

# Experience-dependent tuning in olfactory processing: target and background odor segregation

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AGENCIA  
NACIONAL DE PROMOCION  
CIENTIFICA Y TECNOLOGICA



CONICET



# Experience-dependent tuning in olfactory processing: target and background odor segregation

Brian Smith

Arizona State University

Patricia Fernandez

University of Buenos Aires

Ramon Huerta

Biocircuits, UCSD

Kerem Muezzinoglu,

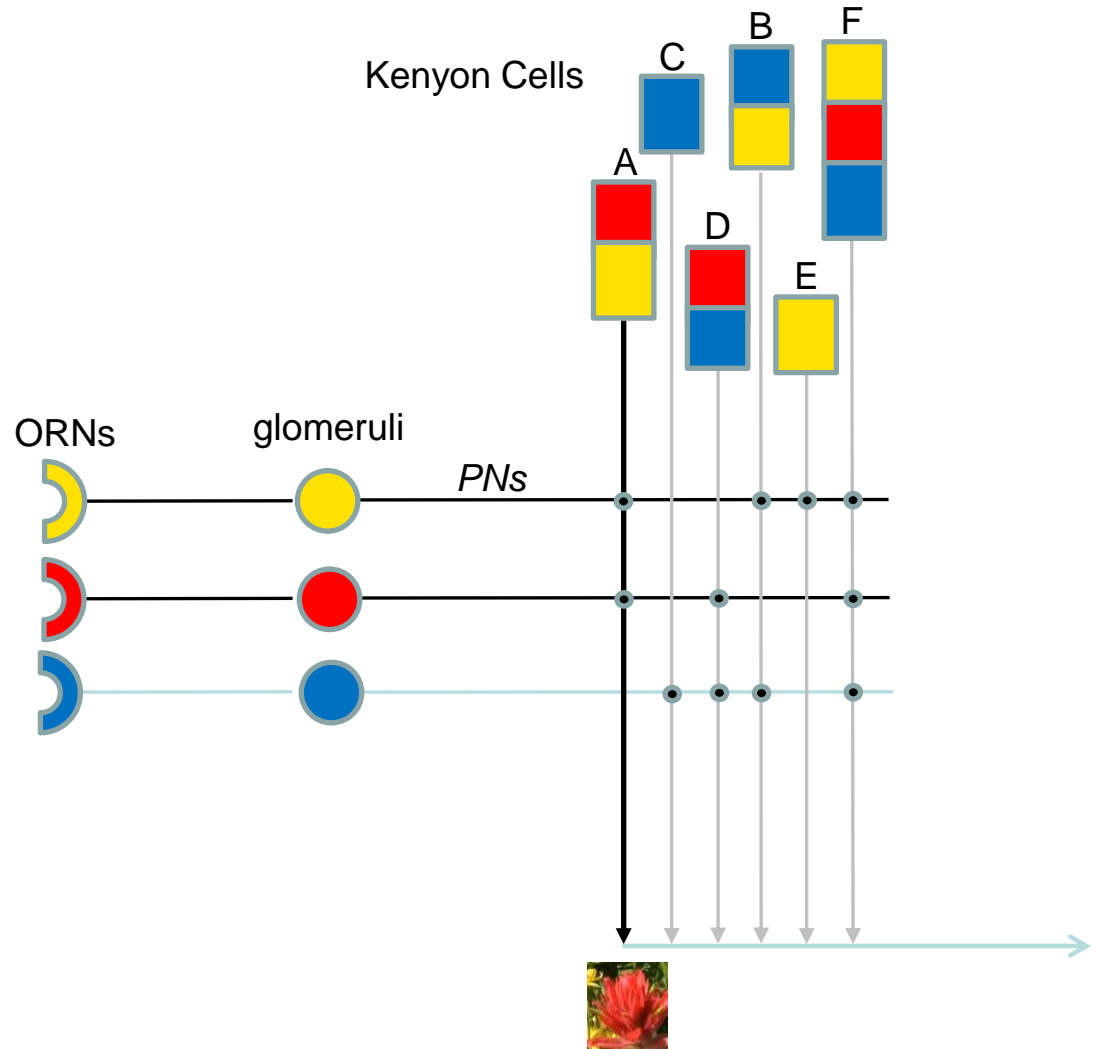
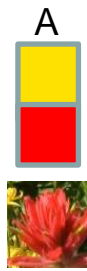
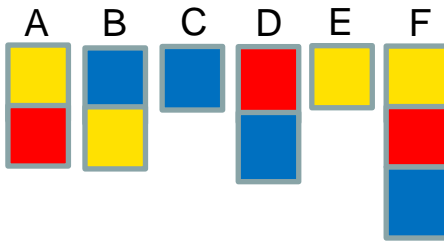
Maxim Bazhenof

UCRiverside

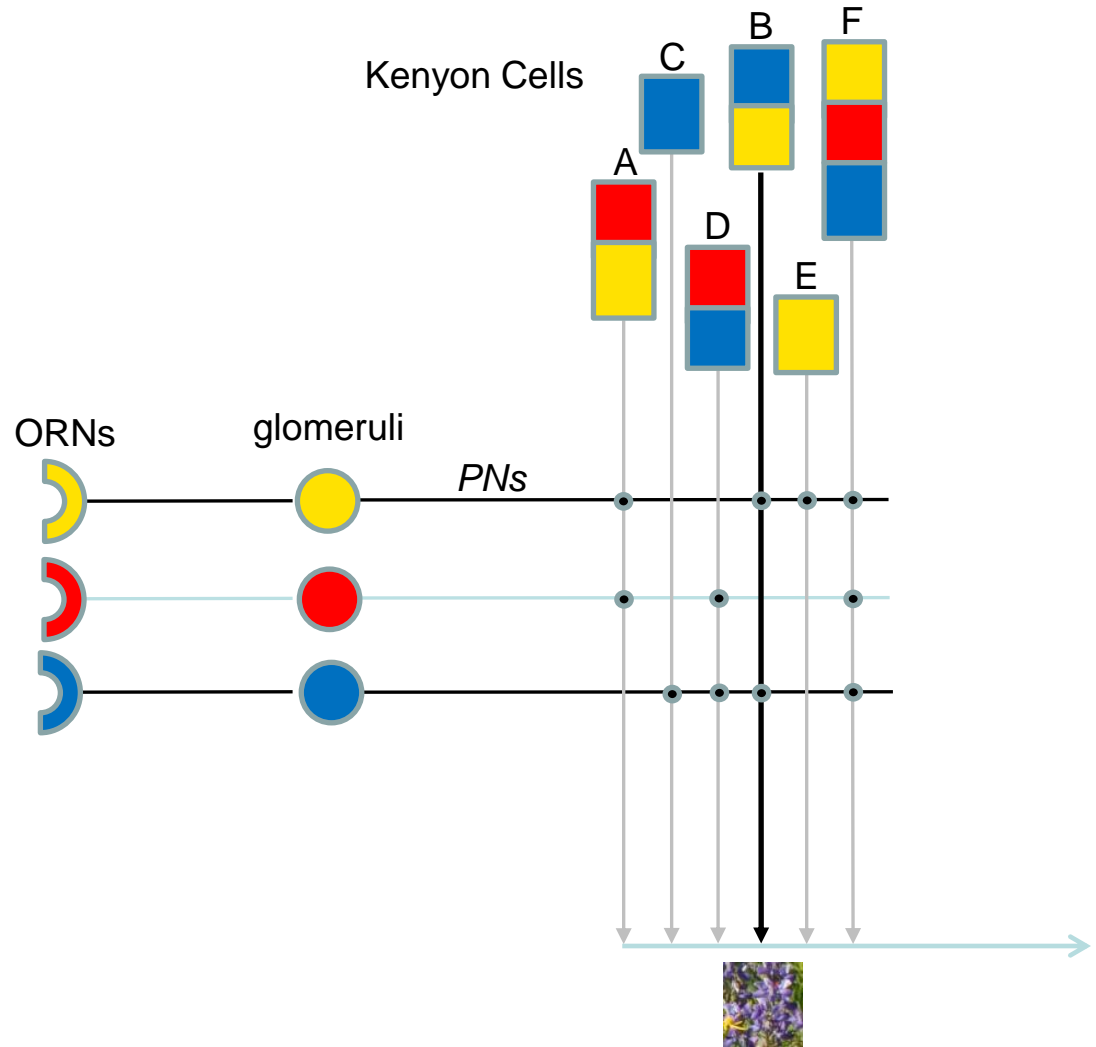
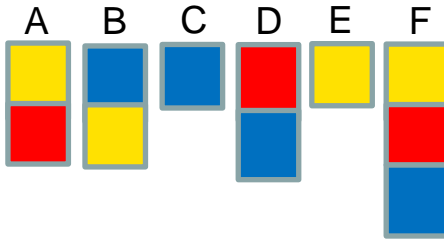
Jen-Yung Chen



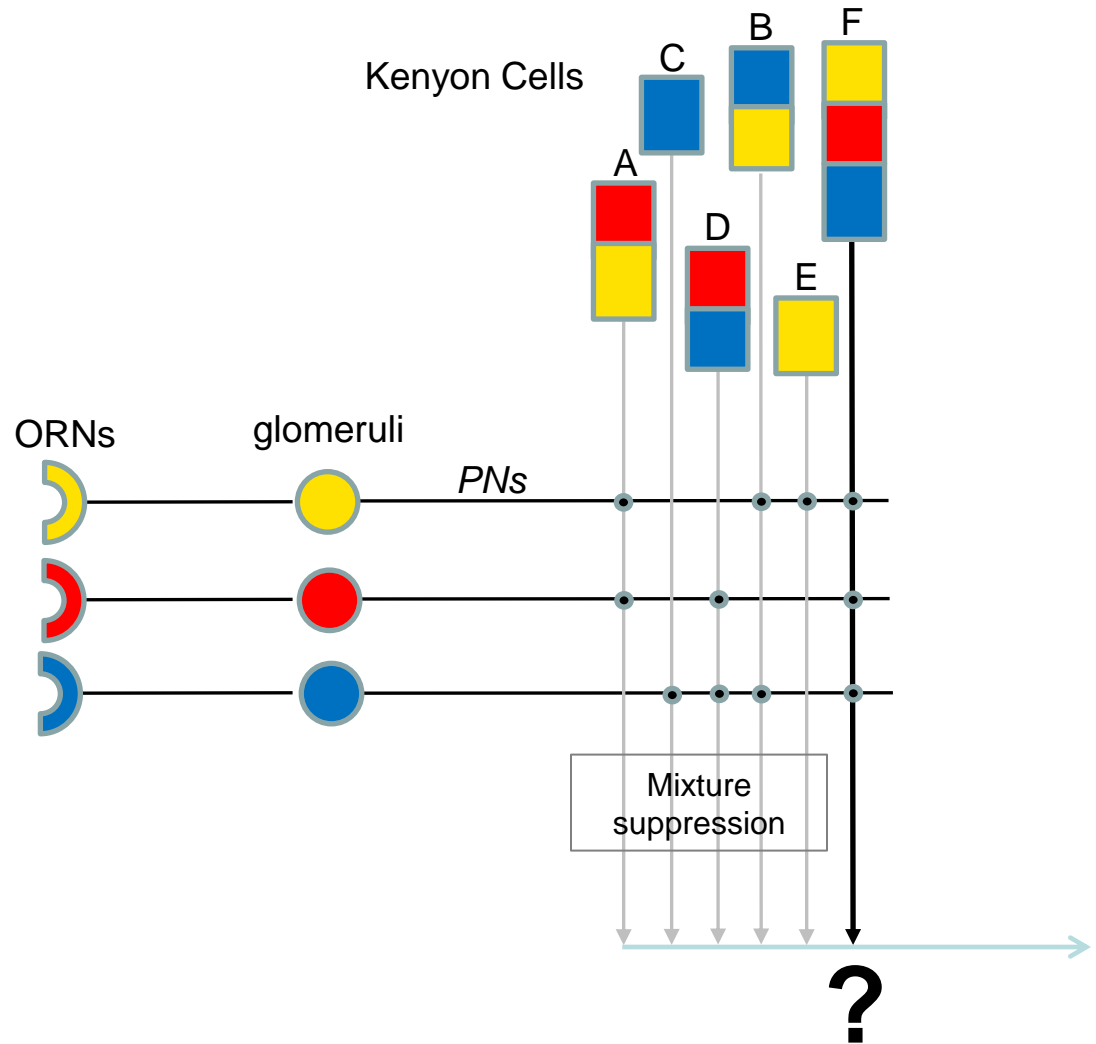
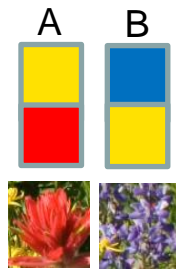
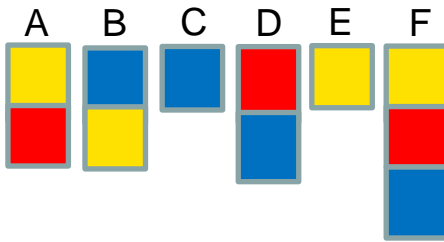
odor molecules



