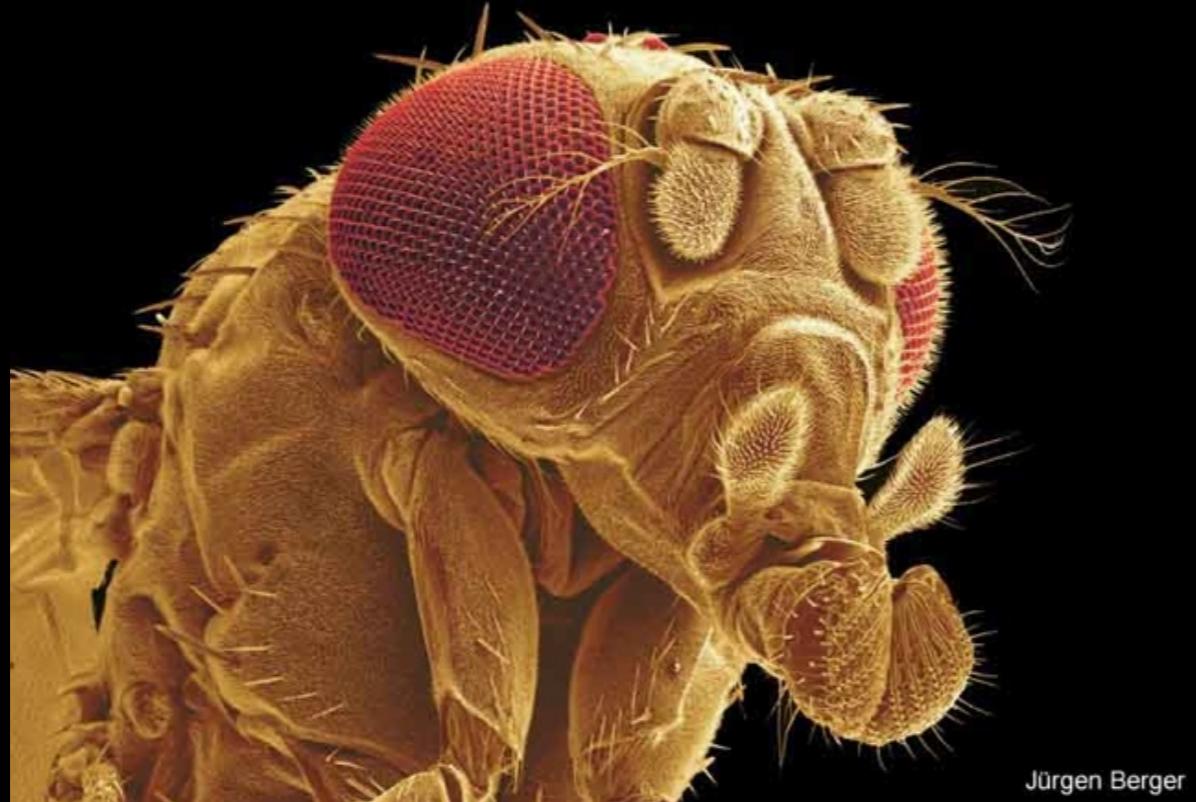


Recognition / Familiarity Memory in Flies

Daisuke Hattori, Yoshinori Aso, Kurtis Swartz,
Gerald Rubin, Larry Abbott, Richard Axel (2017)



Jürgen Berger

- Standing (1973)
- Miller, Li, Desimone (1991)
- Li, Miller, Desimone (1993)
- Xiang, Brown (1998)

