Neural Circuit for Fly Mating

2013/01/15

Tatsuo Okubo

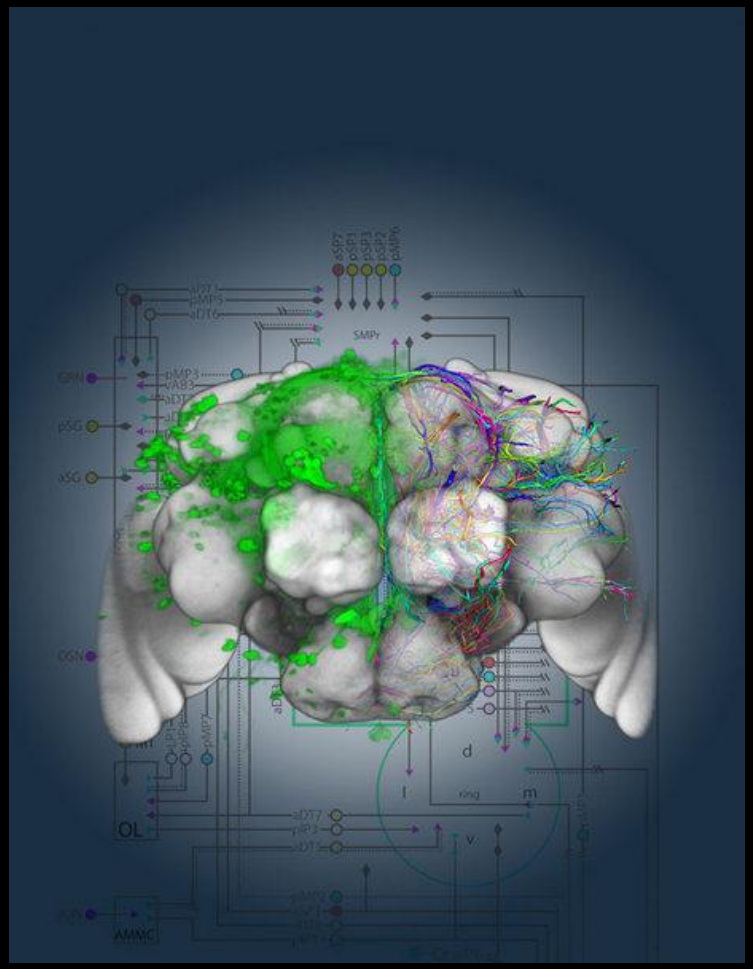
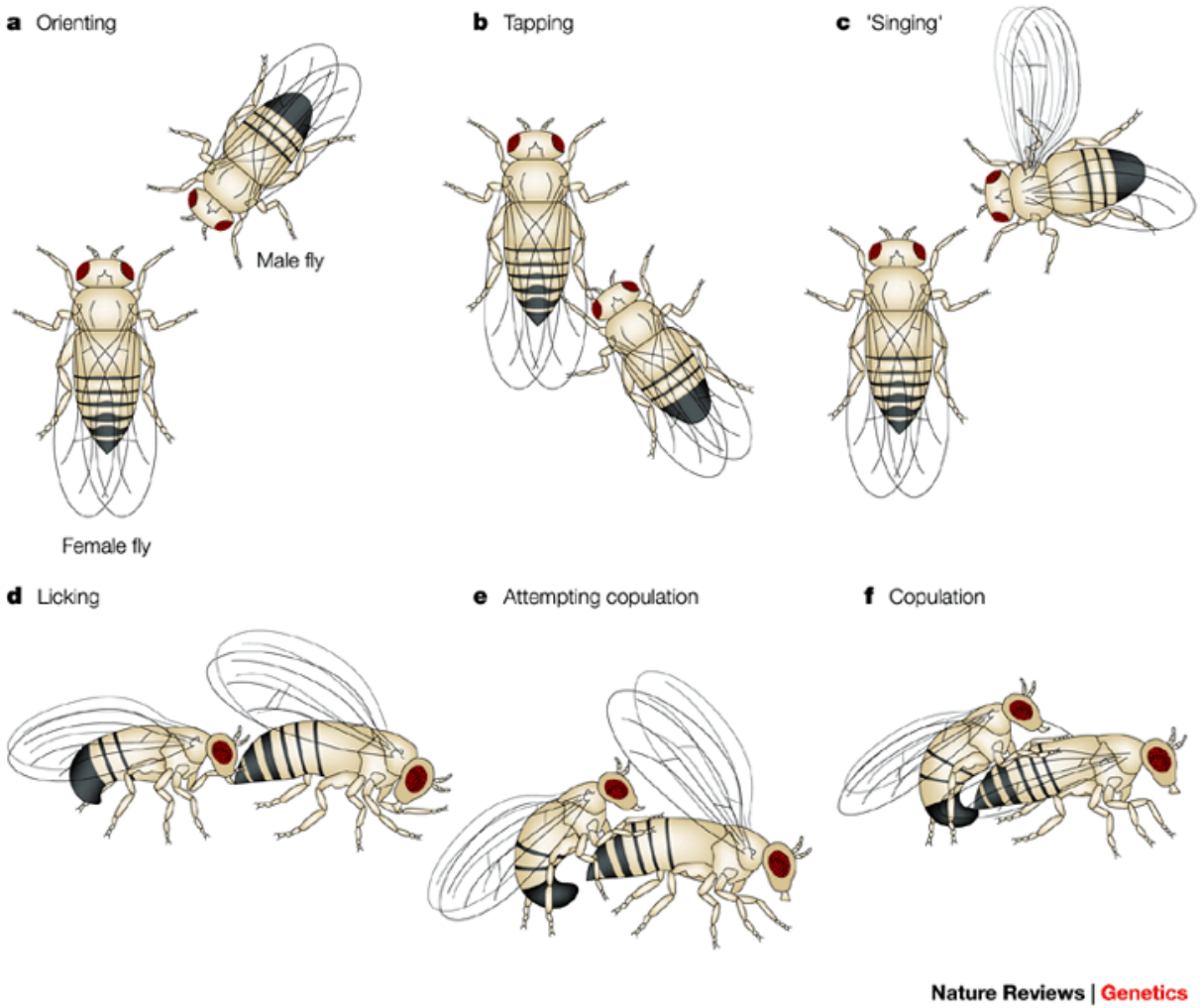


Image: Dickson lab

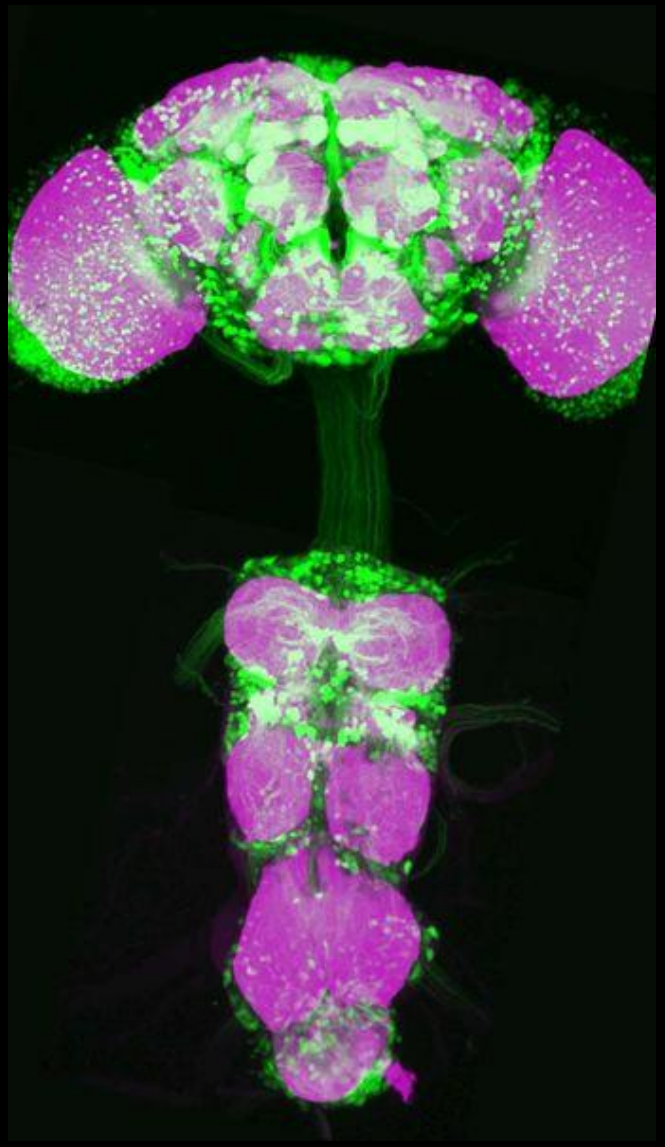
Fly mating

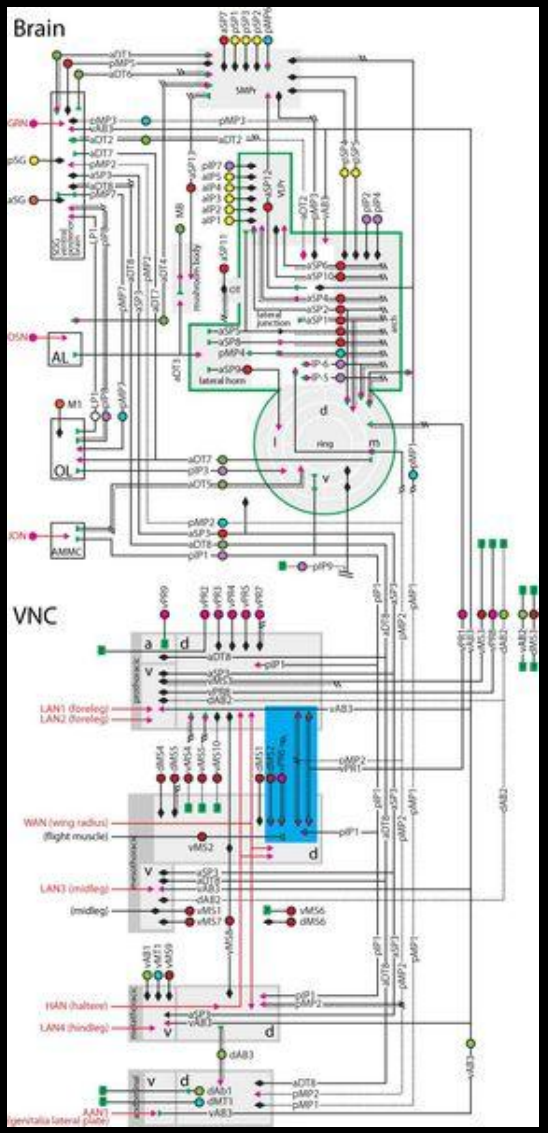


Sokolowski (*Nat Rev Genetics*, 2001)

Drosophila courtship movie (Dylan Clyne)

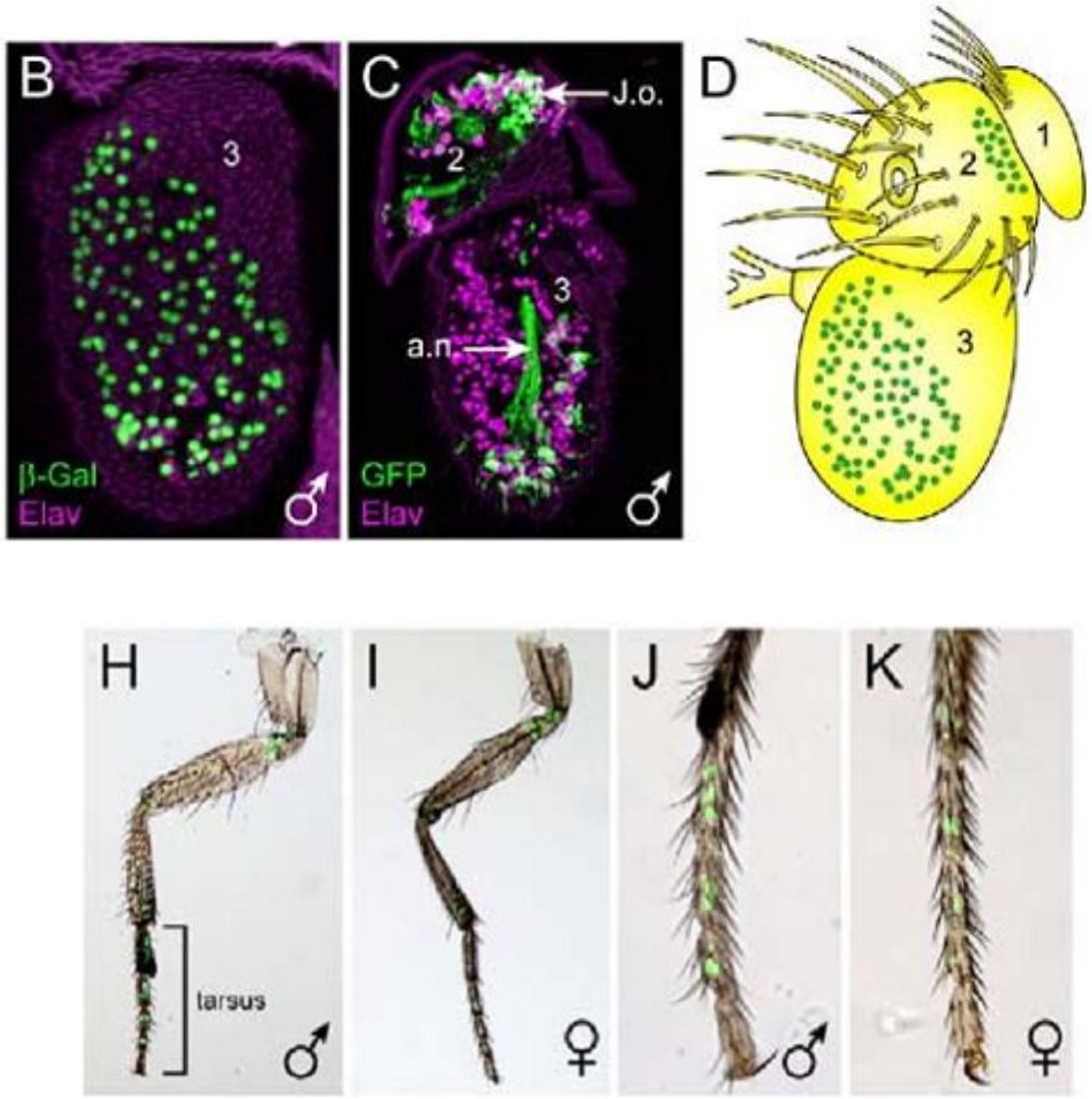
The Fru circuit





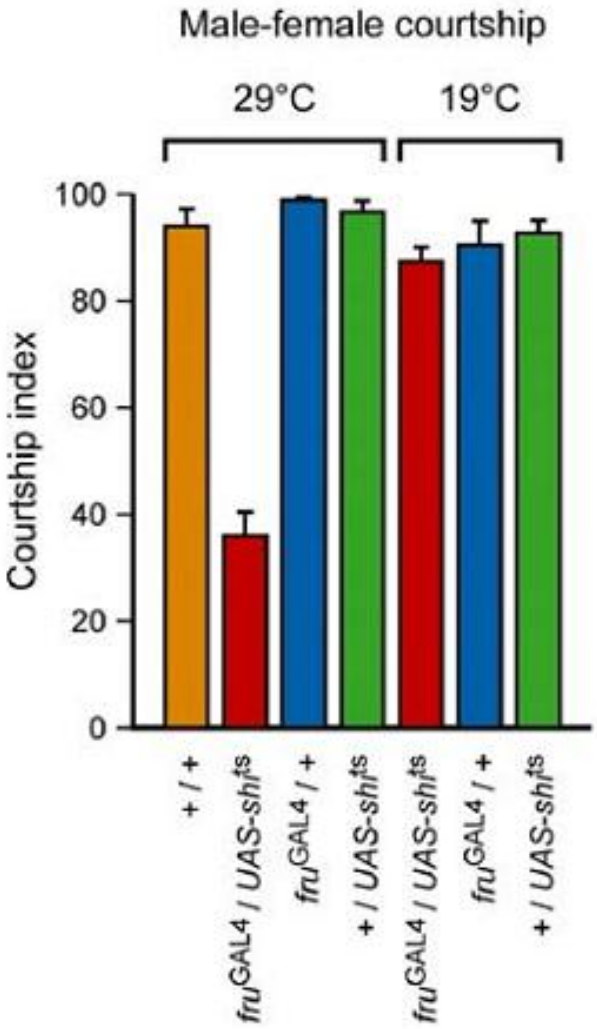
Barry Dickson lab (http://www.imp.ac.at/research/research-groups/dickson-group/research/)

Fru+ neurons are in the various parts of the body



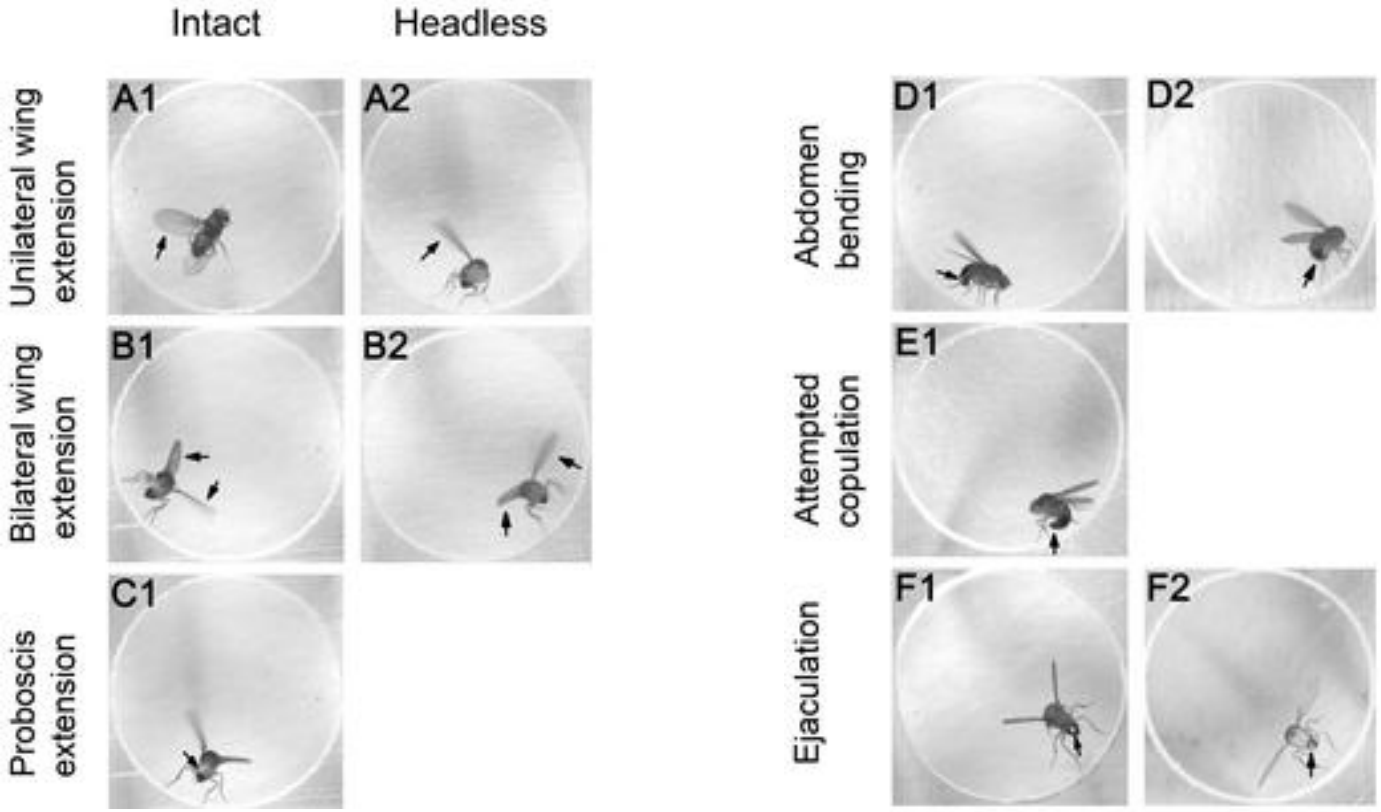
Stockinger … Dickson (*Cell,* 2005)

Fru+ neurons are necessary for mating



Stockinger … Dickson (*Cell,* 2005)

Activation of fru neurons is sufficient for mating



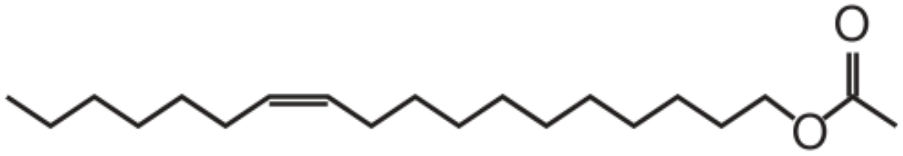
Pan … Baker (*PLoS One,* 2011)