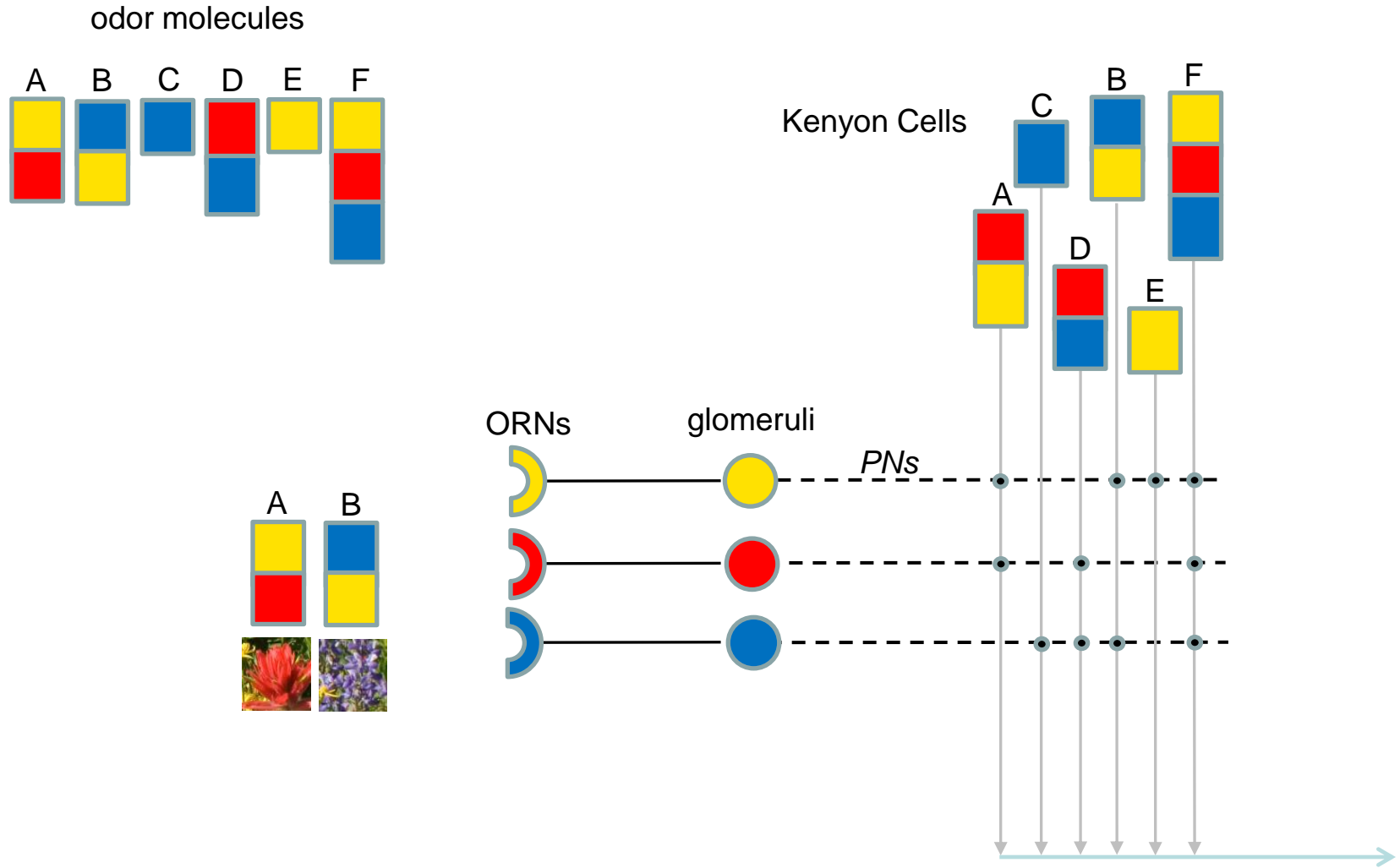
odor molecules



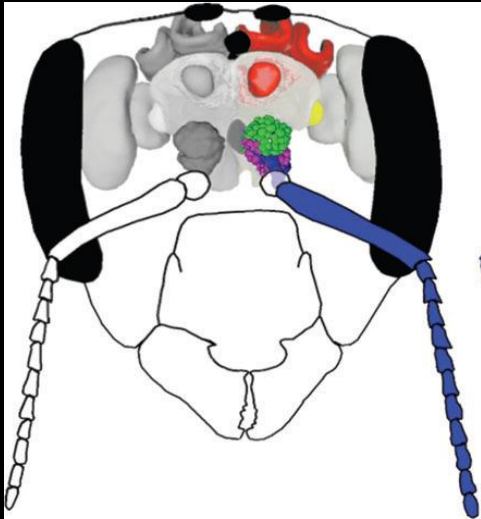
odor molecules



**Hypothesis:** Associative and non-associative learning allows detection of relevant targets on top of background odors by modulating the balance among projection neurons



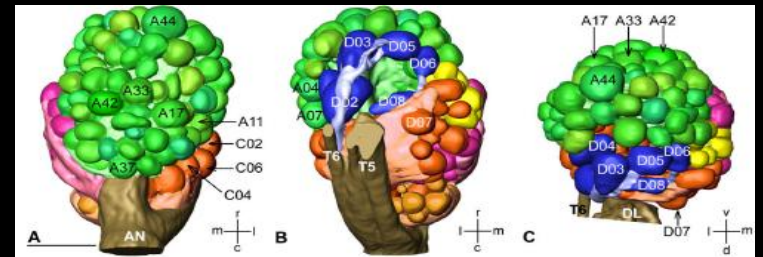
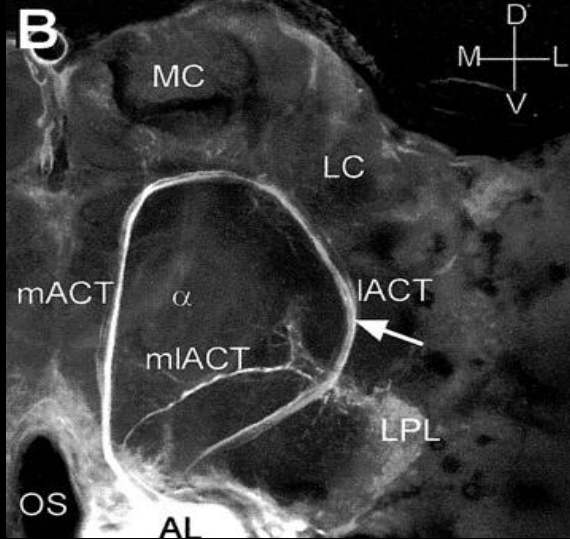
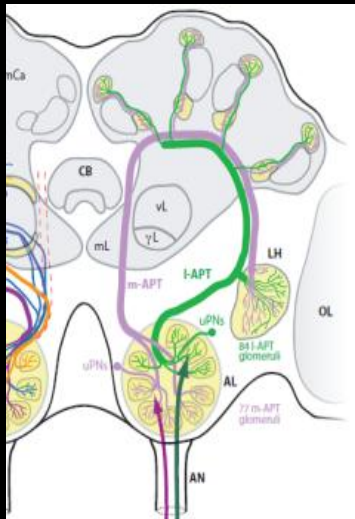
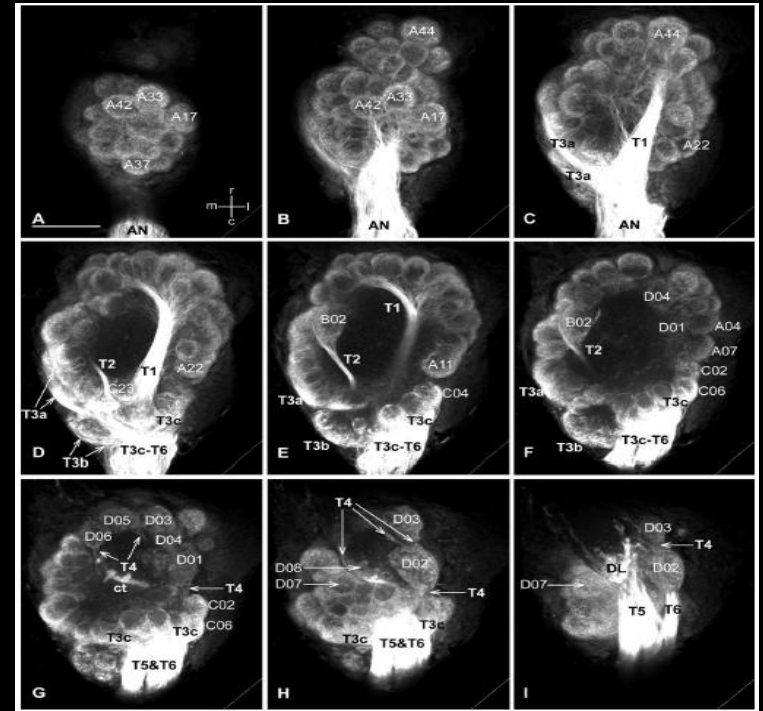
# The antennal lobe, first olfactory neuropil in insects