Daisuke's Dog

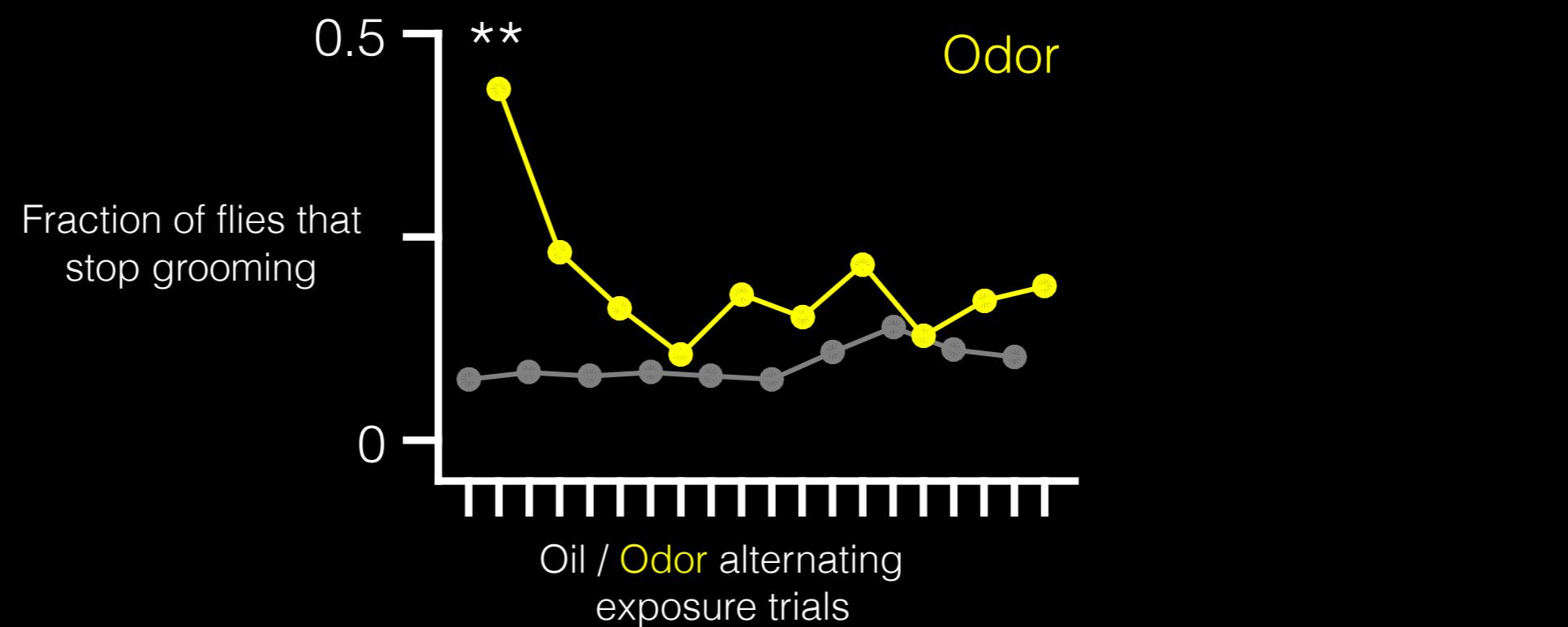


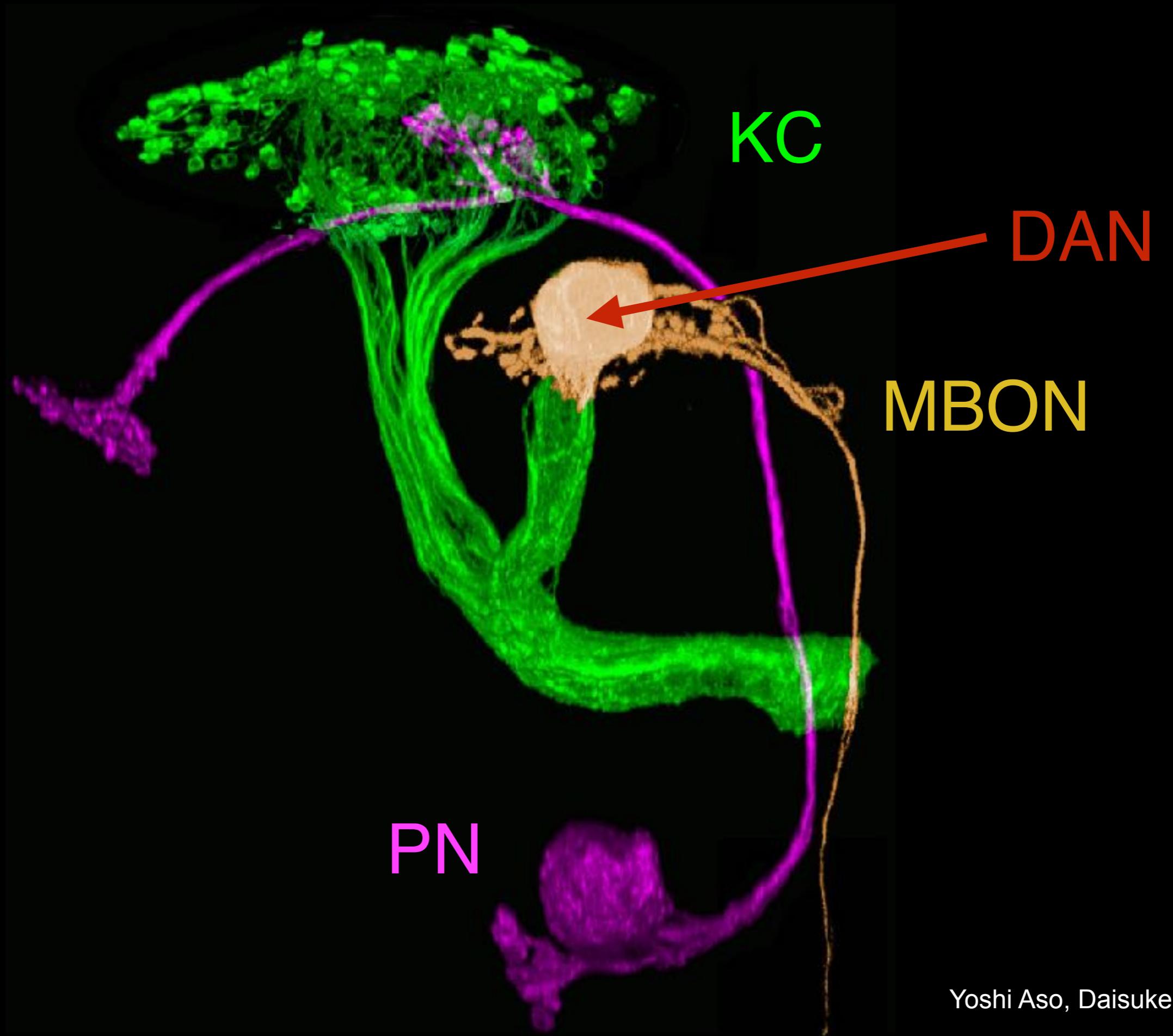


Odor-less solvent
exposure

Odor exposure 1

Odor exposure 2

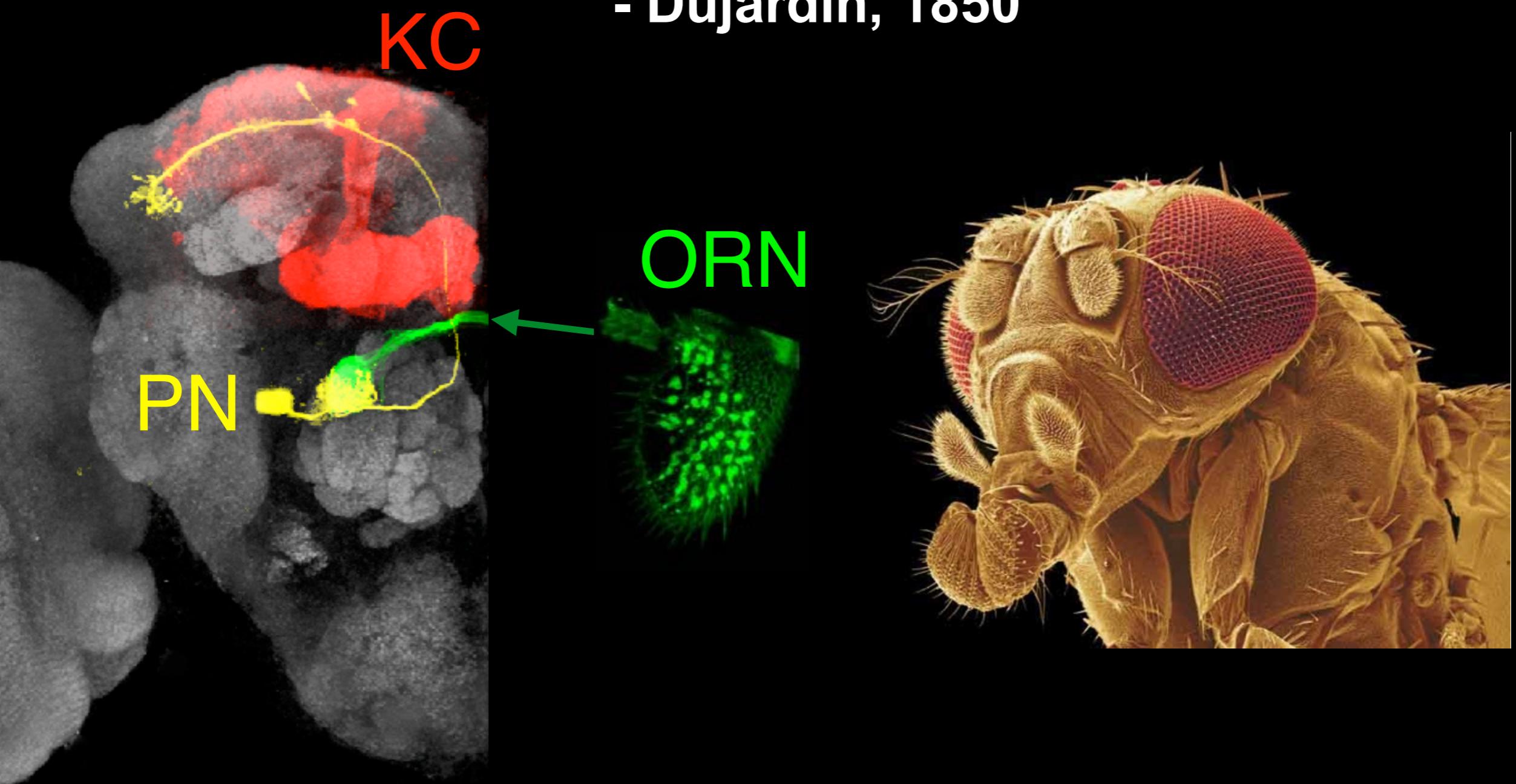


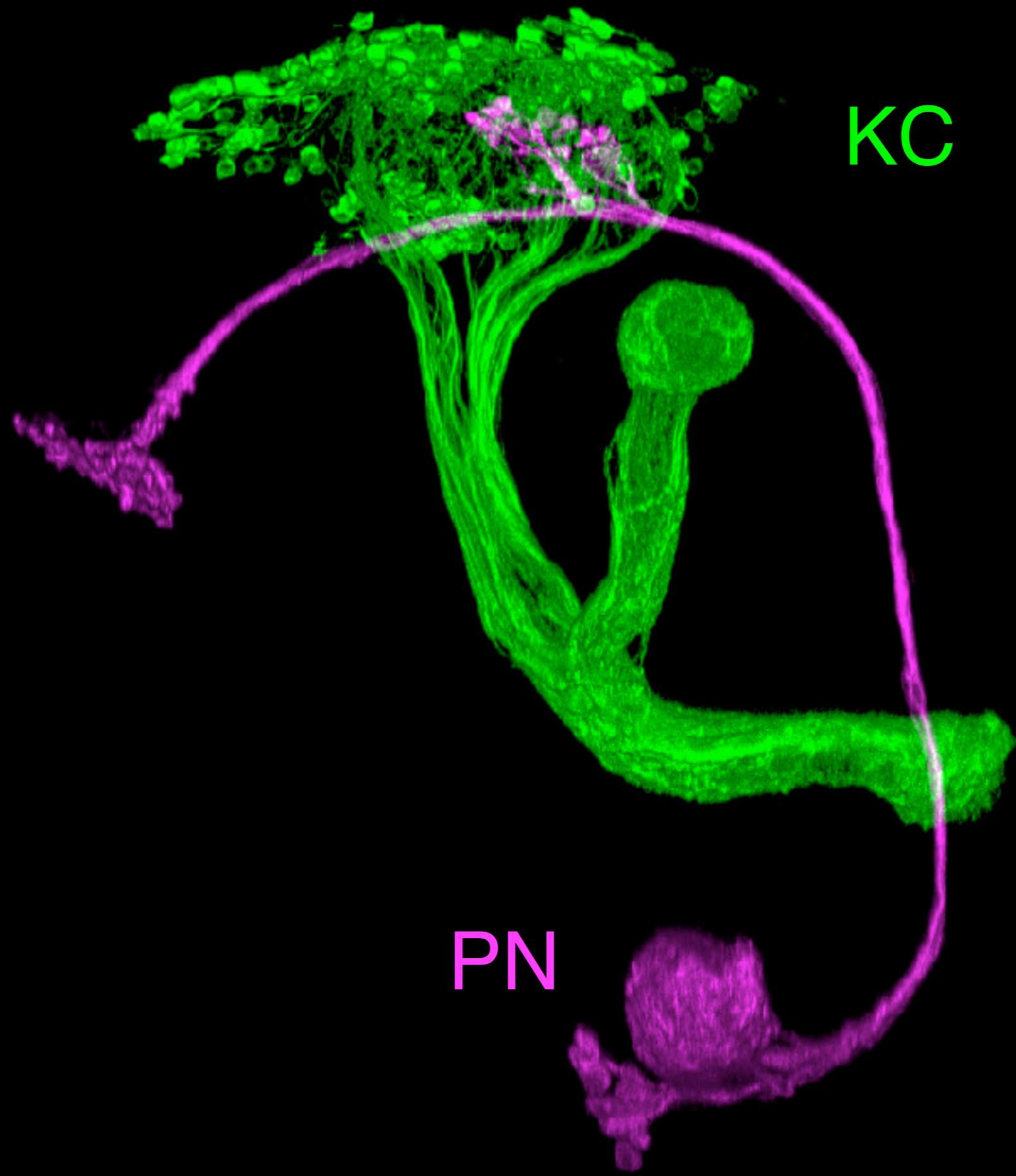


Yoshi Aso, Daisuke Hattori

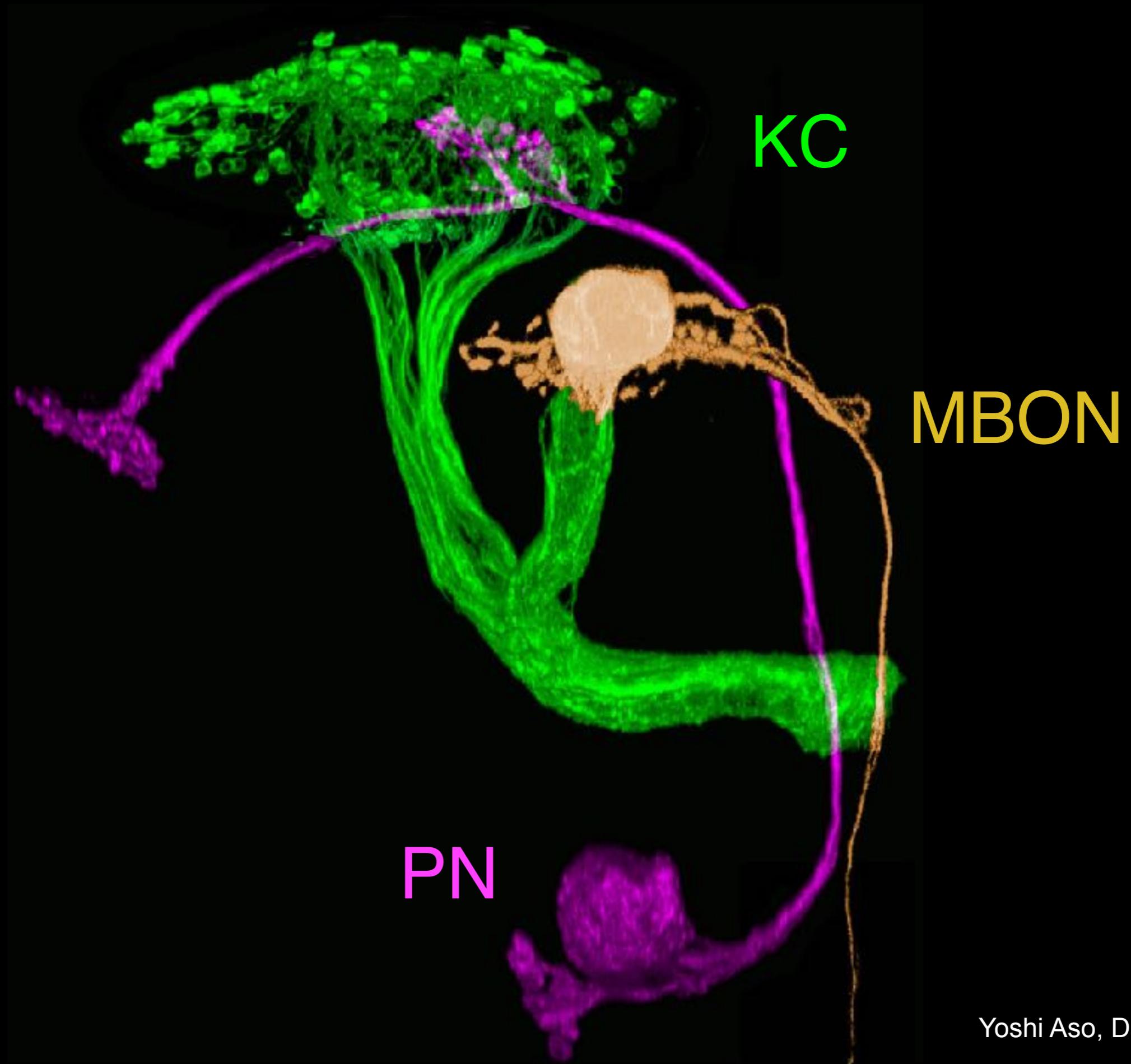
The mushroom body endows organisms with a degree of free will or intelligent control over instinctive actions