Activation of fru neurons using dTRPA1

dTRPA1: warmth-activated cation channel

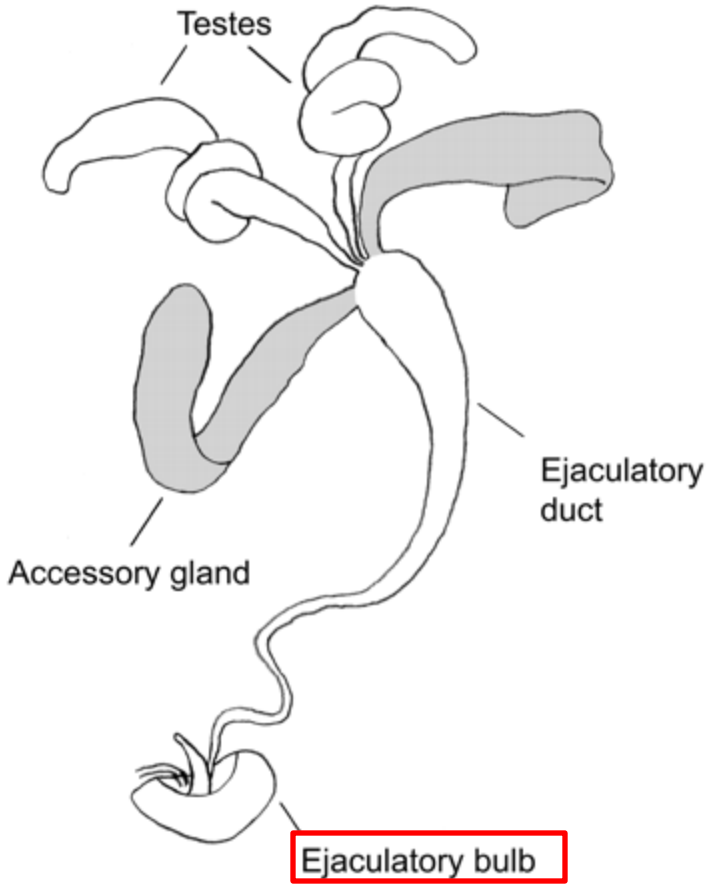
Pan … Baker (*PLoS One,* 2011)

cVA is a male-specific volatile pheromone



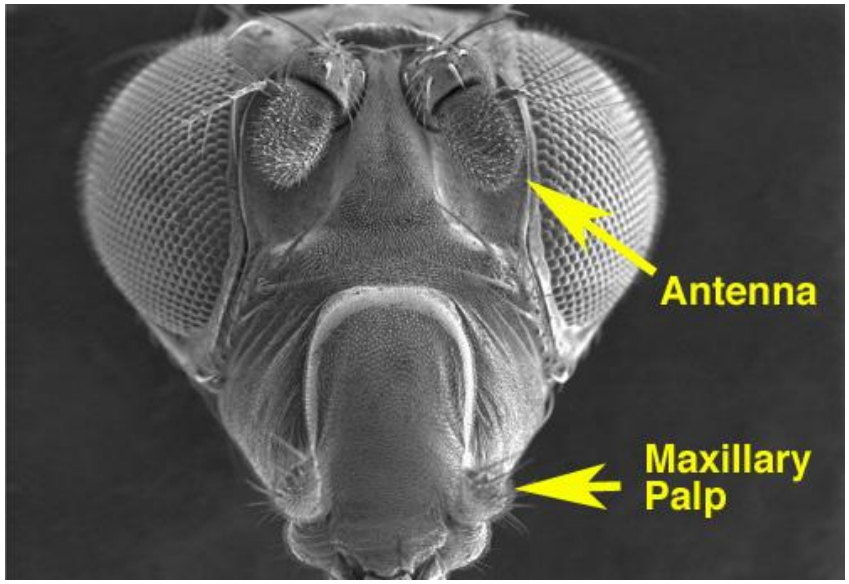
(Z)-11-Octadecenyl acetate
(cVA)

Kurtovic et al. (*Nature,* 2007)

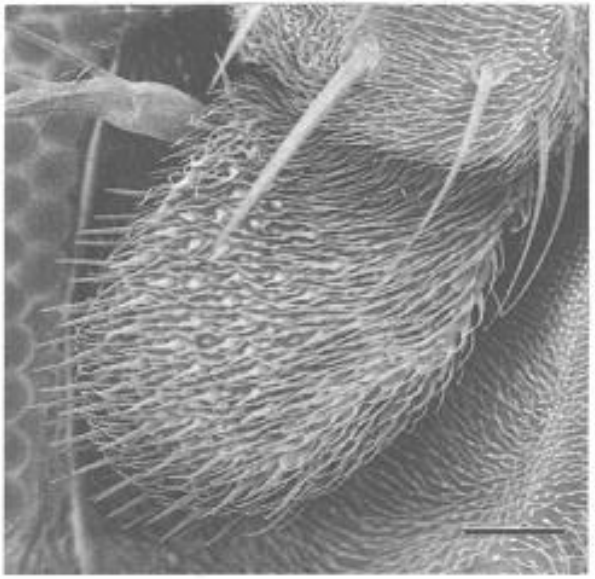


Ram & Wolfner (*Integr Comp Biol,* 2007)

ORNs are on the antenna and maxillary palps



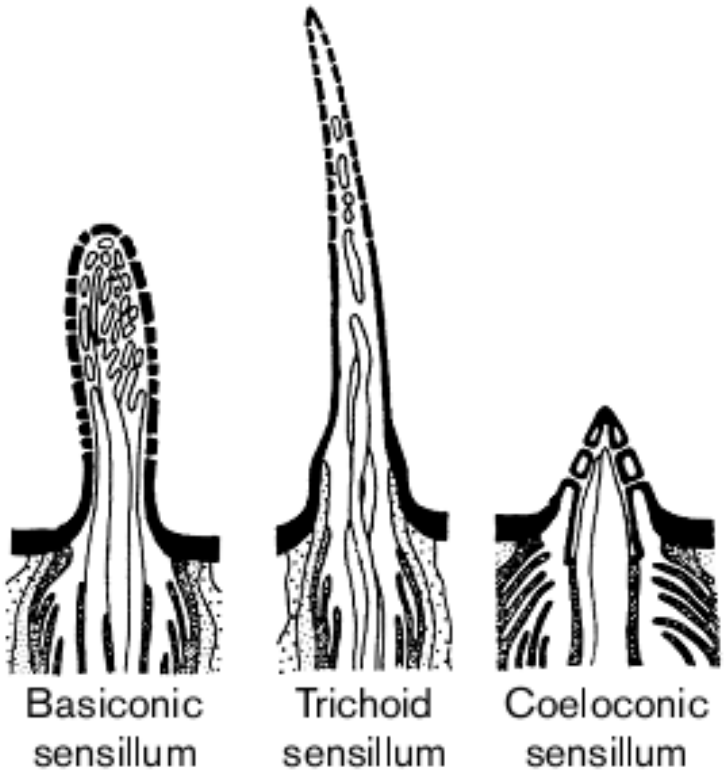
http://www.cdb.riken.jp/jp/04_news/annual_reports/2005/webhelp/index.htm#common/lab2_03fig1.htm



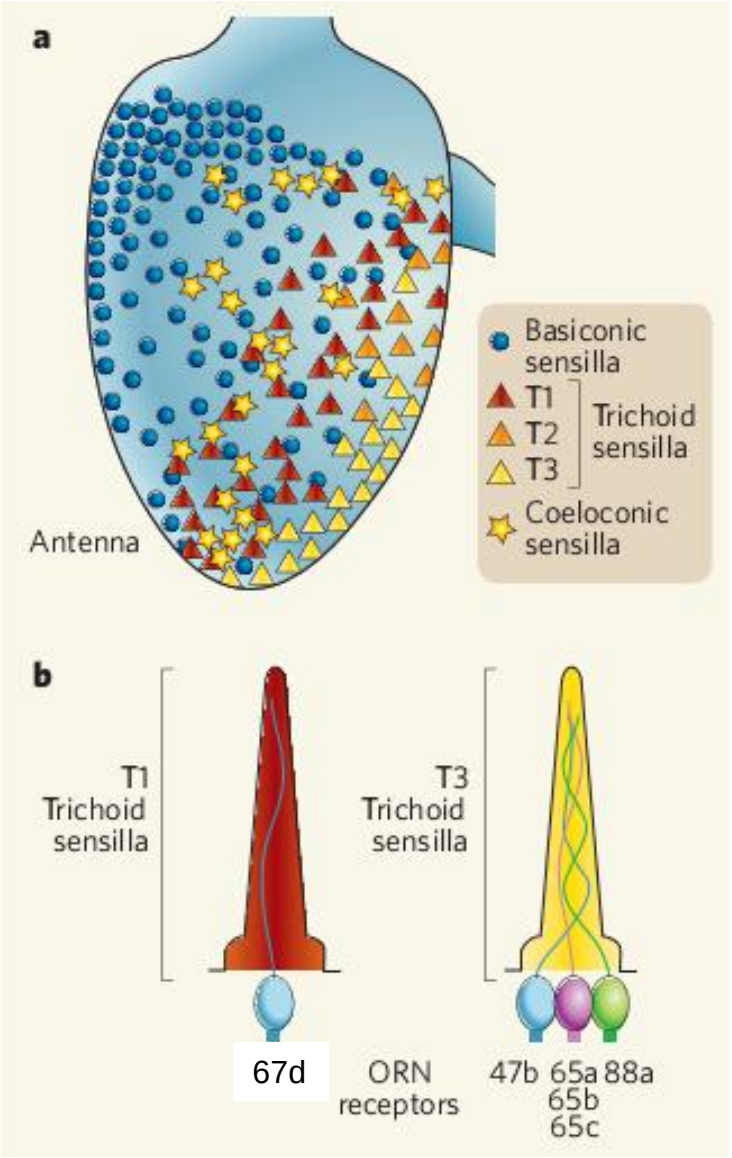
Scanning electron micrograph of third antennal segment

Clyne et al (*Invert Neurosci*, 1997)

Three types of sensilla

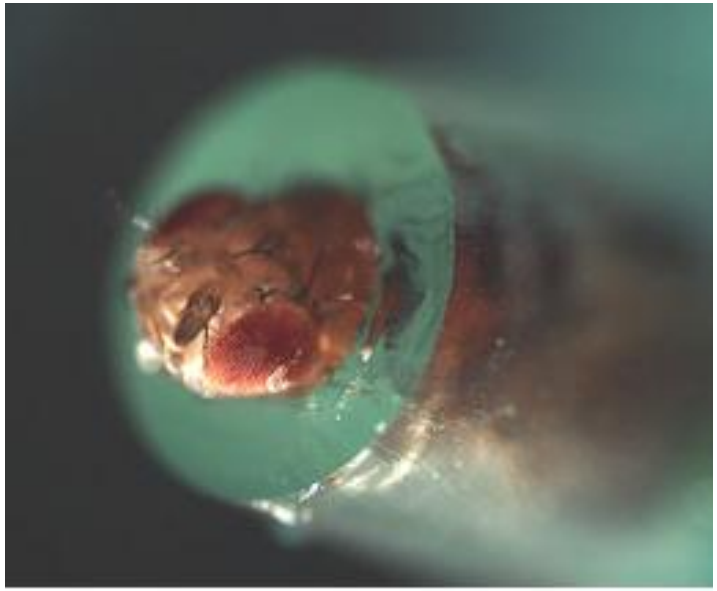


Vosshall (*Curr Op Neurobiol*, 2000)



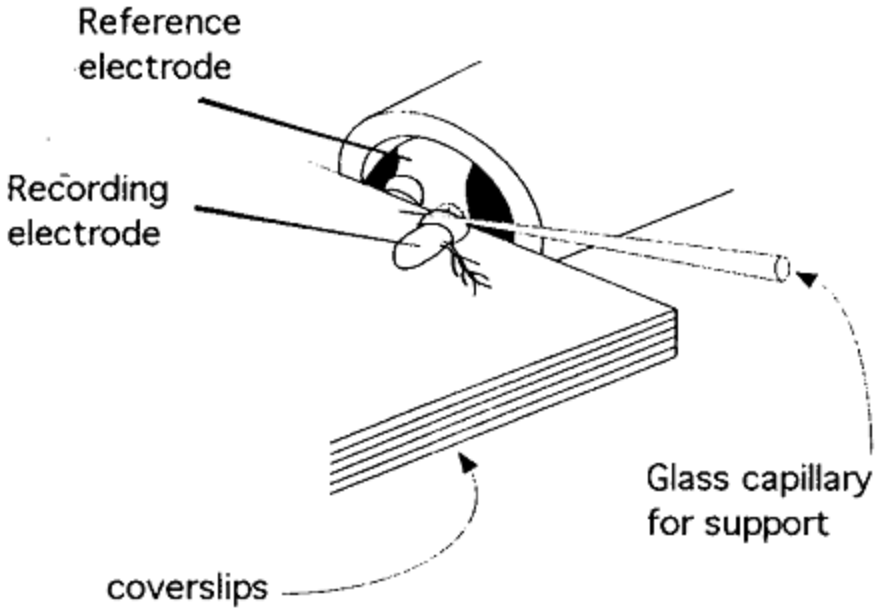
Kyriacou (*News and Views, Nature*, 2007)

Single sensillum recording



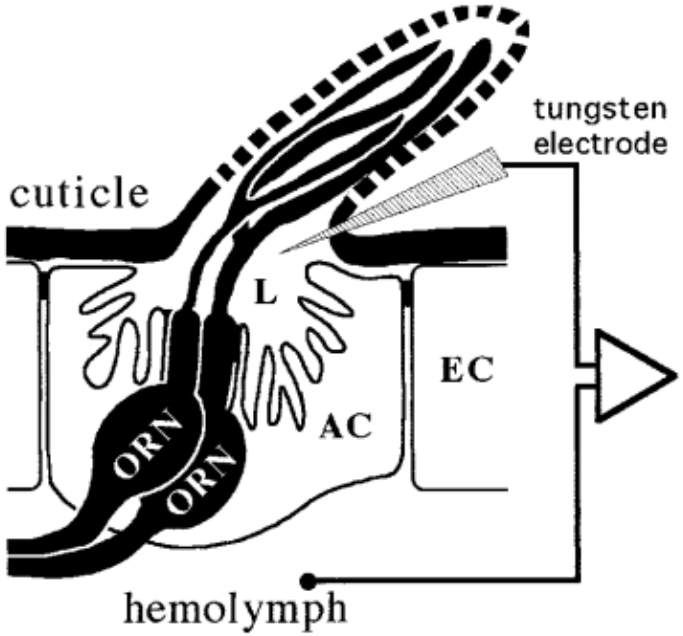
To measure the odor responses of individual olfactory neurons, a fly is immobilized in a pipette tip and an electrode is inserted in its antenna.

John Carlson lab (Yale)

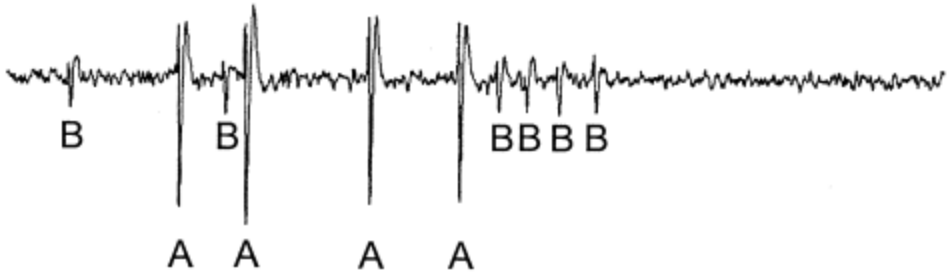


Clyne … Carlson (*Invert Neurosci*, 1997)

Single sensillum recordings

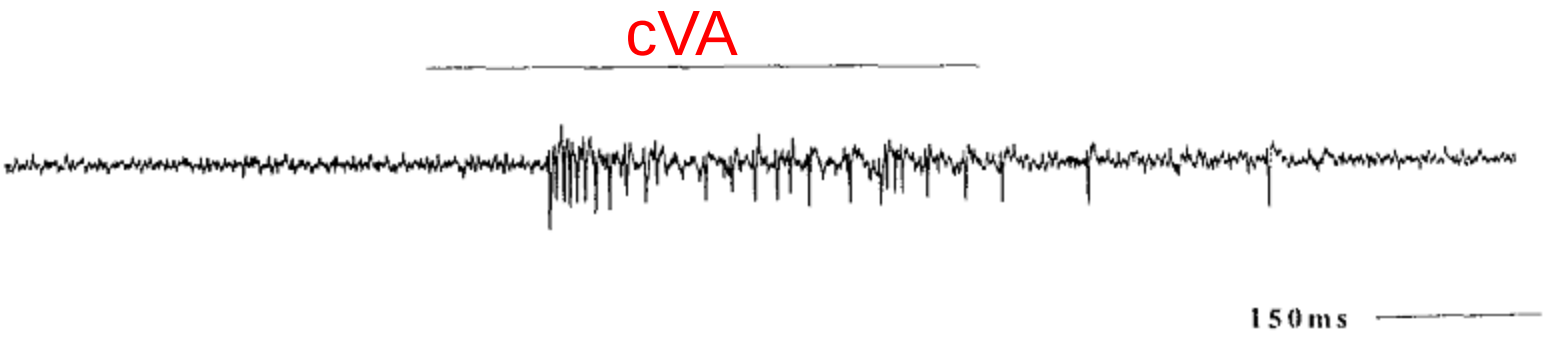


de Bruyne … Carlson (*J Neurosci*, 1999)

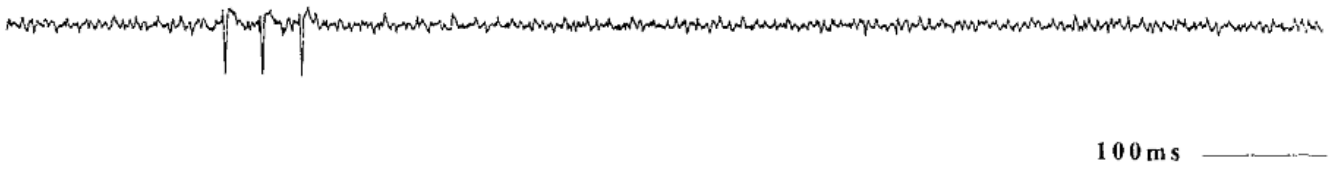


de Bruyne … Carlson (*Neuron*, 2001)

T1 trichoid sensilla responds to cVA



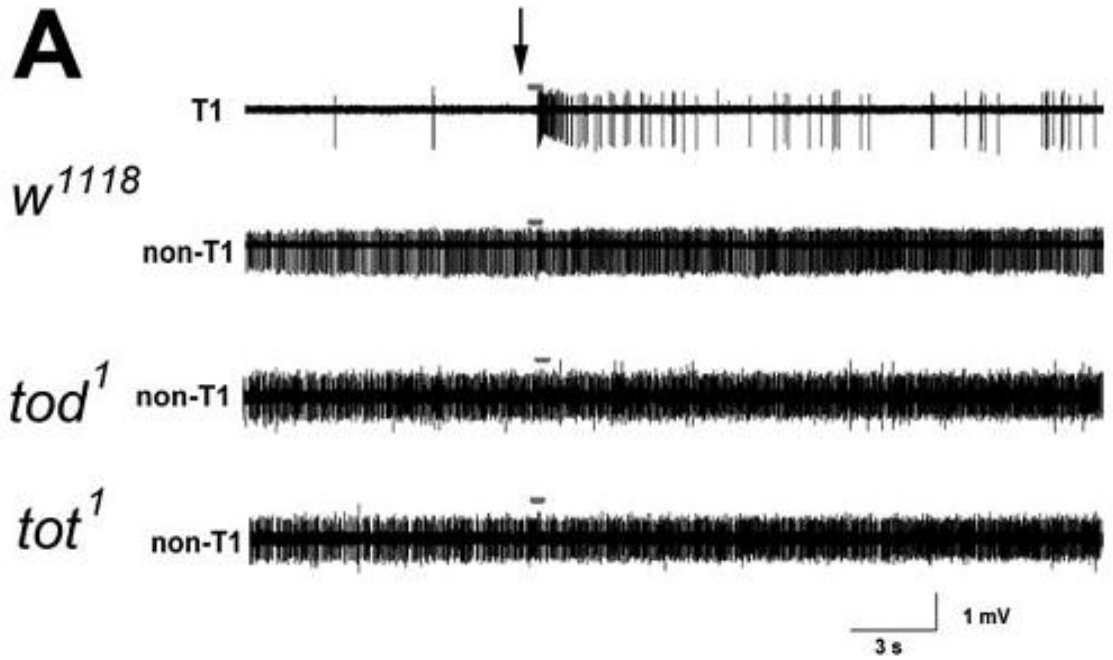
T1 type: low spontaneous activity

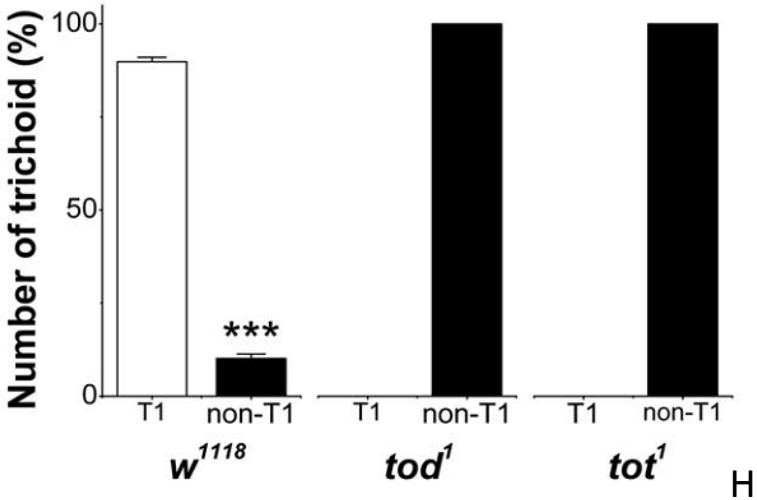


Non-T1 type: high spontaneous activity

Clyne … Carlson (*Invert Neurosci*, 1997)