**Mushroom bodies**  
Lateral protocerebrum

**Antennal lobe**  
800 projection neurons  
4000 local neurons  
160 glomeruli

**Antenna**  
60.000 receptors

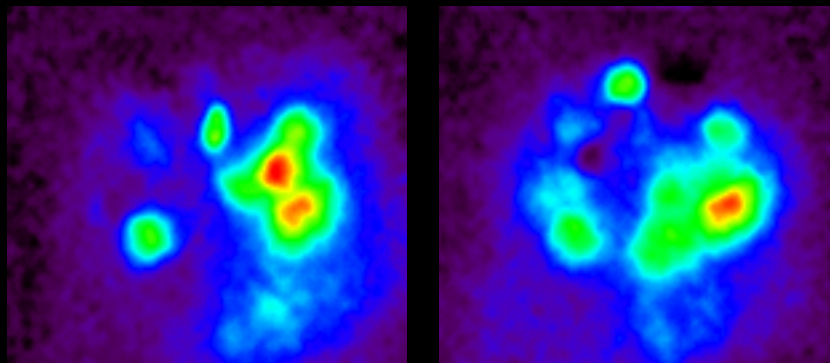
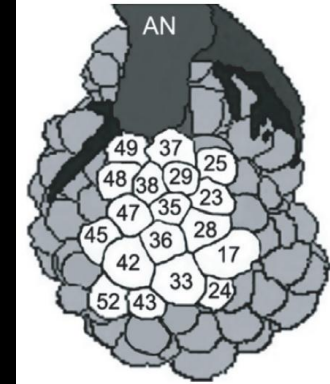
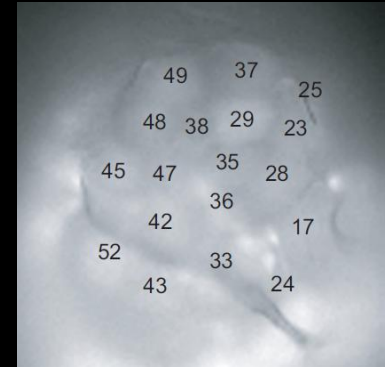
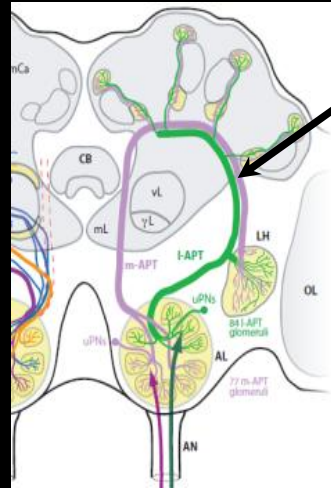
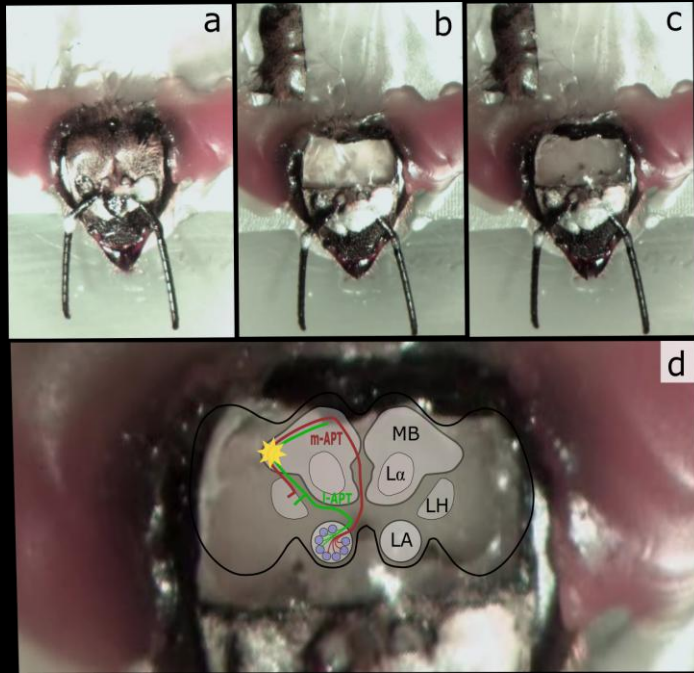


Sachse & Galizia, J. of Neurophysiology, 2002.

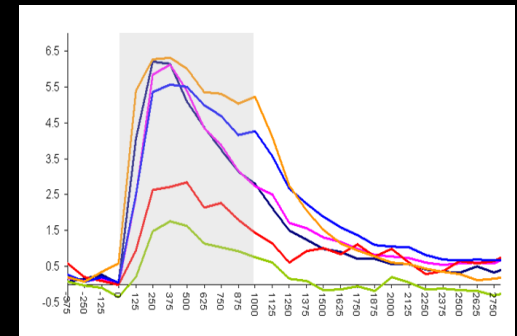
Kirschner et al., JCompNeuro 2006

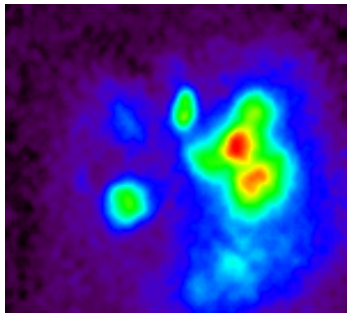


# The antennal lobe, staining Projection neurons and Calcium Imaging

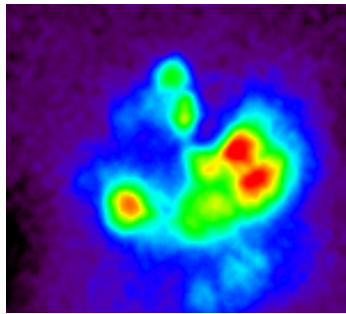


16  
0  
 $\Delta(340/380)\%$

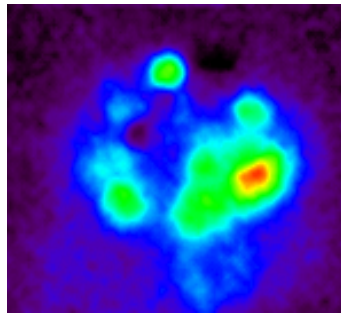




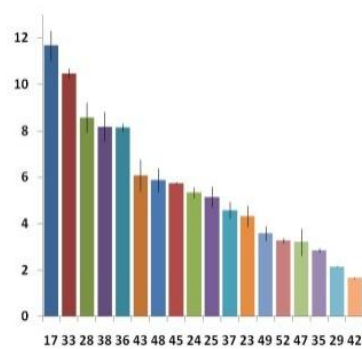
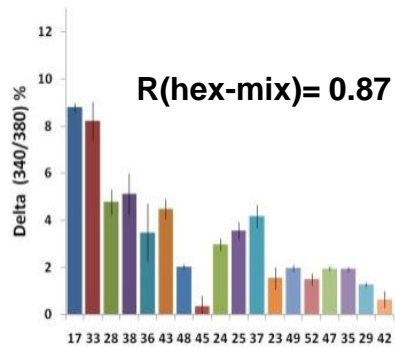
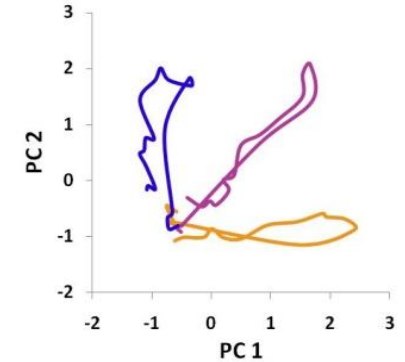
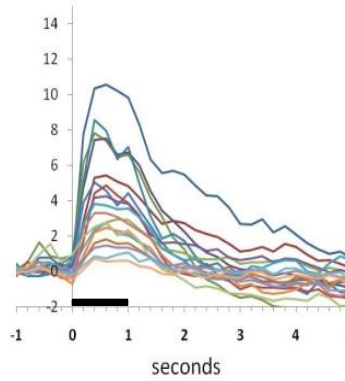
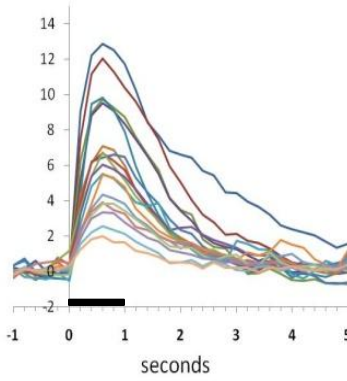
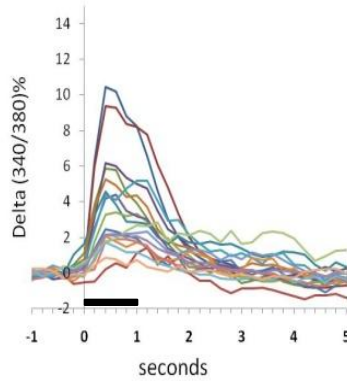
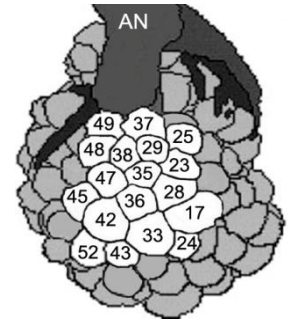
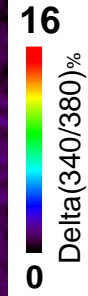
1-hexanol



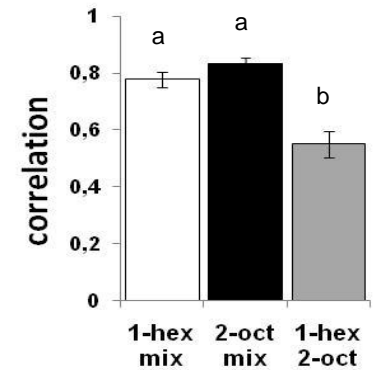
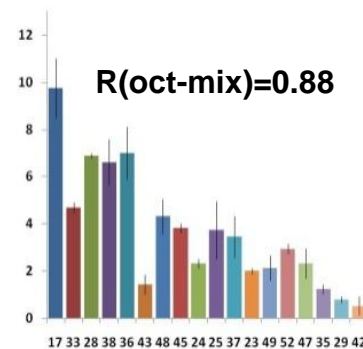
mixture



