From olfaction to oviposition: A global antennal-lobe network is associated with oviposition behavior in the female moth

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European Commission | HORIZON EUROPE 2021-2027

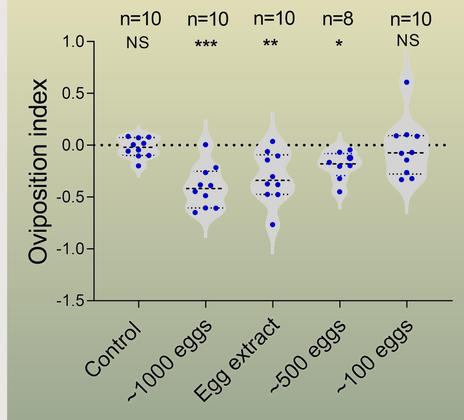
INTRODUCTION

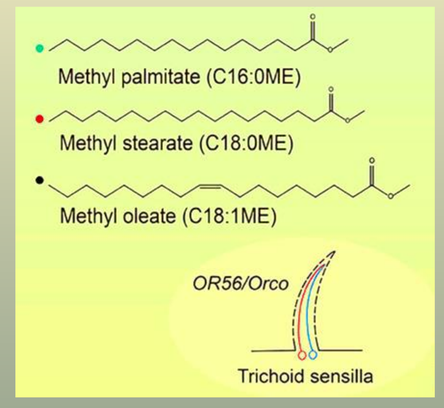
We know

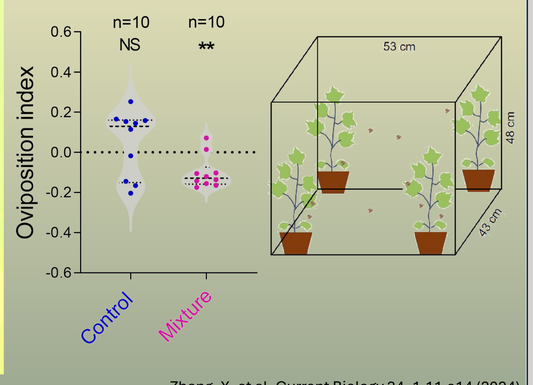
- As other organisms, insects possess neural circuits linked to perception of odorants that induce opposing behaviors, such as **attraction** and **repulsion**.
- *Helicoverpa armigera* females sense three fatty acid methyl esters (FAMEs: methyl oleate, methyl palmitate, and methyl stearate) emitted from the surface of conspecific eggs, which effectively **deter** oviposition behavior.
- In the context of oviposition site selection, it is of vital importance for female herbivorous insects to assess the site with both attractive plant volatiles and repellent FAMEs simultaneously.

Our goal

To explore the representation of these oviposition deterrent (ODs) and oviposition attractant signals in the neurons innervating antennal lobe.

