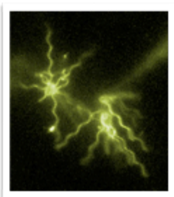
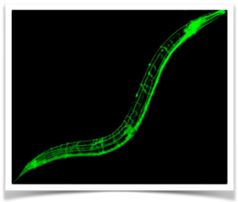
chemotaxis

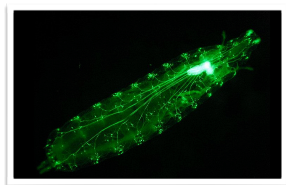
Escherichia coli



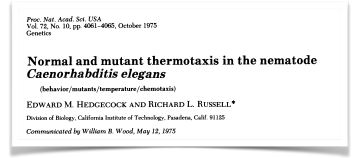
Caenorhabditis elegans



Drosophila larva



thermotaxis



Proc. Nat. Acad. Sci. USA
Vol. 72, No. 10, pp. 4061–4065, October 1975
Genetics

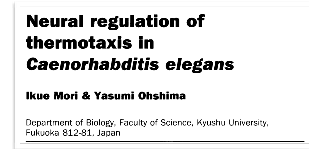
Normal and mutant thermotaxis in the nematode *Caenorhabditis elegans*

(behavior/mutants/temperature/chemotaxis)

EDWARD M. HEDGECOCK AND RICHARD L. RUSSELL*

Division of Biology, California Institute of Technology, Pasadena, Calif. 91125

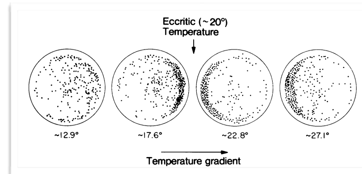
Communicated by William B. Wood, May 12, 1975

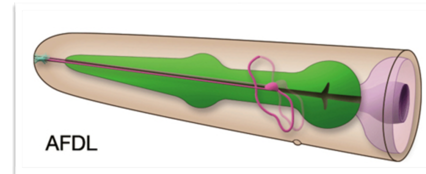


Neural regulation of thermotaxis in *Caenorhabditis elegans*

Ikue Mori & Yasumi Ohshima

Department of Biology, Faculty of Science, Kyushu University, Fukuoka 812-81, Japan