2-octanone

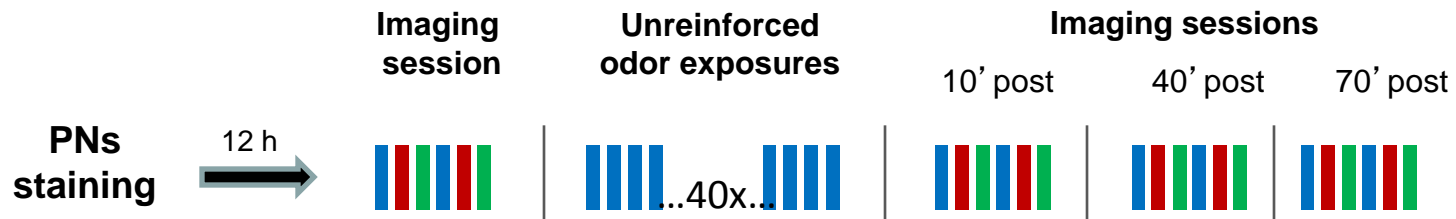


glomeruli

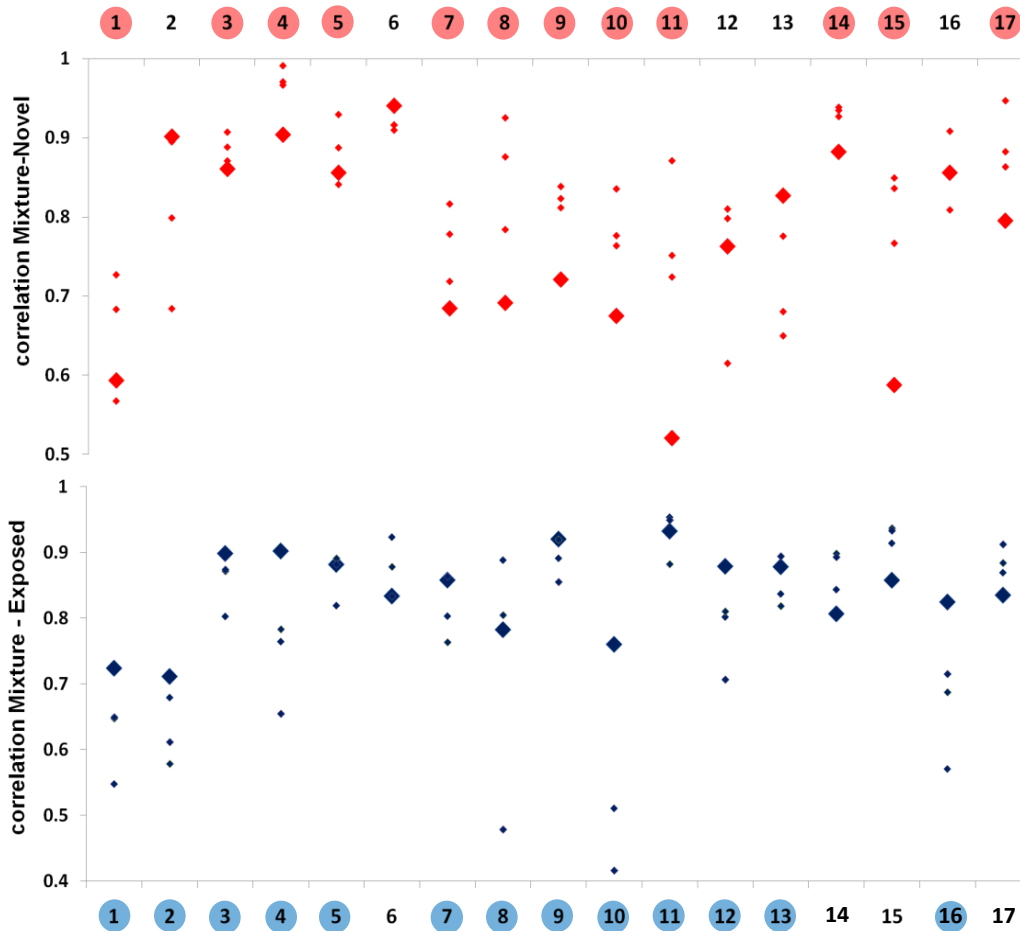


## Non-associative learning:

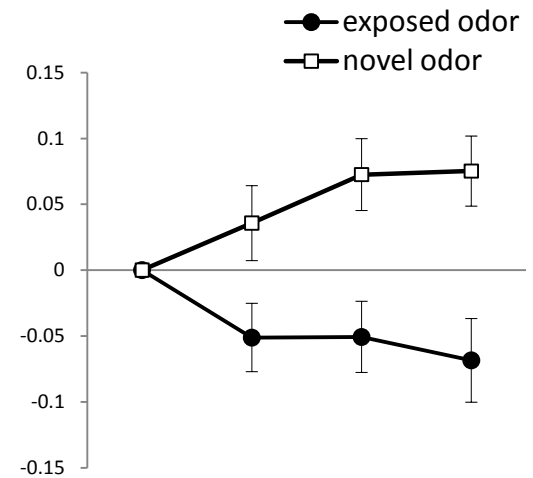
Does repeated unrewarded exposure to an odor change the relative weight of that odor in the representation of a mixture at the level of PNs?



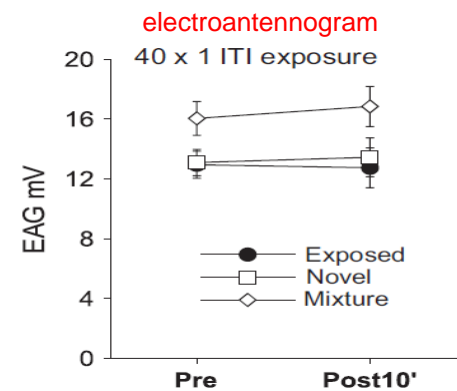
**correlation pure odors - mixture**

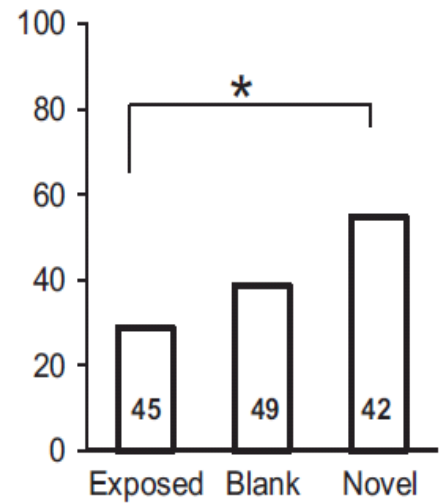
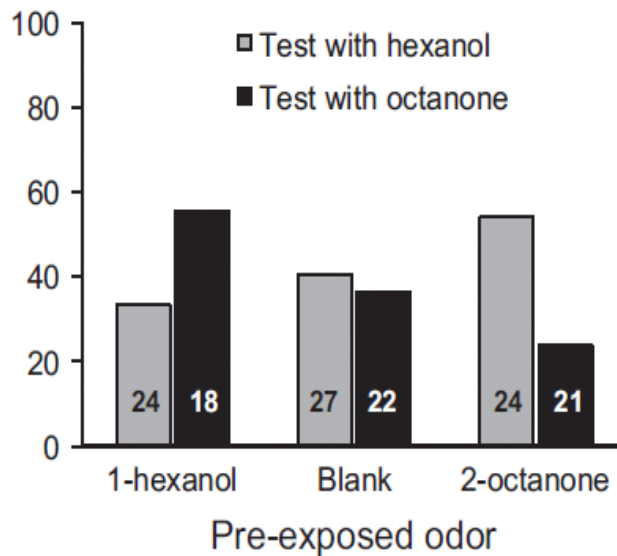
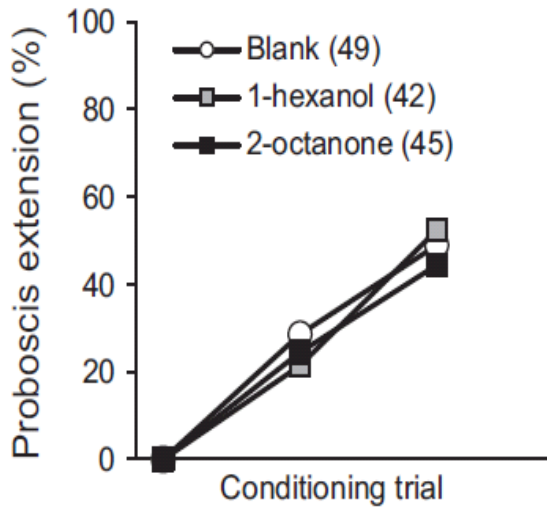
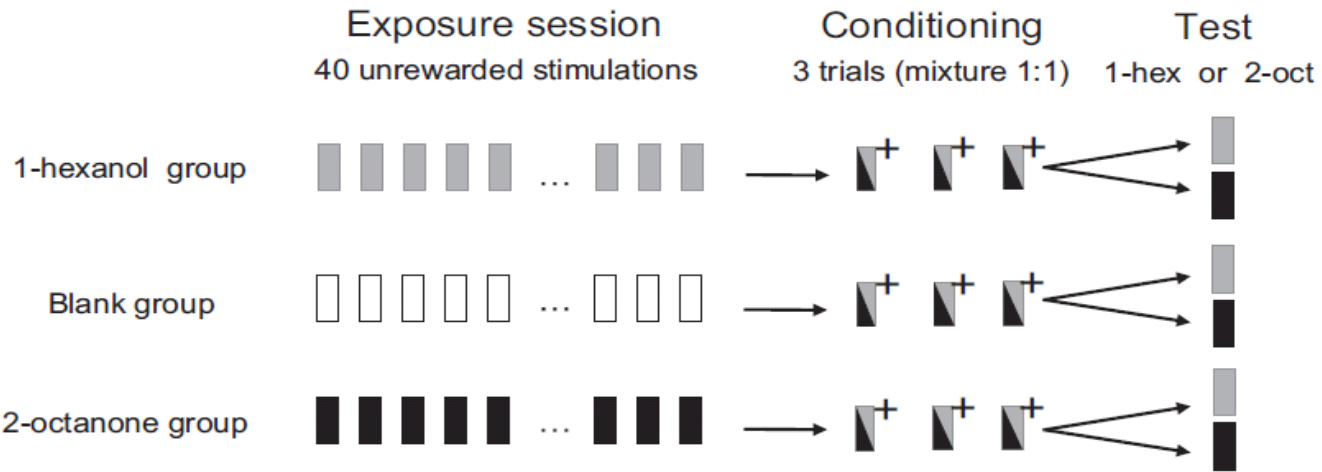


**change in correlation**



pre post10 post40 post70



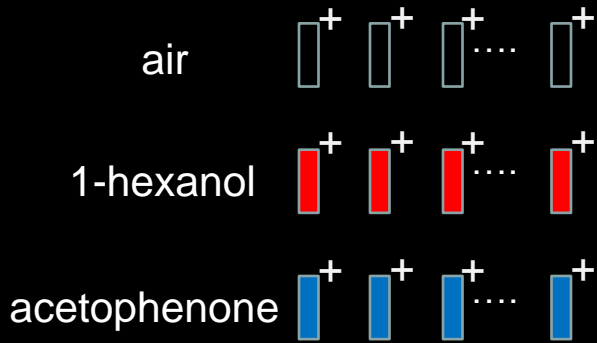


Non-associative plasticity alters the perceptual quality of the mixture

Unrewarded exposure to one of the components produces a shift in the representation of the mixture that makes it more similar to the novel odor and less similar exposed odor

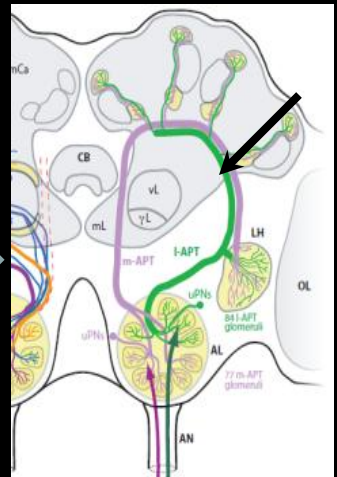
Does appetitive learning to an odor enhance the representation of that odor in the representation of a mixture?