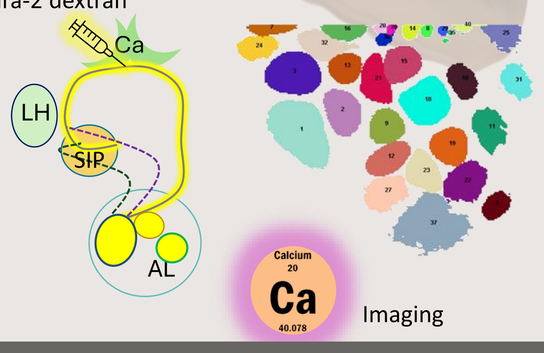




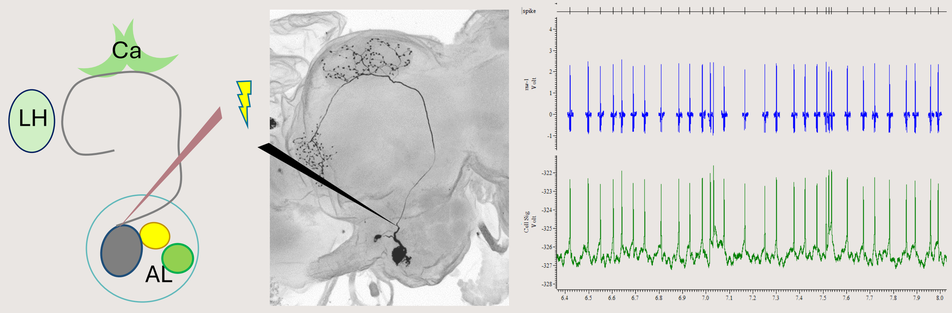


Zhang, X. et al. Current Biology 34, 1-11.e14 (2024)

METHODS

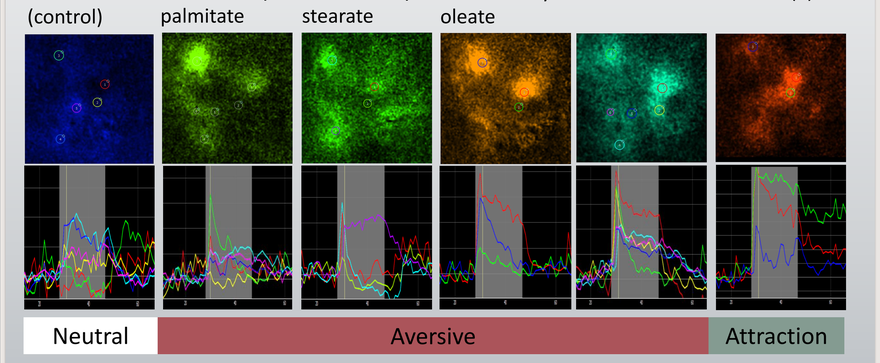


- Calcium imaging of uniglomerular projection neuron (PN) populations.
- Single unit recordings from distinct neuron types within the AL network, including olfactory sensory neurons, 4 types of AL output neurons, local interneurons, centrifugal neurons, and descending neurons.



RESULTS

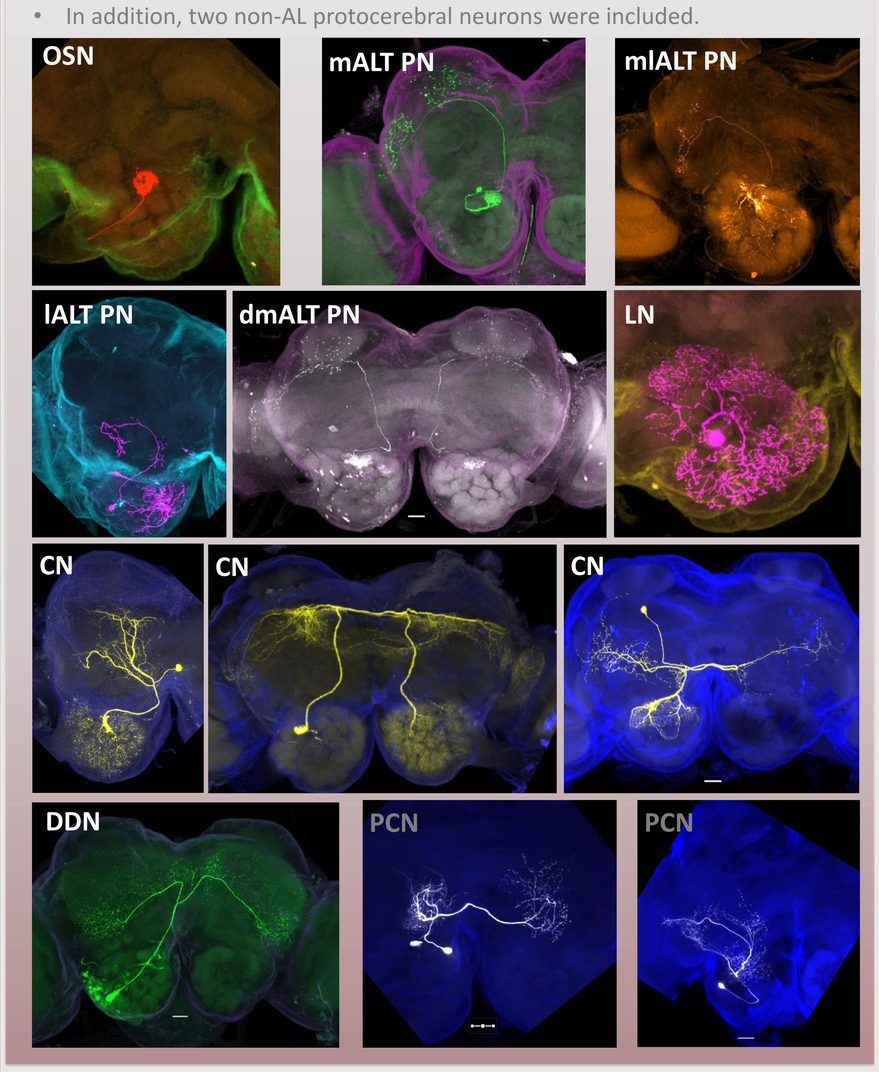
Imaging: Attractants and deterrents activate the same group of PNs