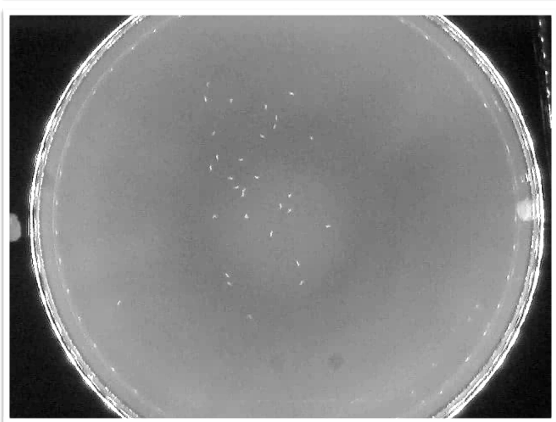




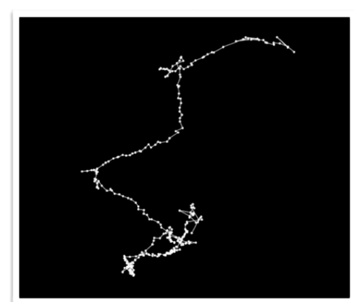
tracking

15 ˚C  25 ˚C

Worms grown at 15 ˚C

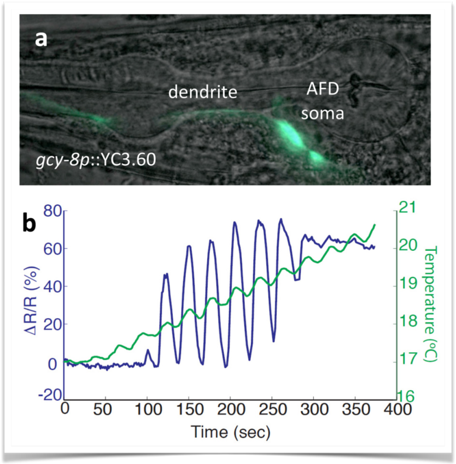


biased random walk

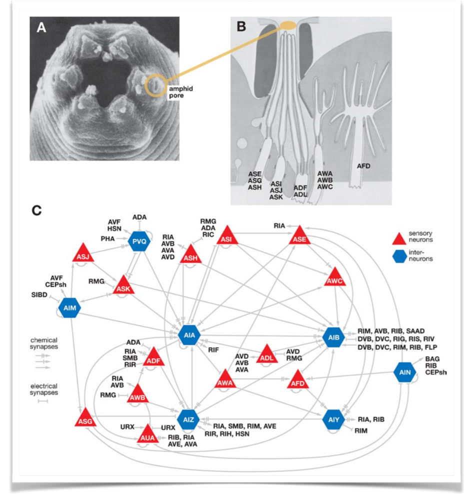


Sense warming… turn more
Sense cooling… turn less

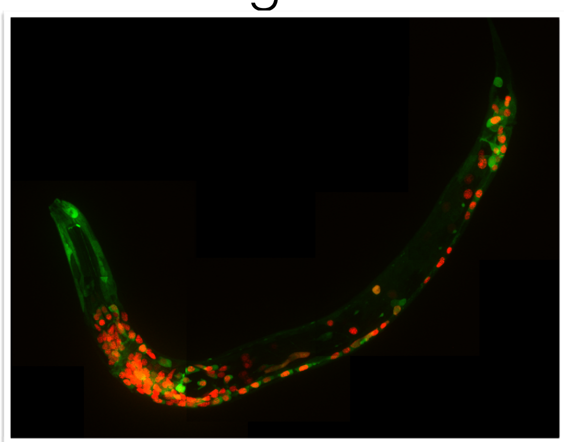
AFD neuron physiology



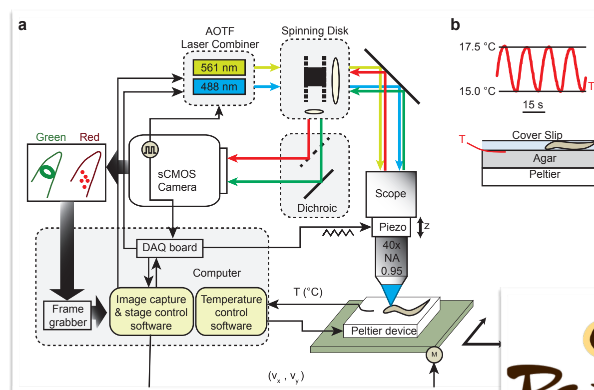
overlapping circuits for chemotaxis and thermotaxis