- Dujardin, 1850



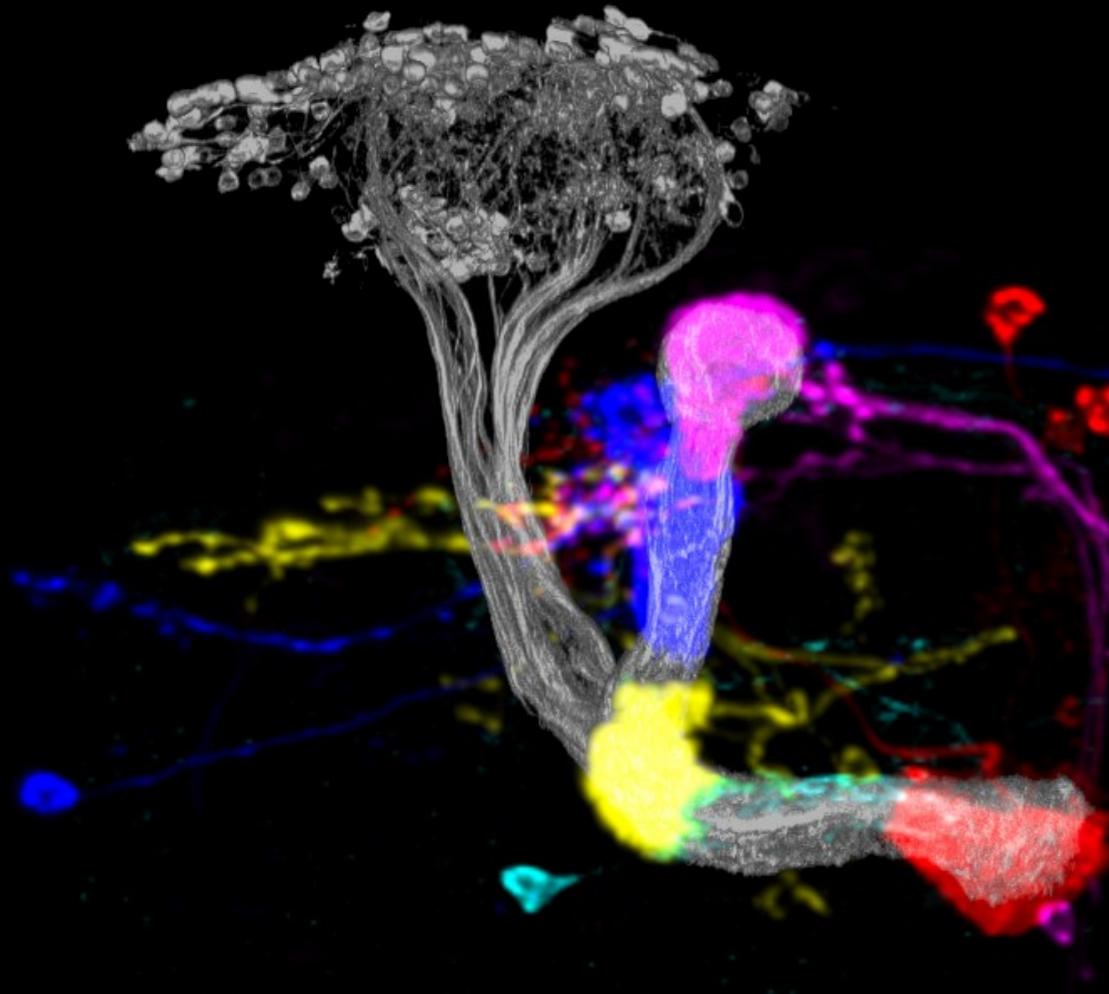


Yoshi Aso, Daisuke Hattori



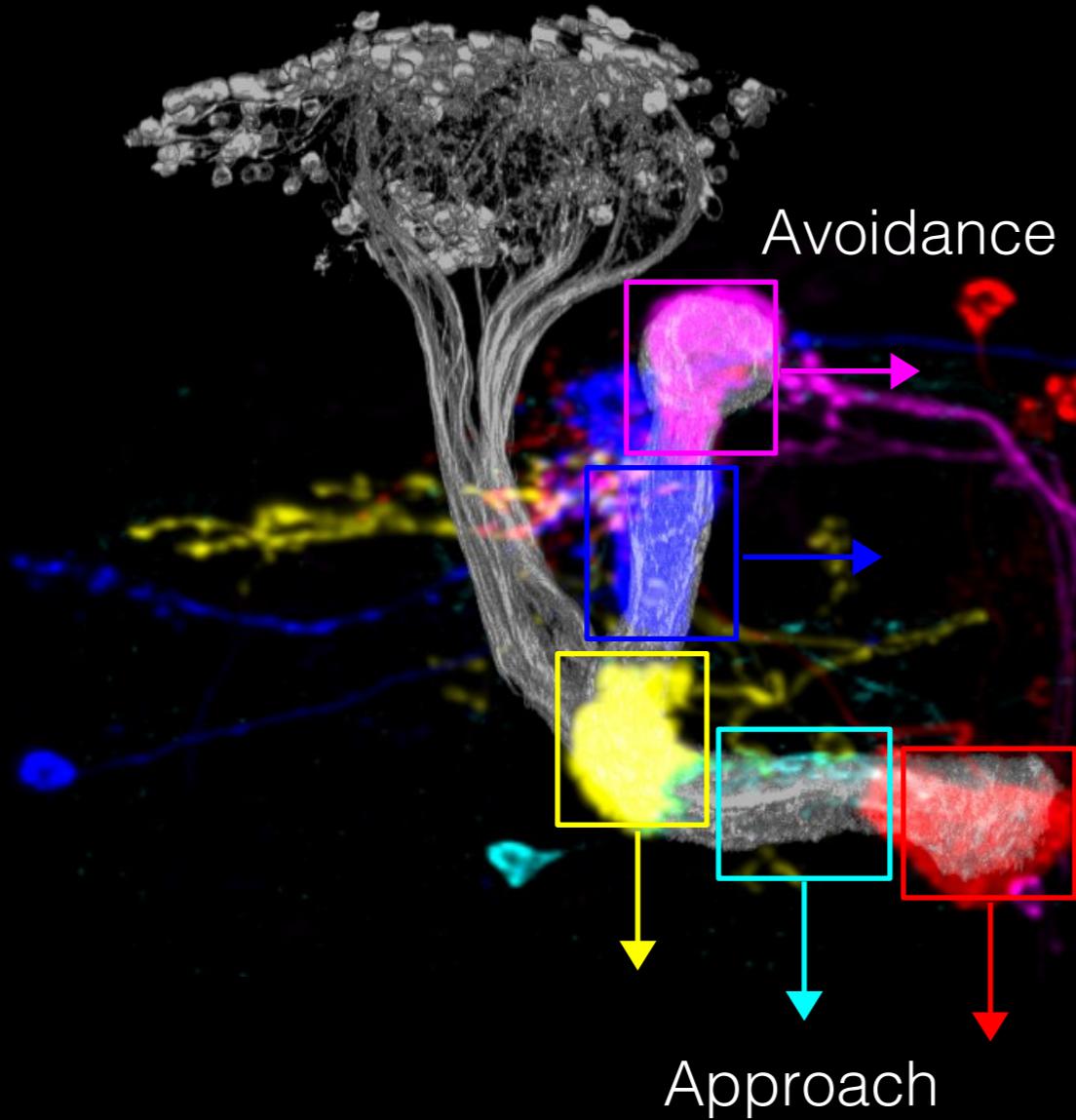
Yoshi Aso, Daisuke Hattori

Mushroom body output neurons

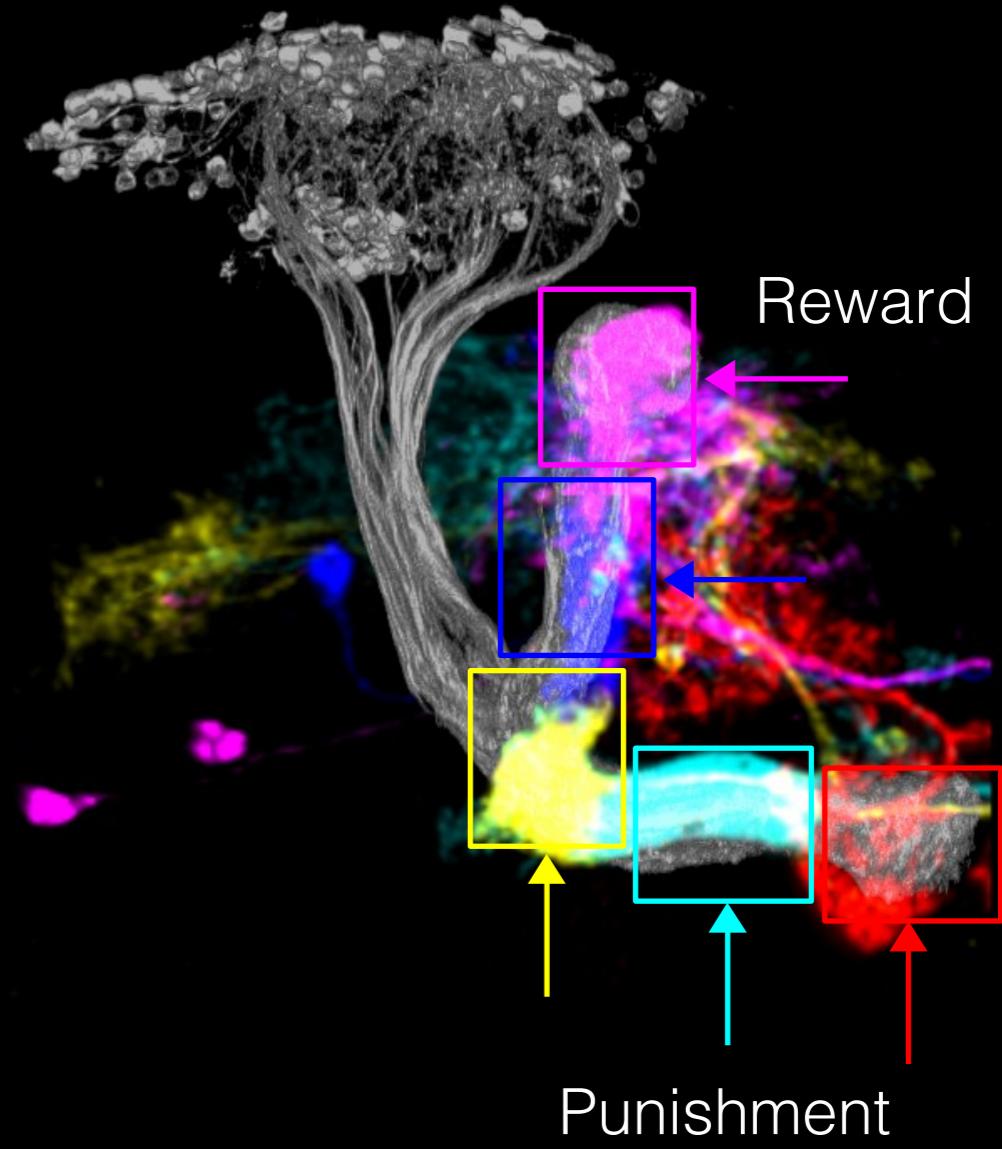


Aso, Hattori, Yu, Johnston, Iyer, Ngo, Dionne, Abbott, Axel, Tanimoto, Rubin (2014)

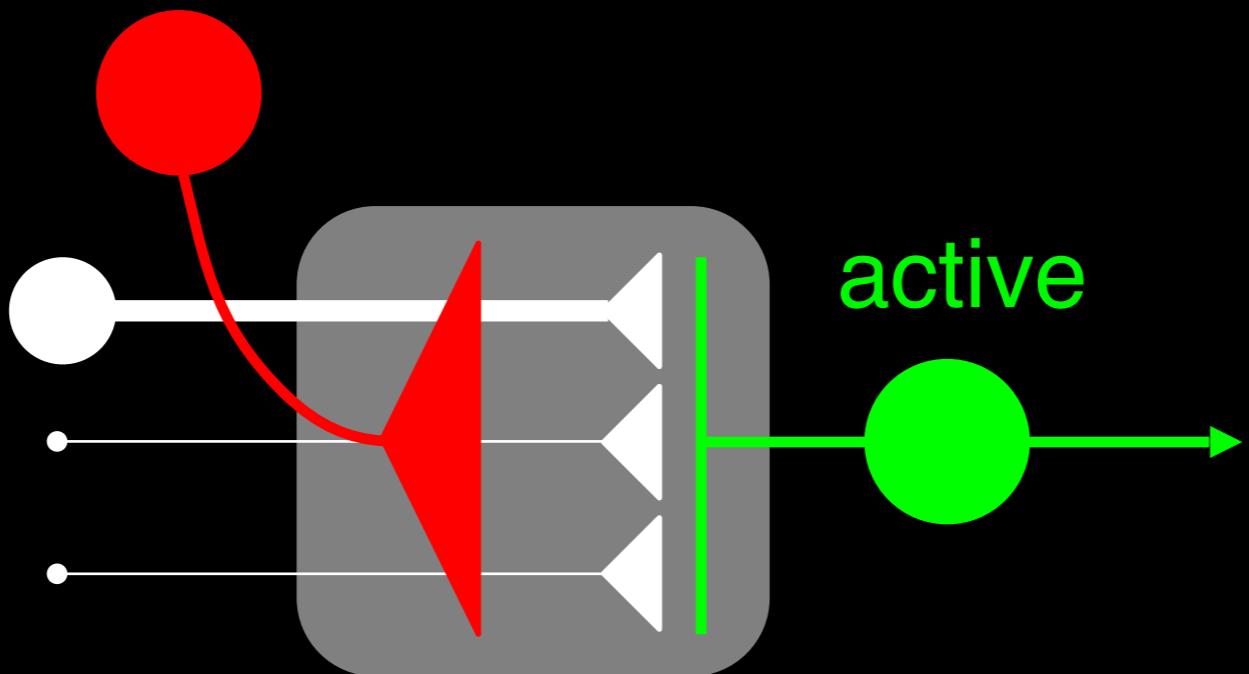
Mushroom body output neurons



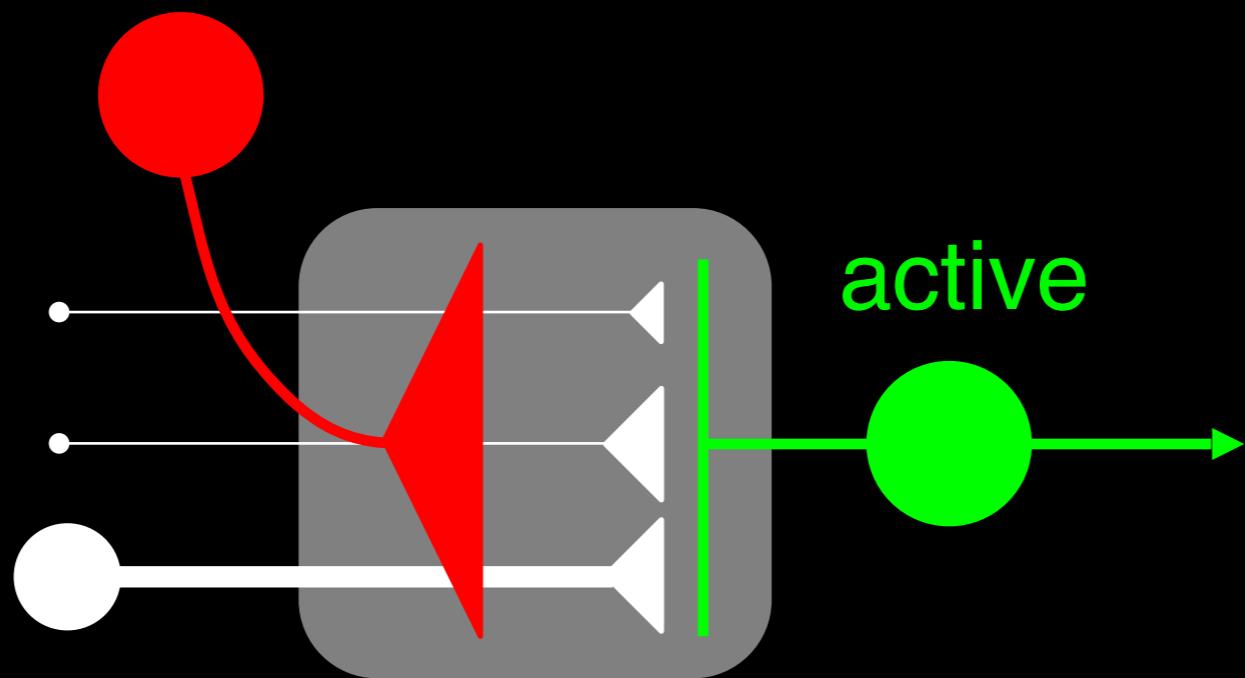
Dopaminergic neurons



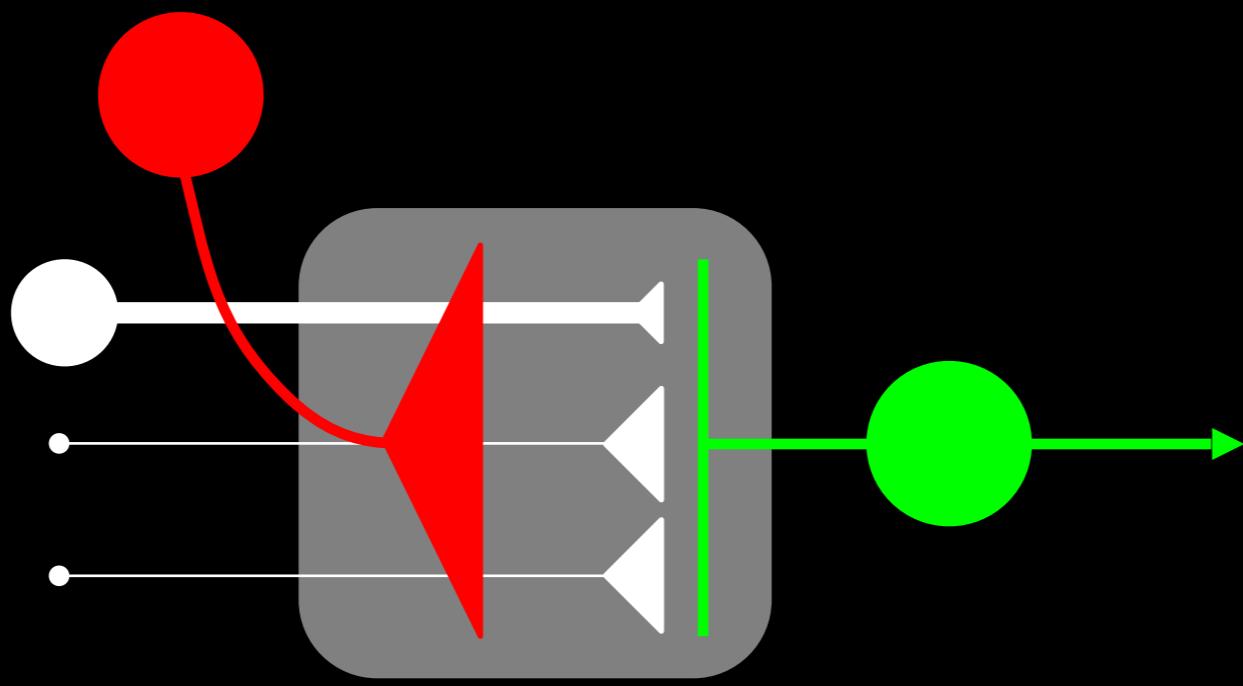
active

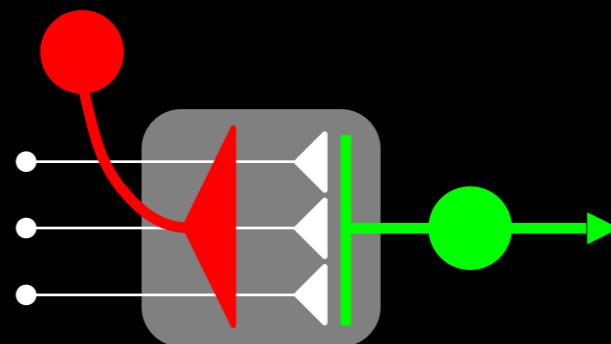
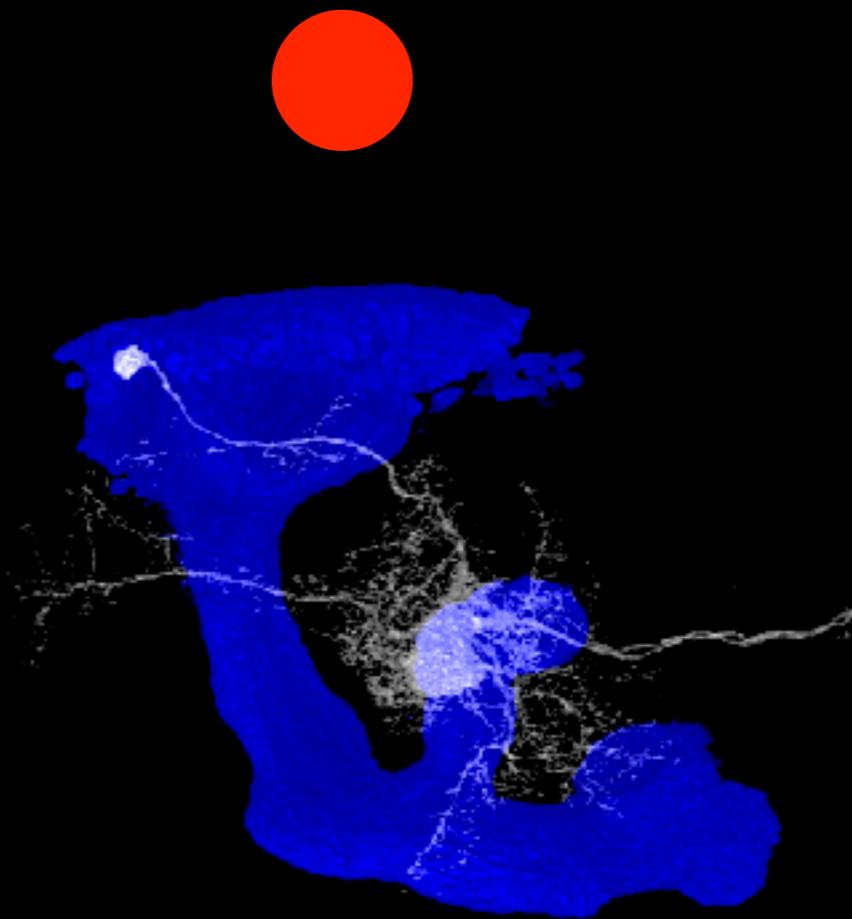
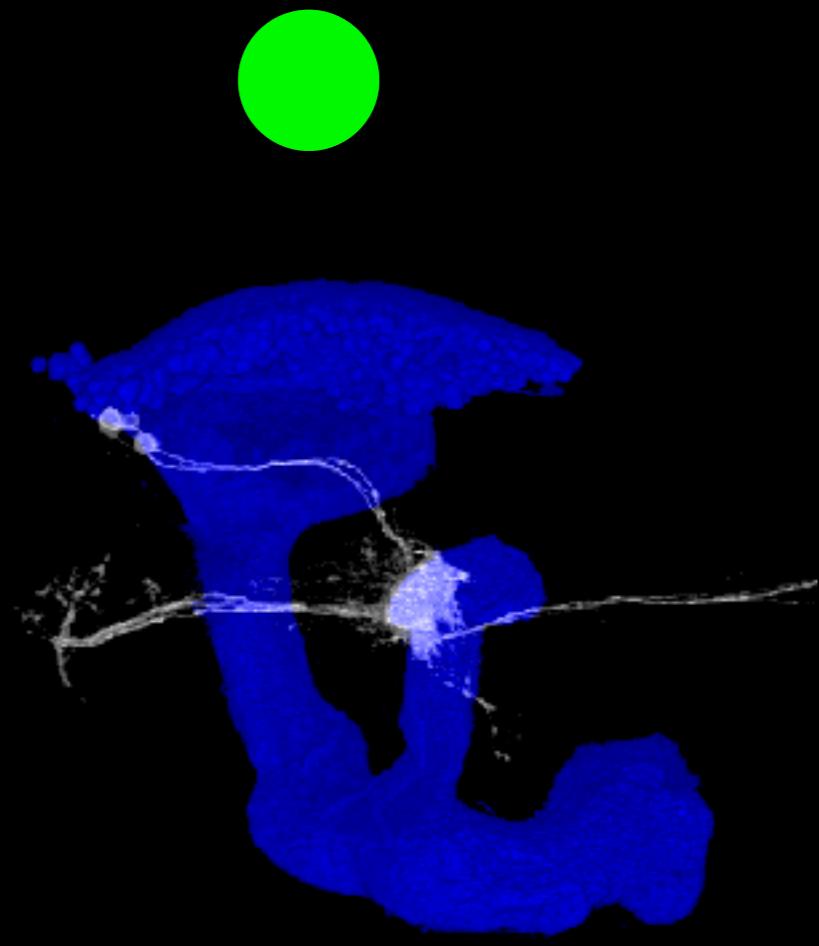