**Conditioning  
(odor + sucrose)  
10 trials / 10 ITI**



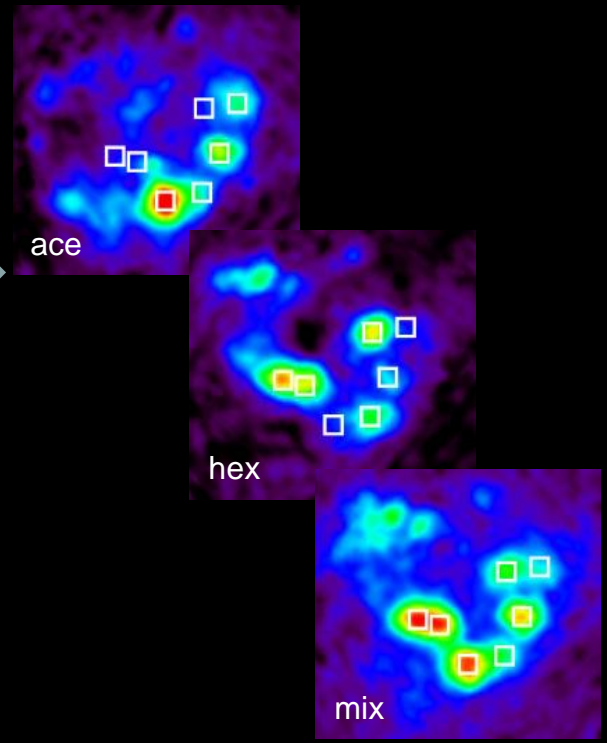
8 h

**STAINING PN's  
for calcium Imaging**

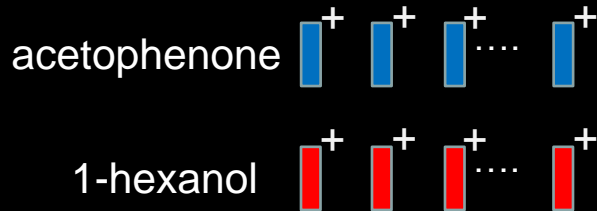


12-16 h

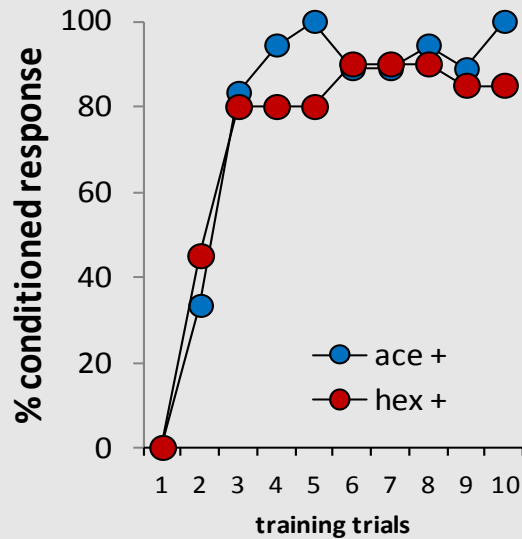
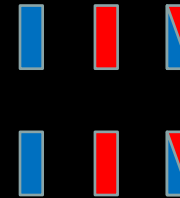
**Calcium Imaging of odor  
elicited patterns in the AL**



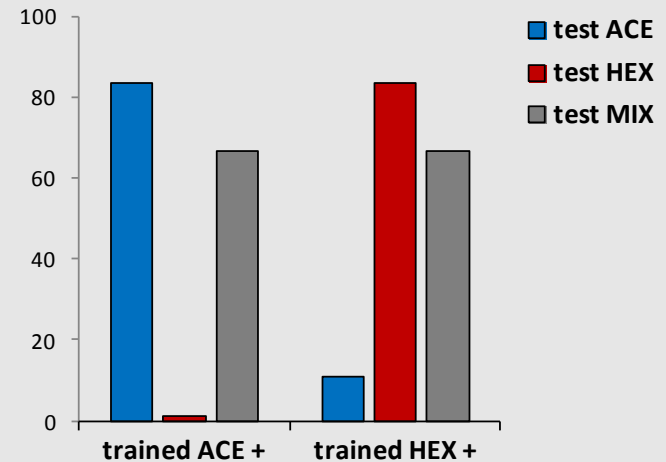
### Conditioning (10 trials) (odor + sucrose)



### Test session

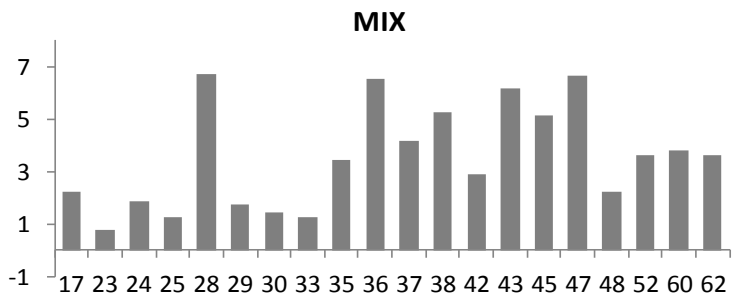
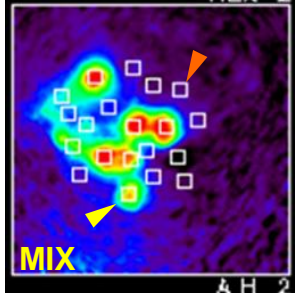
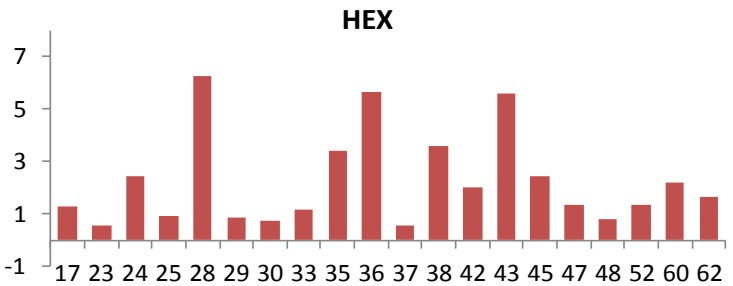
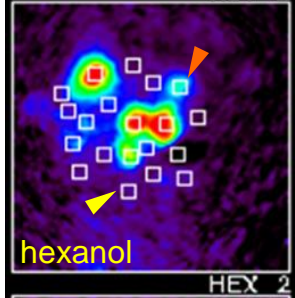
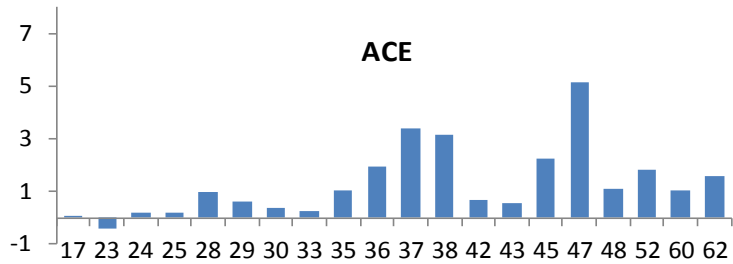
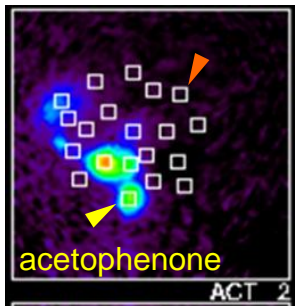


24 h



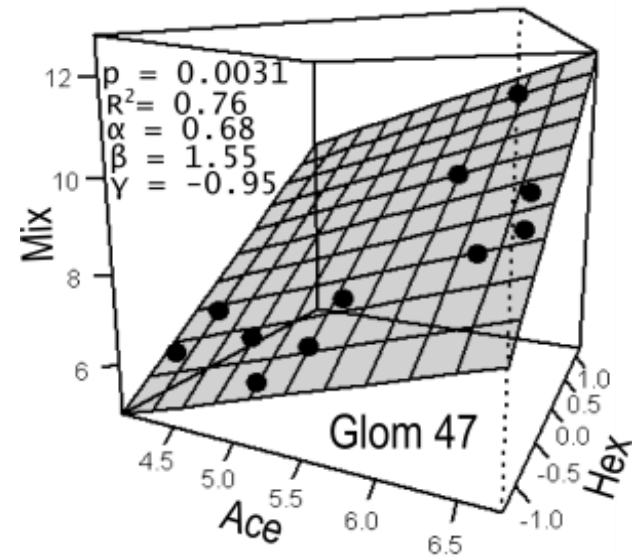
response to the mixture after training  
with the components



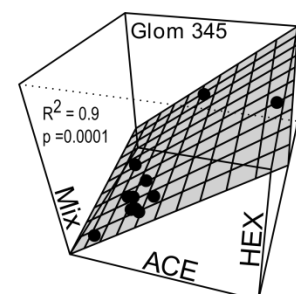
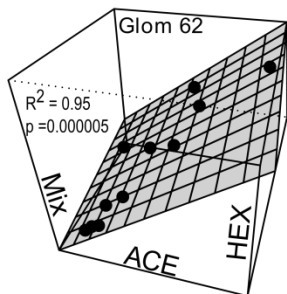
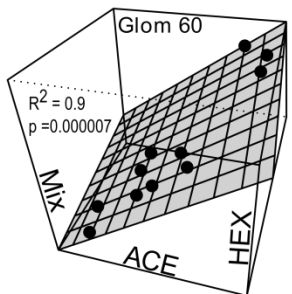
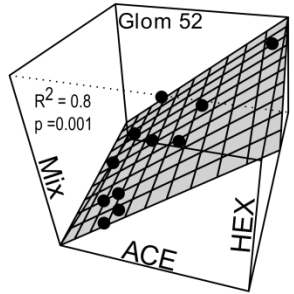
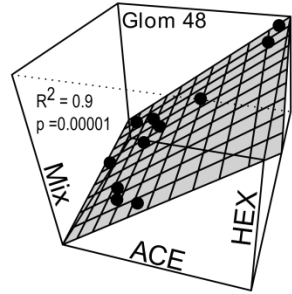
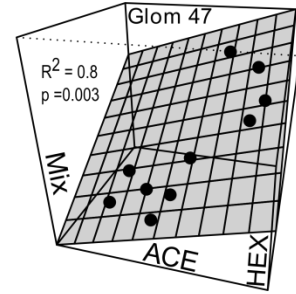
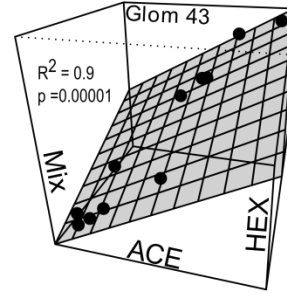
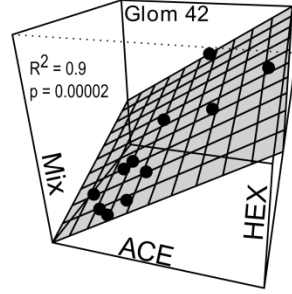
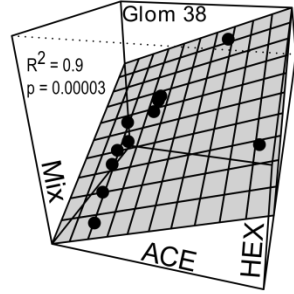
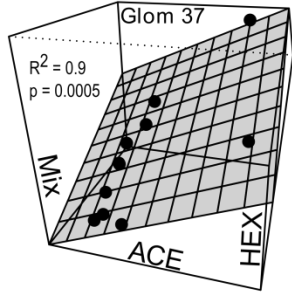
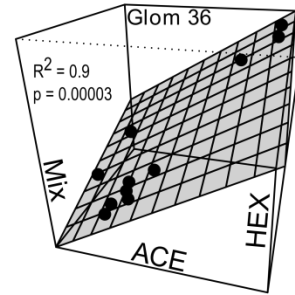
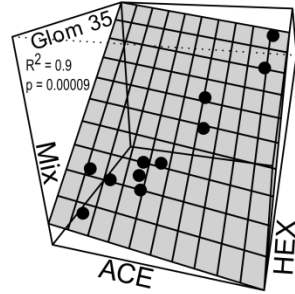
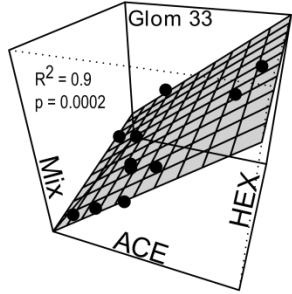
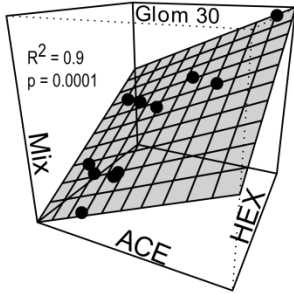
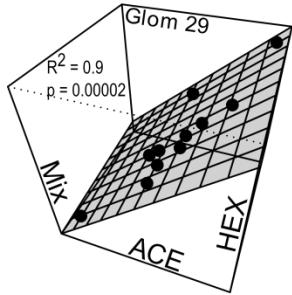
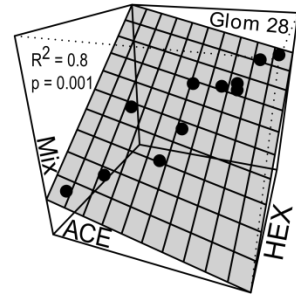
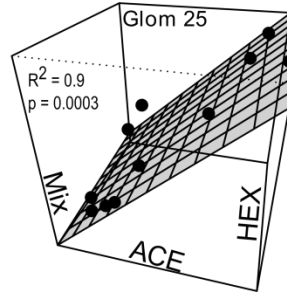
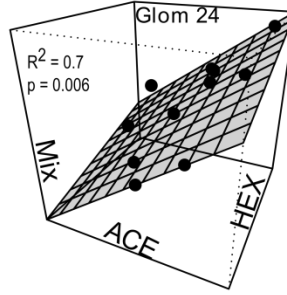
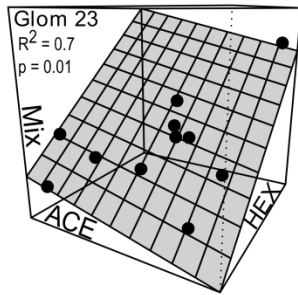
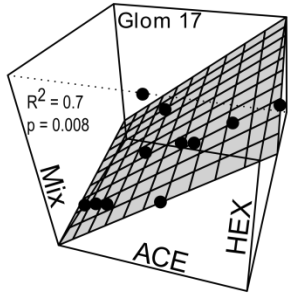


