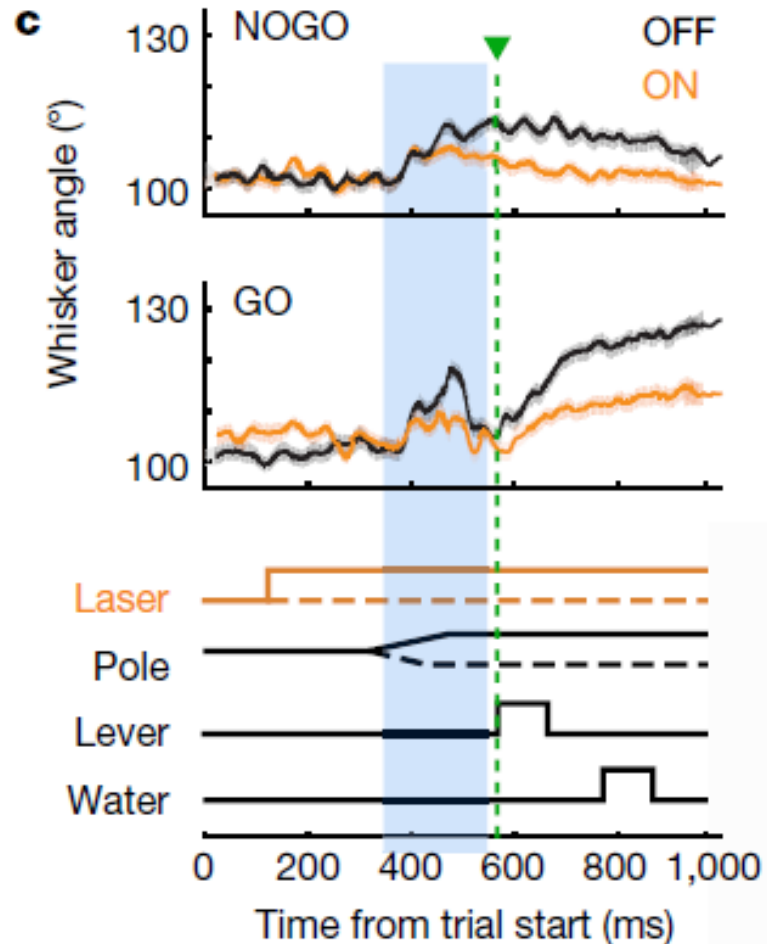
# Transient inactivation of barrel cortex impairs performance



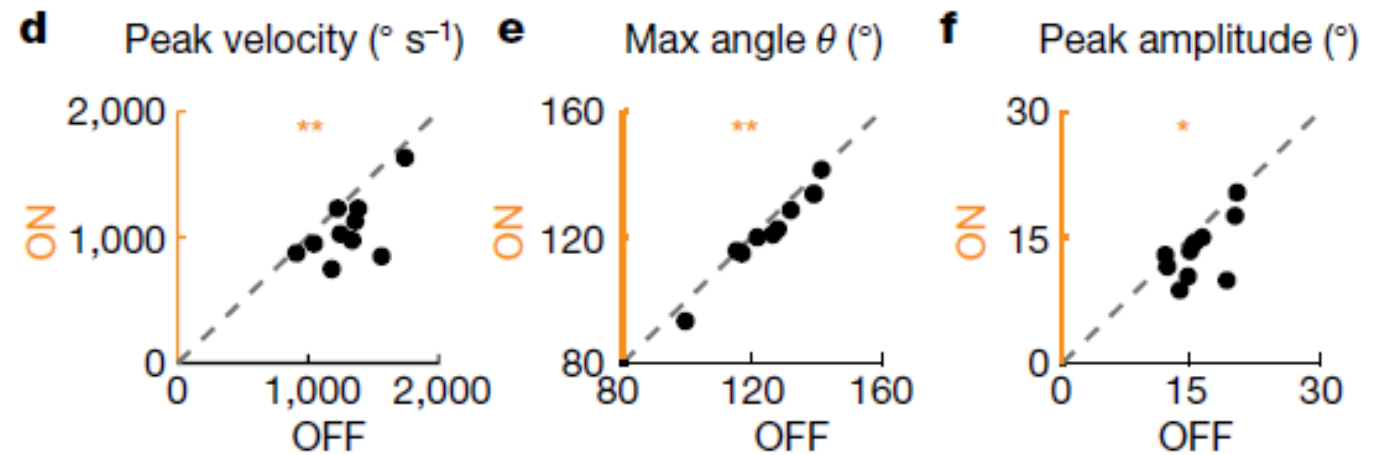
Barrel cortex inactivation reduced overall performance

Performance is still above chance.