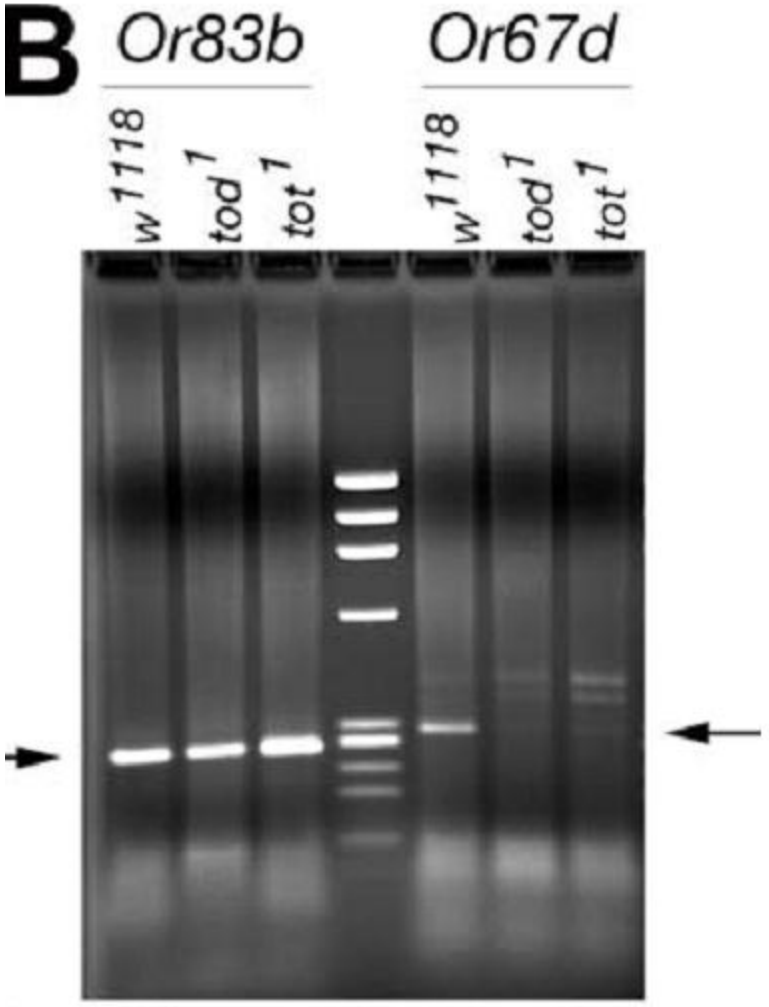
Mutants that do not have cVA response





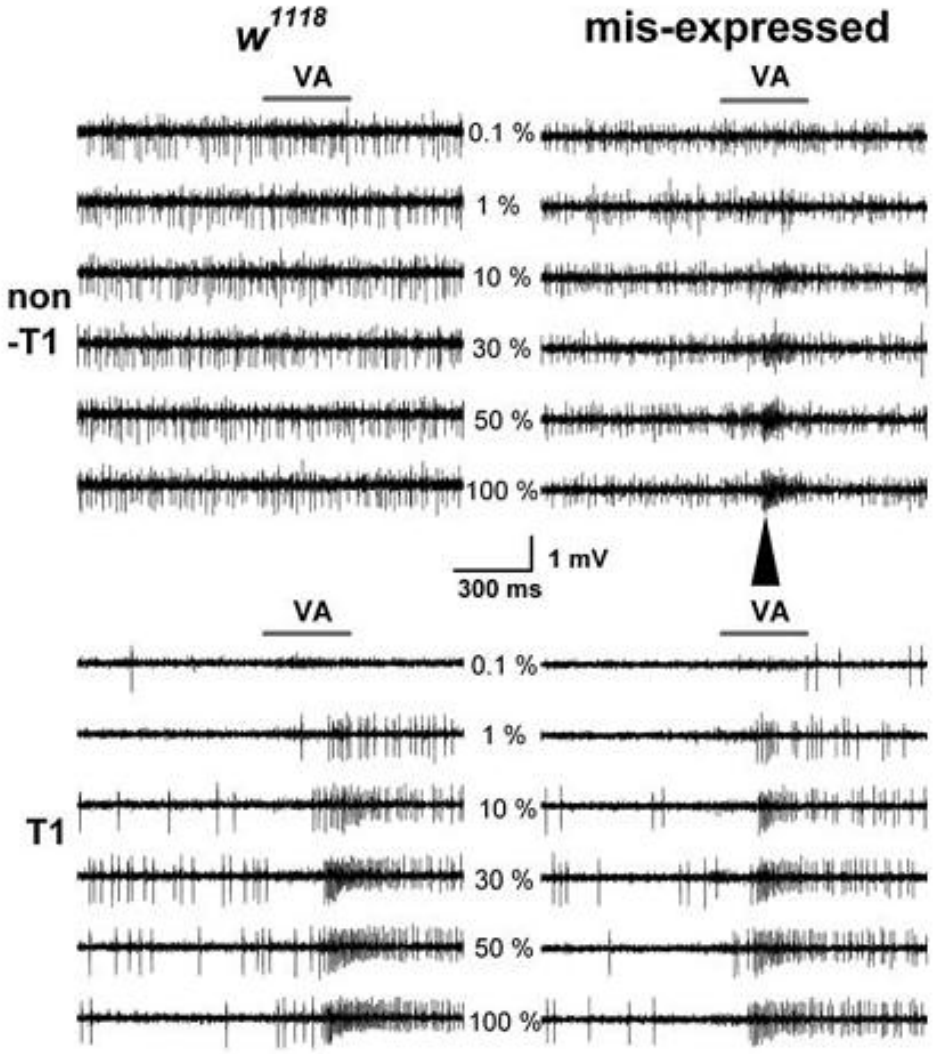
Ha & Smith (*J Neurosci,* 2006)

Both mutants lack Or67d



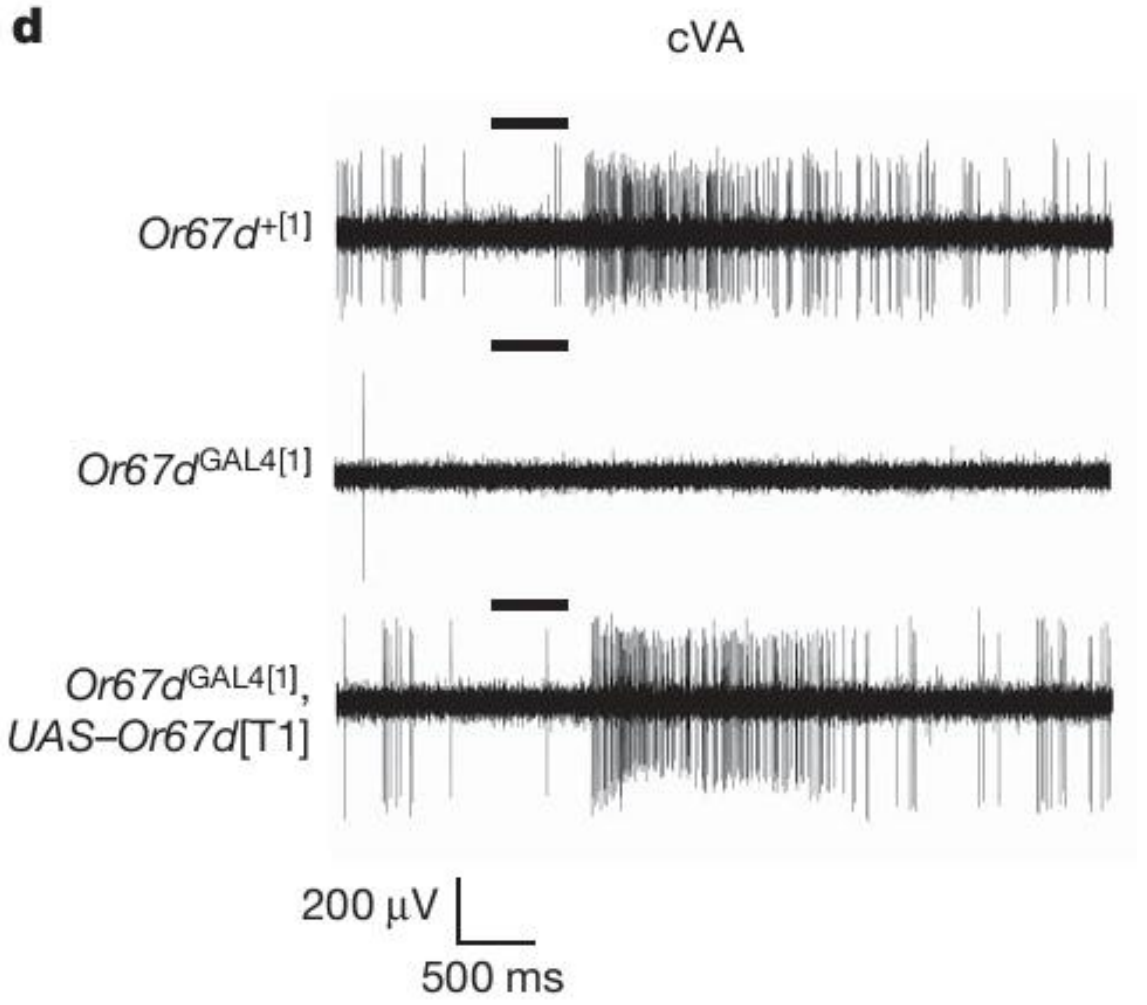
Ha & Smith (*J Neurosci,* 2006)

Misexpression of Or67d in non-T1 makes them responsive to cVA



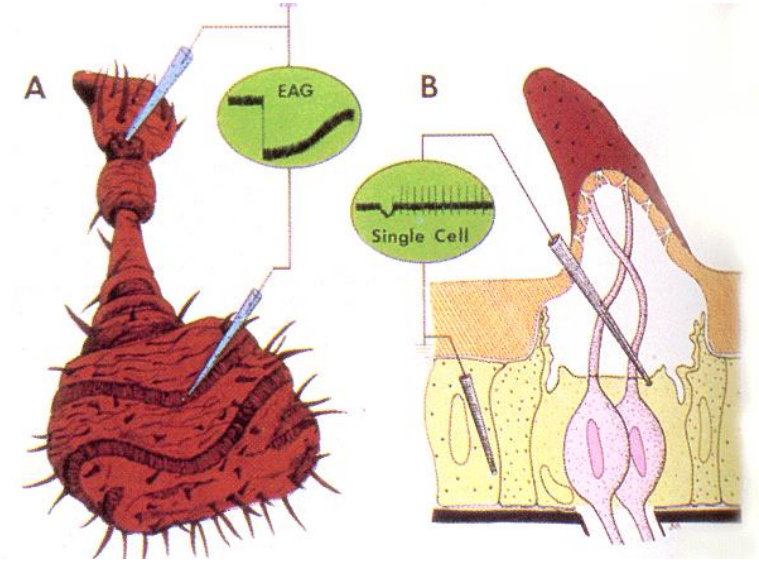
Ha & Smith (*J Neurosci,* 2006)

Or67d-expressing ORNs respond to cVA

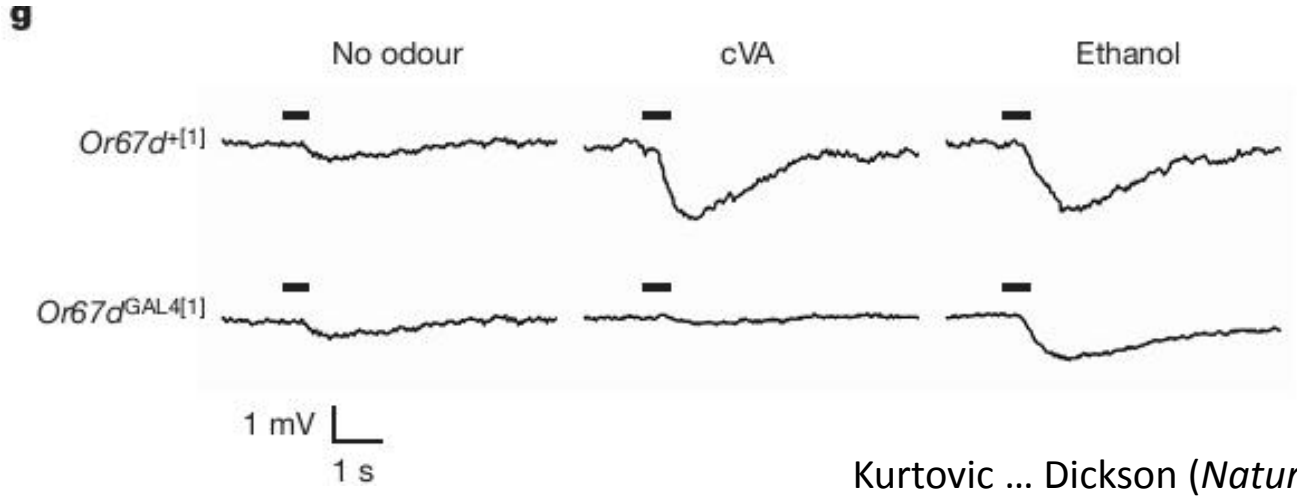


Kurtovic … Dickson (*Nature,* 2007)

Electroantennogram (EAG)

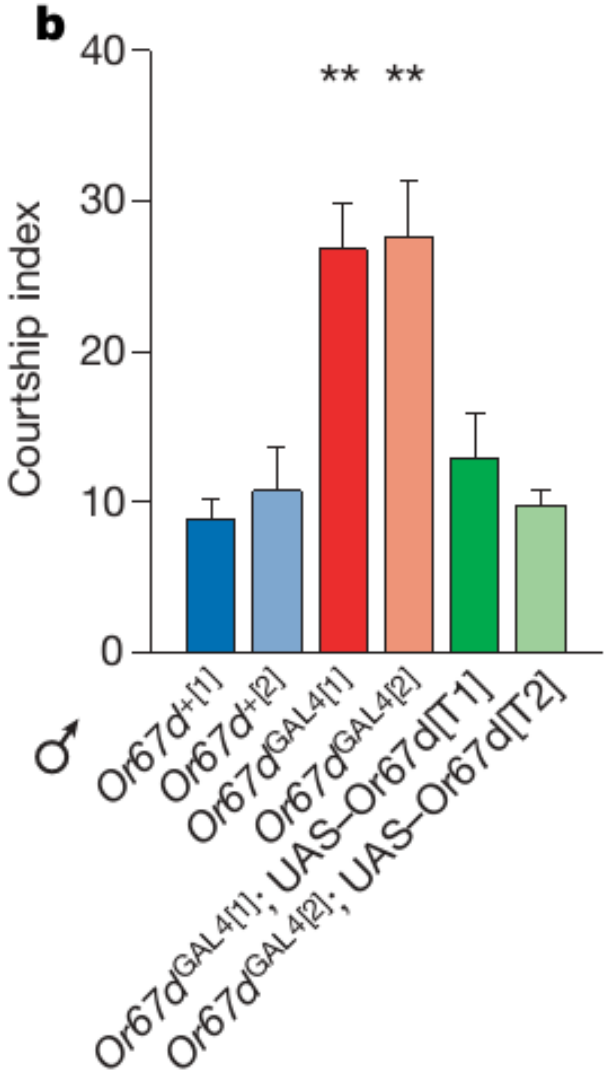


http://www.barkbeetles.org/spb/spbbook/chapt2.html



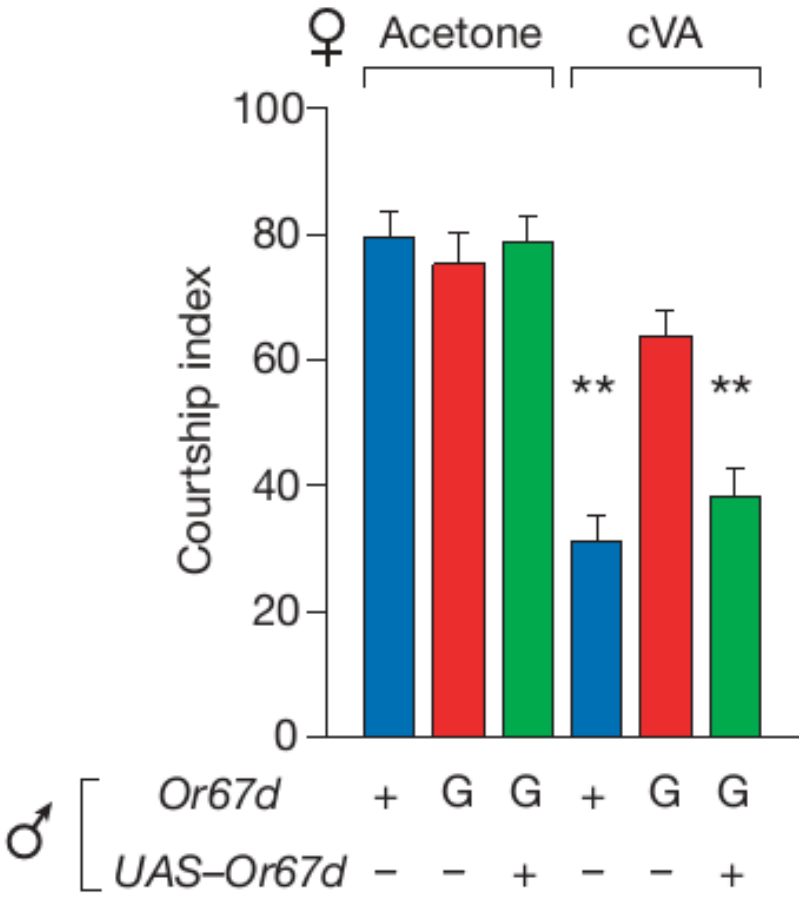
Kurtovic … Dickson (*Nature,* 2007)

Or67d is necessary for male-male courtship suppression



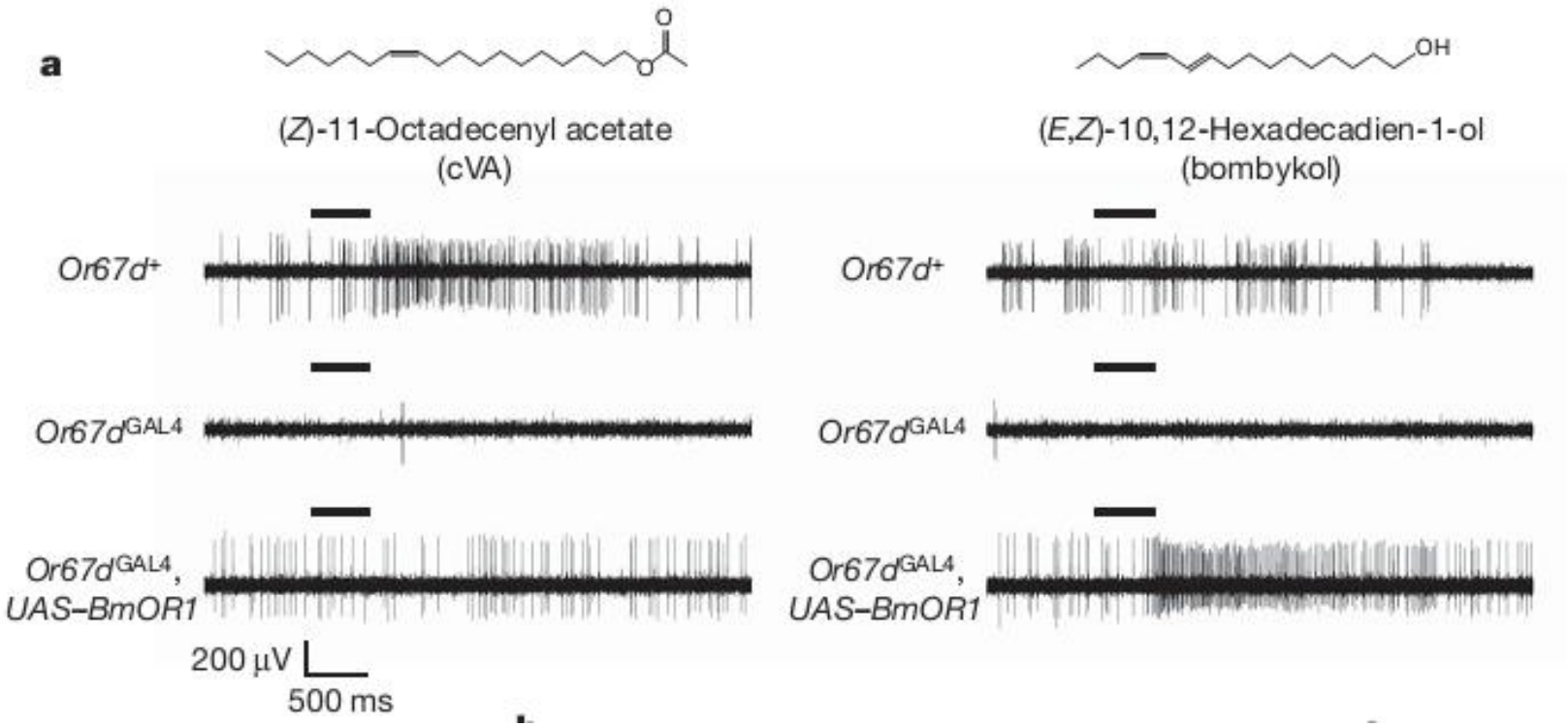
Kurtovic … Dickson (*Nature,* 2007)