### Mixture prediction

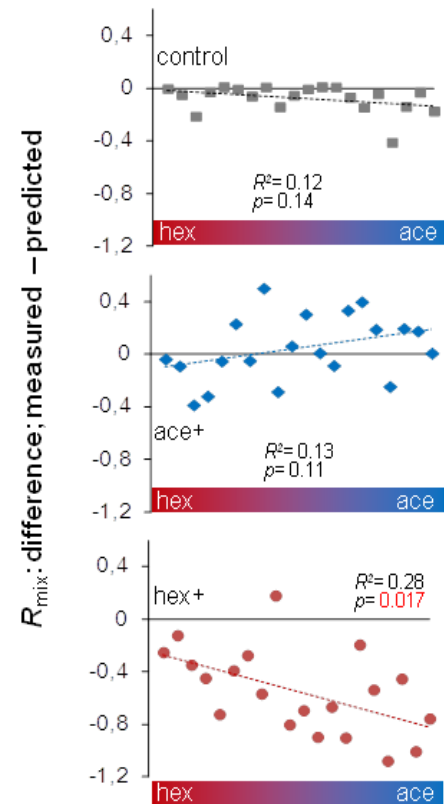
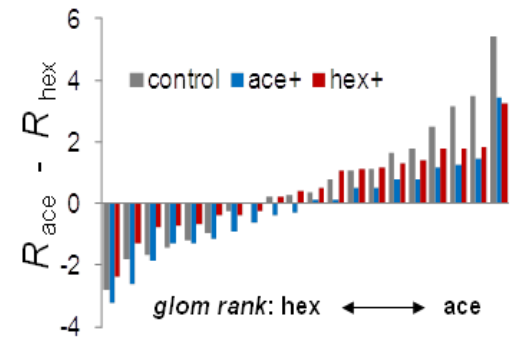
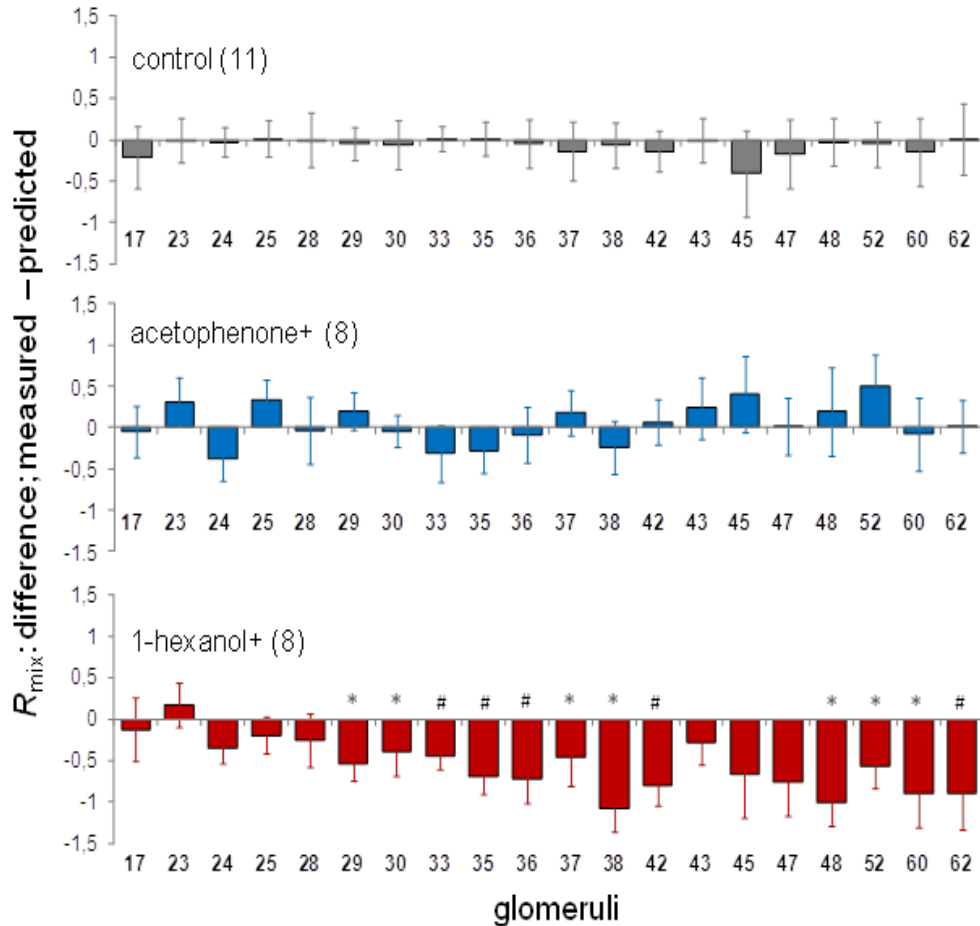
$$R_{mix} = \alpha R_{hex} + \beta R_{ace} + \gamma$$

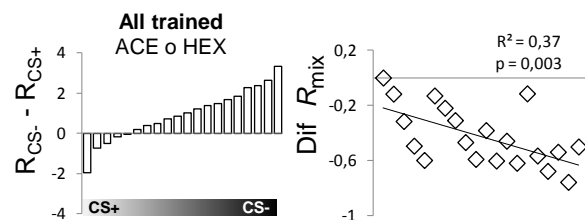
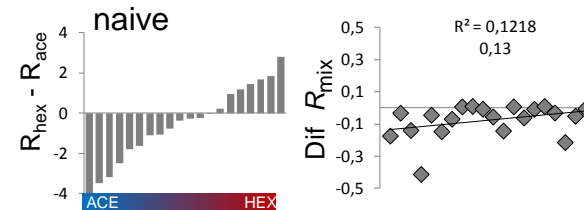
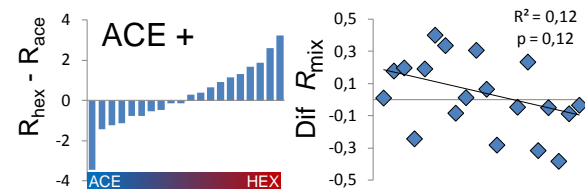
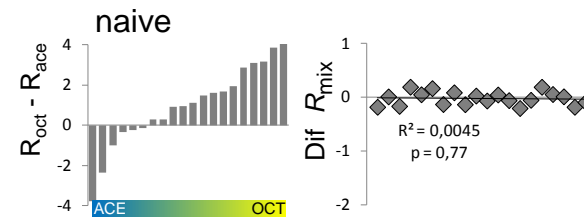
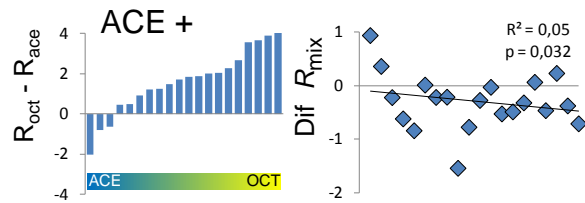
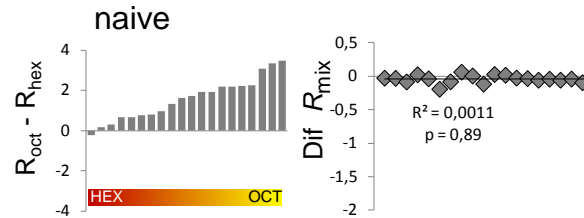
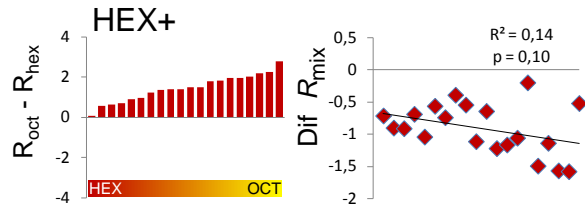
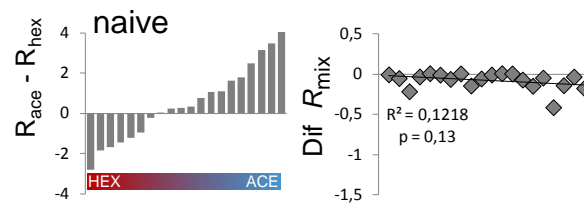
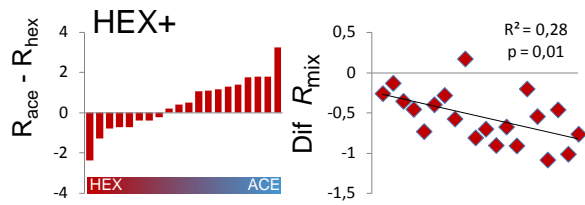


$R^2_{max} = 0.95$     $R^2_{min} = 0.7$     $R^2_{mean} = 0.86$   
 $p_{max} = 0.01$     $p_{min} = 0.000005$     $p_{mean} = 0.002$