Odors with opposite behavioral valence

Single unit recording: Example neurons for 9 neuronal types

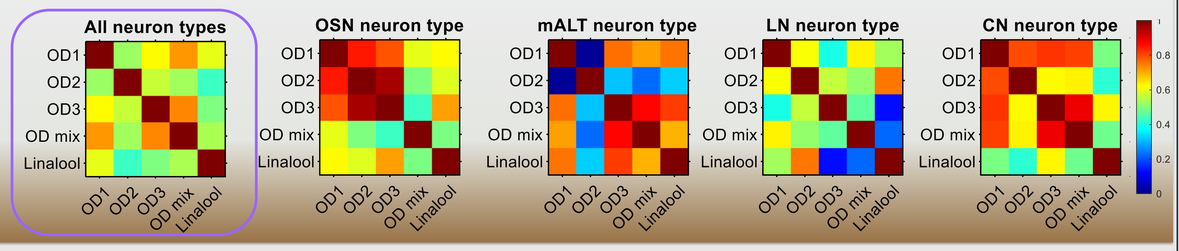
- Totally, 50 AL neurons with morphological identification were collected.
- These AL neurons represent eight different types.
- In addition, two non-AL protocerebral neurons were included.



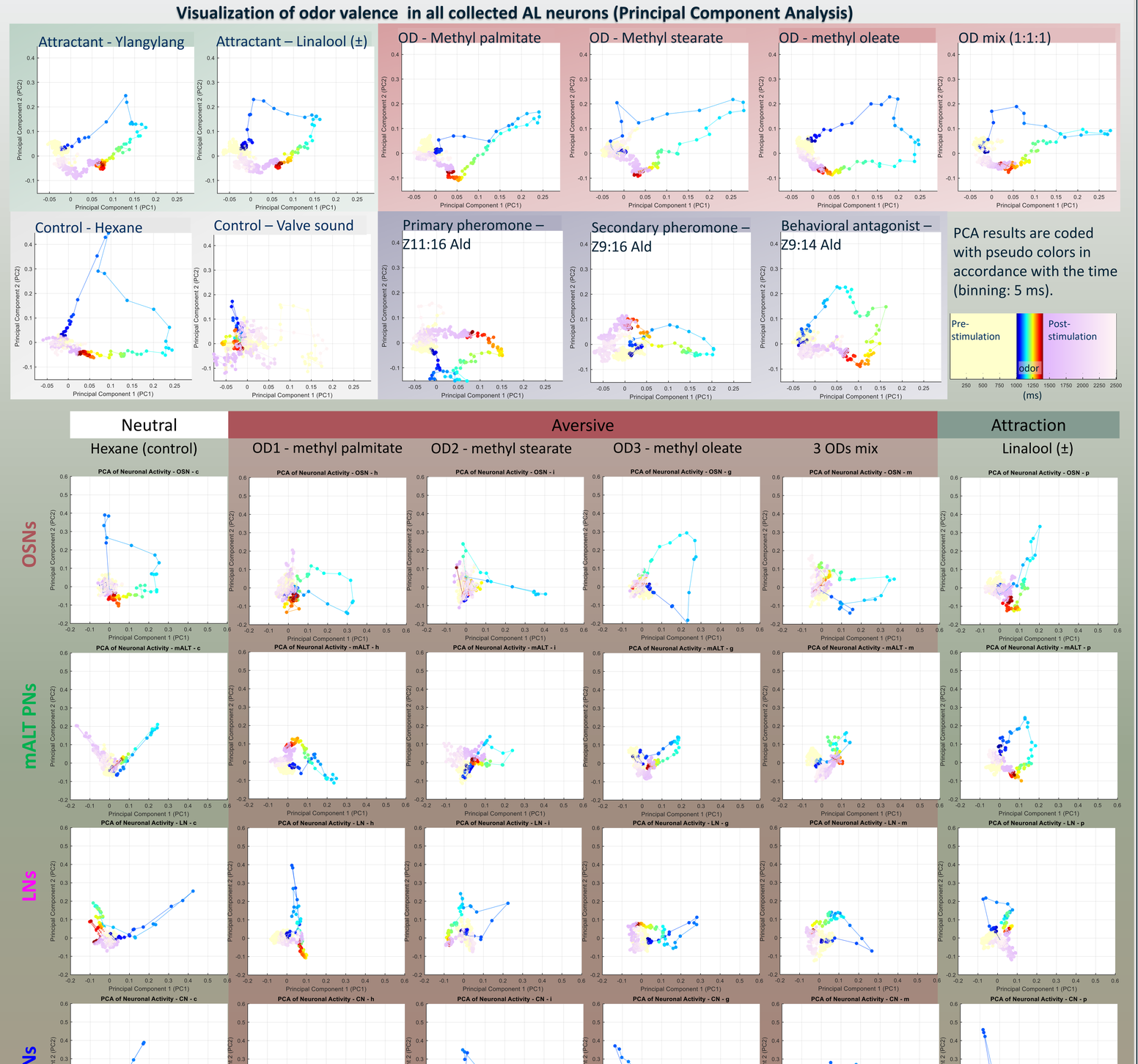
Neuron type	AL innervation	Neuron number
Olfactory sensory neuron (OSN)	**Uniglomerular**	7
Medial tract neuron (mALT PN)	**Uniglomerular**	12
Mediolateral tract neuron (mlALT PN)	Multiglomerular	4
Lateral tract neuron (lALT PN)	Multiglomerular	3
Dorsomedial tract neuron (dmALT PN)	Uniglomerular	1
Local interneuron (LN)	**Multiglomerular**	13
Centrifugal neuron (CN)	**Multiglomerular**	7
Descending neuron (DDN)	Multiglomerular	3
Protocerebral neuron (PCN)	-	2

Characterization of oviposition deterrents (ODs) vs. plant odor

Corrrelations between response amplitute of every two given stimuli across different neuron groups. (bin size: 5ms)



Visualization of odor valence in all collected AL neurons (Principal Component Analysis)



PCA results are coded with pseudo colors in accordance with the time (binning: 5 ms).

CONCLUSIONS

- Odors detected by the same olfactory receptor (OR56) can elicit distinct response patterns across various synaptic levels.
- The valence of behaviorally significant odors in the female olfactory system is represented in multiple synaptic layers.
- Signal processing of the FAMEs likely engages a global network within, and possibly beyond, the antennal lobe.