active

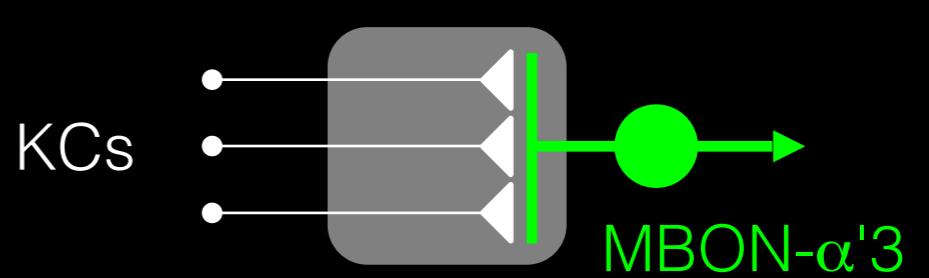
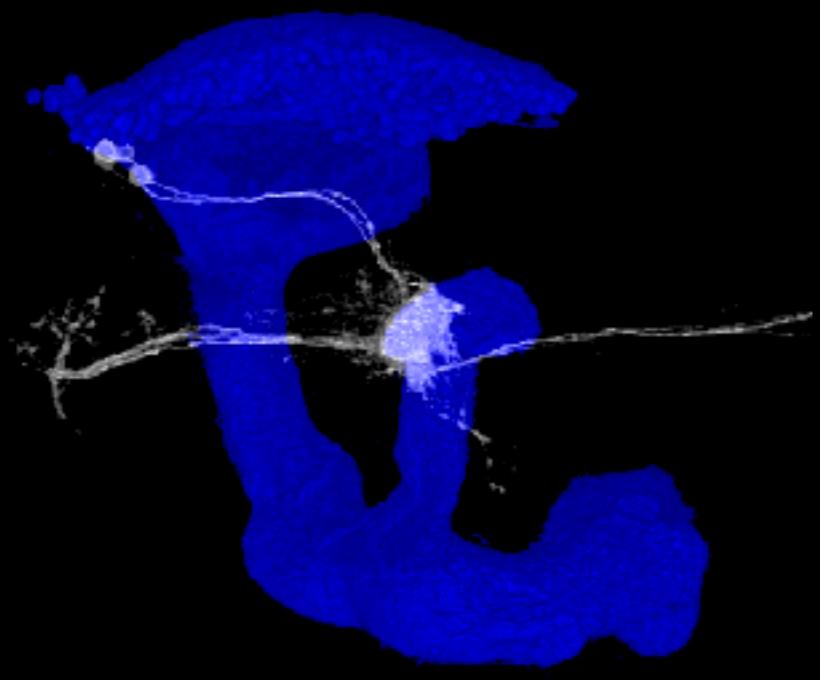


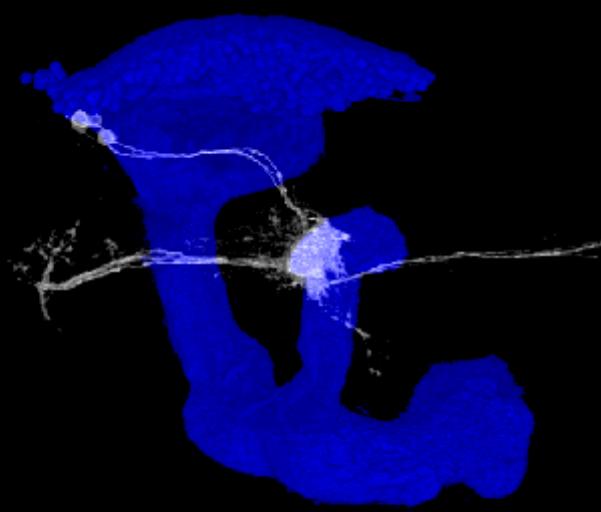
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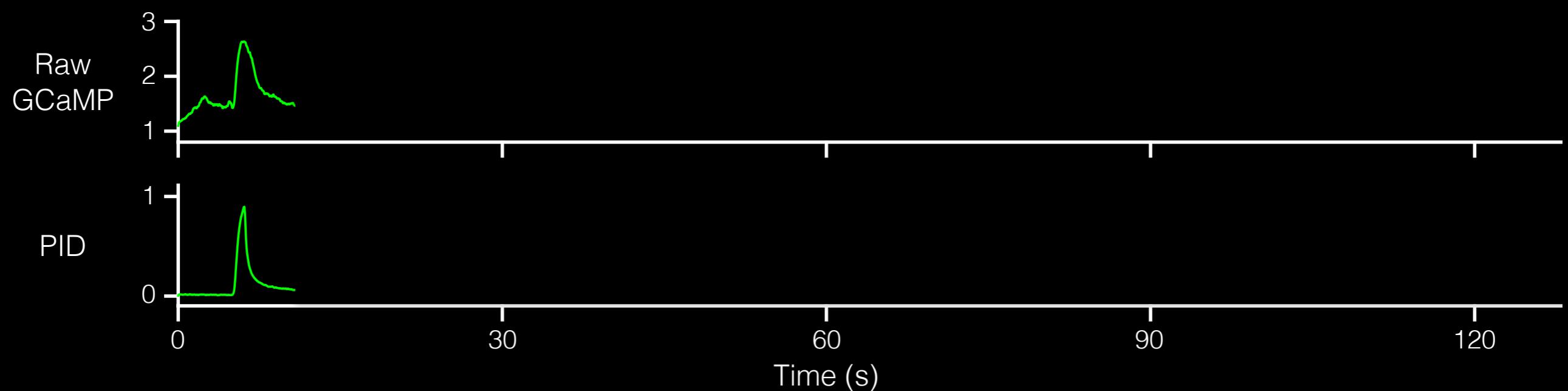


MBON- $\alpha'3$

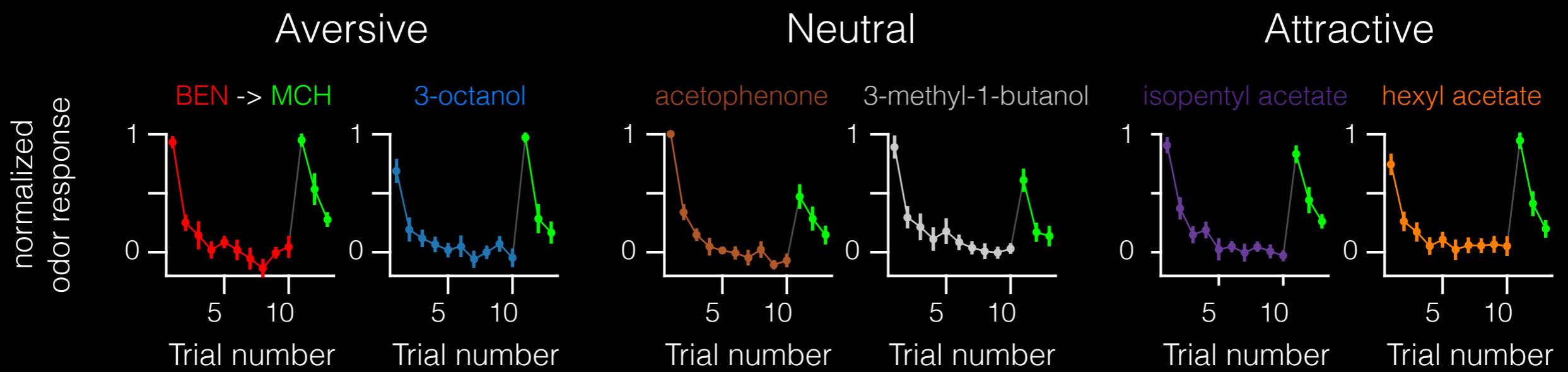




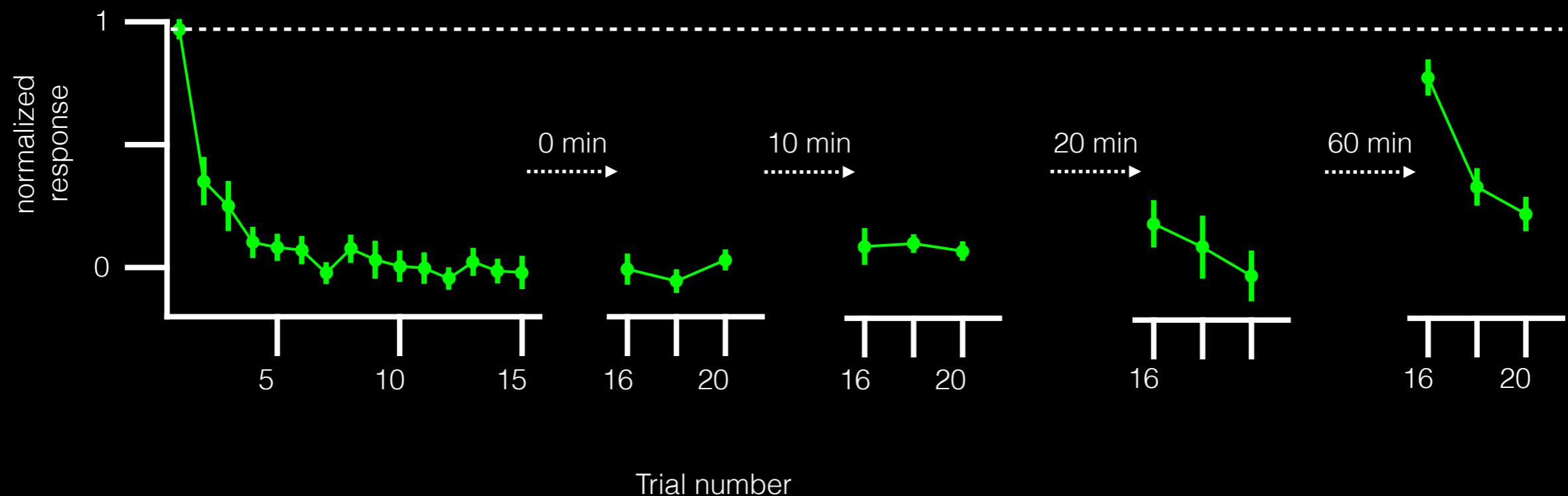
Odor: 4-methylcyclohexanol (MCH)



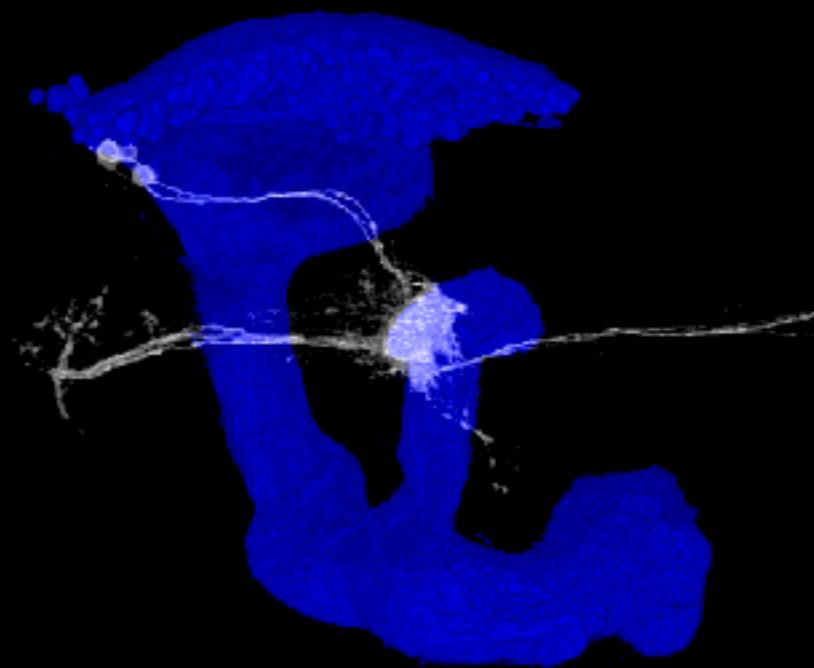
Suppression is Observed for all Odors but is Stimulus Specific