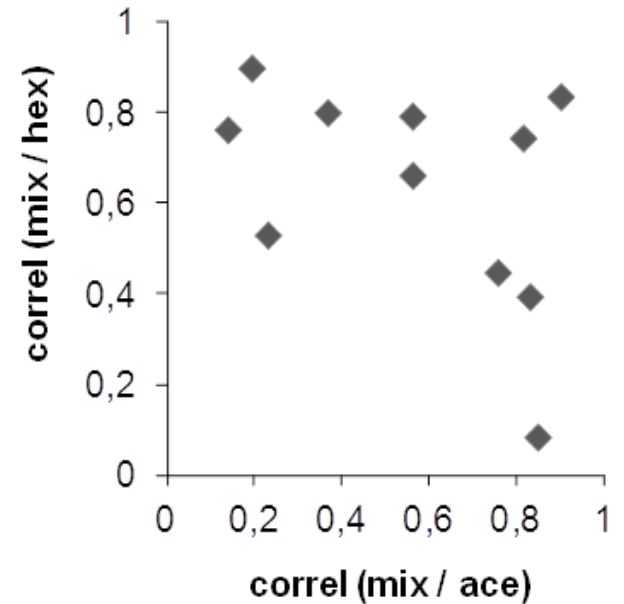
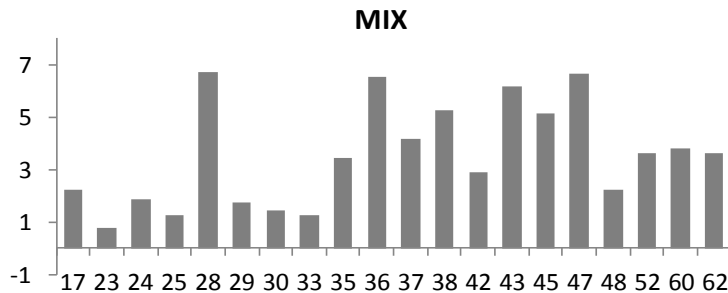
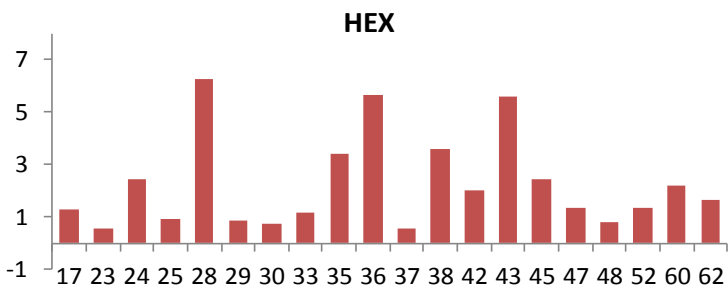
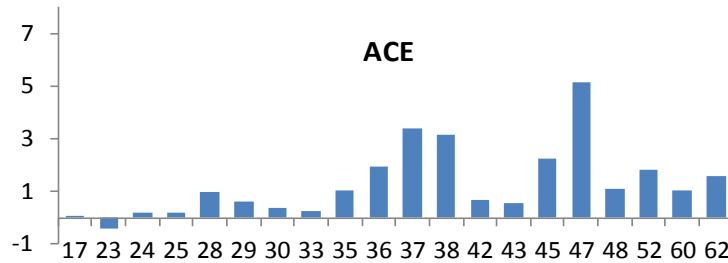
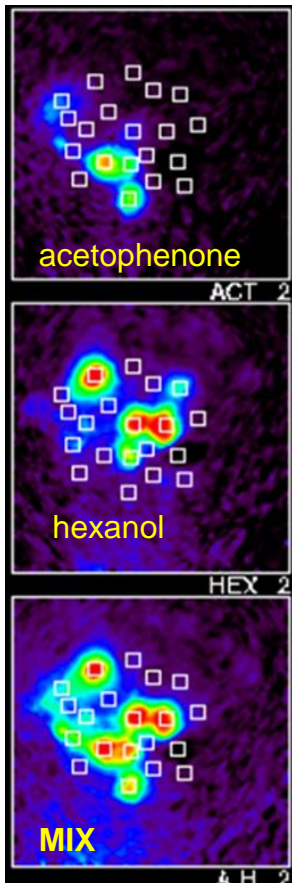
The prediction models obtained for control animals were used to predict the pattern for the mixture in trained animals



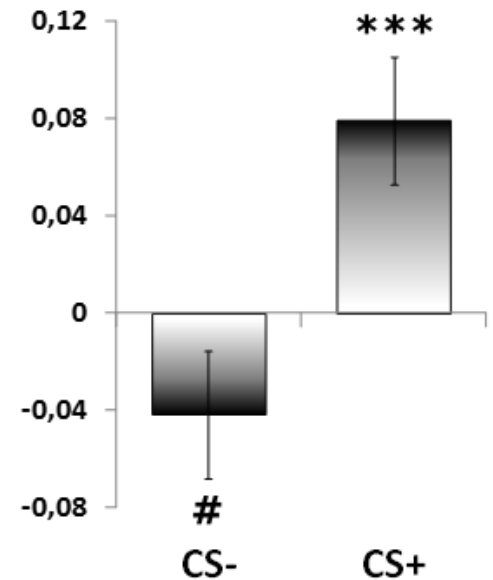
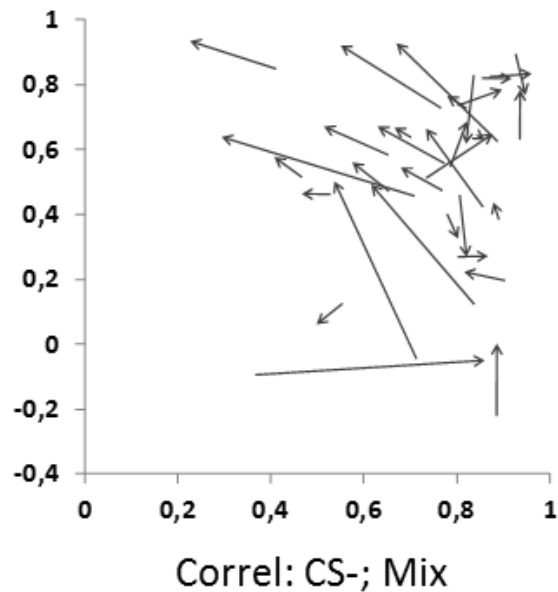
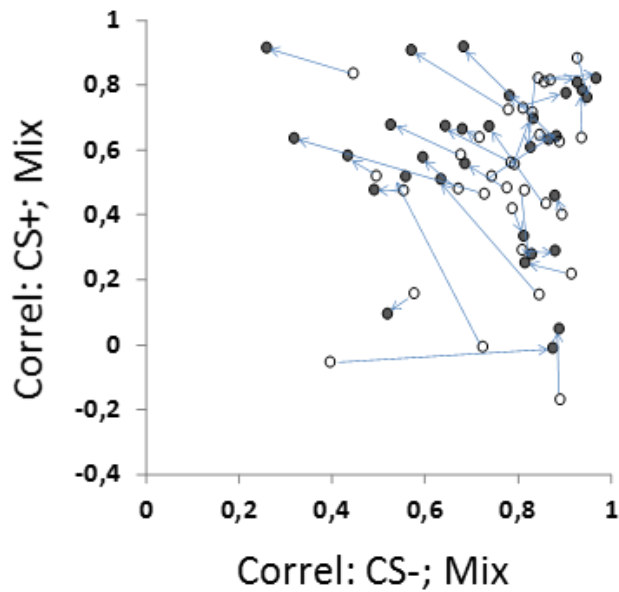


Training:	CS+	vs.	CS-
1-hexanol	1-hexanol		acetophenone
1-hexanol	1-hexanol		2-octanone
acetophenone	acetophenone		2-octanone
acetophenone	acetophenone		1-hexanol

How do changes in individual glomeruli affect the relative weight of the components in the representation of the mixture?

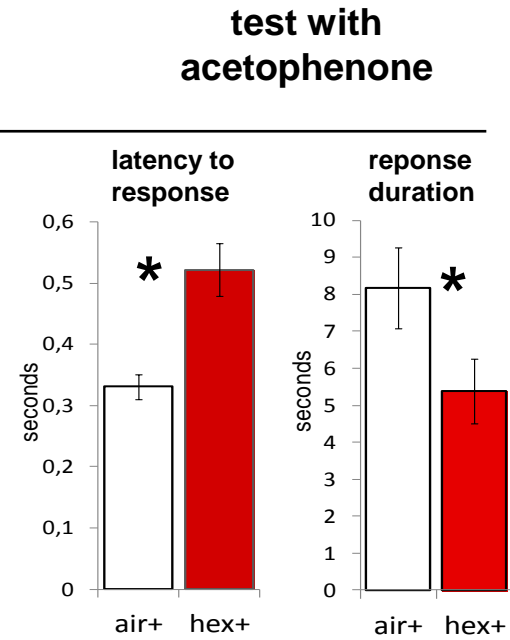
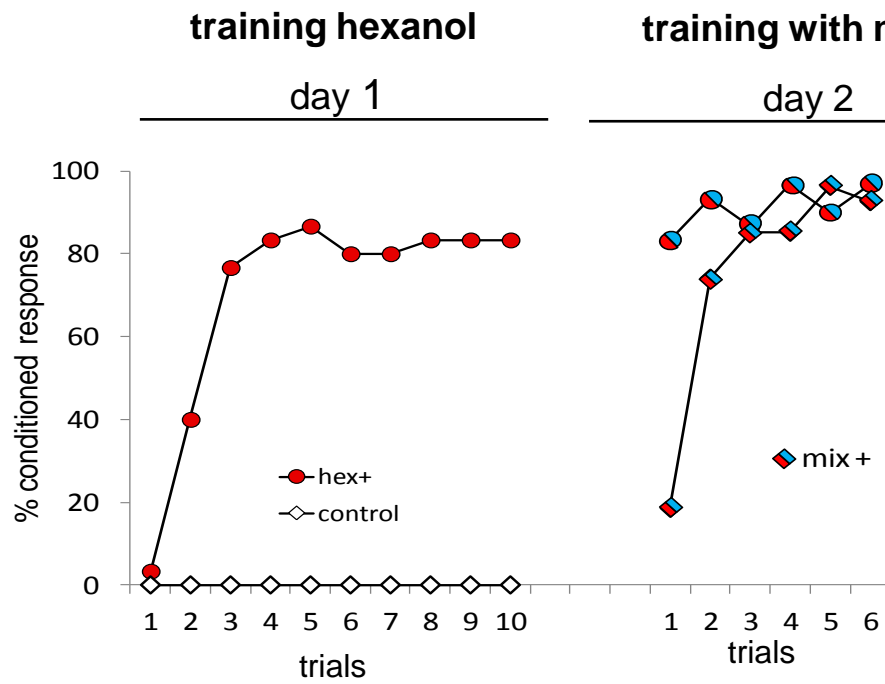


How do changes in individual glomeruli affect the relative weight of the components in the representation of the mixture?

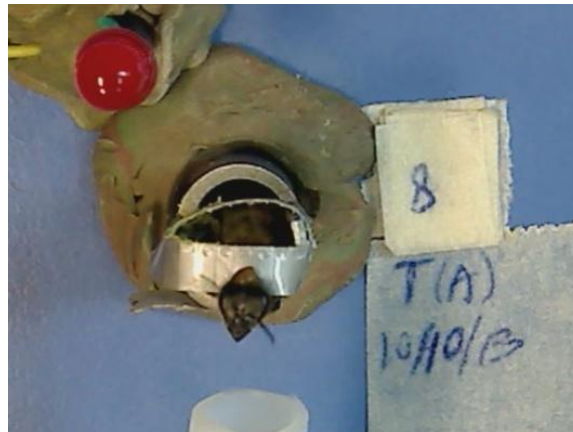


<b>Training:</b>	<b>CS+</b>	<b>vs.</b>	<b>CS-</b>
1-hexanol	1-hexanol		acetophenone
1-hexanol	1-hexanol		2-octanone
acetophenone	acetophenone		1-hexanol
acetophenone	acetophenone		2-octanone