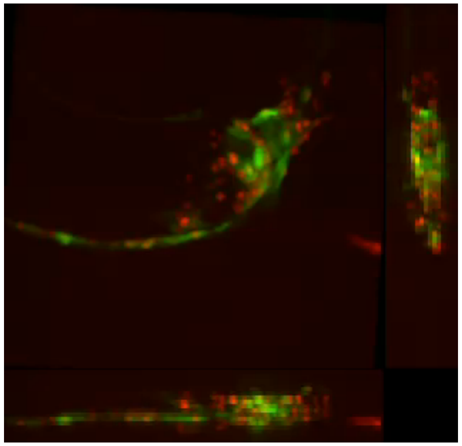
panneuronal imaging in roaming animals



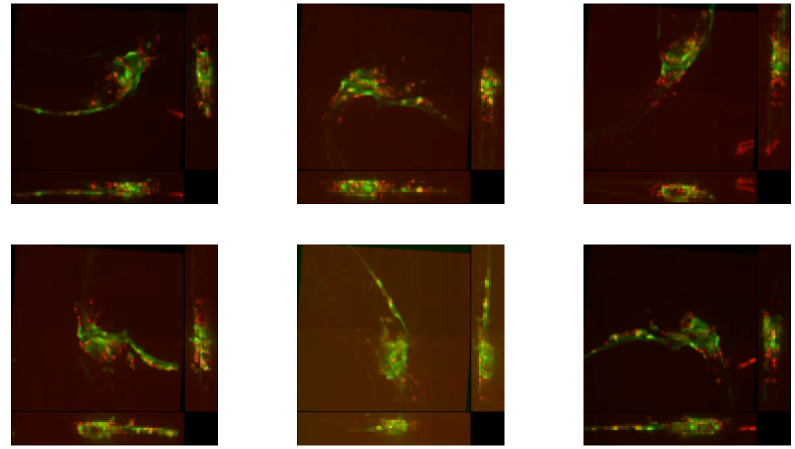
panneuronal imaging in roaming animals



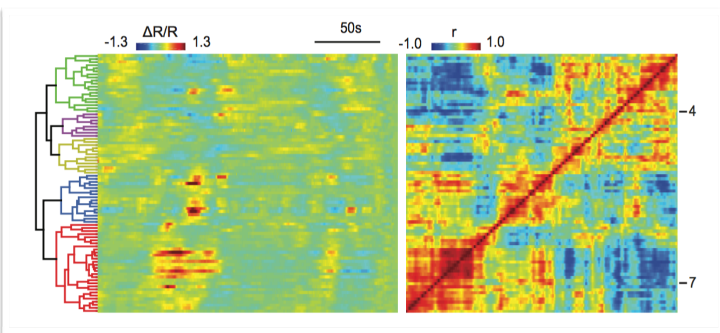
high speed whole brain imaging



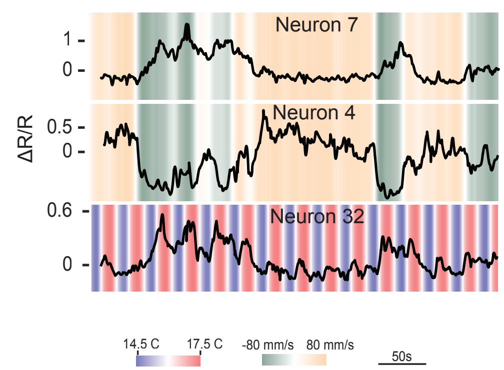
automated tracking



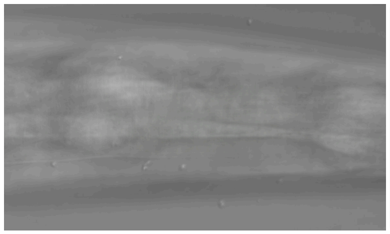
brain dynamics is low dimensional

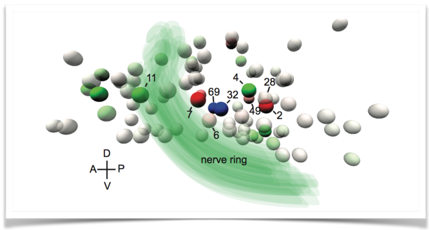


sensory to motor representation

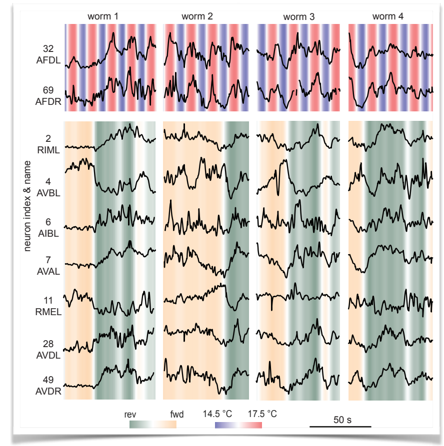


worm atlas

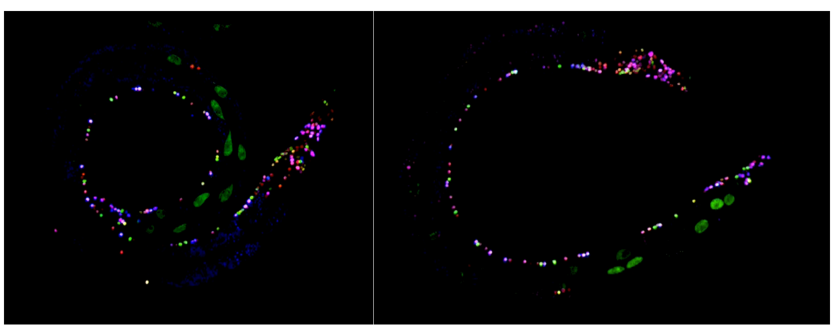




sparse sensory representation broad motor representation