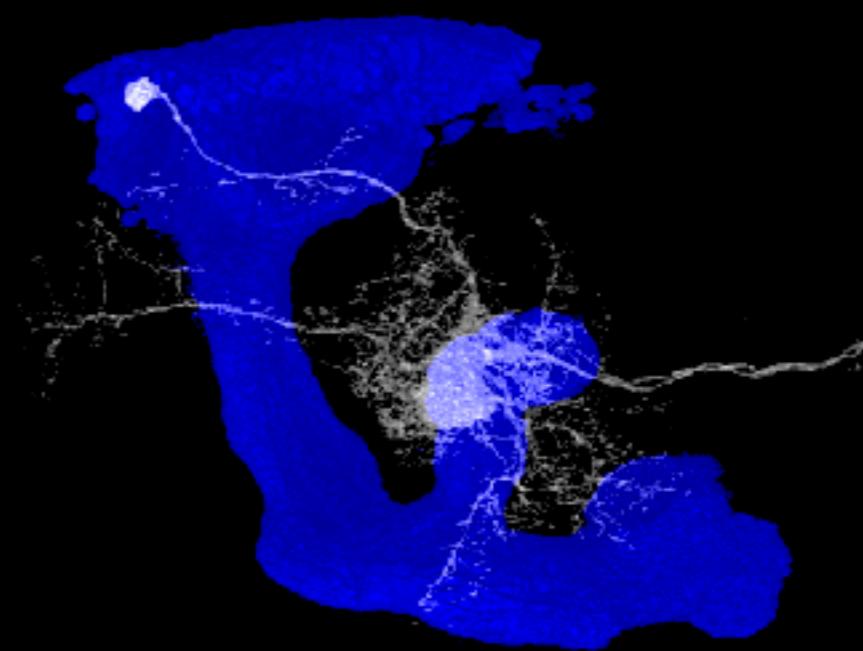
Suppression is persistent



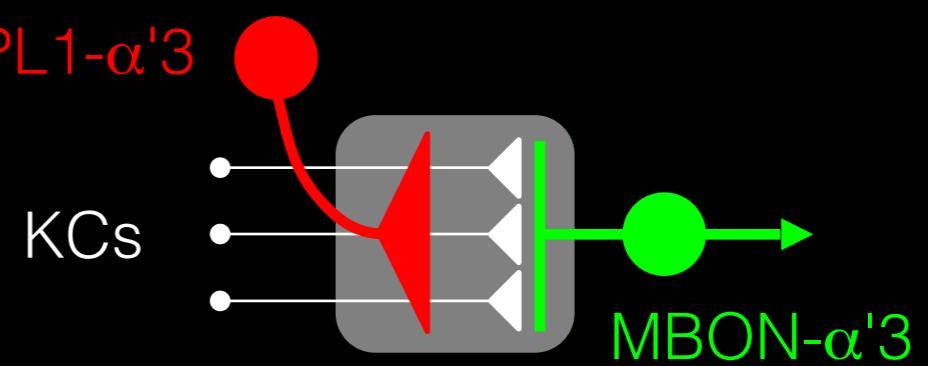
MBON- $\alpha'3$



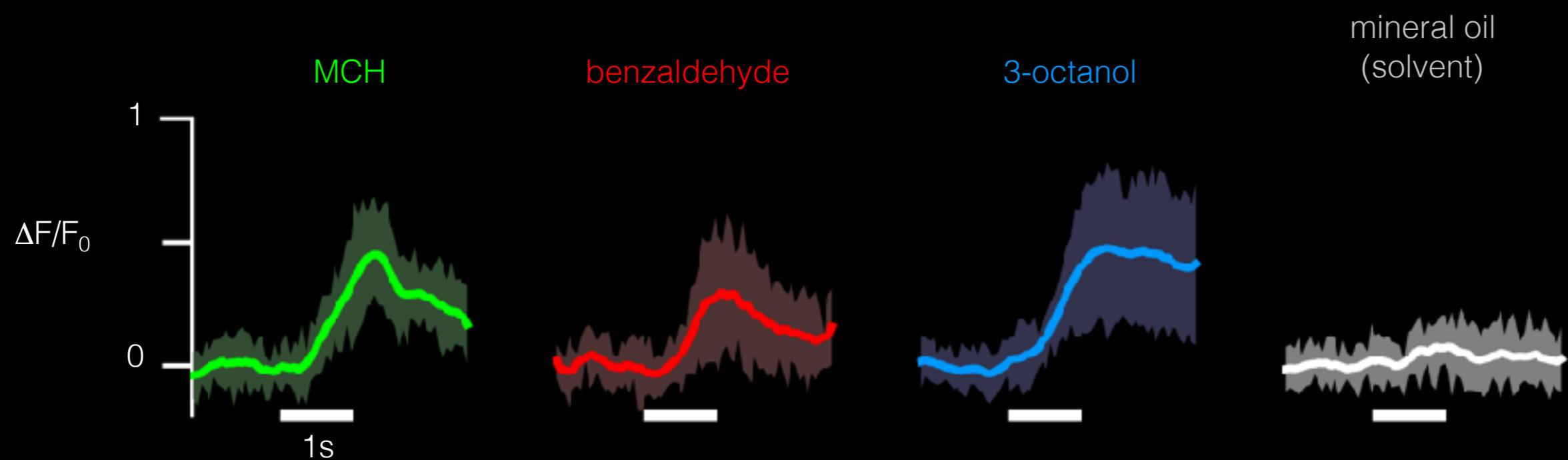
PPL1- $\alpha'3$



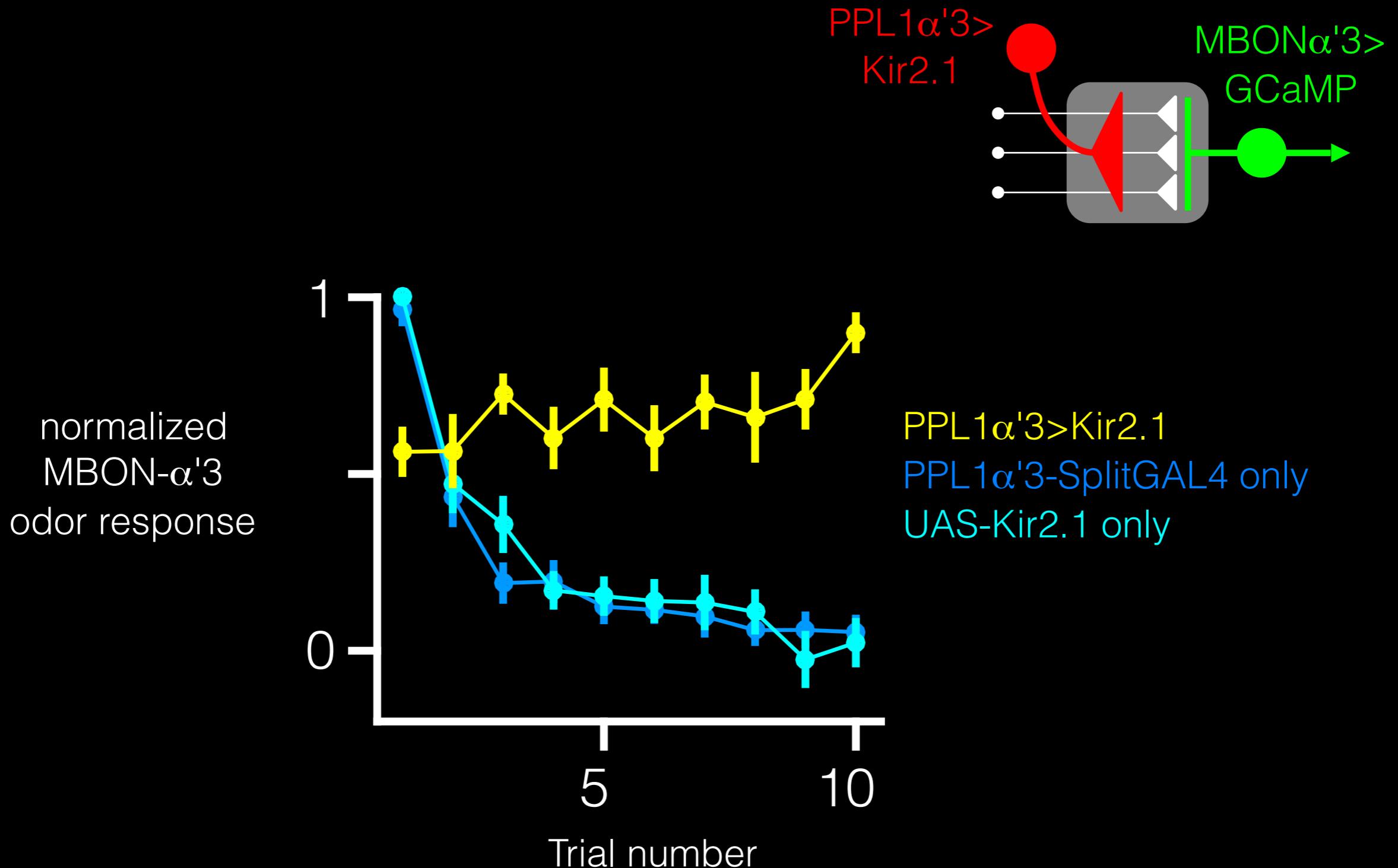
PPL1- $\alpha'3$

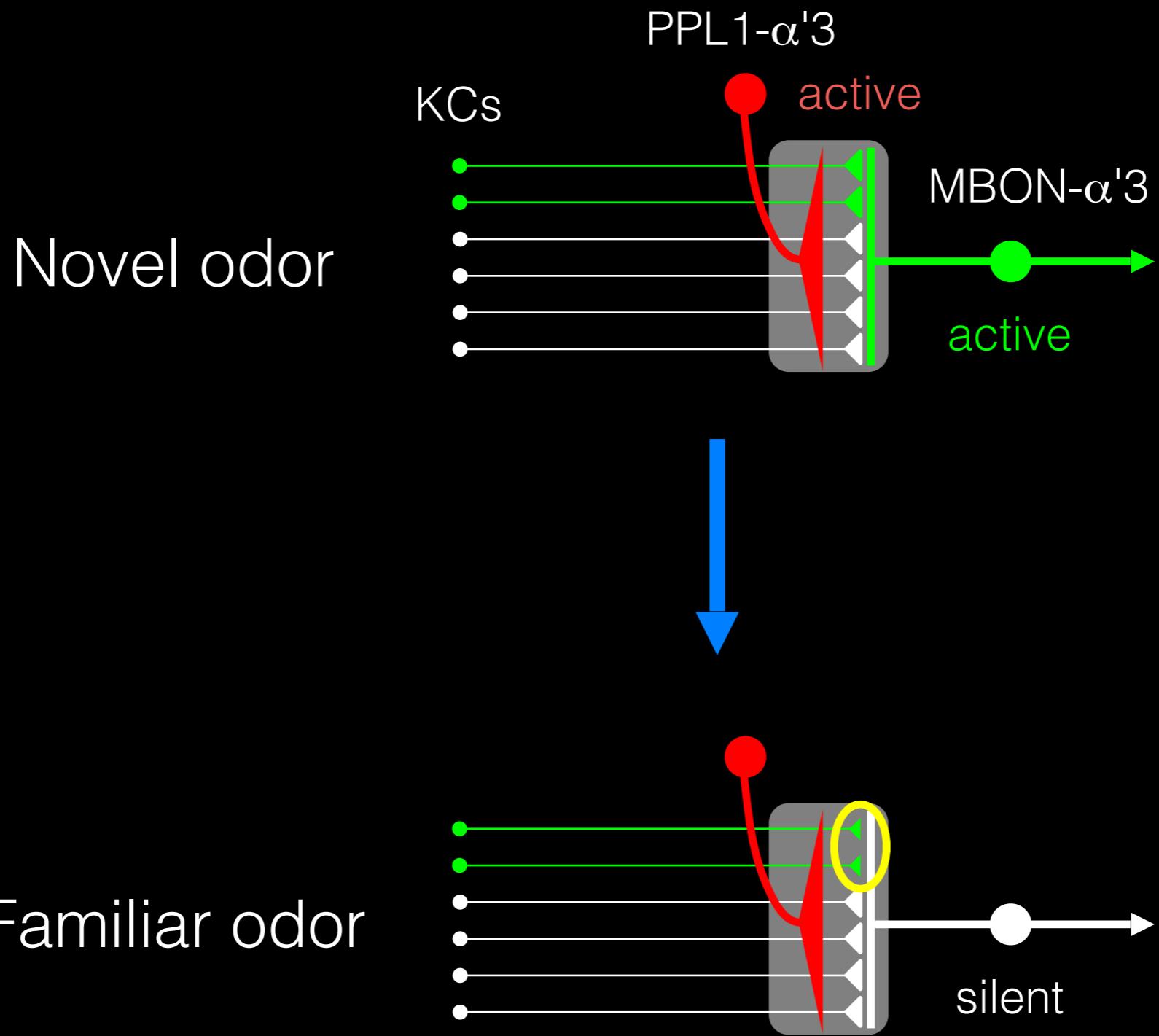


Odor activates PPL1- $\alpha'3$

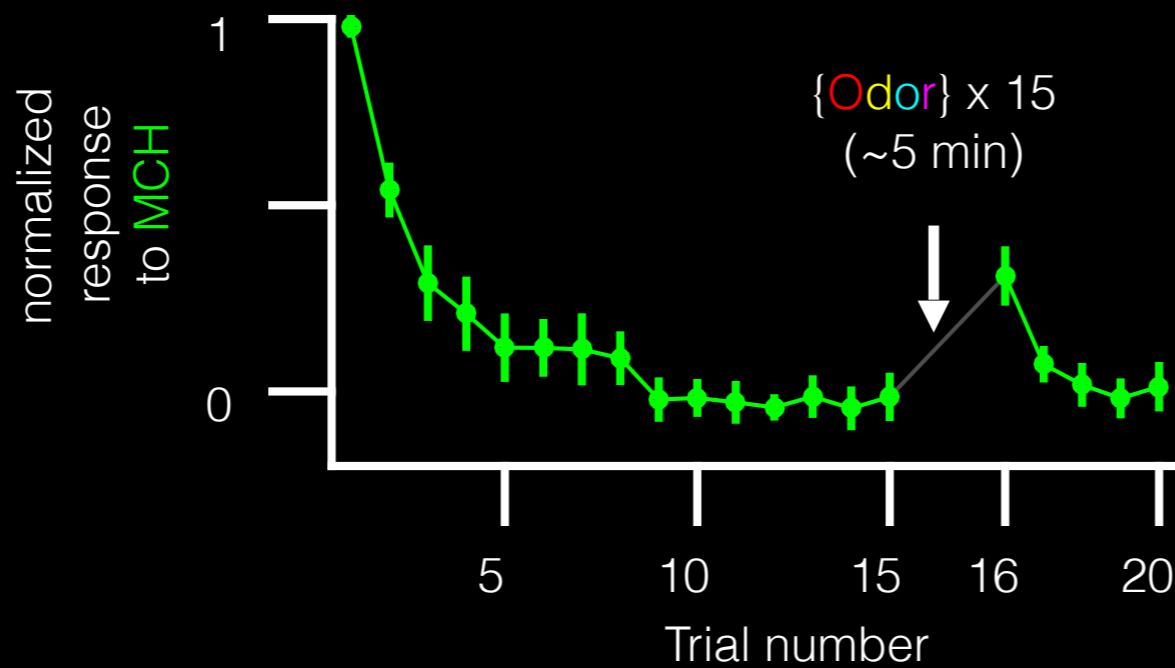


PPL1- $\alpha'3$ activity is required for suppression of MBON- $\alpha'3$