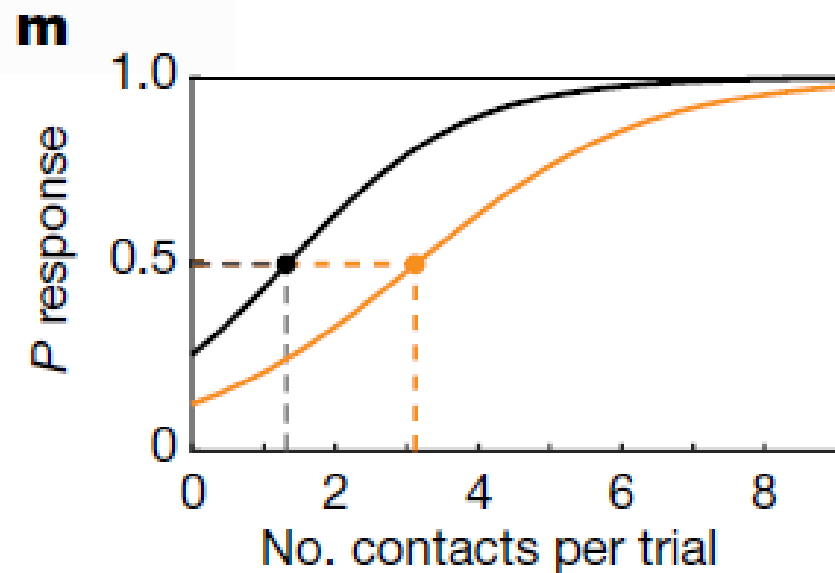
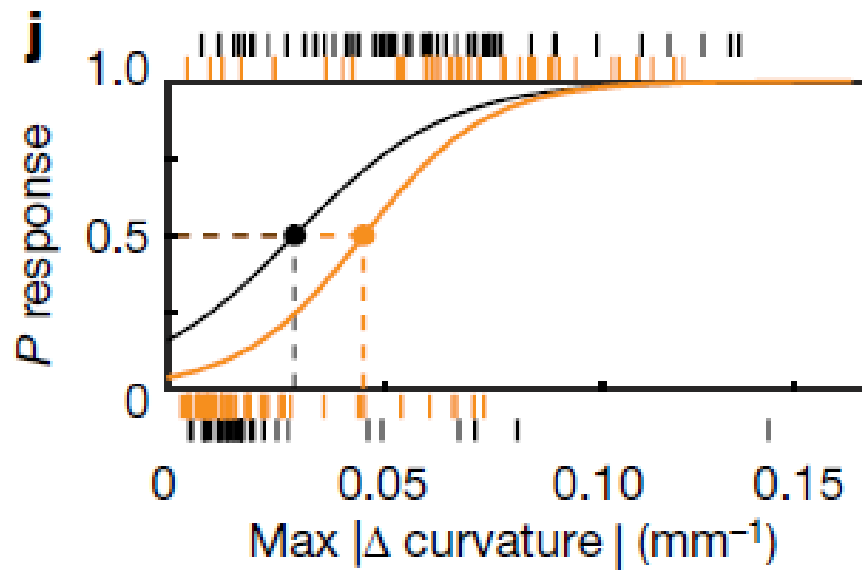
# Transient inactivation alters whisking kinematics