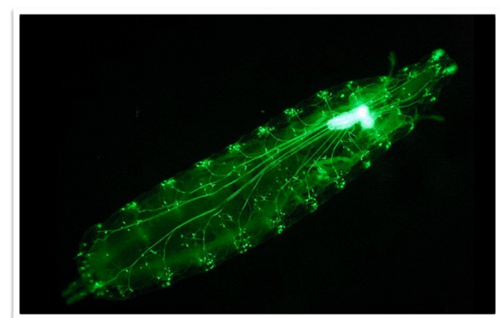


deterministic brainbow

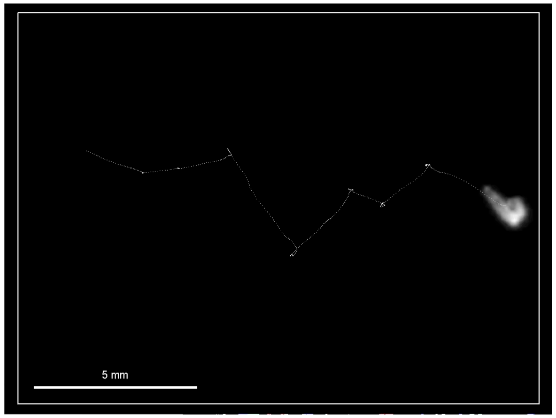


Ev Yemini & Oliver Hobert

Drosophila larva

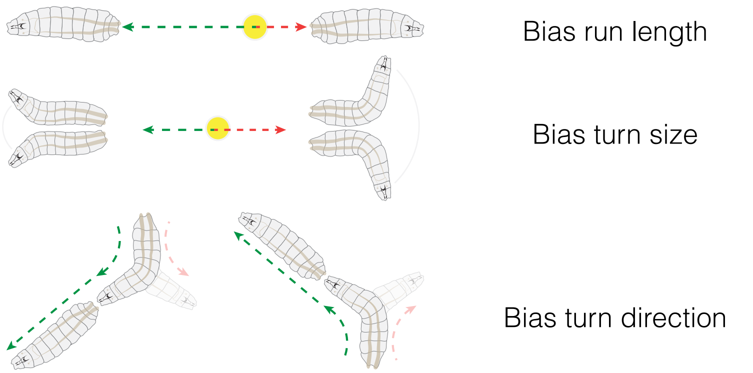


decision-making



Luo et al., 2010

sensorimotor transformations

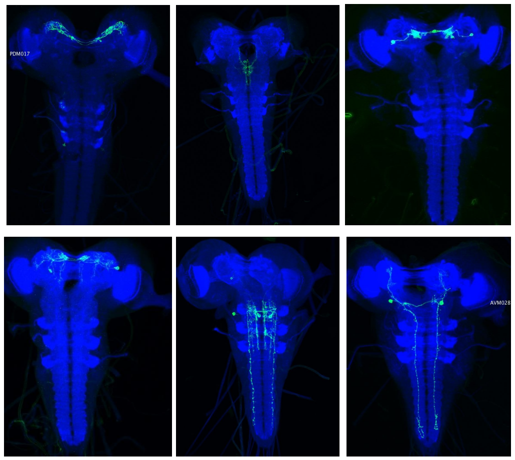


Janelia Farm

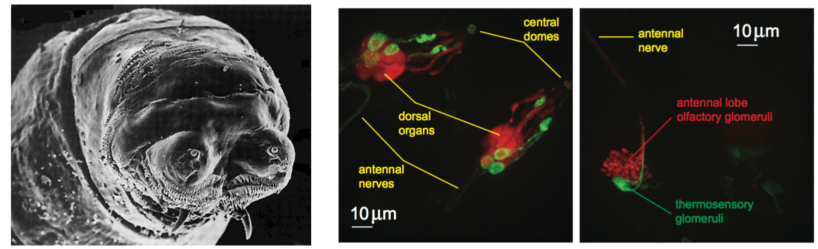
multiple animal gait and trajectory analyzer

Gershow et al., 2012

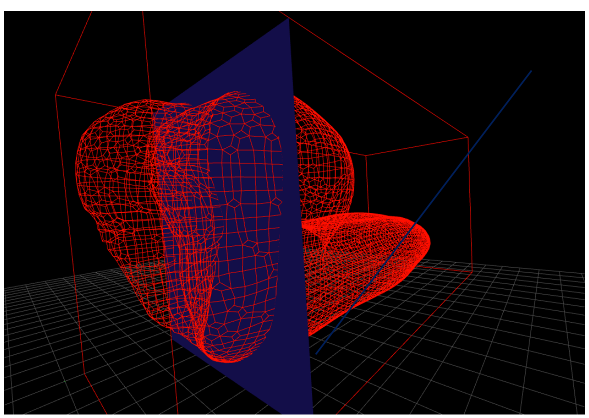
thermotaxis hits



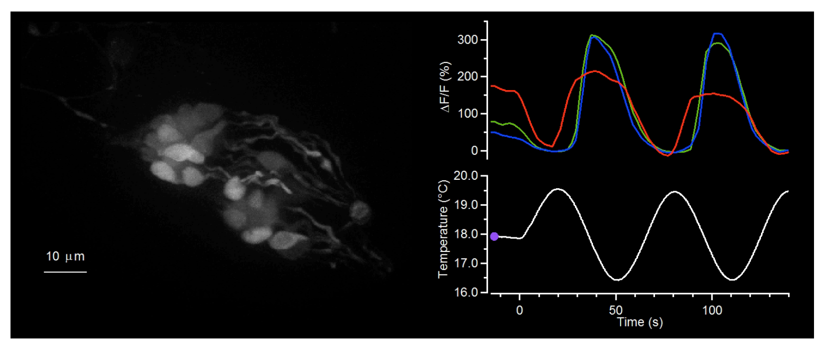
thermosensory neurons and chemosensory neurons