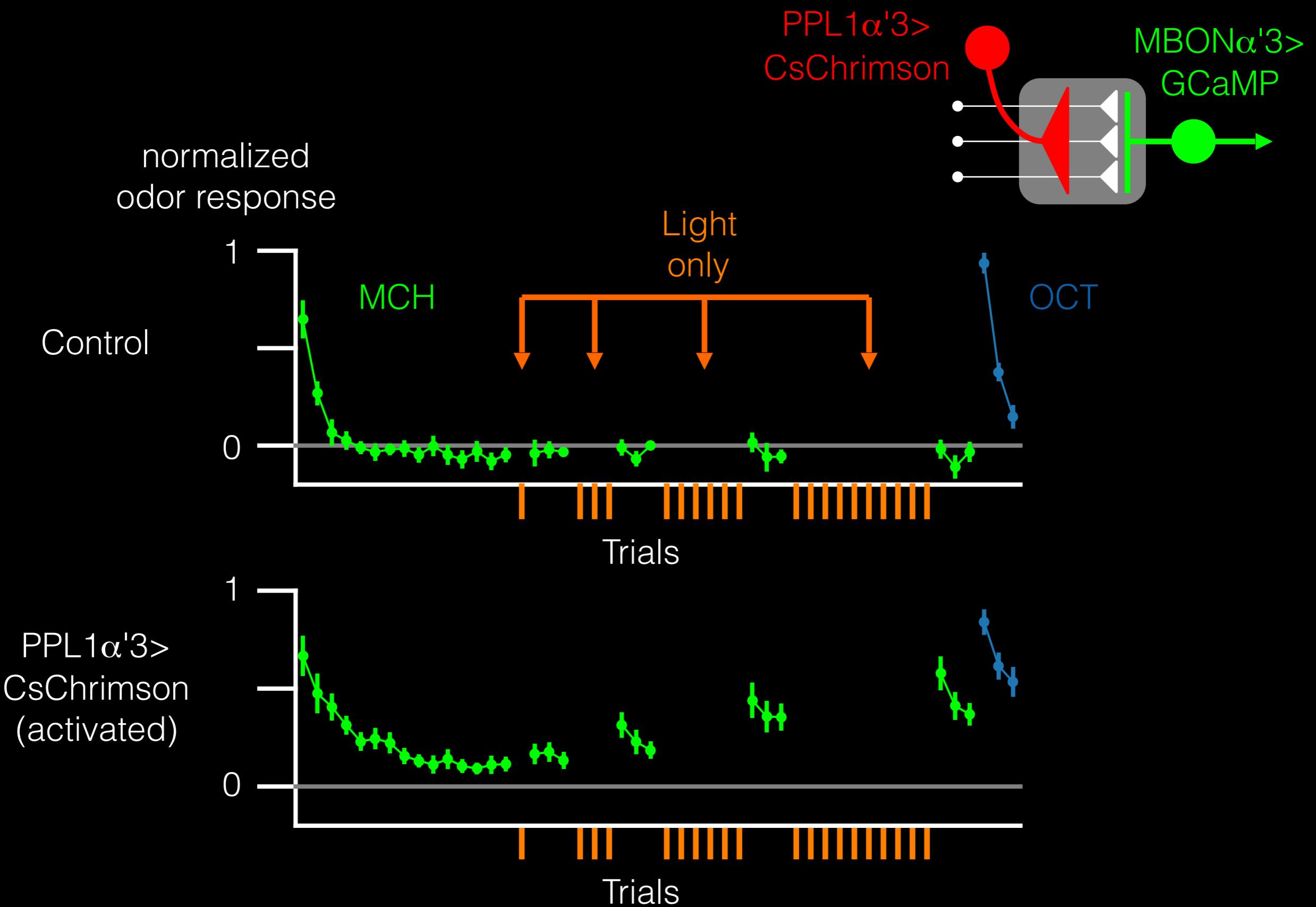




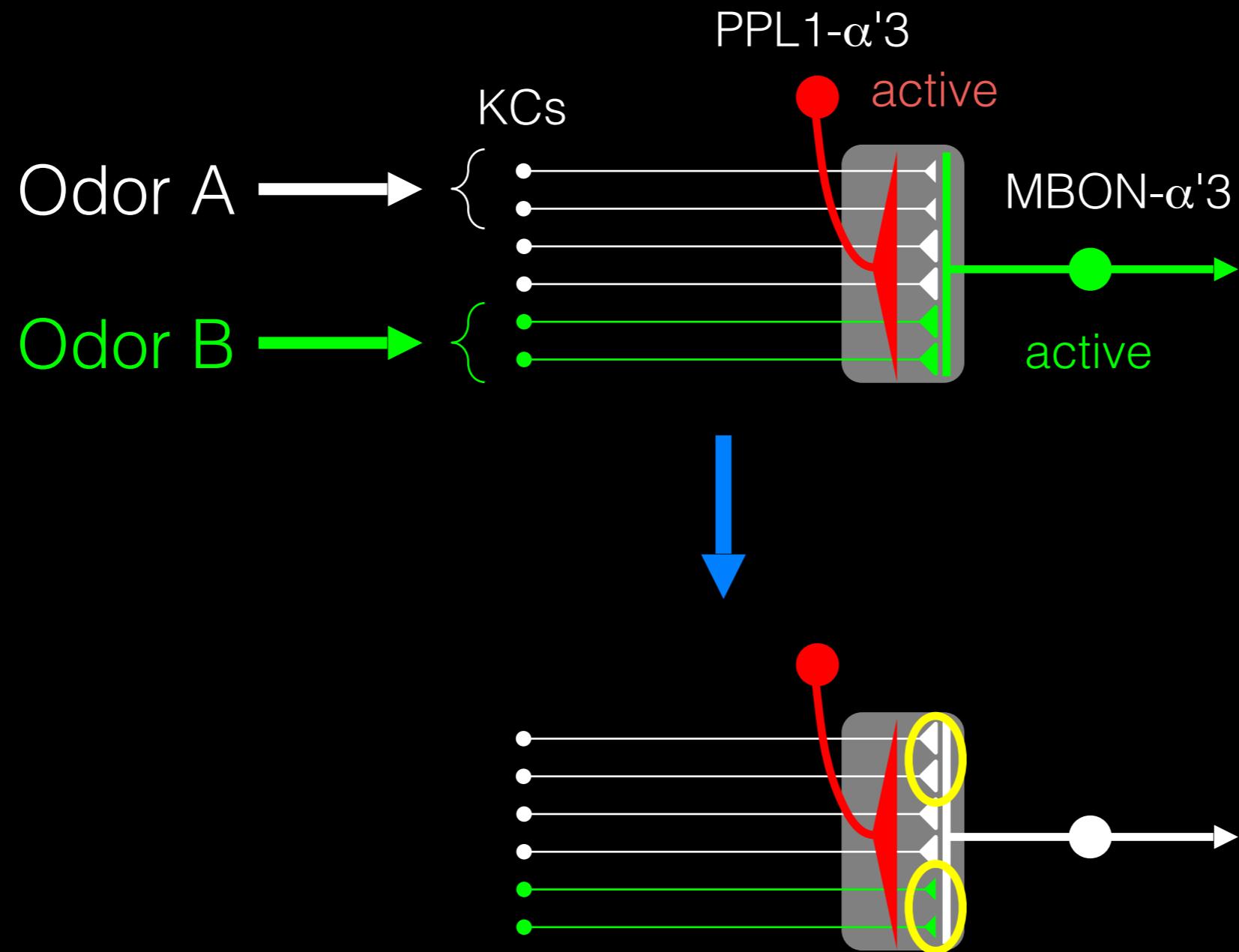
Novel odor enhances decay of familiarity



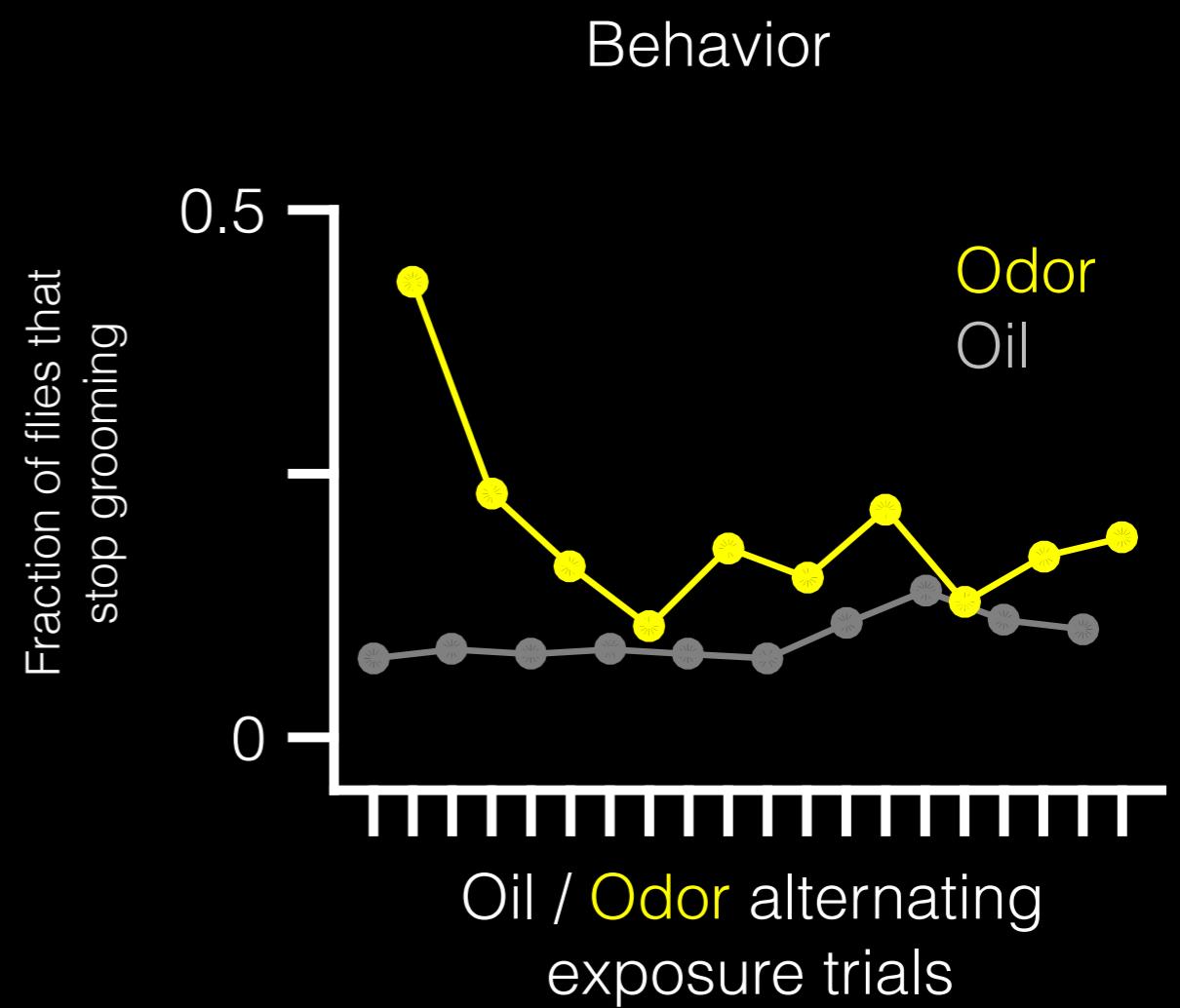
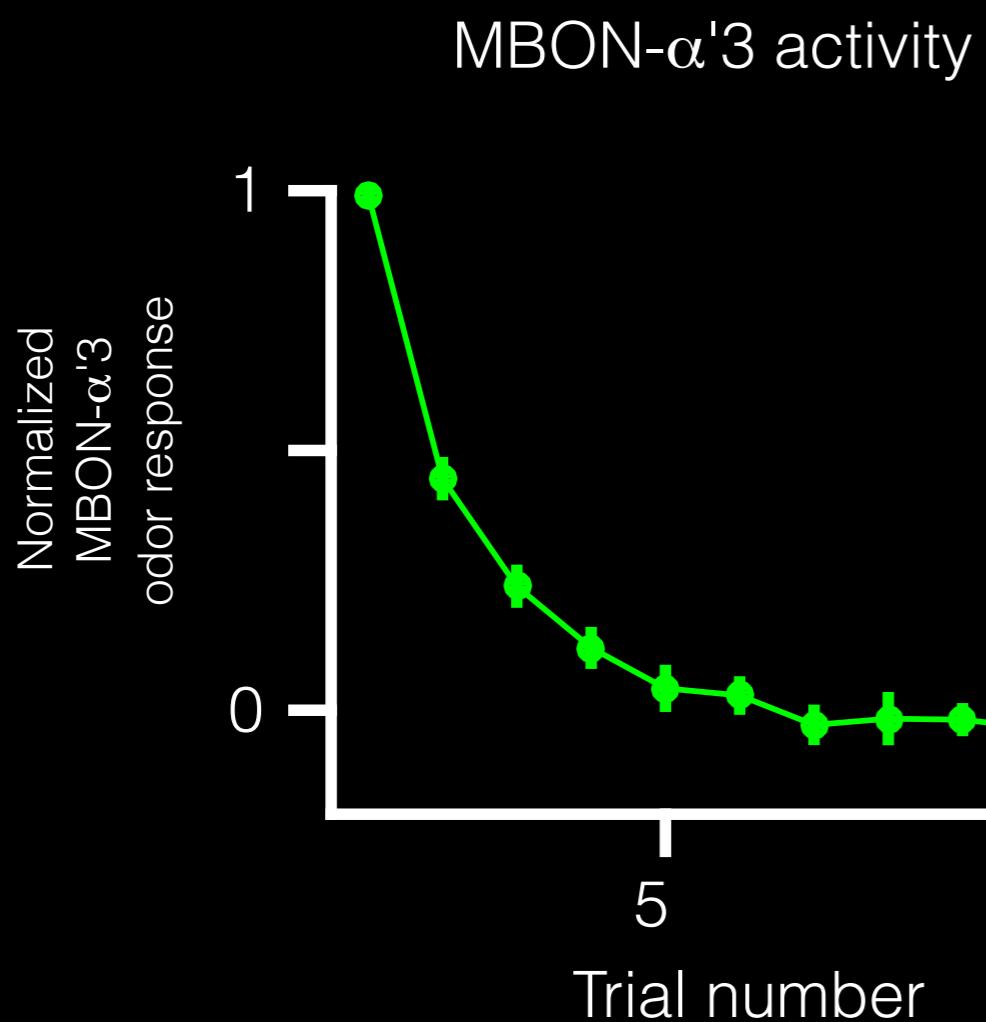
Recovery of MBON response upon PPL1- $\alpha'3$ activation in the absence of odor



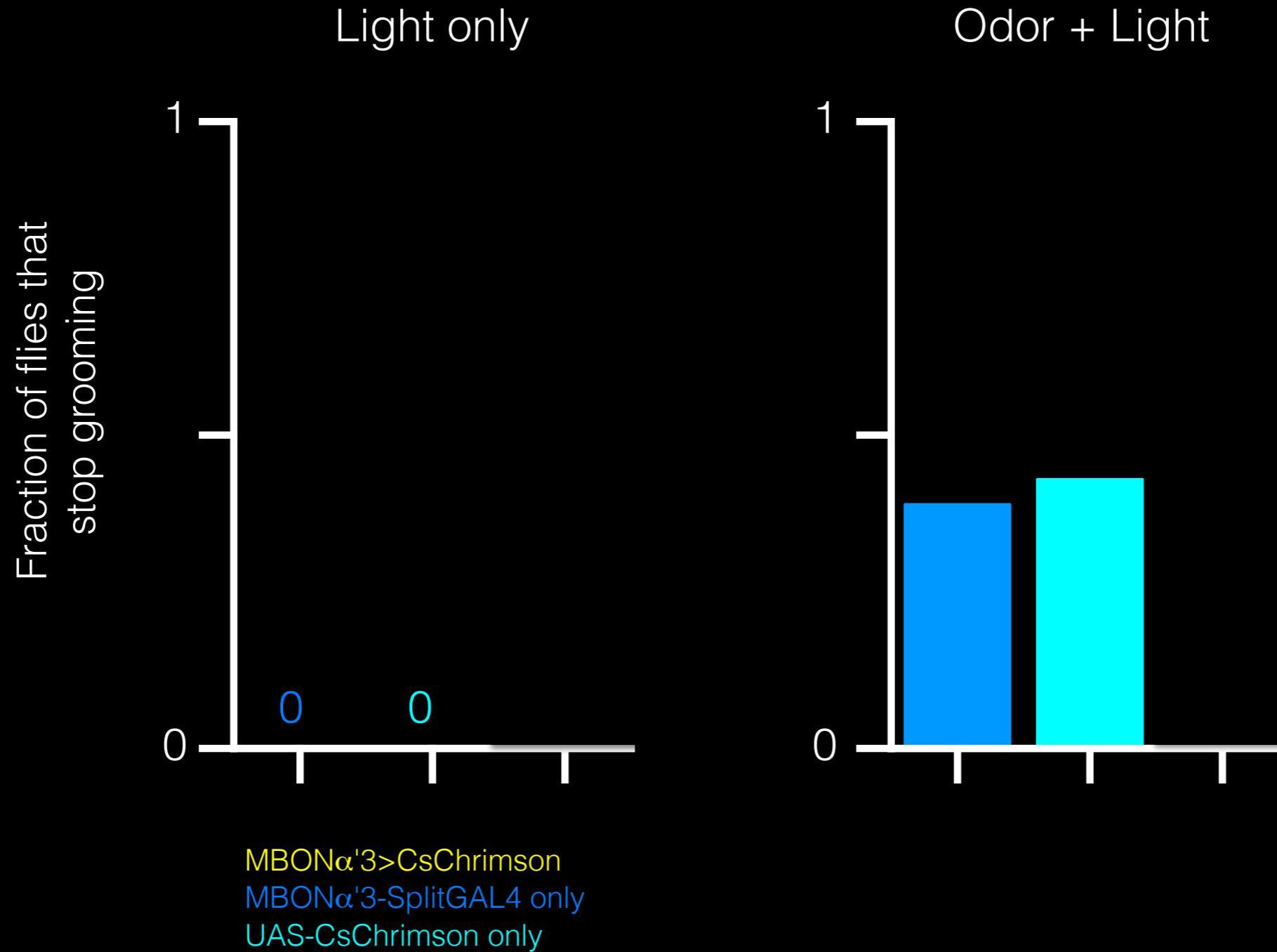
Bidirectional effect of dopamine contributes to generation of novelty response without saturation