Or67d mediates cVA induced courtship suppression



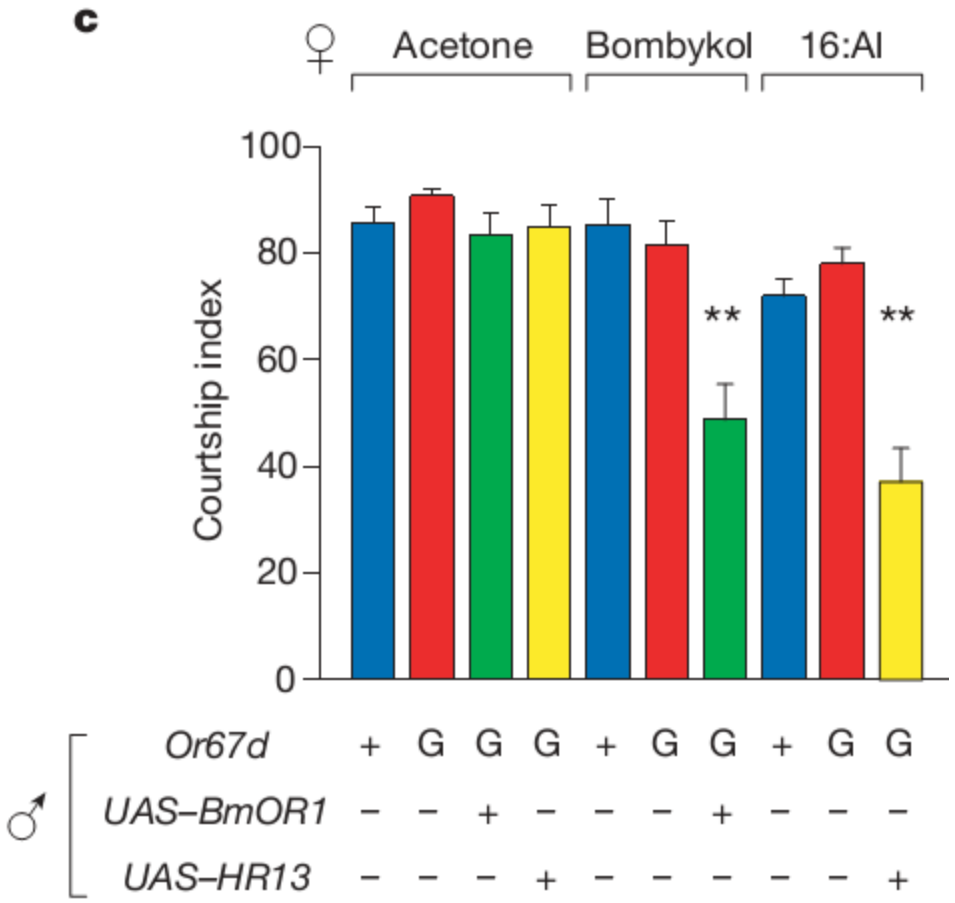
Kurtovic … Dickson (*Nature,* 2007)

Heterologous expression of moth pheromone receptors



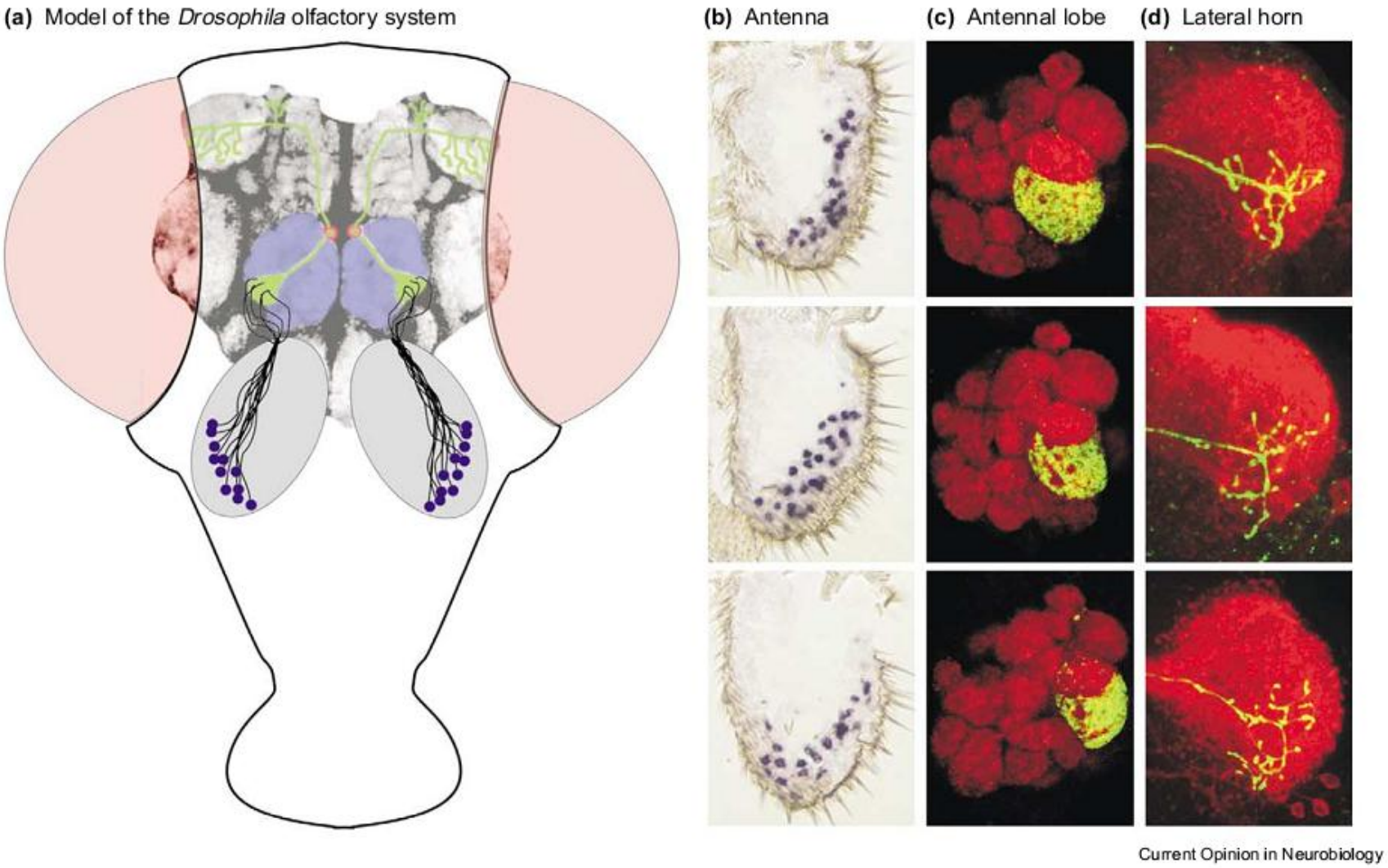
Kurtovic … Dickson (*Nature,* 2007)

Activation of Or67d is sufficient for courtship suppression



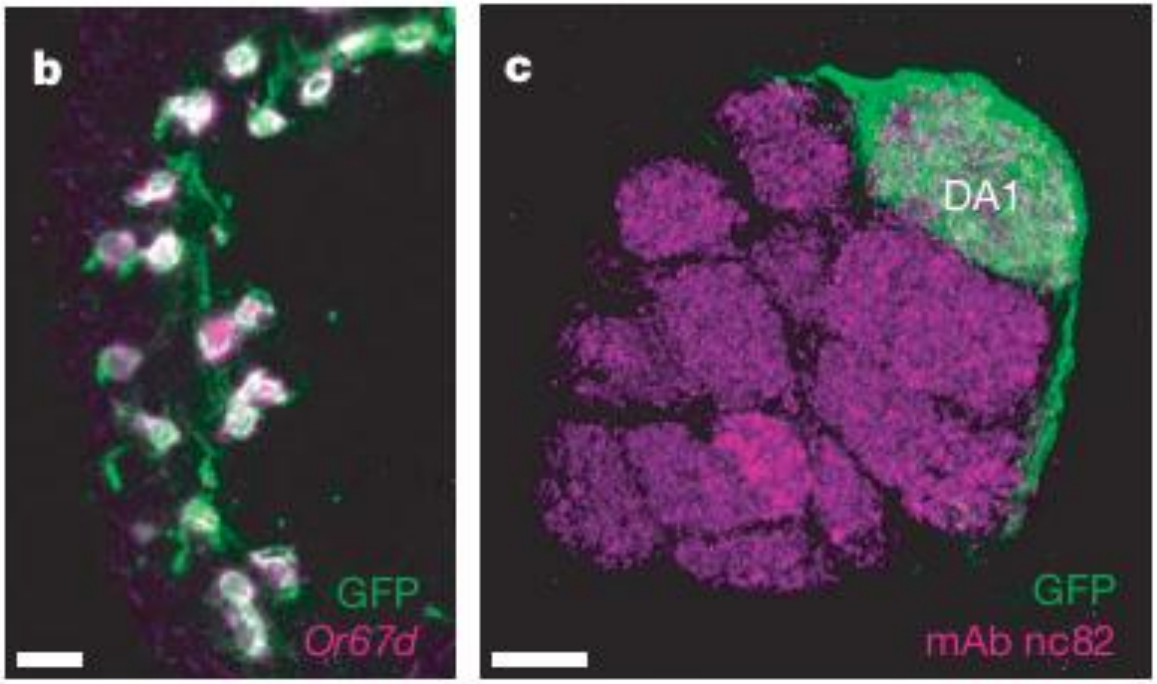
Kurtovic … Dickson (*Nature,* 2007)

ORNs project to the antenna lobe



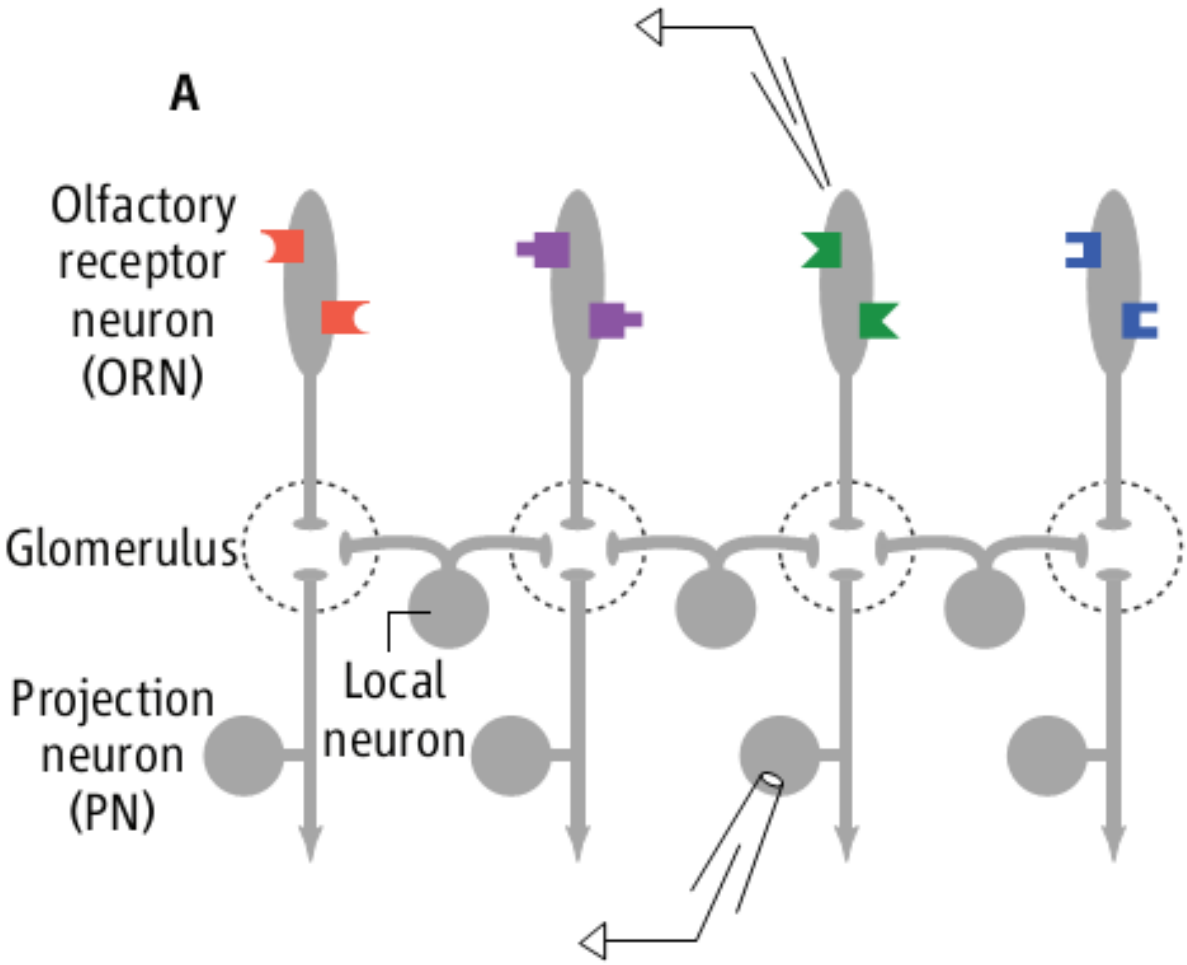
Keller & Vosshall (*Curr Opin Neurobiol,* 2003)

Or67d neurons projects to DA1 glomerulus



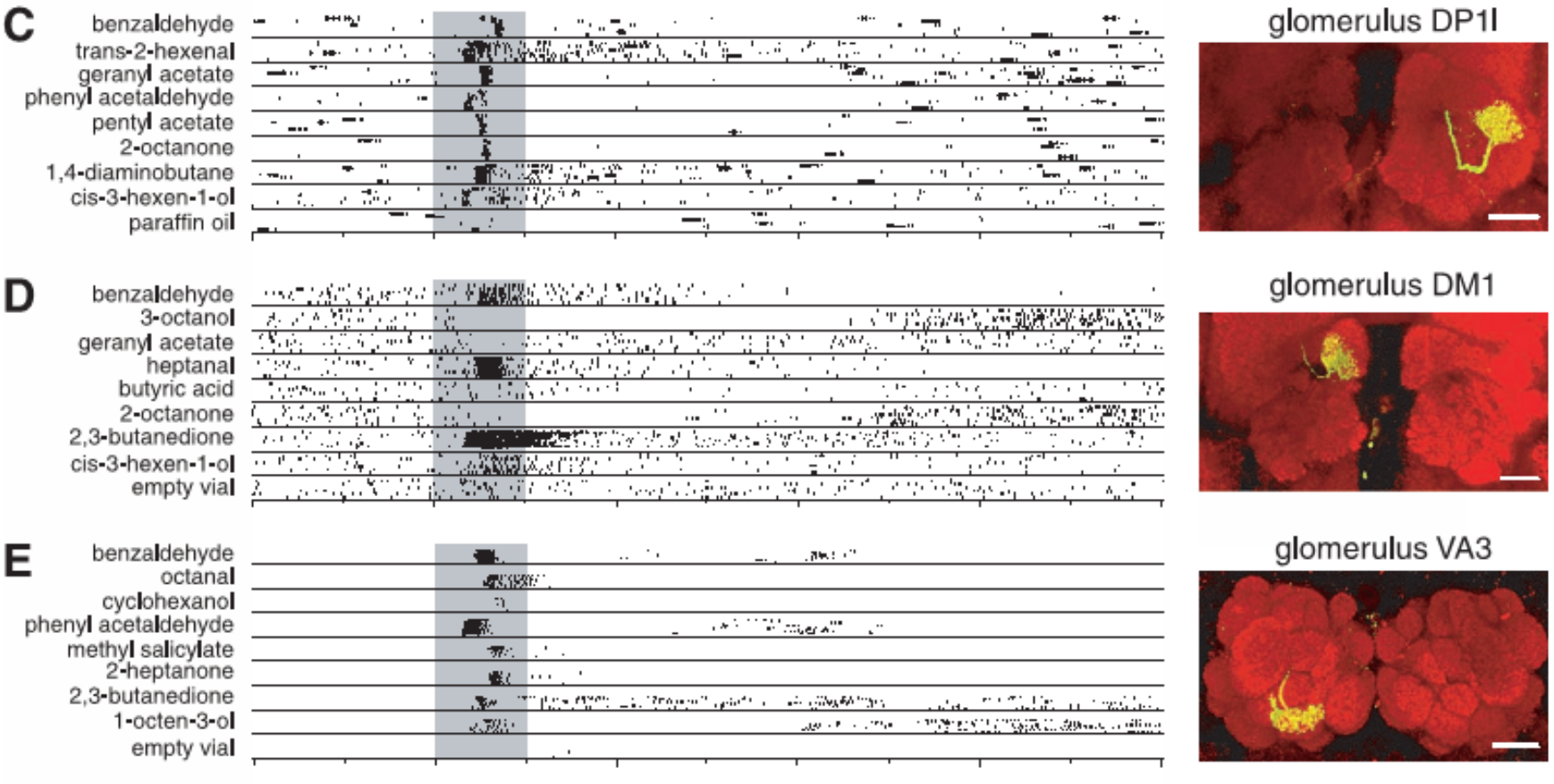
Kurtovic … Dickson (*Nature,* 2007)

Transformation of odor representation from ORN to PN



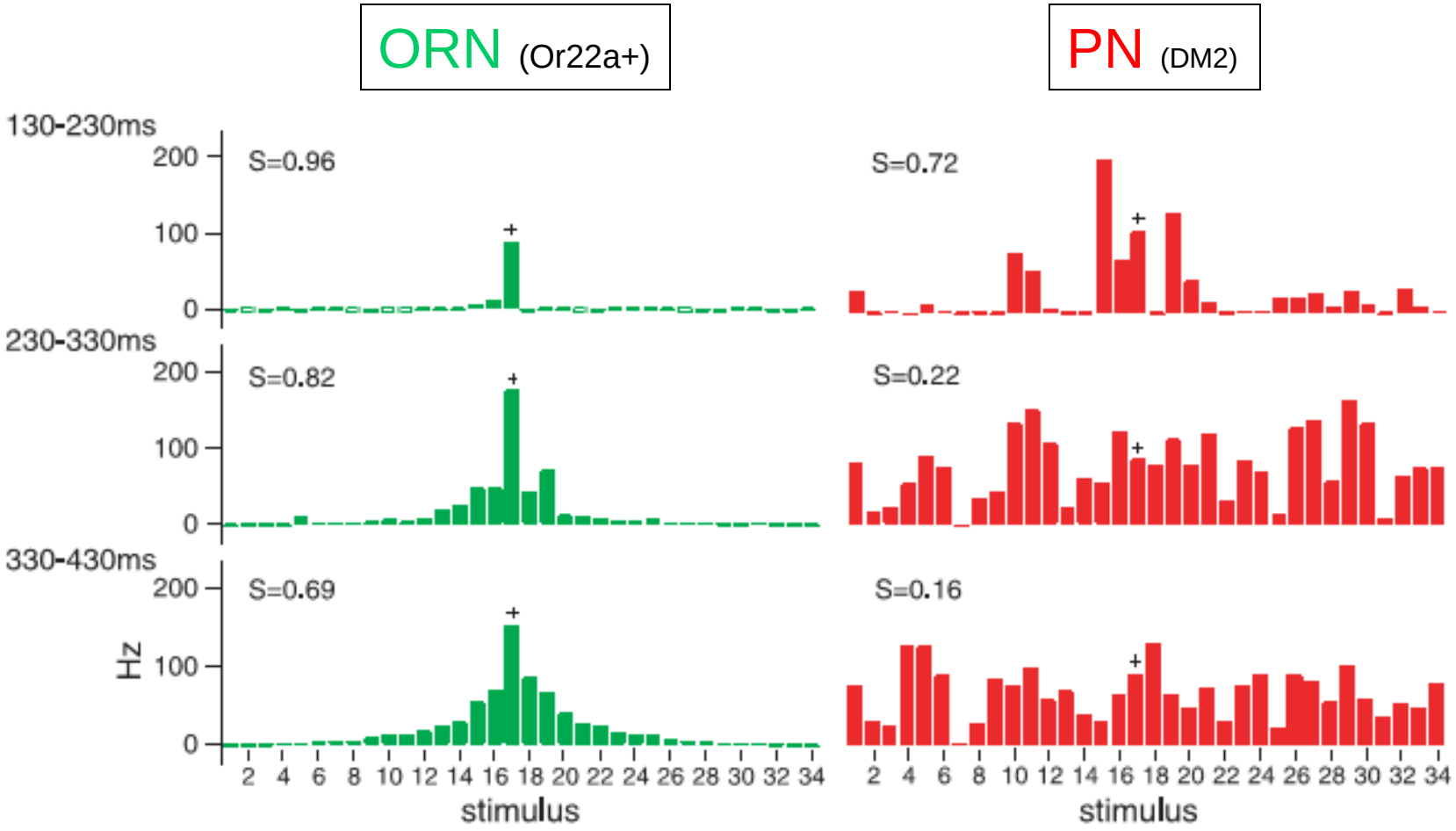
Wilson (*Science,* 2007)