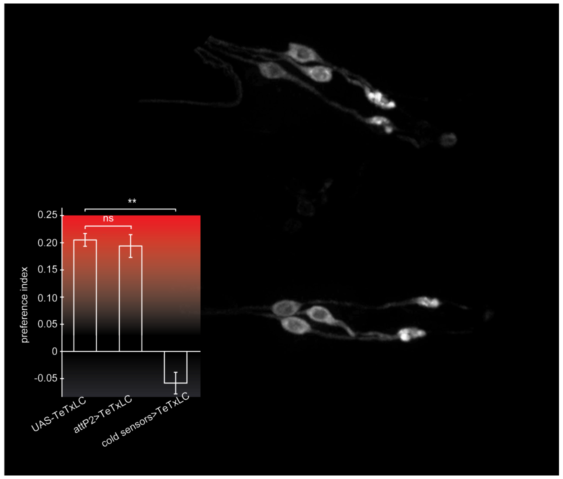
Then find the hits in the connectome

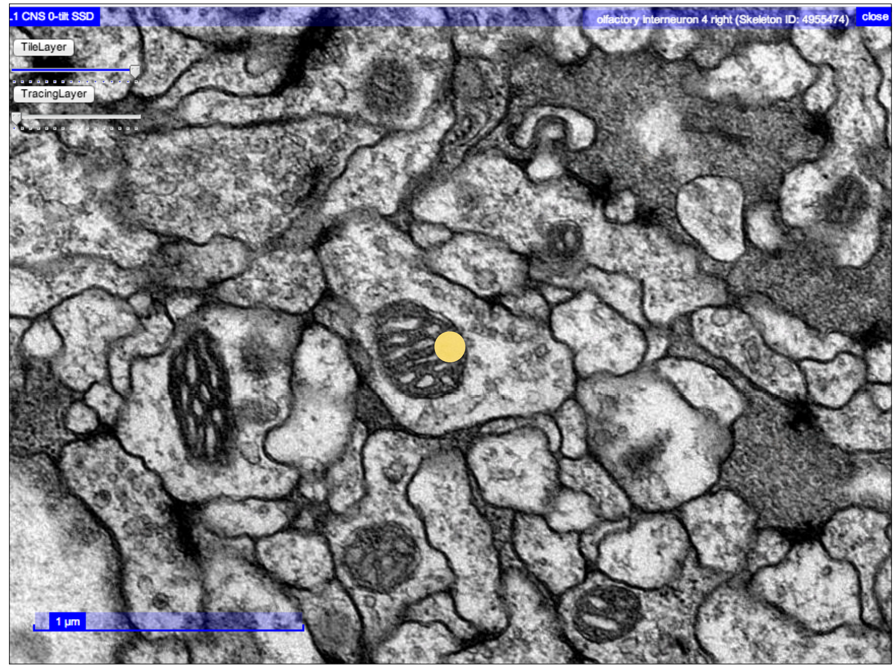


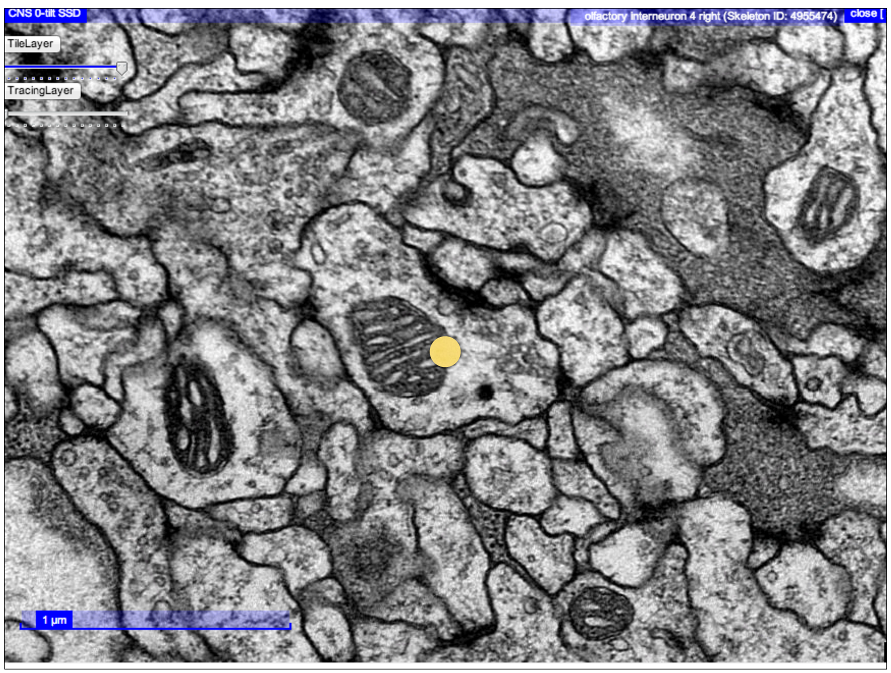
Drosophila “AFD” neurons

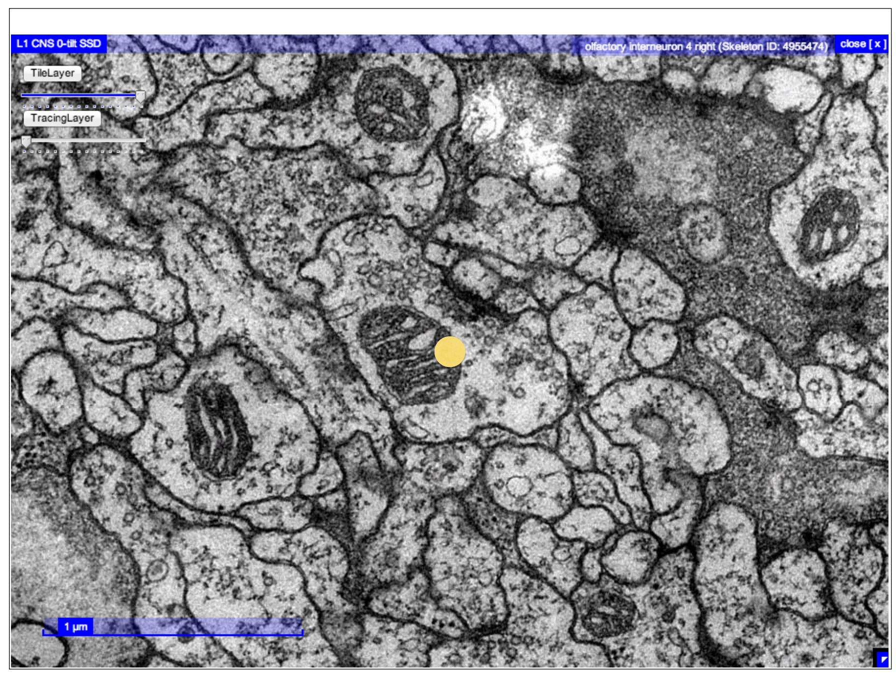


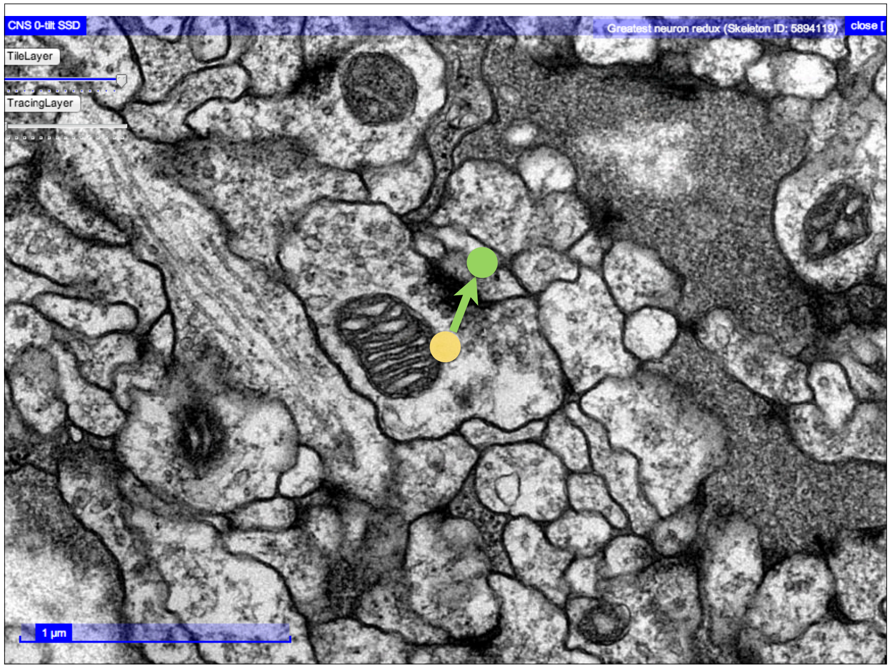