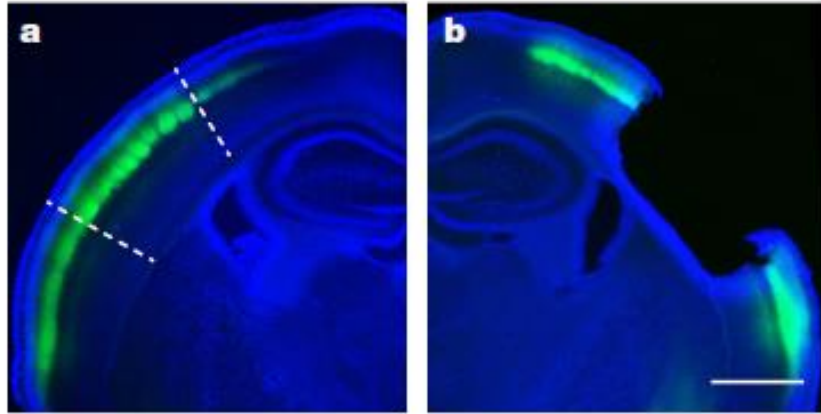
Barrel cortex inactivation results in decreased velocity, max angle and peak amplitude of whisking



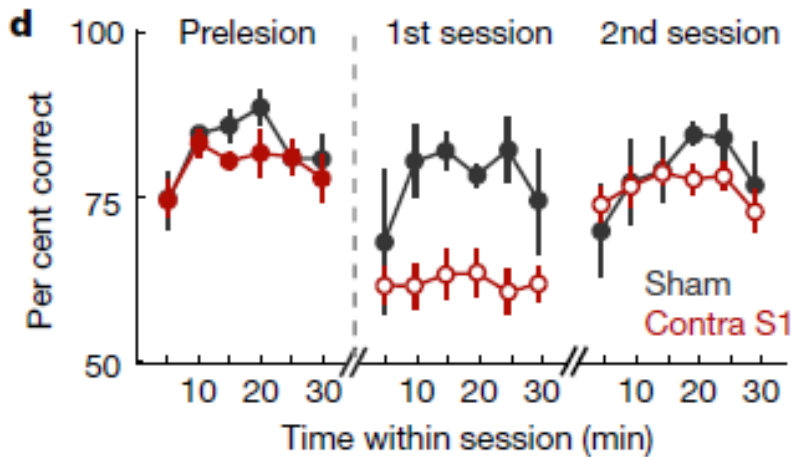
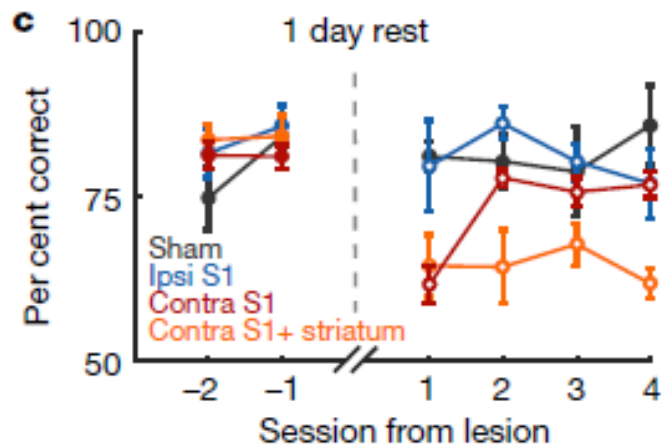
# Transient inactivation increases detection threshold