# Do changes alter the perception of the mixture?



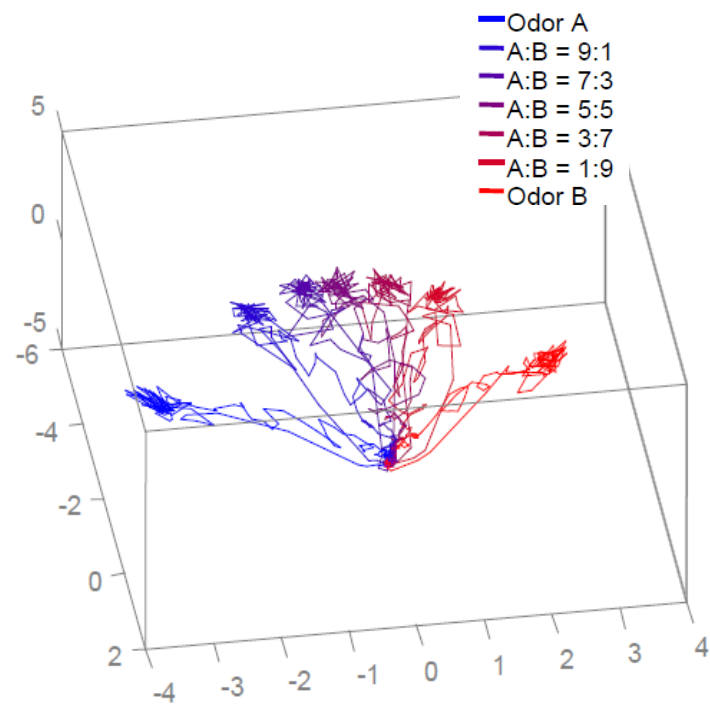
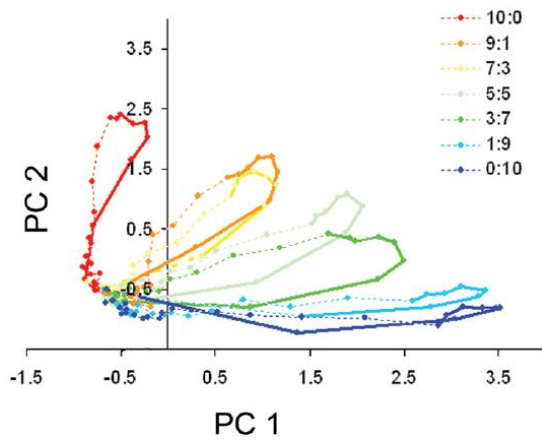
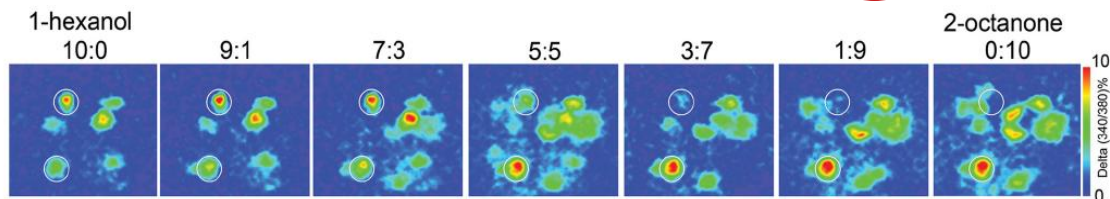
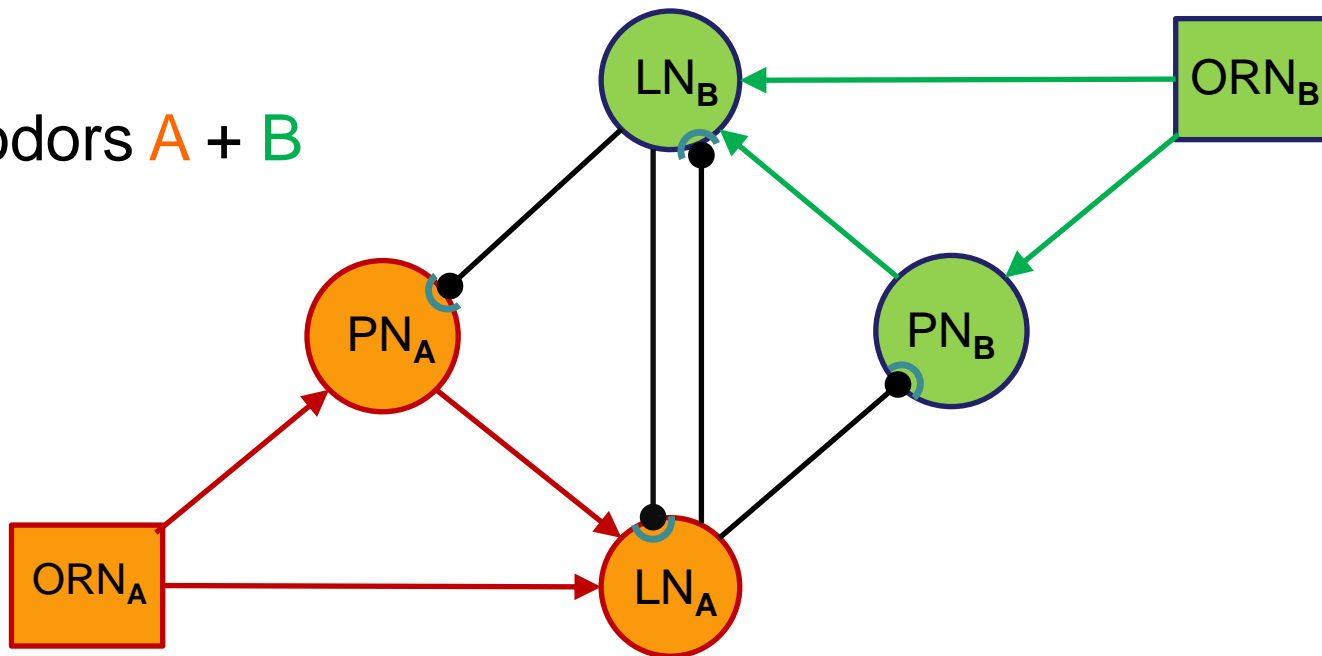
control



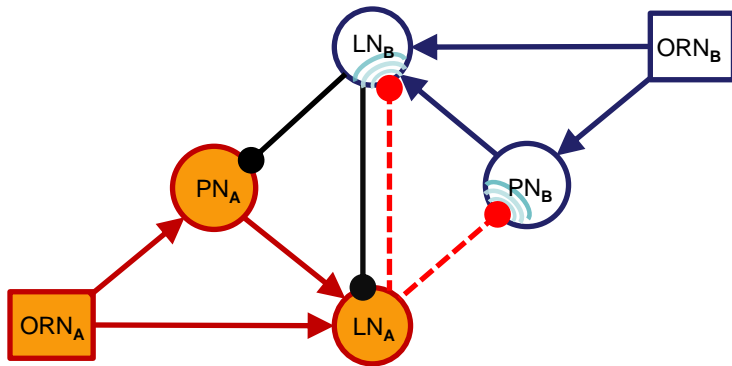
hex+



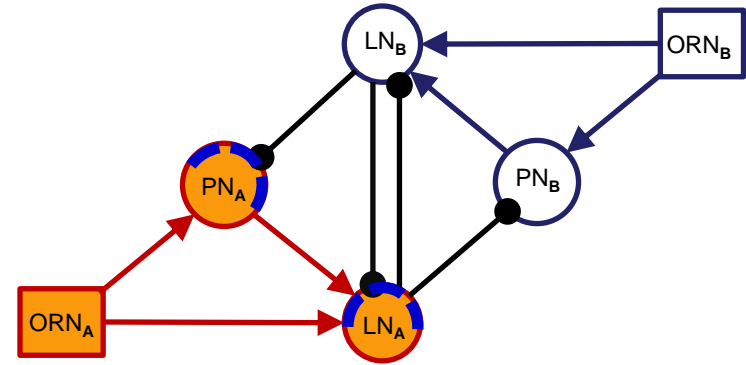
odors A + B



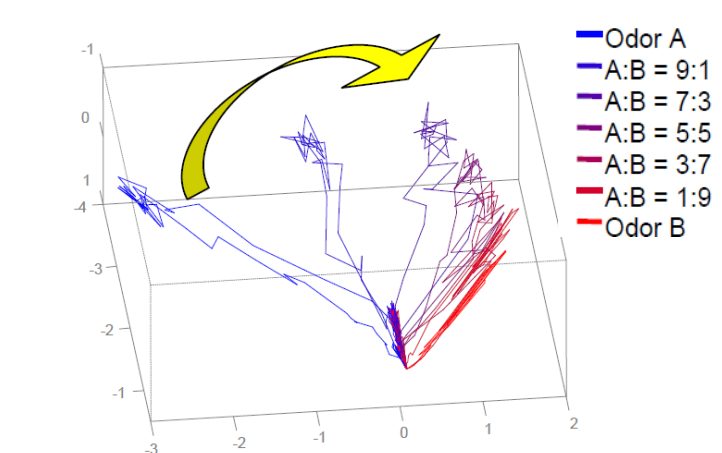
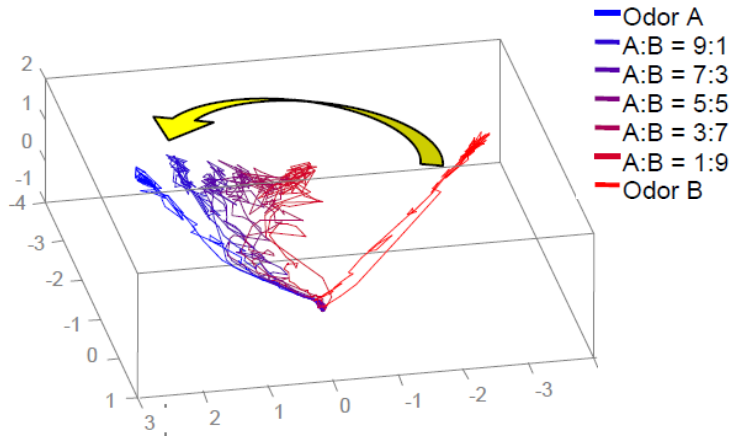
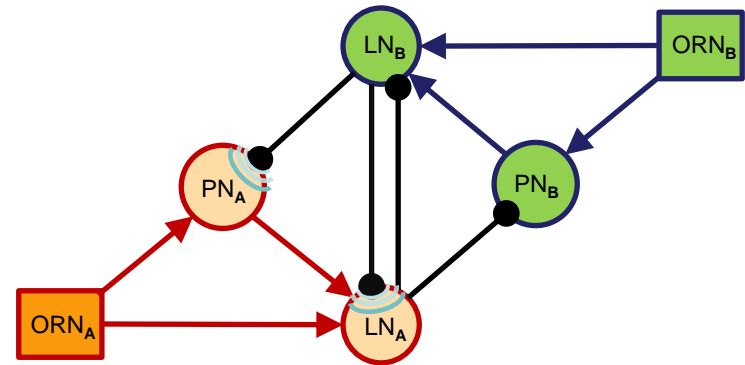
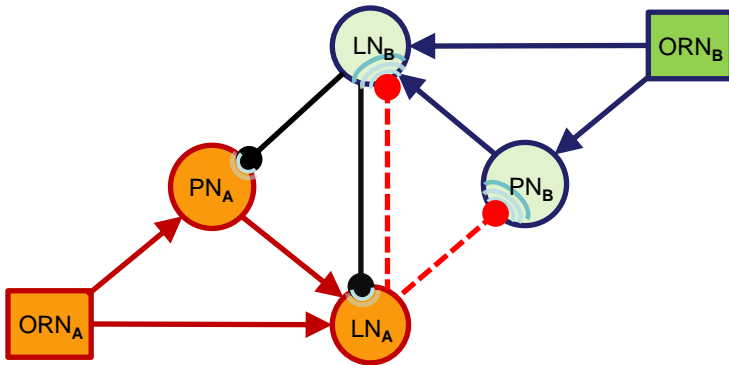




Increase the synaptic strength every time that the pre-synaptic side of an inhibitory synapse is active



Increase the synaptic strength every time that the post-synaptic side of an inhibitory synapse is active



Experience dependent plasticity in the antennal lobe network might equip animals with a dynamical and adjustable filter to detect relevant cues



thank you very much

for your attention

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Ramon Huerta

Jen-Yung Chen

Kerem Muezzinoglu