Drosophila “AFD” neurons



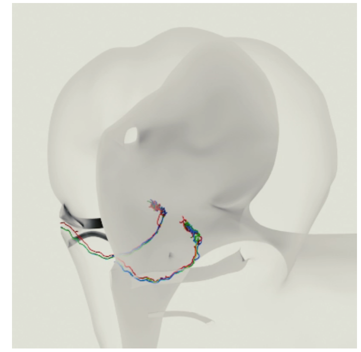




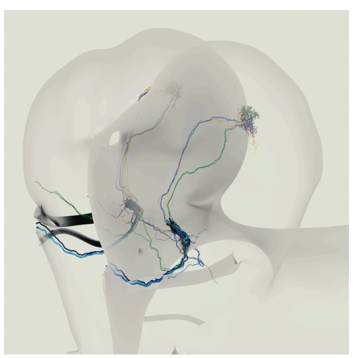




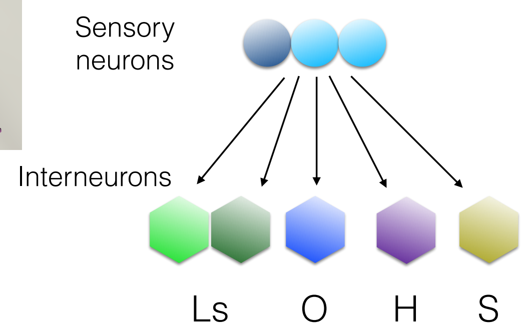
Novel thermosensory neurons



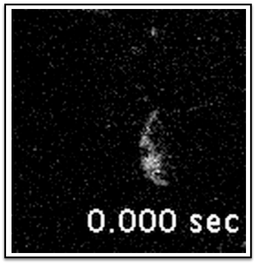
First relay reconstruction reveals 5 classes of PNs