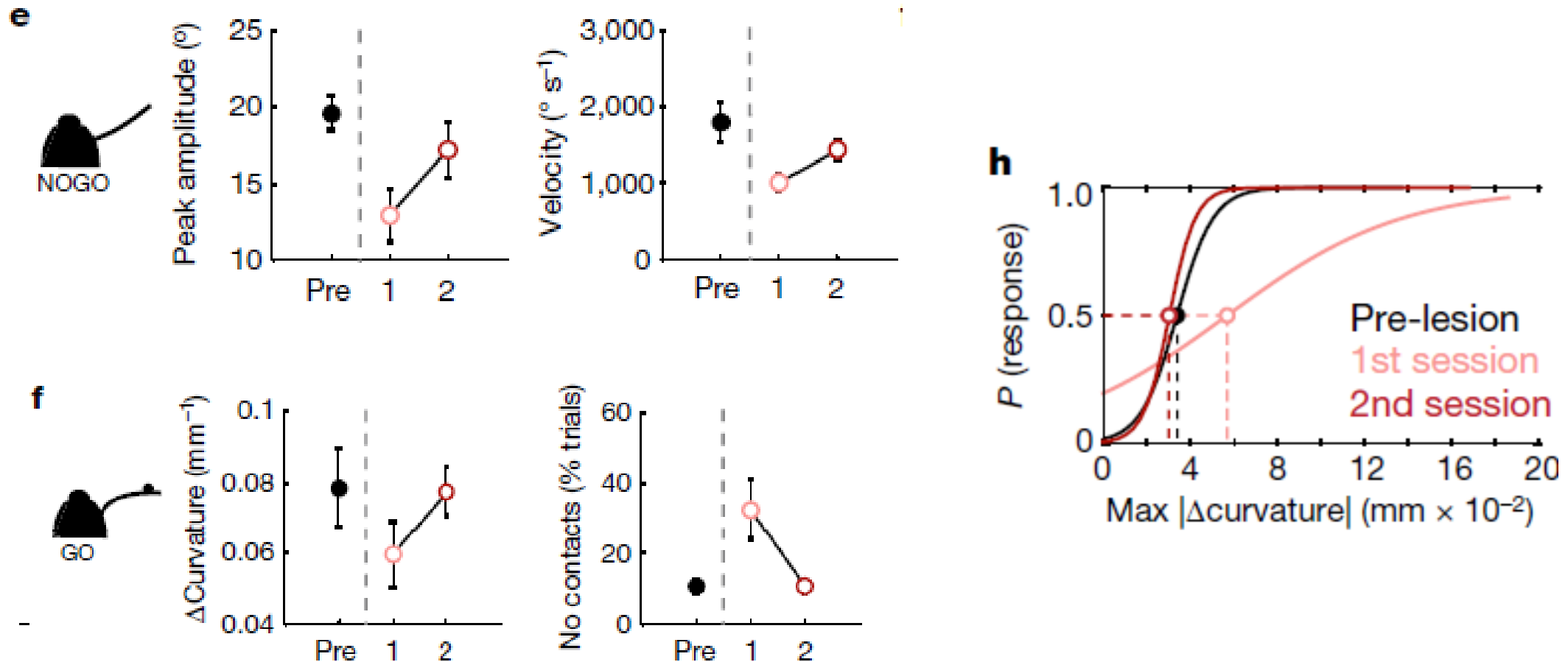
## 2. Performance recovers after permanent barrel cortex lesion