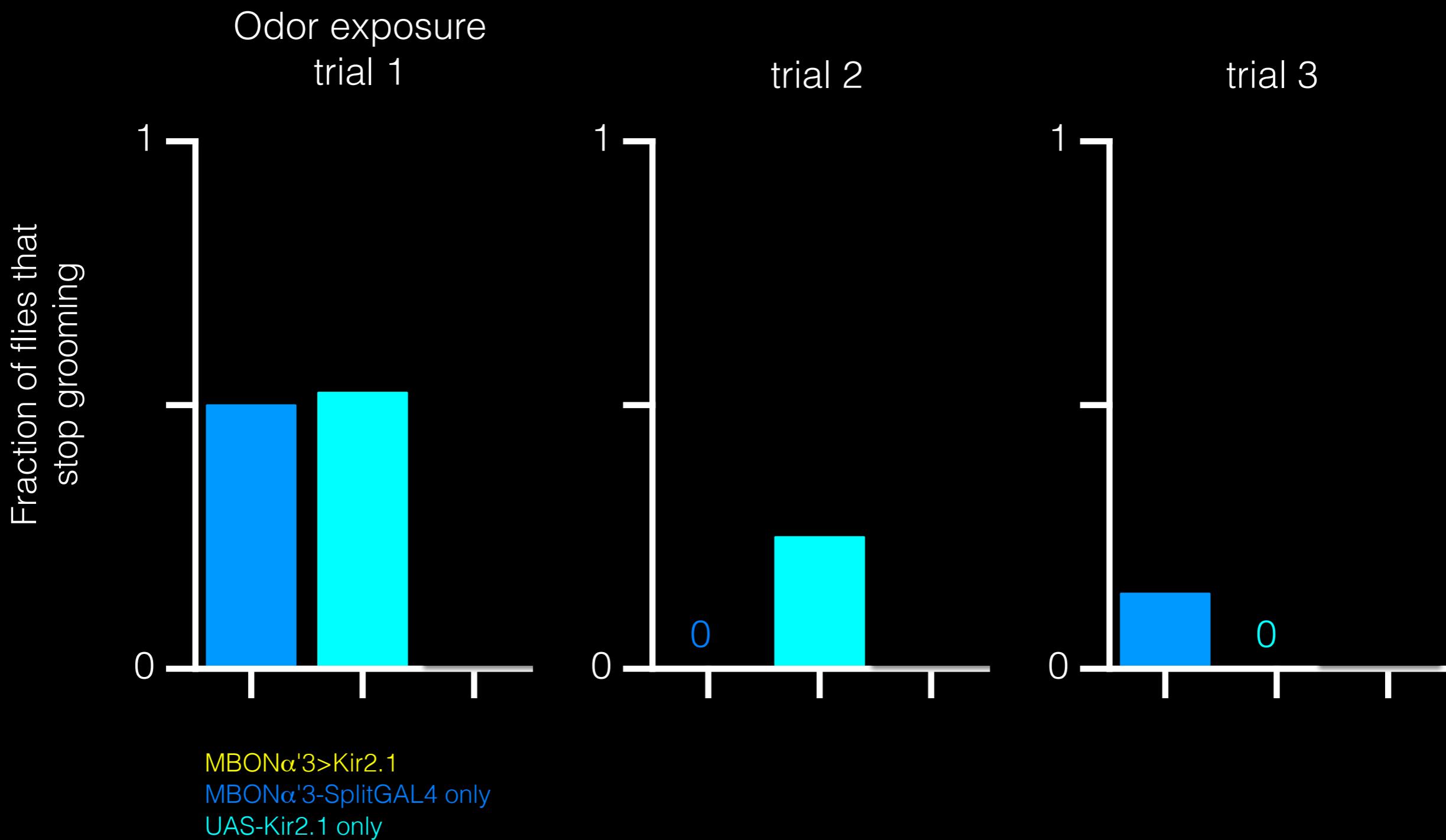
Cessation of grooming ~ alerting response to novel odor



Optogenetic Activation of MBON- $\alpha'3$ Elicits an Alerting Response And Disrupts Grooming