PNs respond to multiple odors



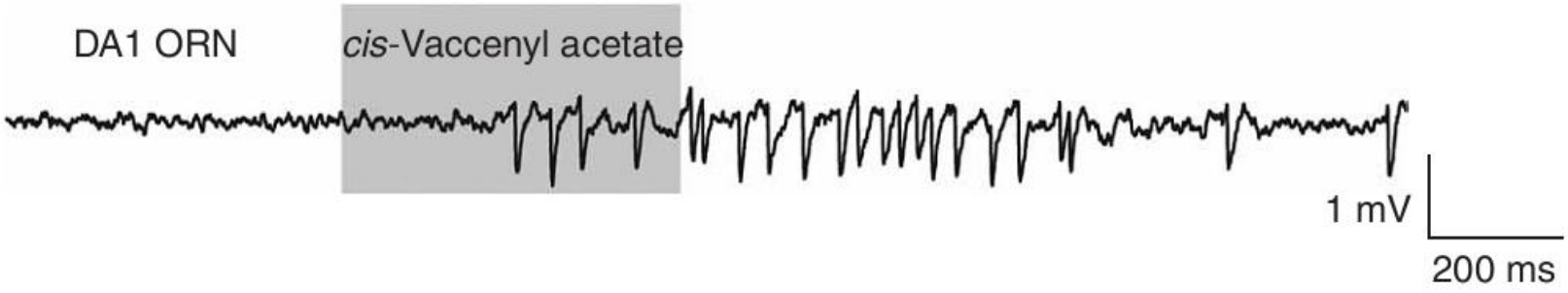
Wilson … Laurent (*Science,* 2004)

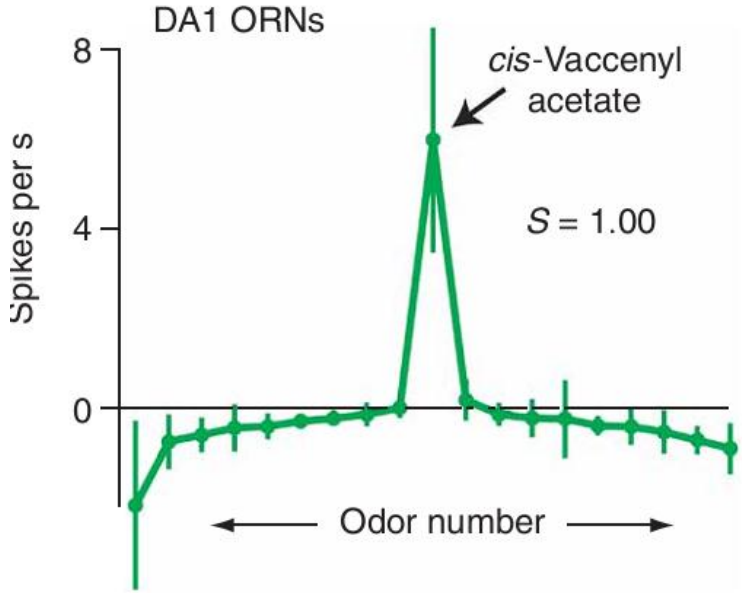
Broader tuning in PNs compared to ORNs

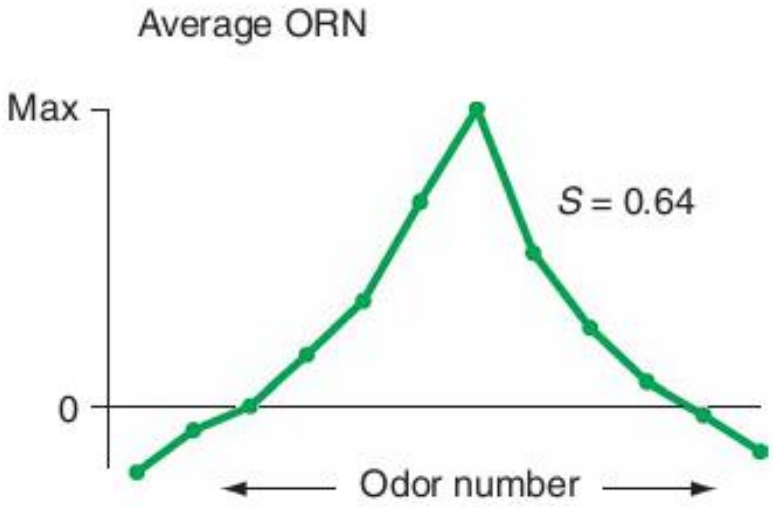


Wilson … Laurent (*Science,* 2004)

Or67d ORN response is highly selective to cVA

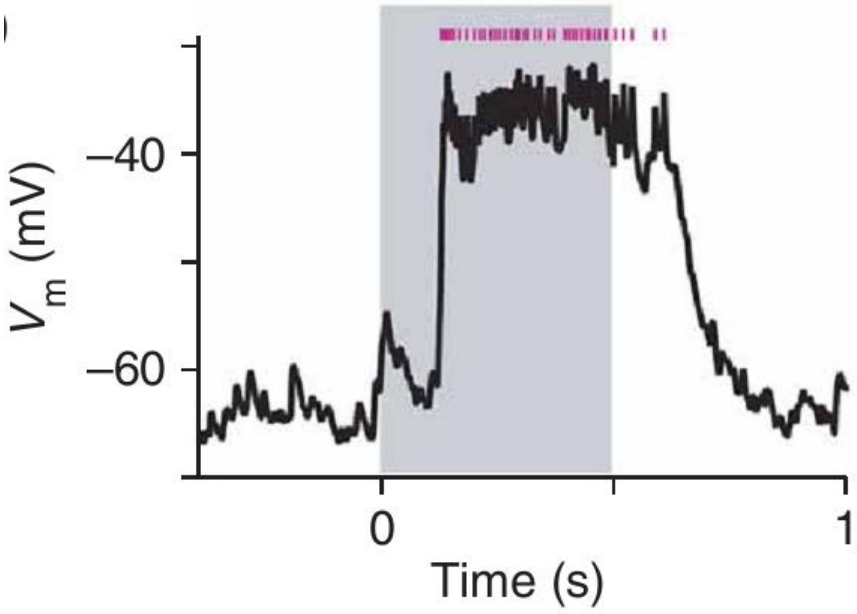


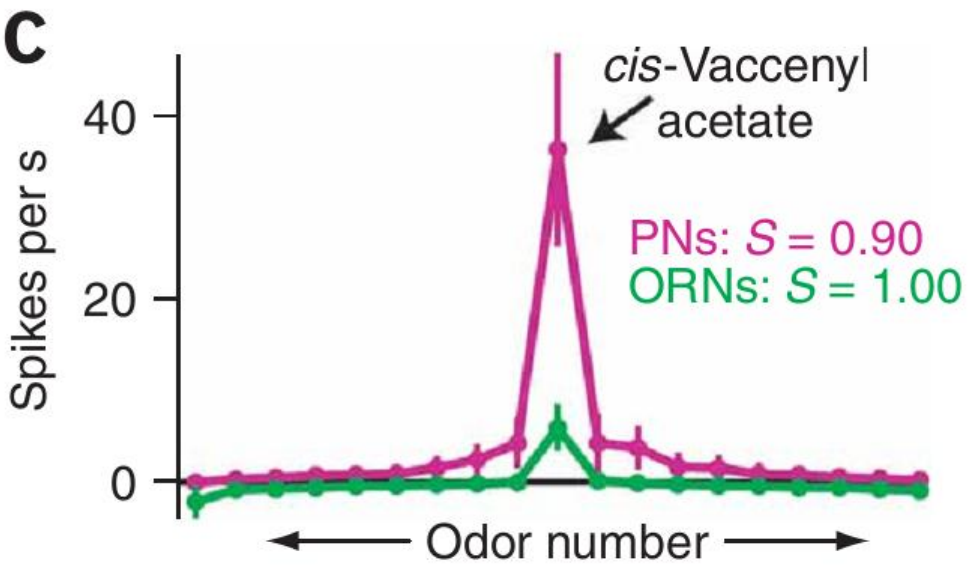




Schlief & Wilson (*Nature Neurosci,* 2007)

DA1 PNs response is also highly selective to cVA





Schlief & Wilson (*Nature Neurosci,* 2007)

A dimorphic pheromone circuit in *Drosophila* from sensory input to descending output

Vanessa Ruta[1], Sandeep Robert Datta[1]†, Maria Luisa Vasconcelos[1]†, Jessica Freeland[1], Loren L. Looger[2] & Richard Axel[1]

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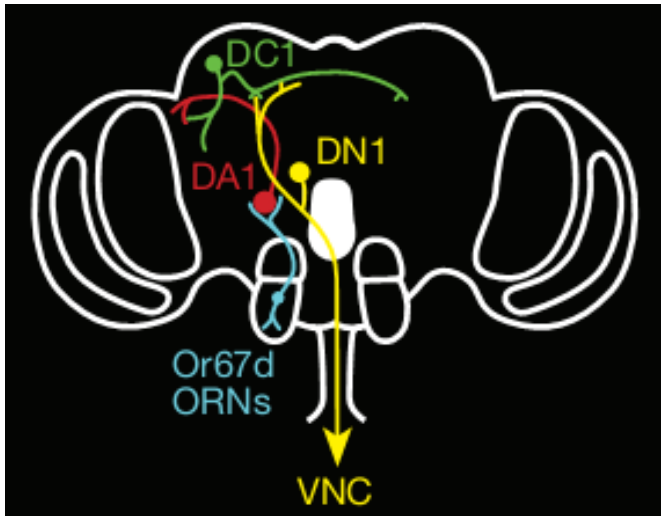
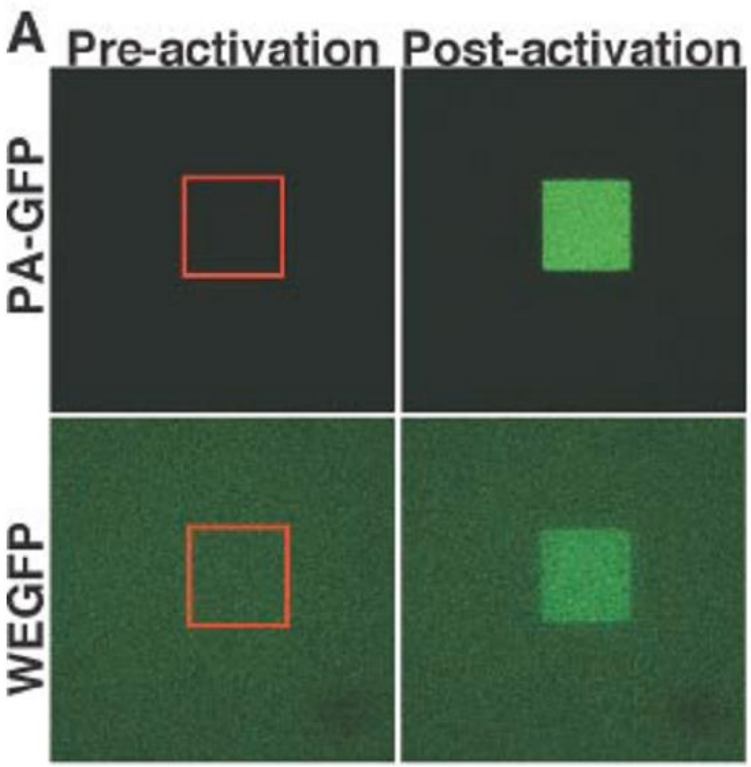
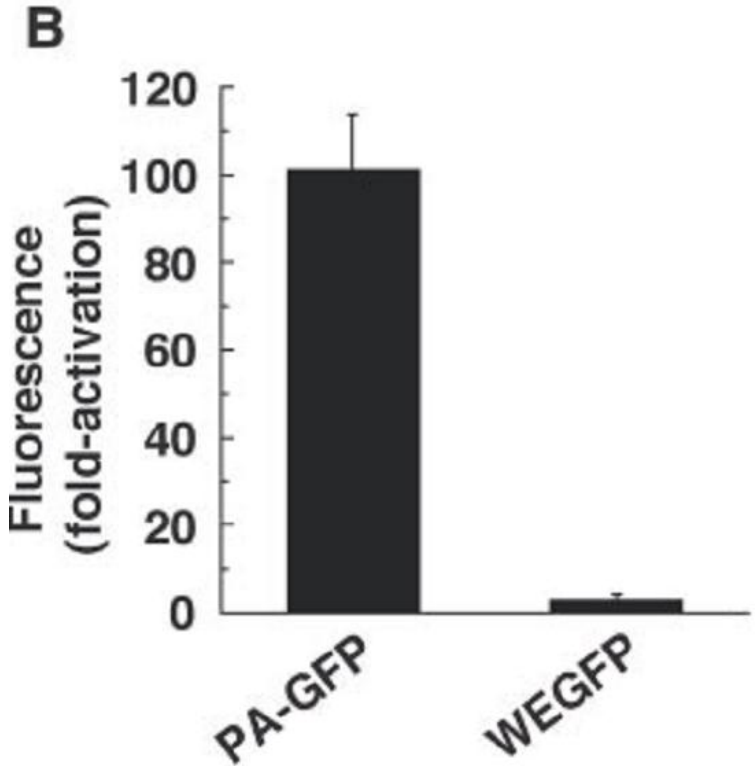


Photoactivatable-GFP (PA-GFP)



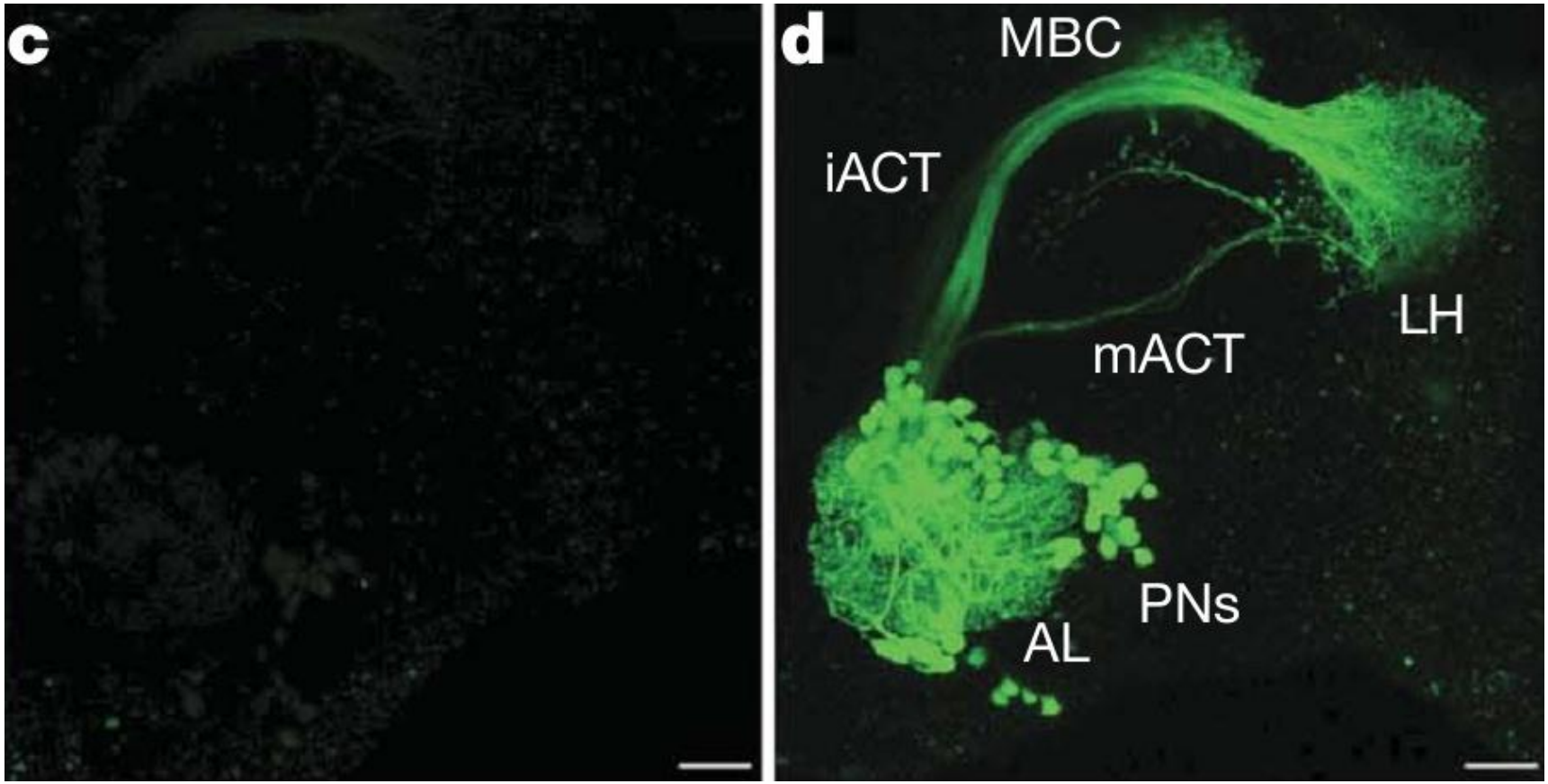


Patterson & Lippincott-Schwartz (*Science,* 2002)

Using PA-GFP for circuit tracing

before

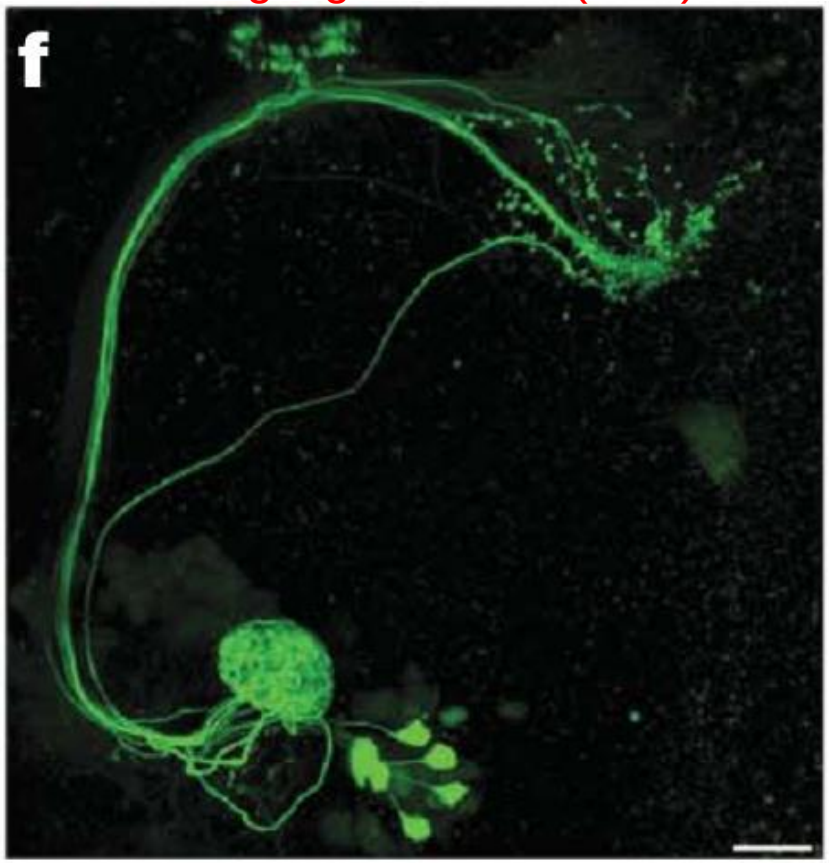
after



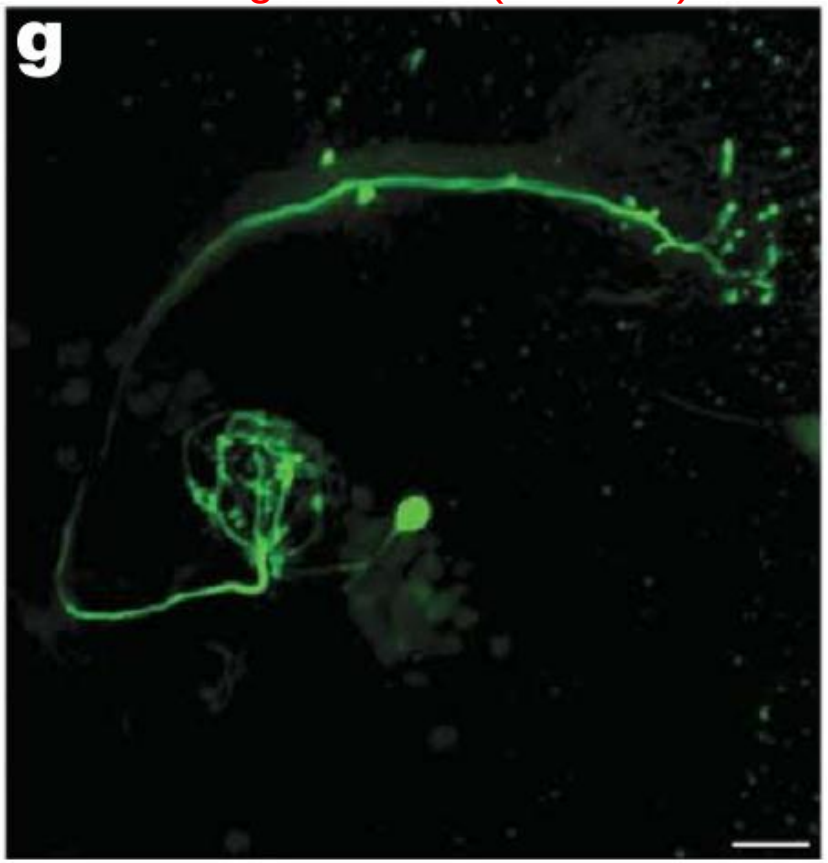
Datta… Axel (*Nature,* 2008)