Recovery was abrupt between first and second post-lesion sessions

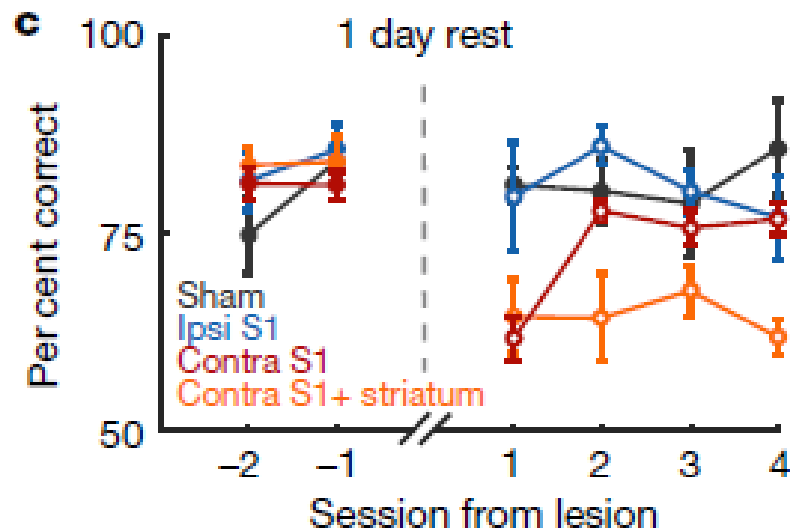


# Recovery in both motor kinematics and sensory threshold

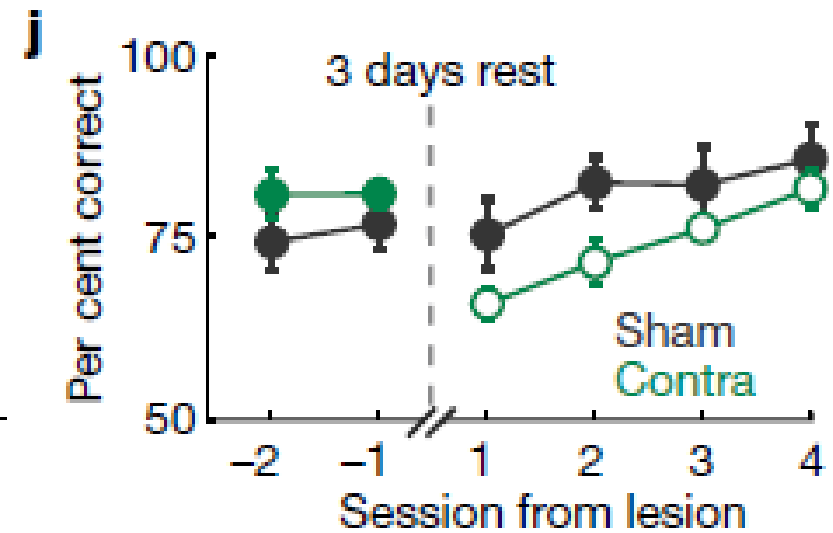




# Recovery requires re-exposure to the task

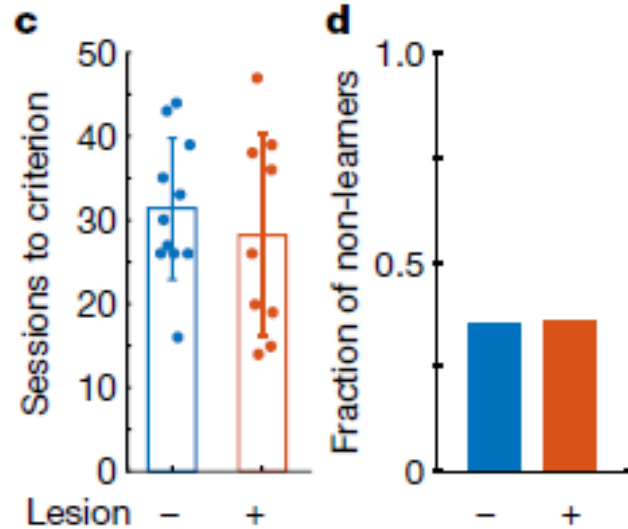
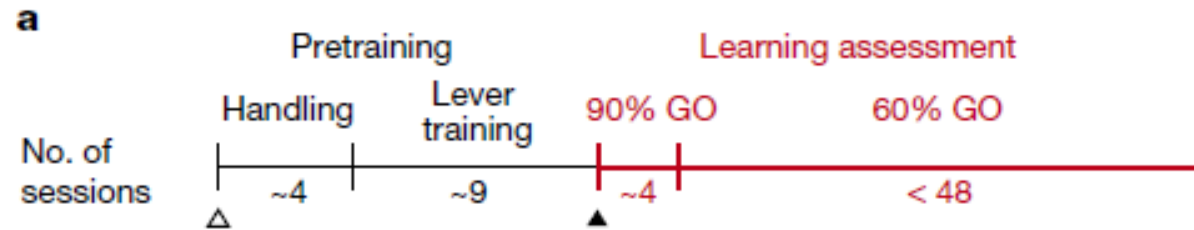


1-day rest after lesion



3-day rest after lesion

### 3. Barrel cortex is not required for learning the task



# Discussion

- Tricky to establish causality
- Impairment after transient inactivation does not absolutely indicate necessity
  - ***Possibility 1***: Other redundant structures
  - ***Possibility 2***: Sudden loss of barrel cortex has off-target effects (diaschisis)

# Discussion

## *What is the role of cortex?*

“... behavioral conditions for which cortex is indispensable might involve more complex discrimination, egocentric or allocentric context, working memory.”