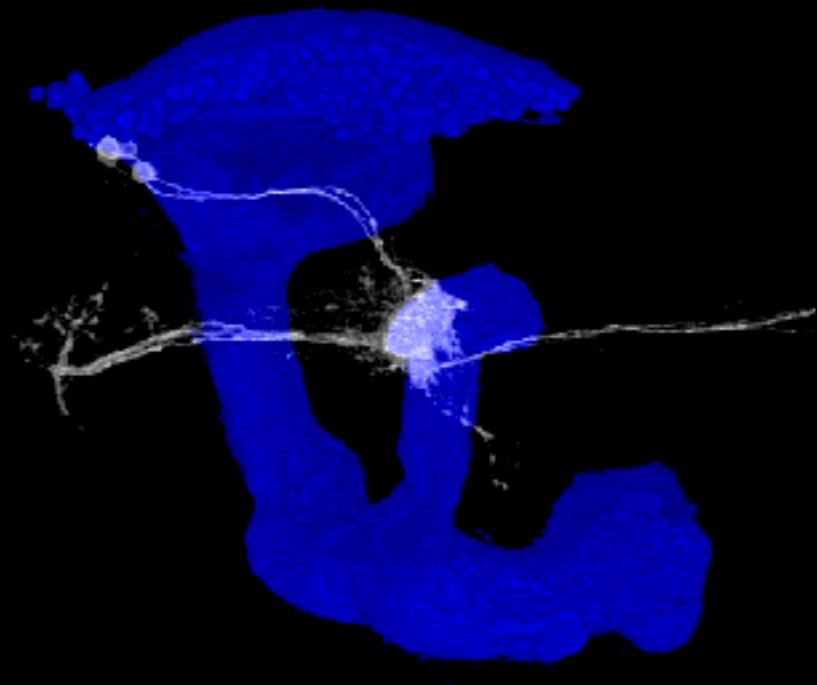


Silencing MBON- $\alpha'3$ Eliminates the Alerting Response

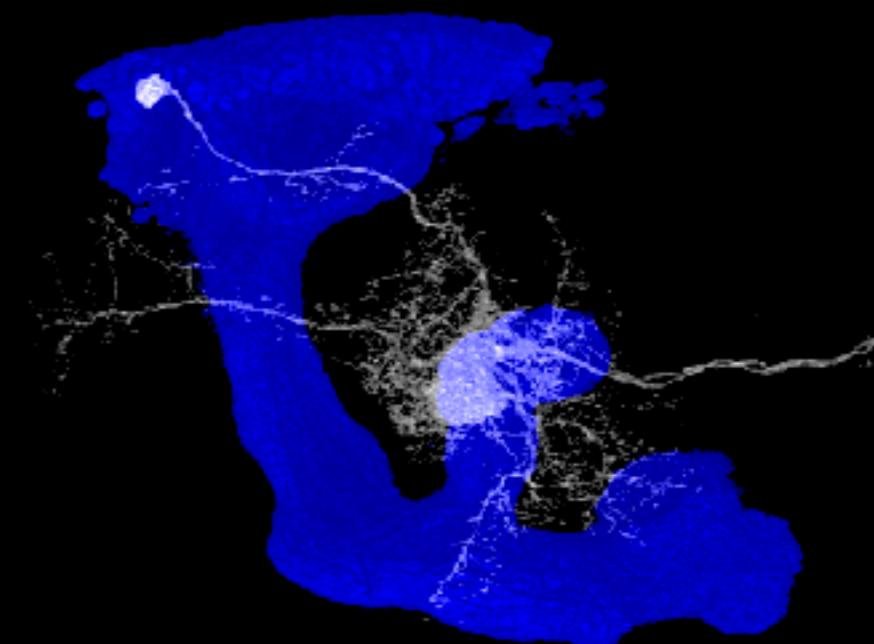


The $\alpha'3$ compartment represents novelty and familiarity

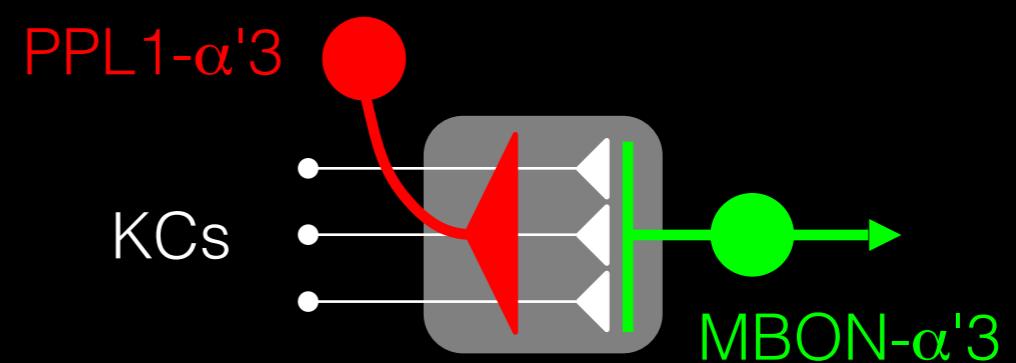
MBON- $\alpha'3$



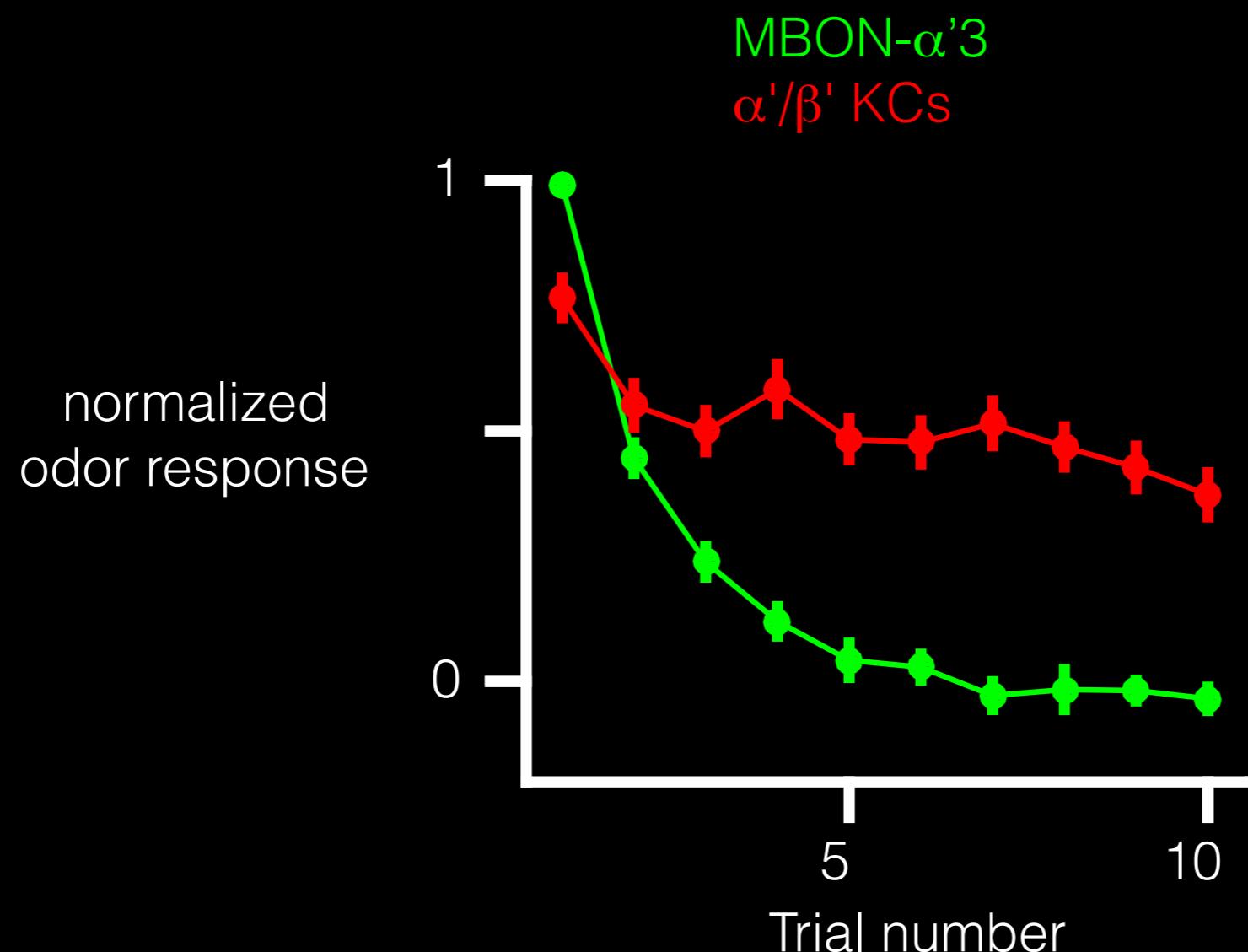
PPL1- $\alpha'3$



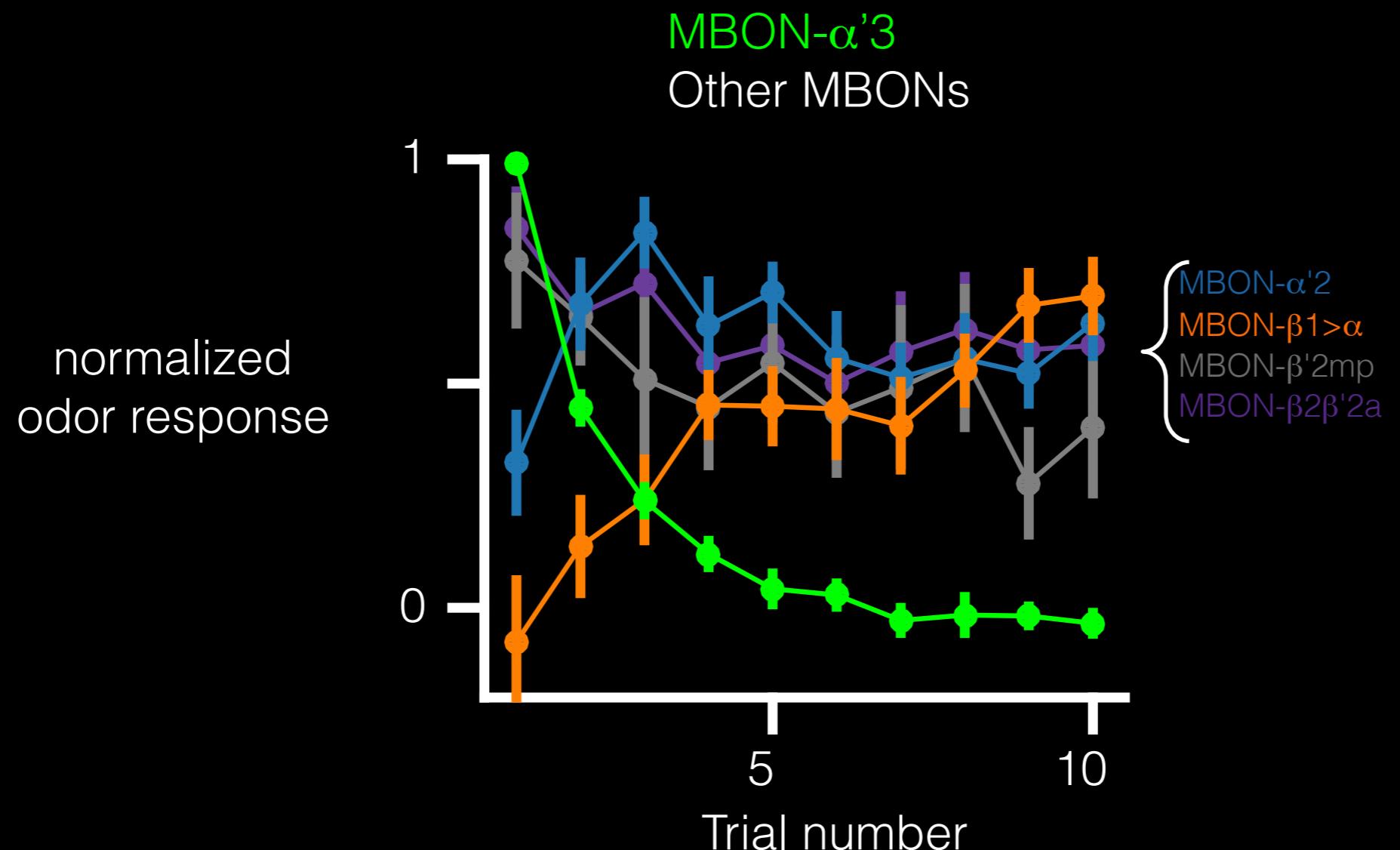
MBON excitation: novelty
MBON suppression: familiarity



Suppression of MBON- $\alpha'3$ is not due to sensory adaptation



Suppression is specific to MBON- $\alpha'3$

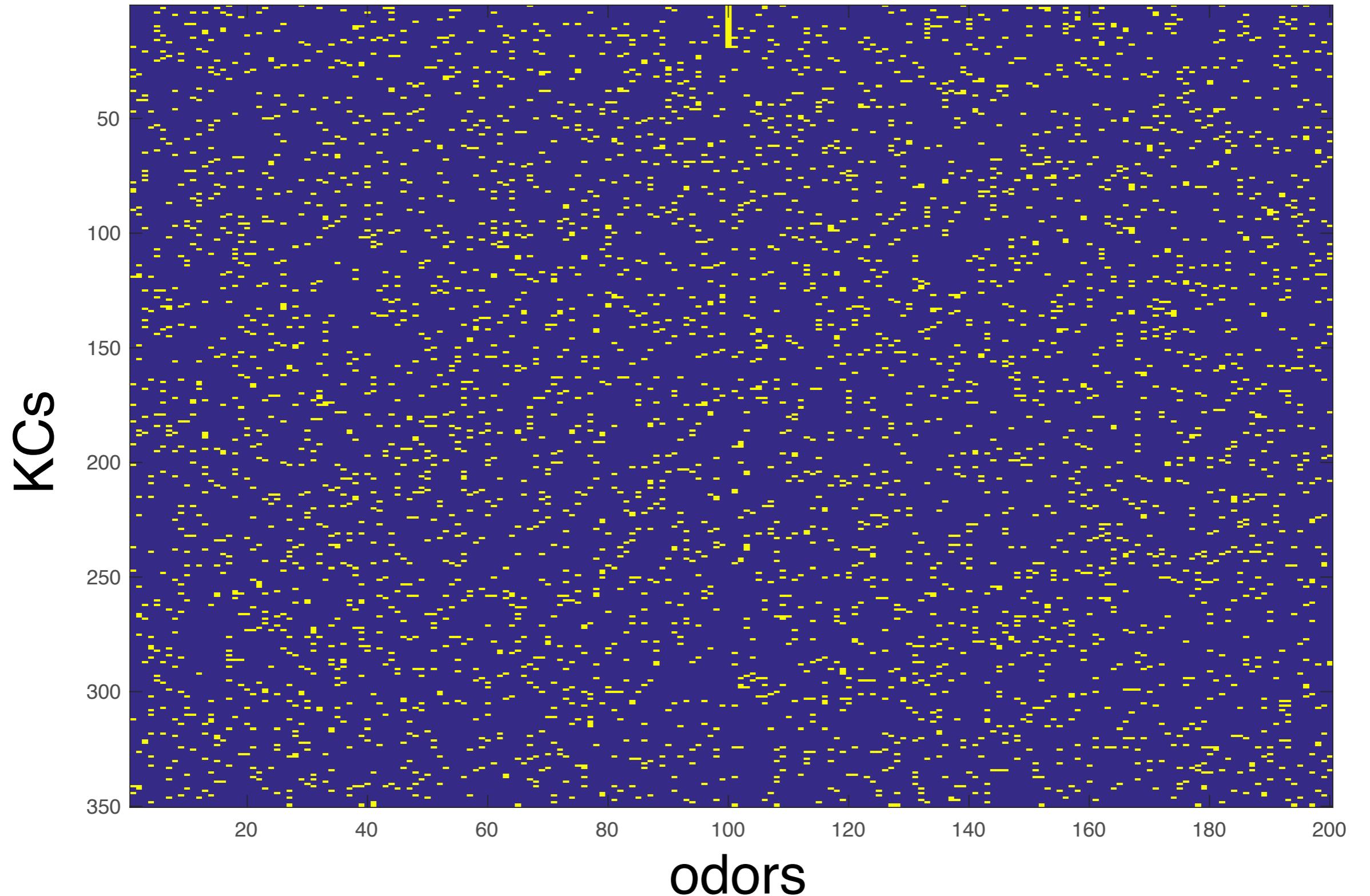


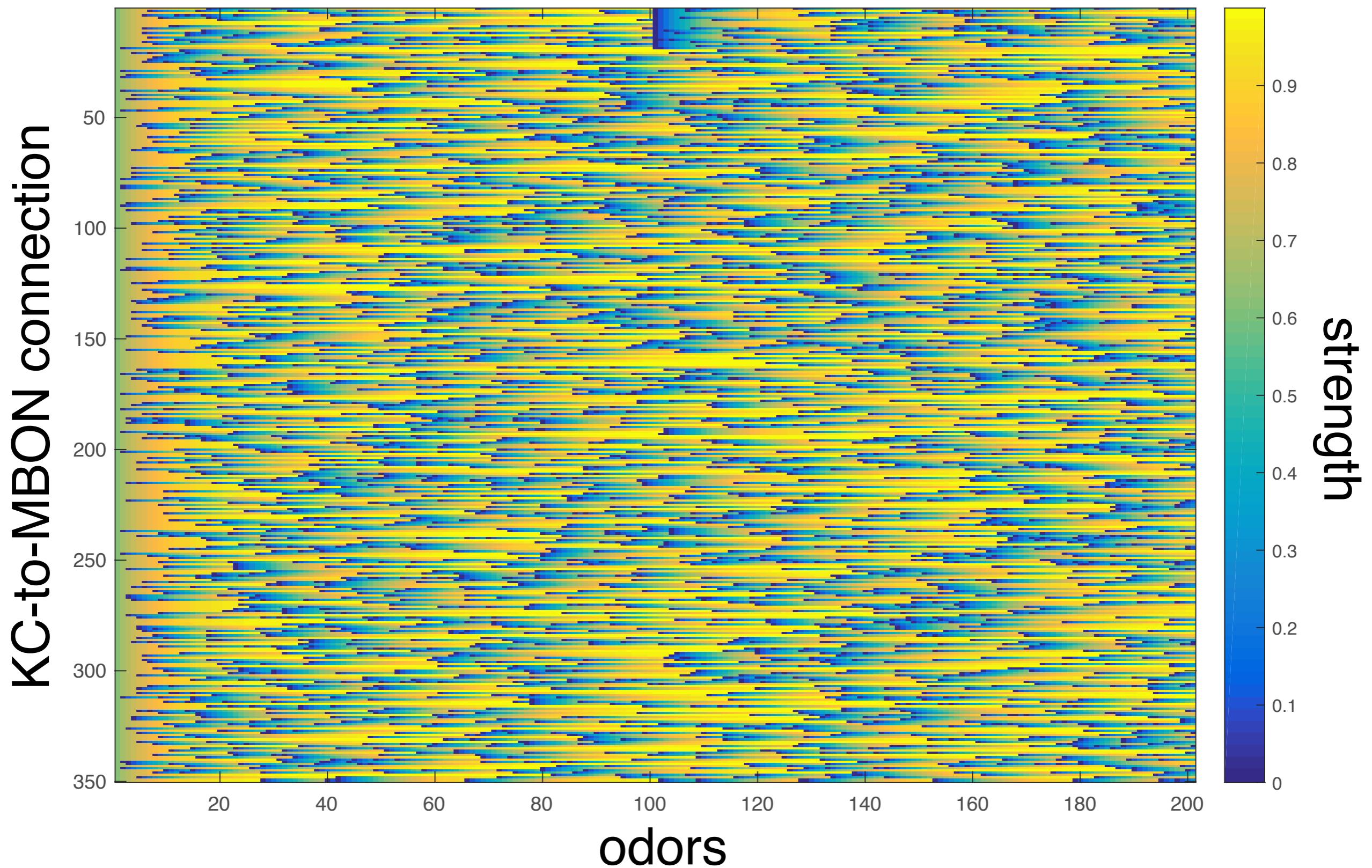
$$\text{MBON input} = \sum_{i=1}^N w_i R_i^{\text{KC}}$$

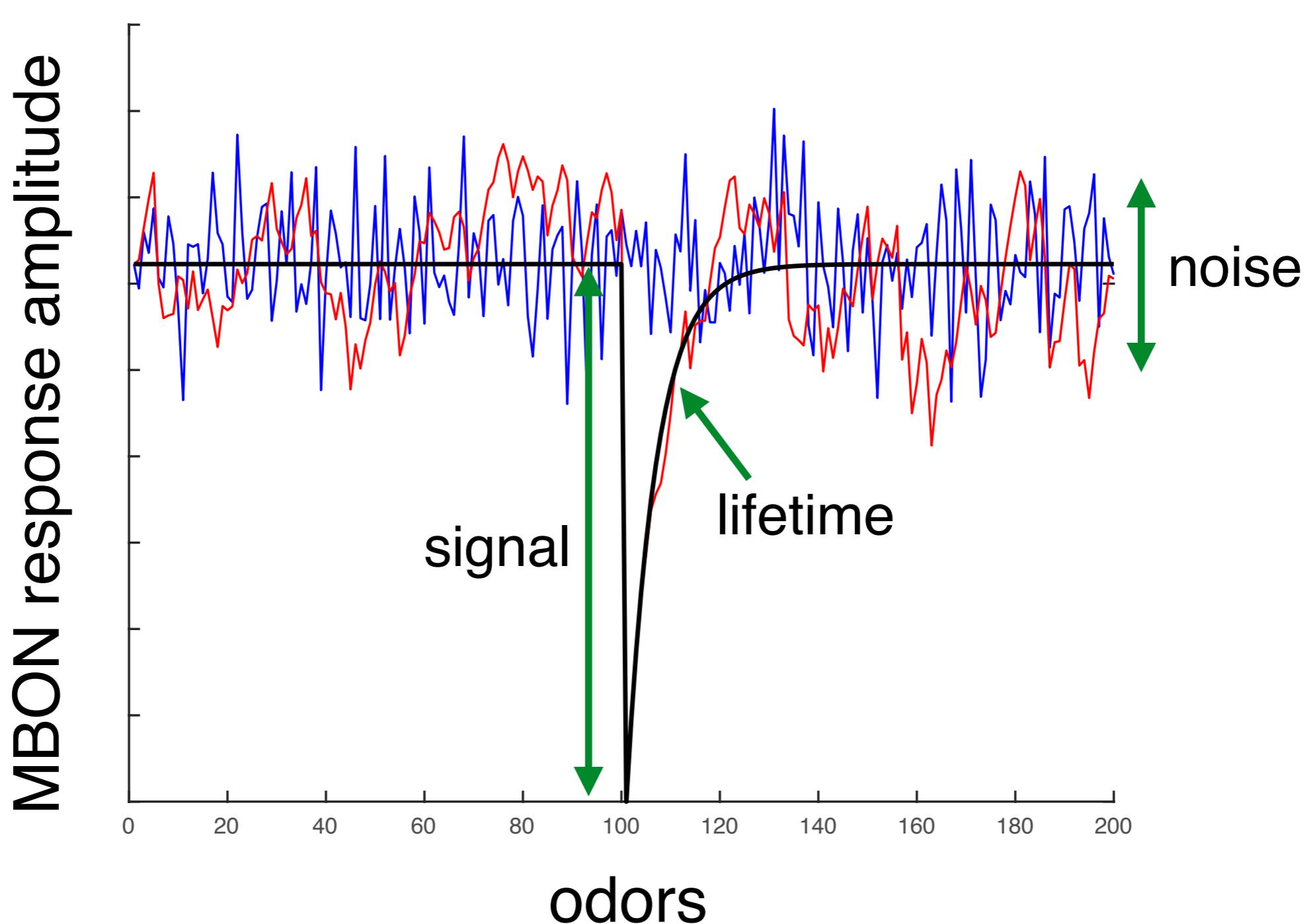
when odor is presented (fraction f of KCs active)

if KC_i active $w_i \rightarrow 0$

if KC_i inactive $w_i \rightarrow w_i + \alpha(1 - w_i)$







$$\text{MBON input} = \sum_{i=1}^N w_i R_i^{\text{KC}}$$

when odor is presented (fraction f of KCs active)

$$\text{if } \text{KC}_i \text{ active } w_i \rightarrow 0$$

$$\text{if } \text{KC}_i \text{ inactive } w_i \rightarrow w_i + \alpha(1 - w_i)$$

$$\bar{w} = 1 - \frac{f}{1 - (1 - f)(1 - \alpha)} \quad \tau = \frac{-1}{\ln((1 - f)(1 - \alpha))}$$

$$\sigma_w^2 = 1 - \frac{f}{1 - (1 - f)(1 - \alpha)^2} - \left(\frac{f}{1 - (1 - f)(1 - \alpha)} \right)^2$$

$$\text{SNR} = \frac{\bar{w}}{\sigma_w}$$