Photoactivation of a single neuron

Single glomerulus (DA1)

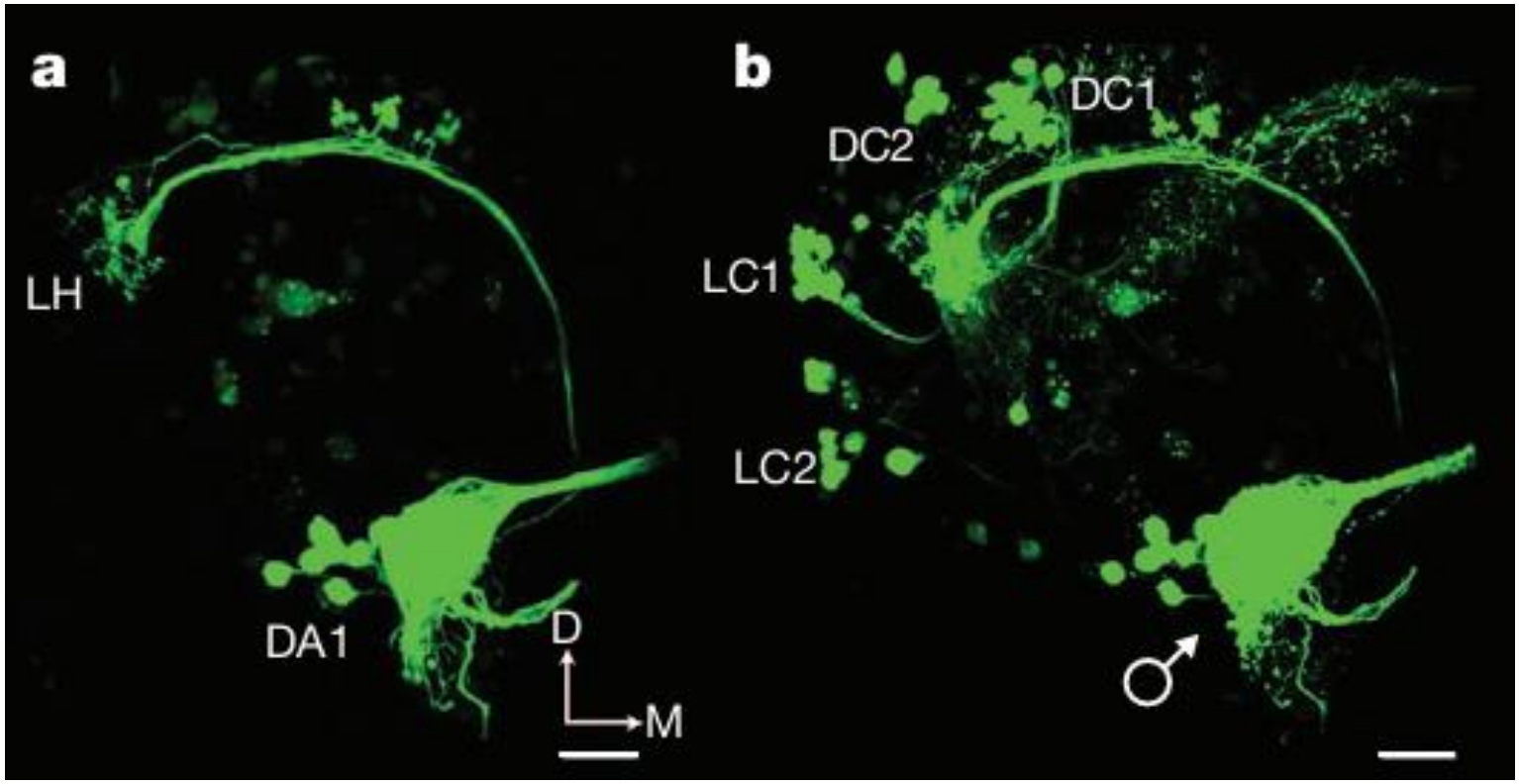


Single neuron (DA1 PN)



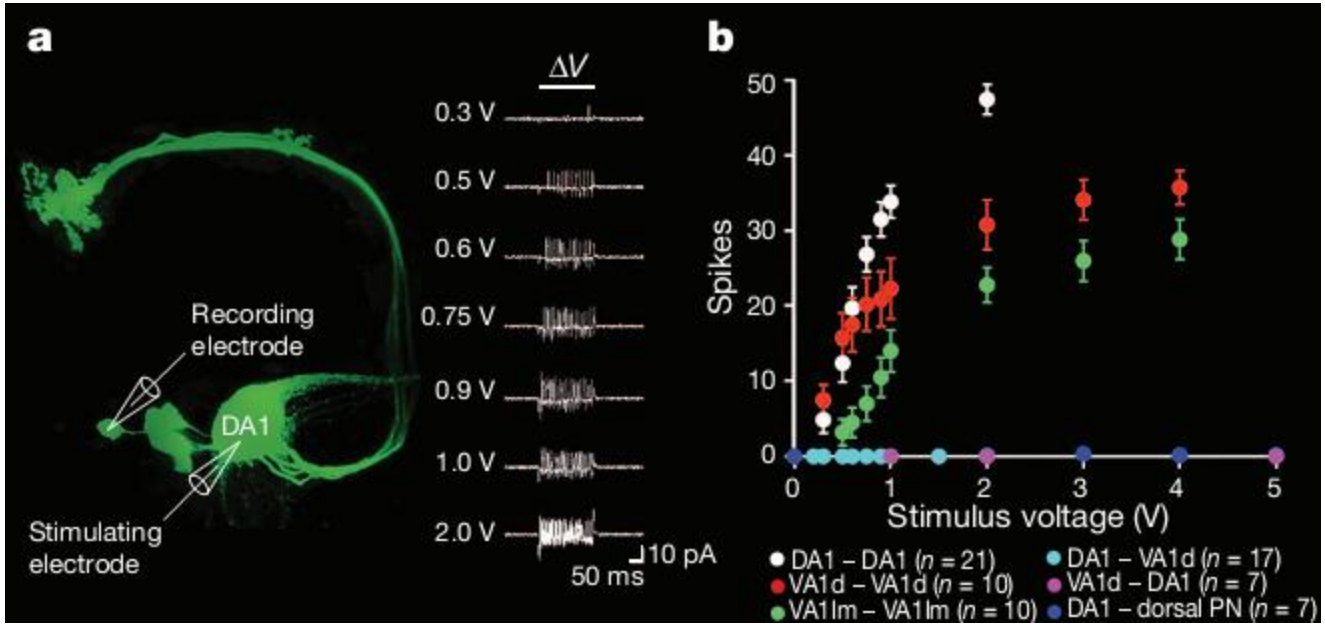
Datta… Axel (*Nature,* 2008)

DA1 PNs projects to four areas in the lateral horn



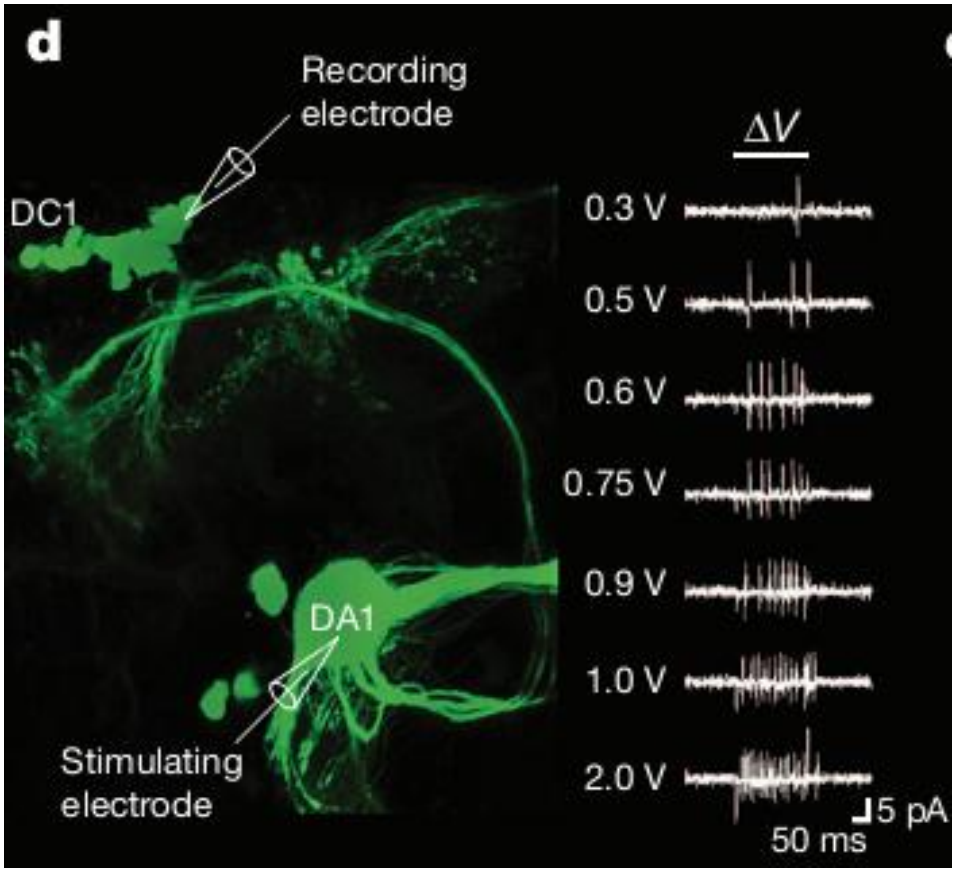
Ruta… Axel (*Nature,* 2010)

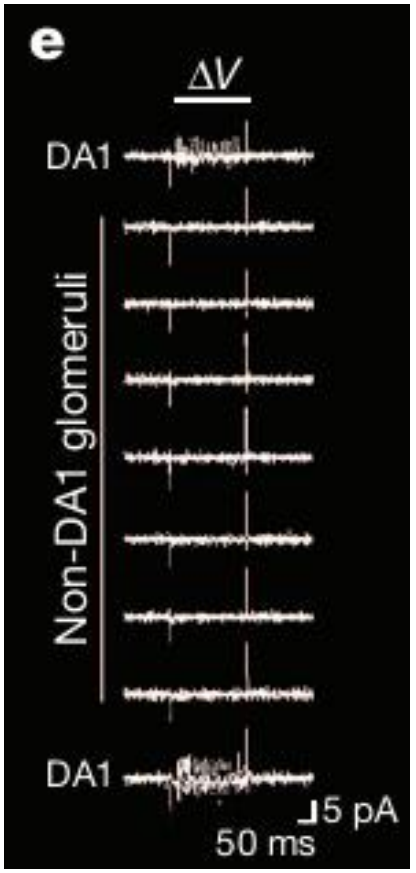
Activation of specific glomerulus



Ruta… Axel (*Nature,* 2010)

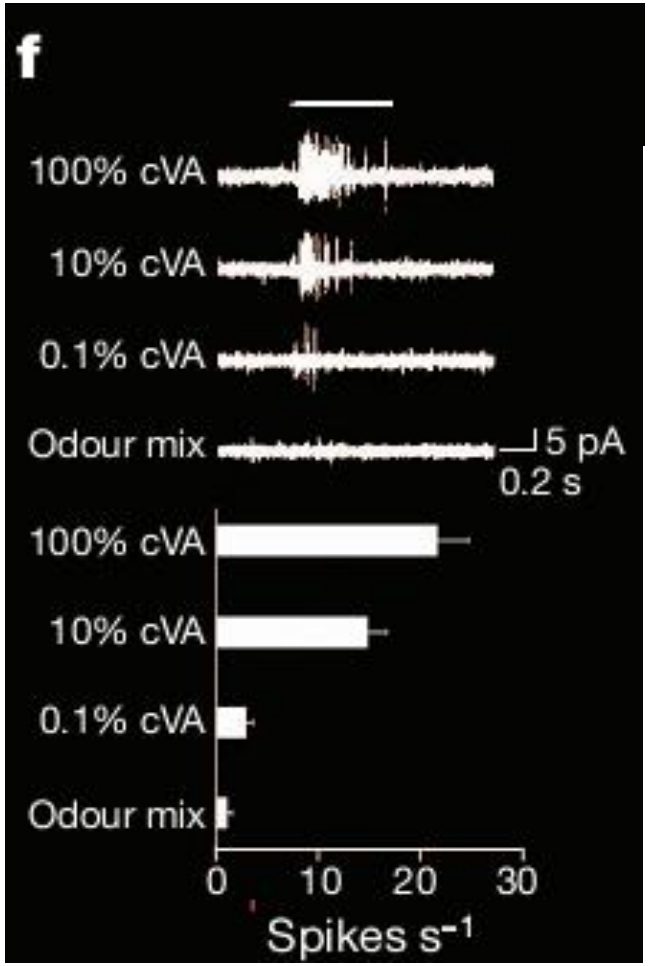
Functional connectivity between DA1 and DC1

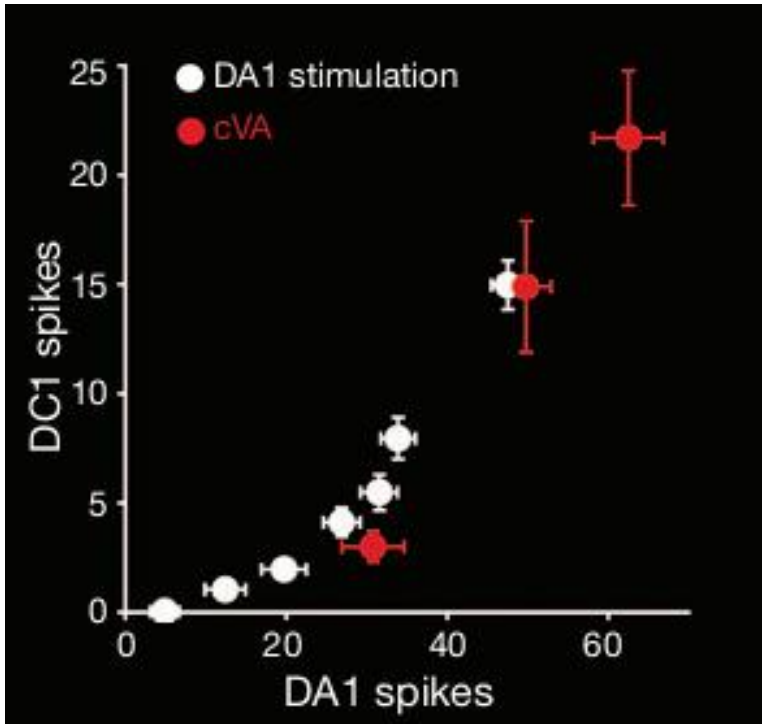




Ruta… Axel (*Nature,* 2010)

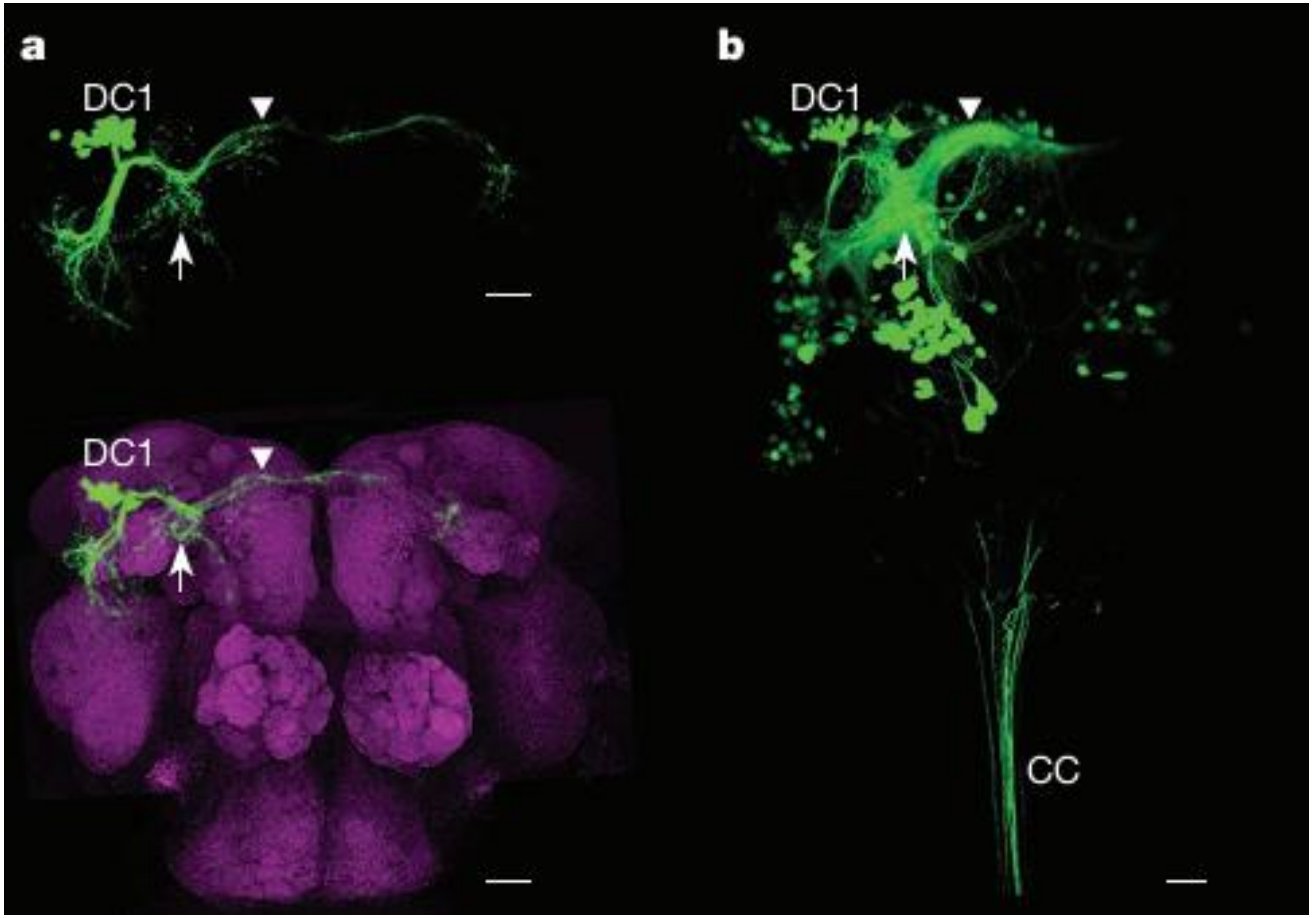
DC1 neurons respond to cVA





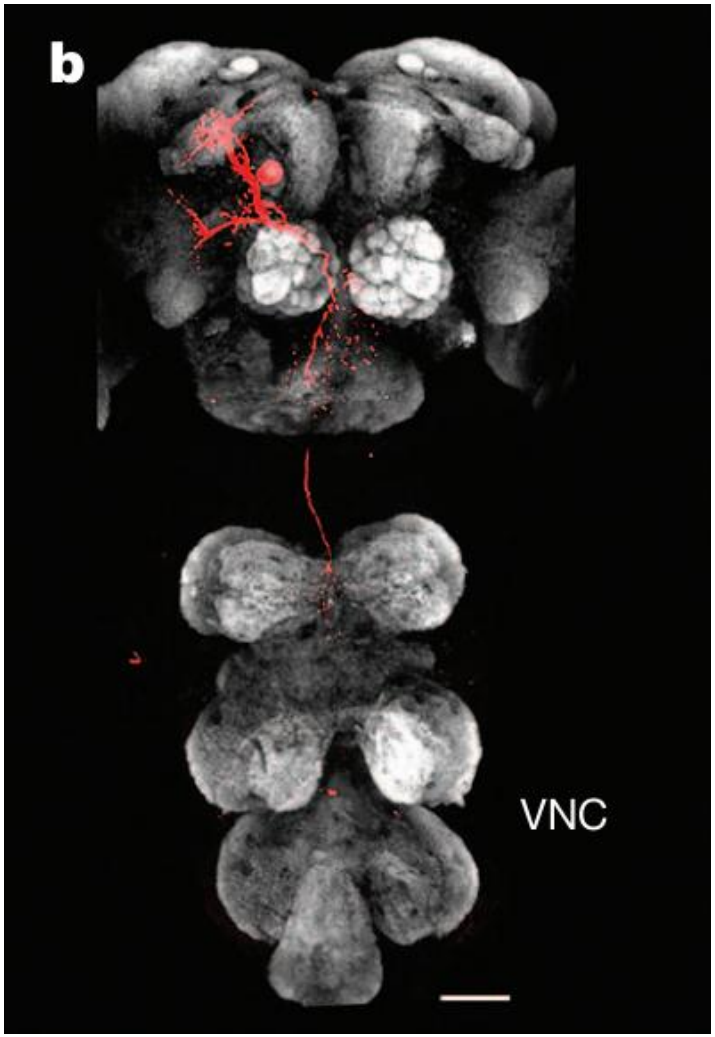
Ruta… Axel (*Nature,* 2010)