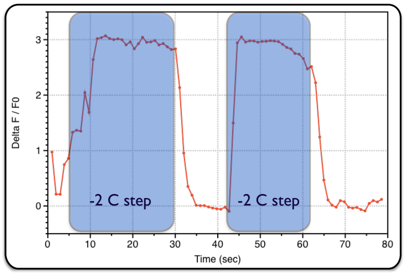


the first relay



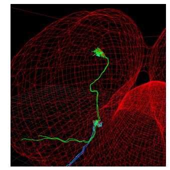
PN L responds to cold

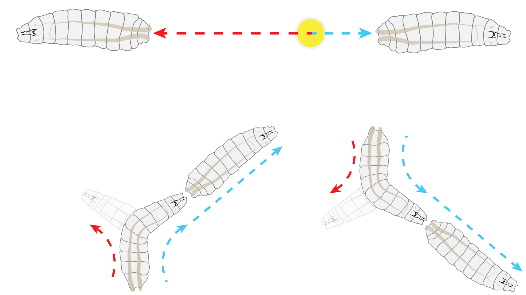




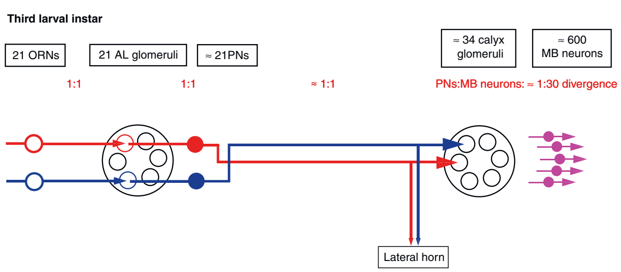
partial sensorimotor inversion

inactivate PNL



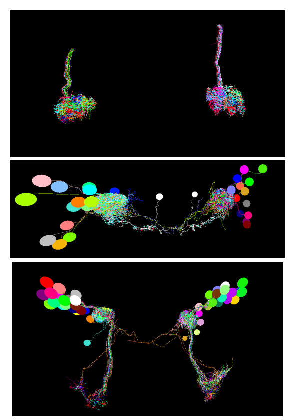


how do chemotaxis and thermotaxis circuits generate behavior?



Vosshall & Stocker, 2007

larval antennal lobe connectome



olfactory neurons (ORNS)
(21 innervating AL on each side)

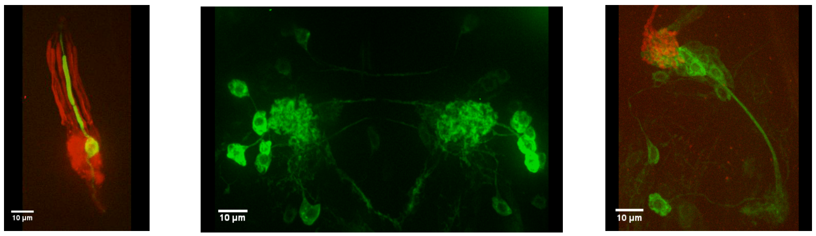
local interneurons (LNs)
(15 on each side)

projection neurons (PNs)

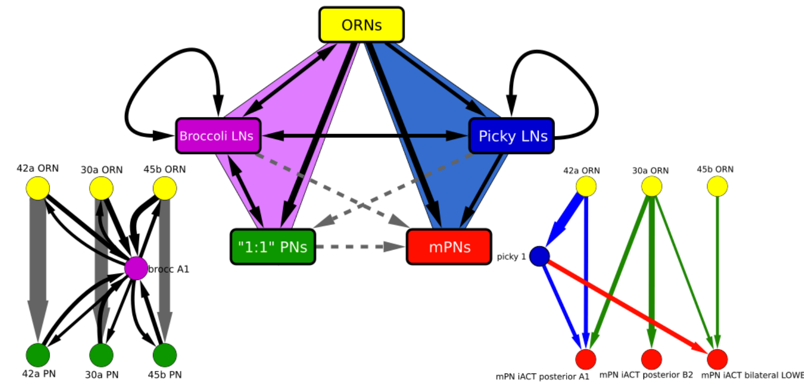
Matthew Berck, Avinash Khanderwal, Matthieu Louis, Albert Cardona