Finding neurons that connect to DC1



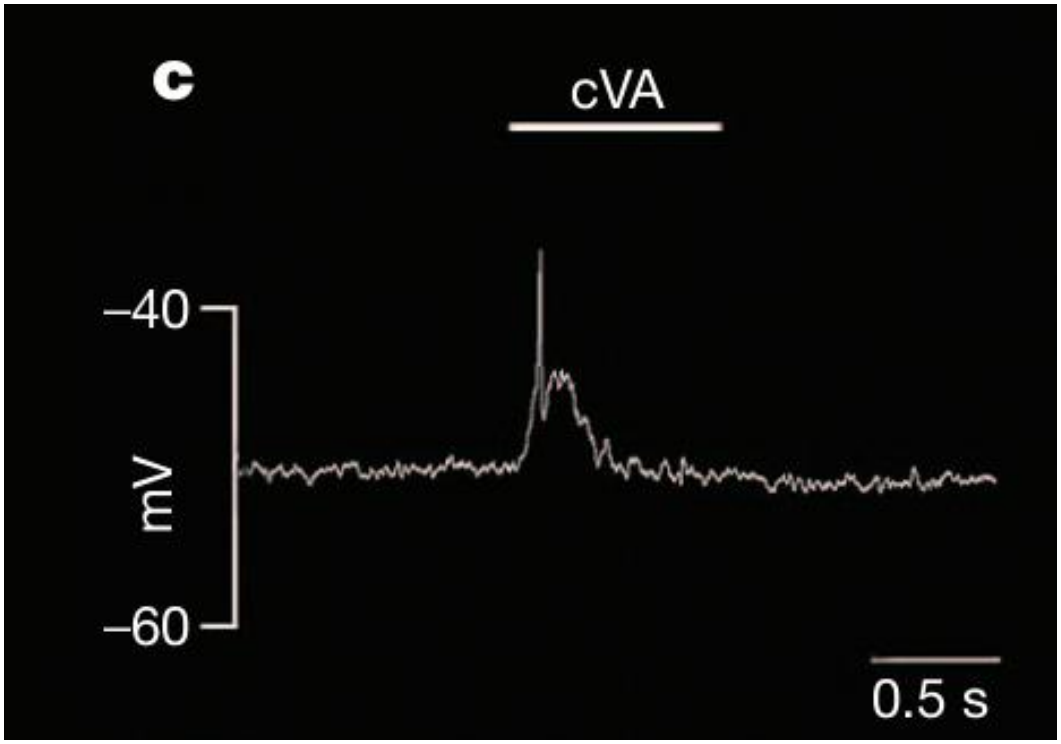
Ruta… Axel (*Nature,* 2010)

DC1 and DN1



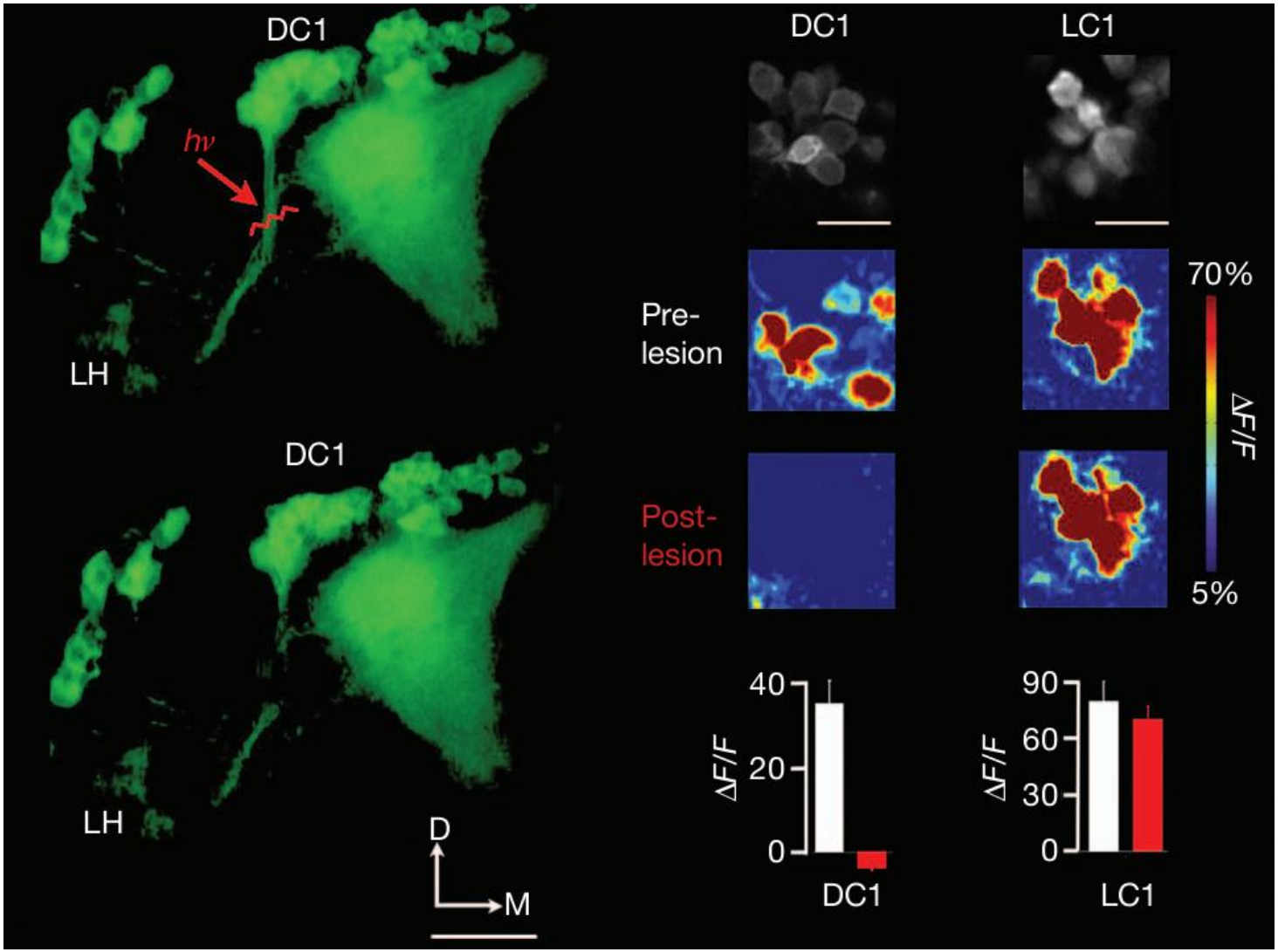
Ruta… Axel (*Nature,* 2010)

DN1 responds to cVA weakly



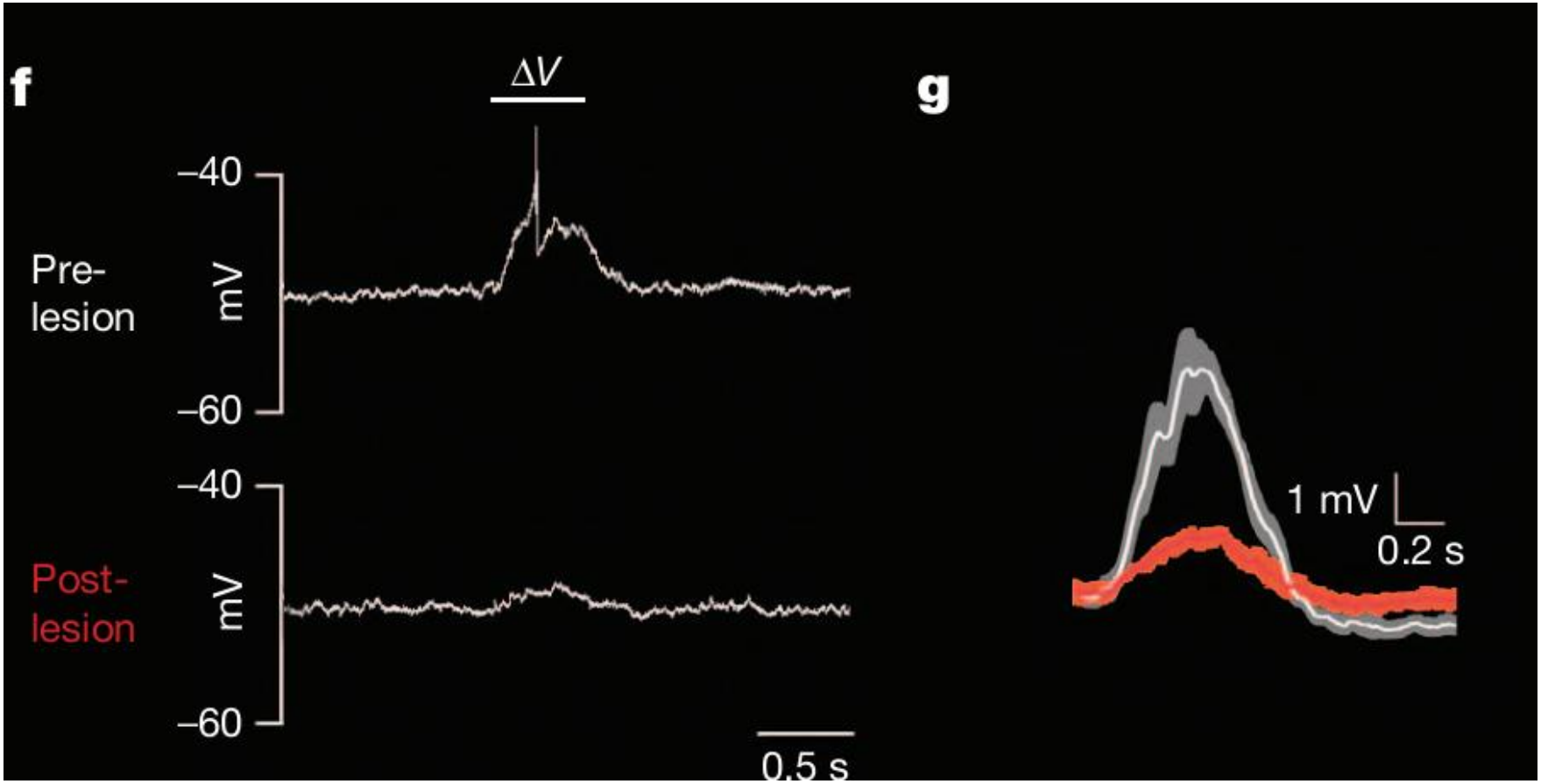
Ruta… Axel (*Nature,* 2010)

Laser-mediated microsurgery

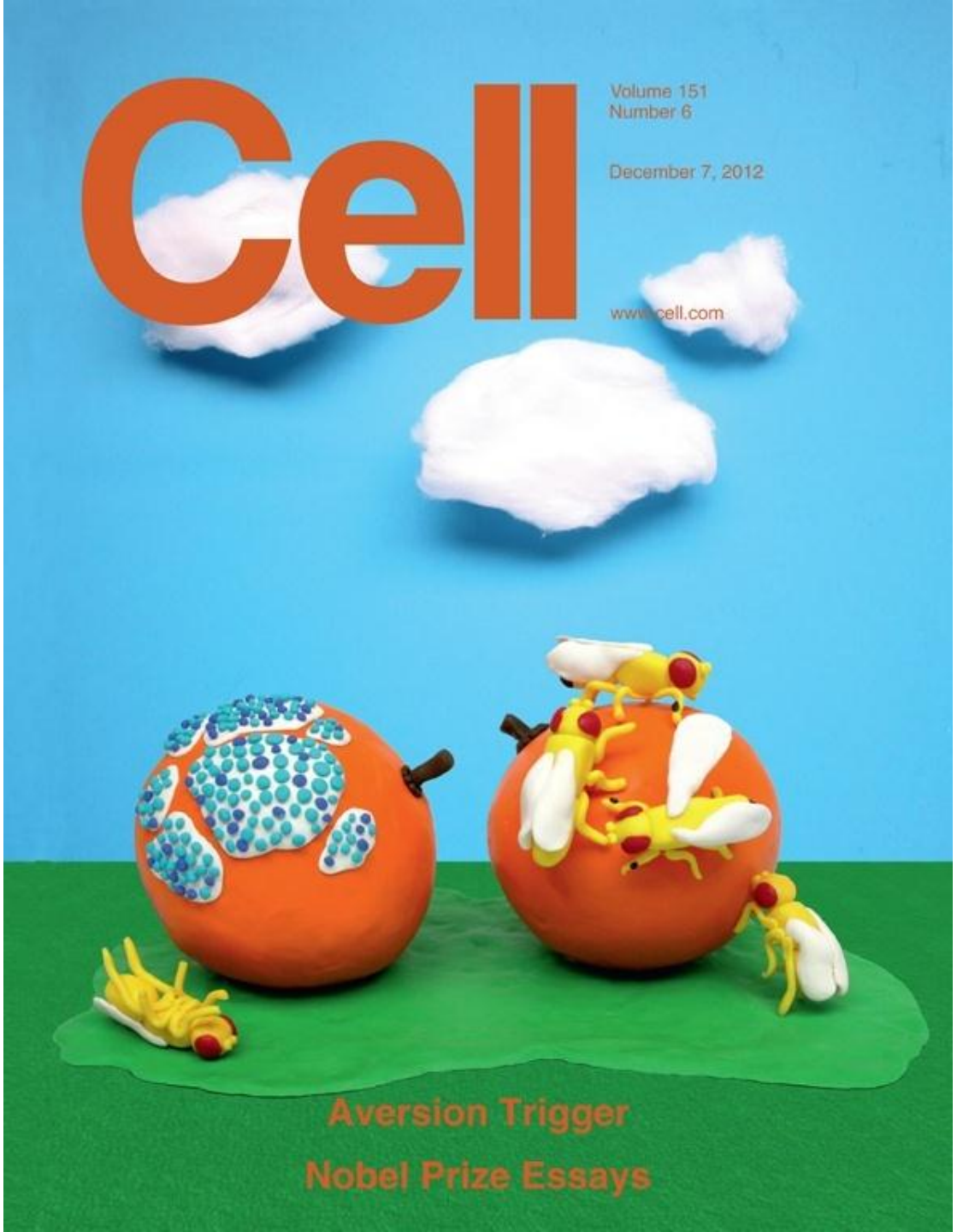


Ruta… Axel (*Nature,* 2010)

DN1 gets cVA input from DC1

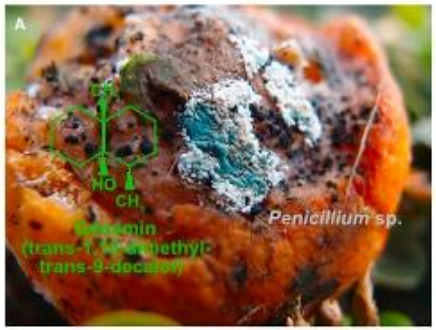


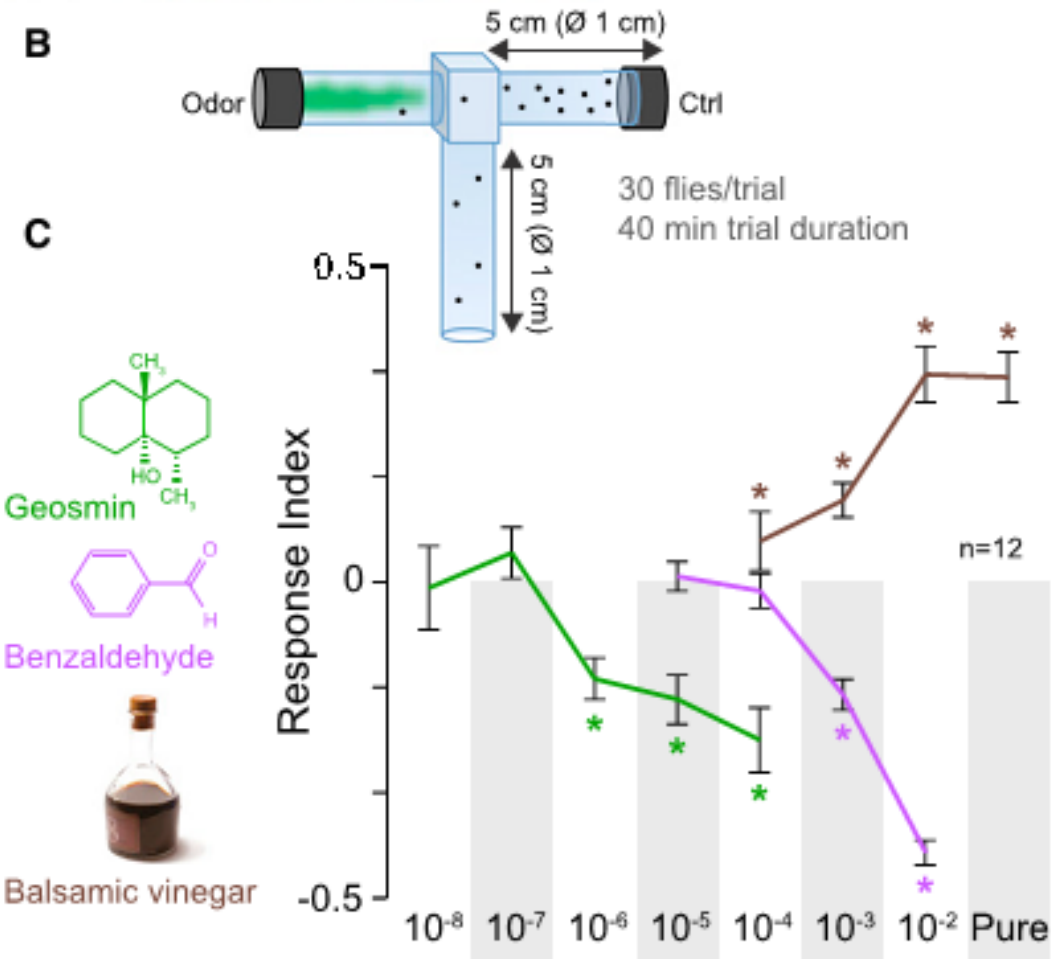
Ruta… Axel (*Nature,* 2010)



Stensmyr et al.
(*Cell*, 2012)

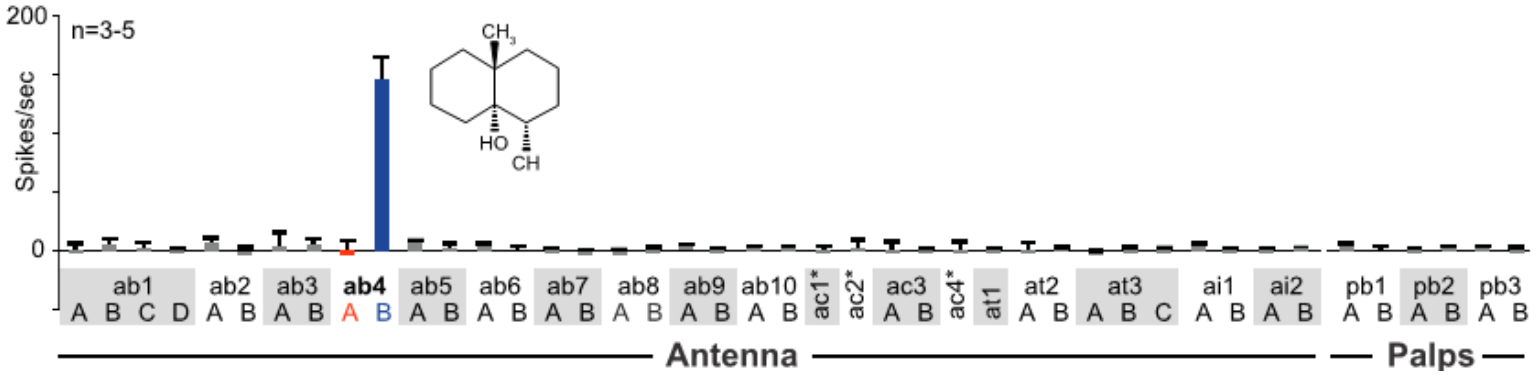
Geosmin induces avoidance

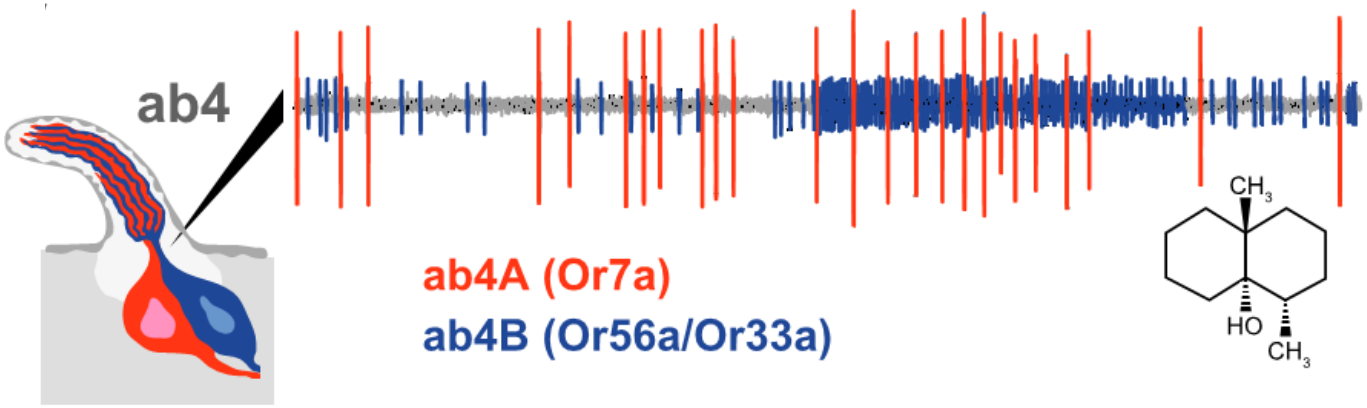




Stensmyr et al. (*Cell*, 2012)

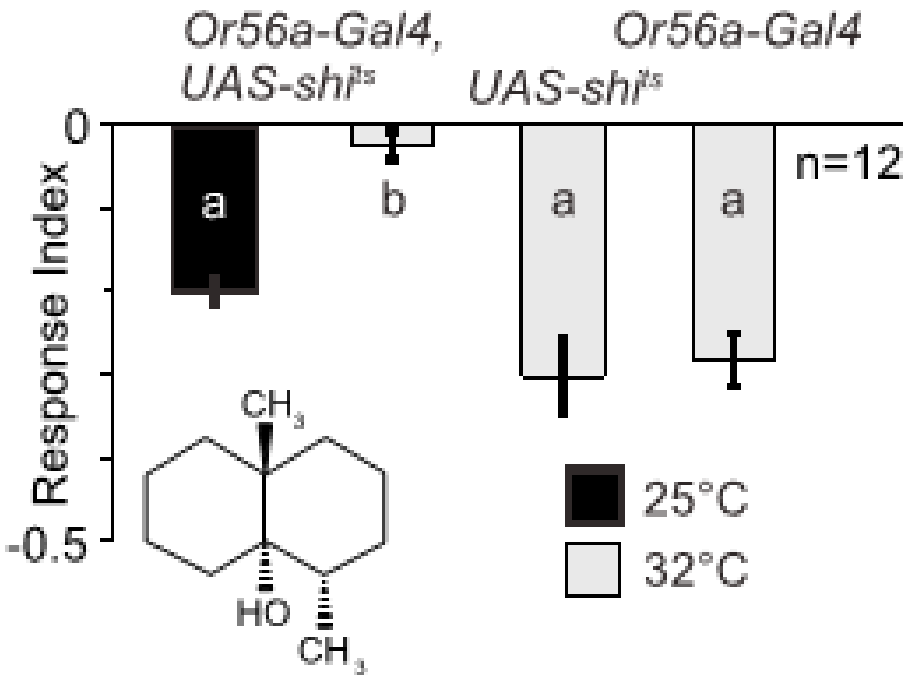
Geosmin activates a single class of ORNs





Stensmyr et al. (*Cell*, 2012)

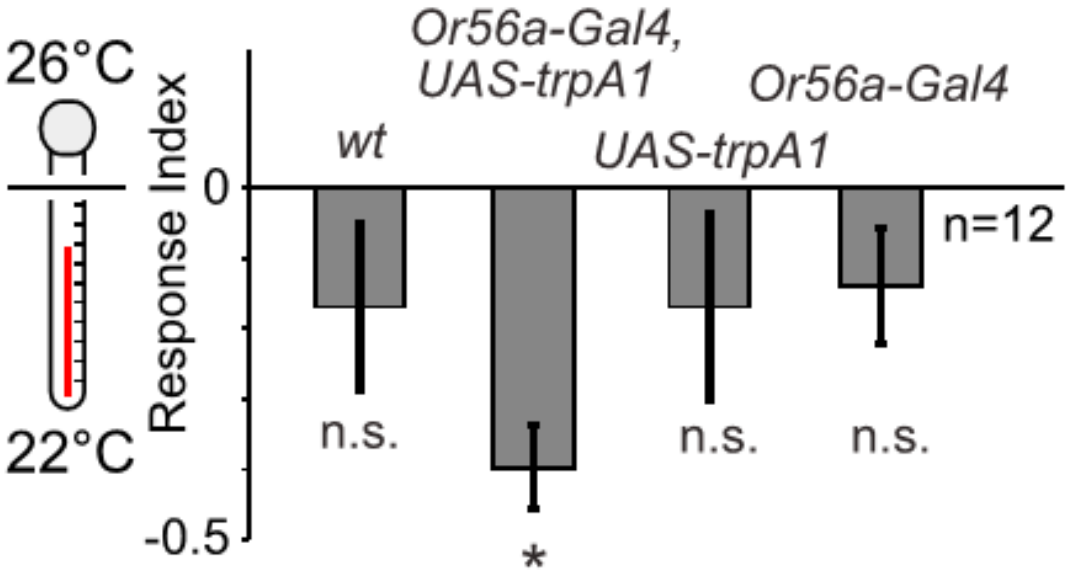
Or56a is necessary for avoidance



Temperature-sensitive allele of shibire

Stensmyr et al. (*Cell*, 2012)

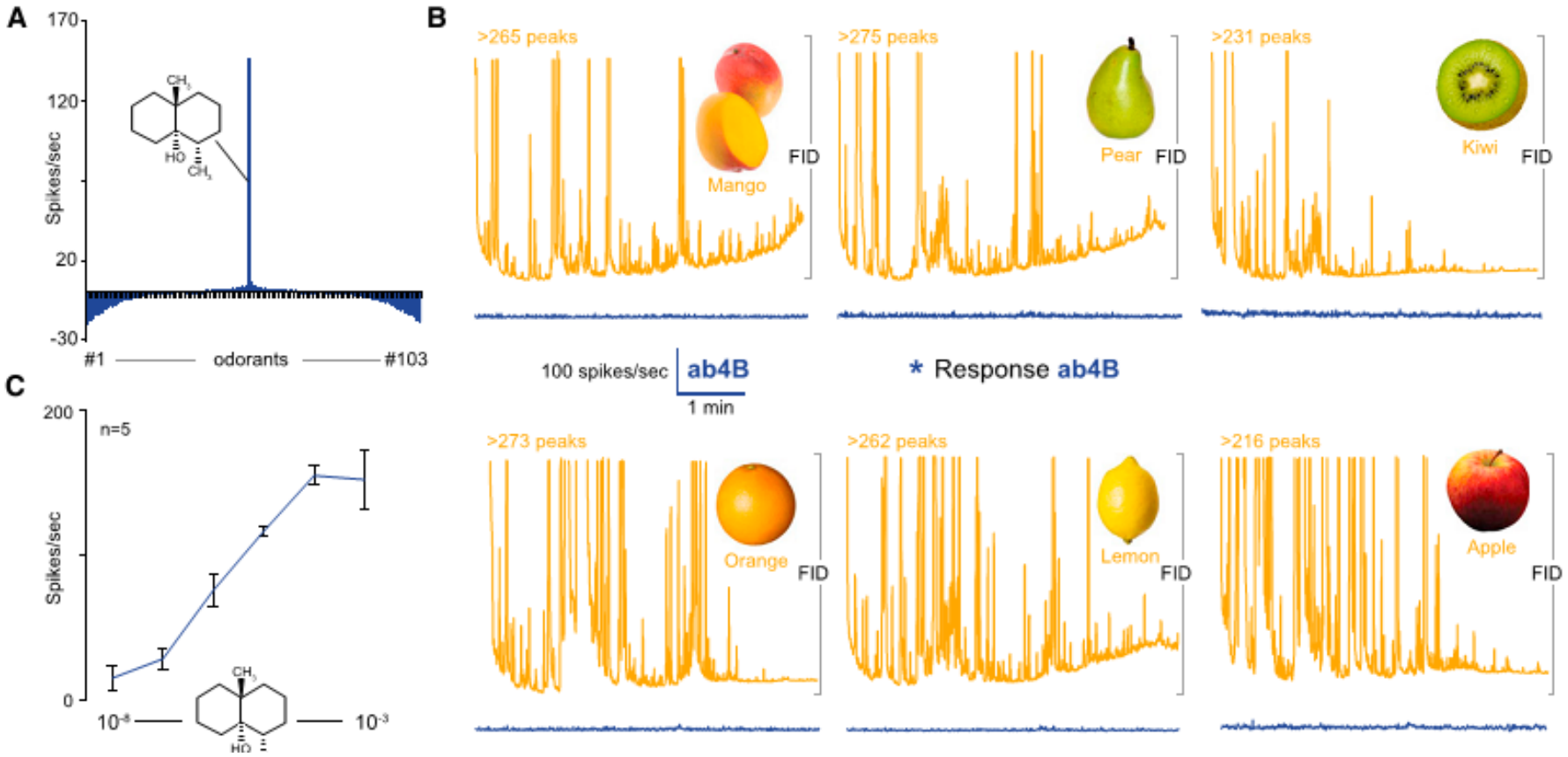
Or56a is sufficient for avoidance



dTRPA1:temperature-sensitive cation channel

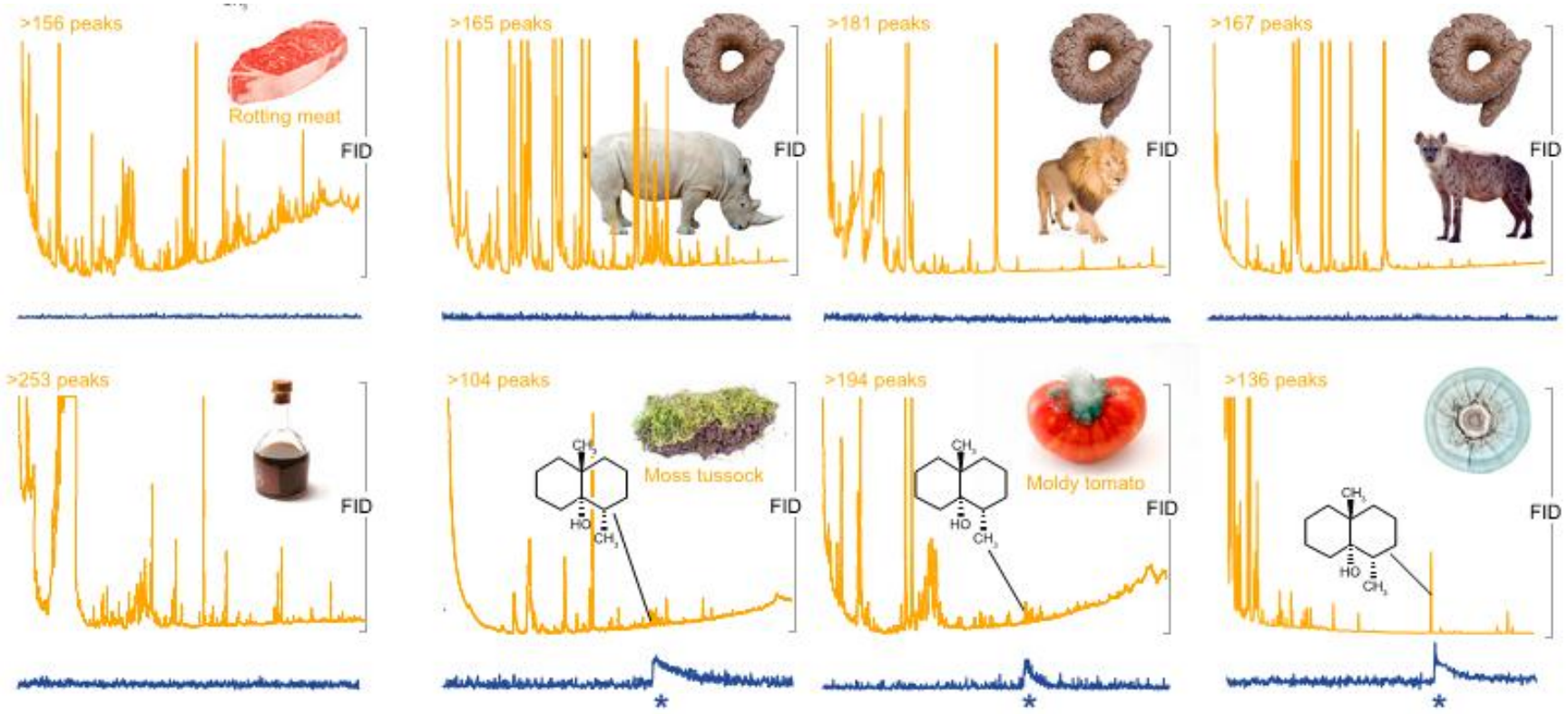
Stensmyr et al. (*Cell*, 2012)

Testing natural odors



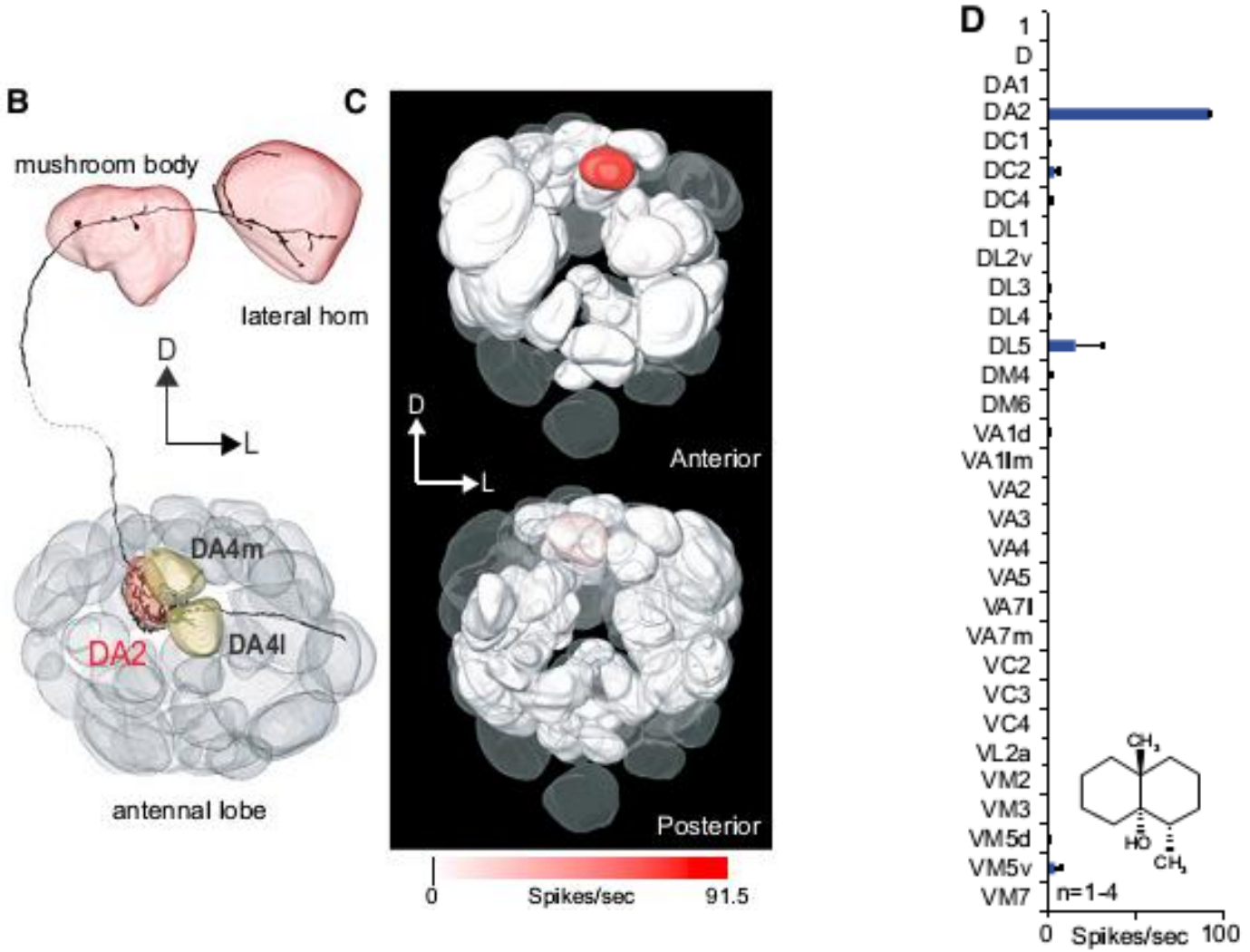
Stensmyr et al. (*Cell*, 2012)

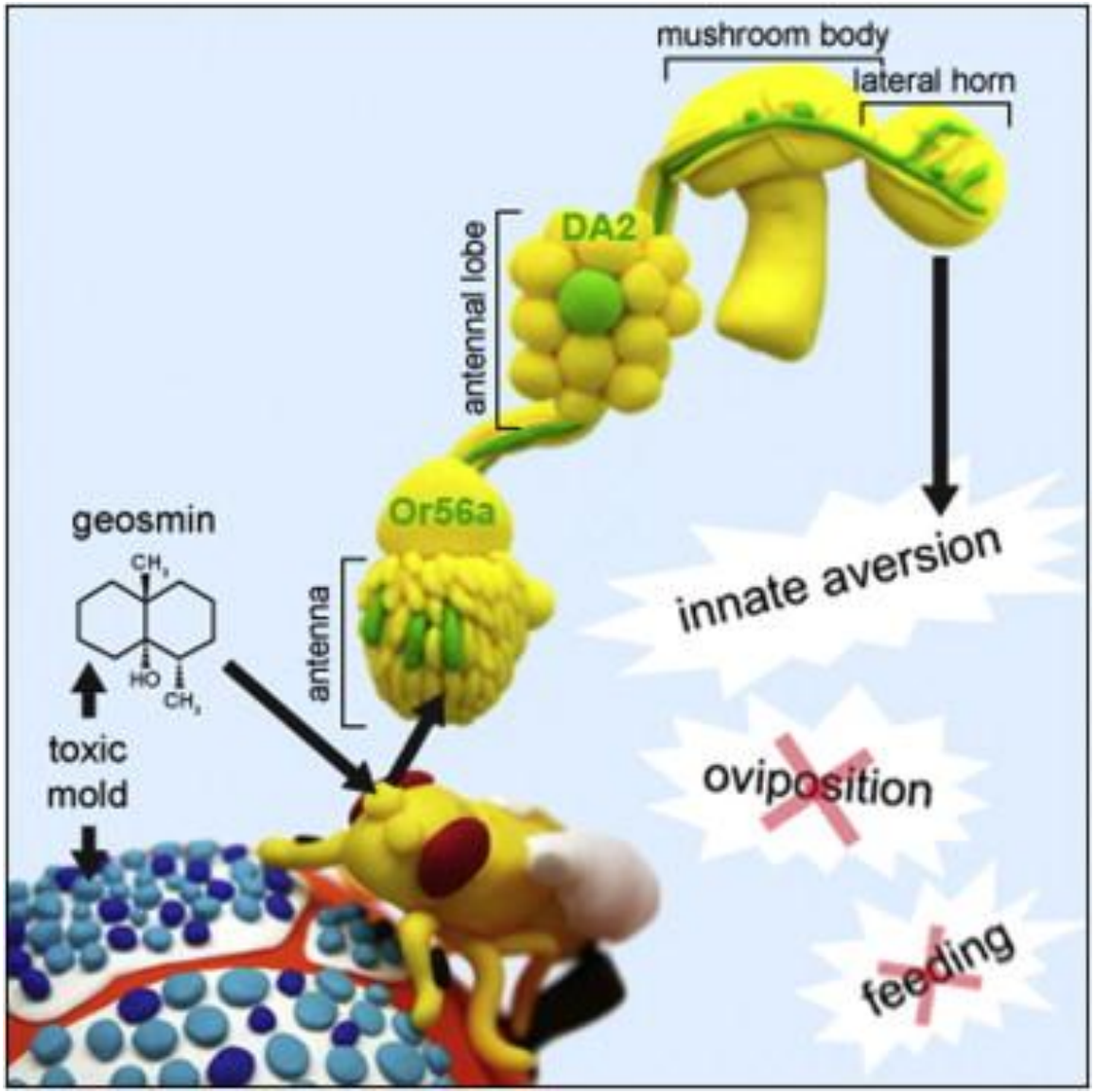
More natural odors



Stensmyr et al. (*Cell*, 2012)

Geosmin activates DA2 glomerulus





Stensmyr et al. (*Cell*, 2012)