Optical neurophysiology accesses the entire circuit with single cell resolution

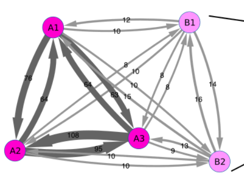
ORNs LNs PNs



two overlapping circuits with distinct wiring patterns

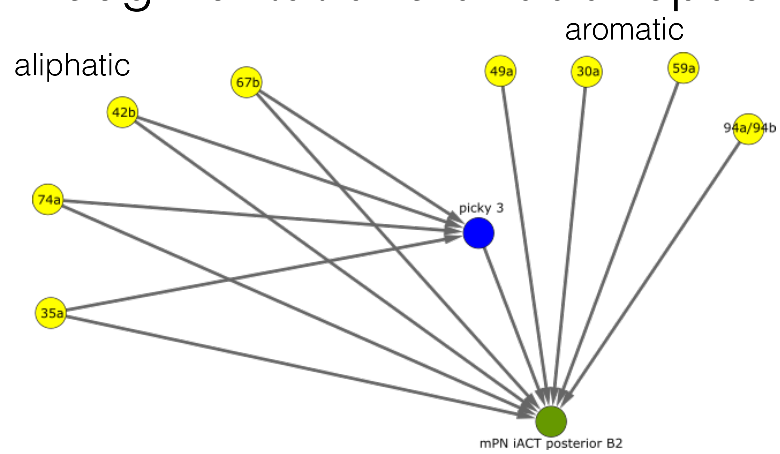


panglomerular local neurons interconnectivity

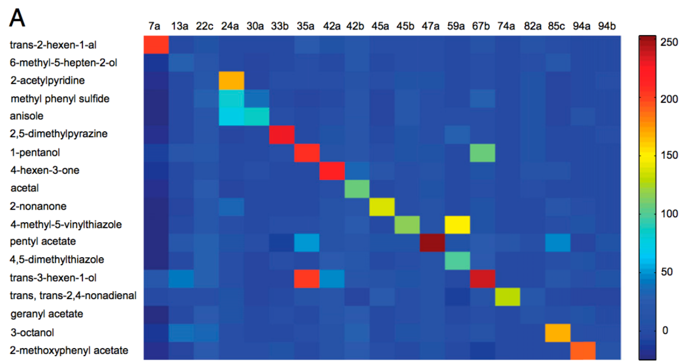


Right Antennal Lobe LNs			Ipsilateral Brocc. A 1	Ipsilateral Brocc. A 2	Ipsilateral Brocc. A 3	Ipsilateral Brocc. B 1	Ipsilateral Brocc. B 2	Bilateral Brocc. Asymmetric Left	Bilateral Brocc. Asymmetric Right	Bilateral Brocc. Symmetric Left	Bilateral Brocc. Symmetric Right	Ventral LN	Choosy 1	Choosy 2	Picky 0	Picky 1	Picky 2	Picky 3	Picky 4
Ips. Brocc.	A	1	0	76	63	10	10	1	5	22	16	2	7	2	3	10	8	10	6
		2	64	0	95	8	10	2	2	16	22	3	1	1	8	7	2	9	2
		3	64	108	0	8	9	0	1	11	36	4	9	6	4	7	5	9	2
	B	1	12	10	8	0	14	1	9	3	7	3	10	3	15	7	7	10	4
		2	15	10	13	16	0	1	5	2	2	1	4	6	15	11	5	5	4
Bil. Brocc.	Asym.	Left	5	6	4	0	0	0	11	0	3	3	0	0	1	0	0	6	1
		Right	12	12	14	6	3	8	0	3	2	4	0	3	4	0	0	4	2
	Sym.	Left	13	27	21	0	0	1	5	0	1	0	1	3	2	7	11	1	7
		Right	18	38	43	2	3	1	4	0	0	1	0	0	6	13	4	2	5
ventral LN			8	11	10	10	2	1	14	5	4	0	8	8	9	9	19	1	15
Choosy		1	0	0	2	4	3	0	3	4	0	0	0	8	1	10	2	0	3
		2	0	0	2	6	1	1	10	0	1	0	4	0	3	4	0	0	4
Picky		0	5	7	14	5	8	3	4	38	48	5	3	5	0	18	7	4	14
		1	4	3	1	1	5	0	1	2	4	1	2	5	0	0	0	0	2
		2	0	0	0	2	1	0	1	0	0	1	2	4	1	4	0	0	4
		3	2	5	2	1	1	0	1	4	0	0	4	3	2	1	2	0	0
		4	1	5	7	4	4	1	2	1	3	5	6	8	1	4	23	7	0

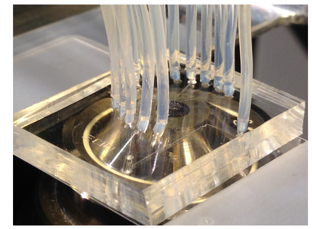
mPNs perform interesting segmentations of odor space

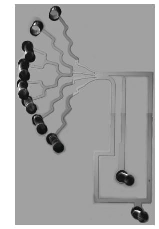


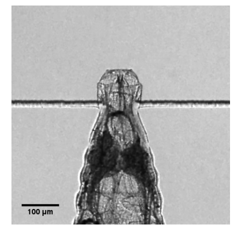
cognate odors

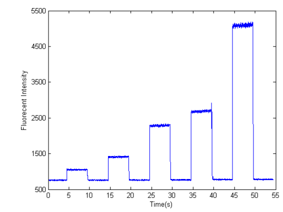


Microfluidics

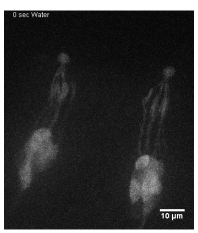


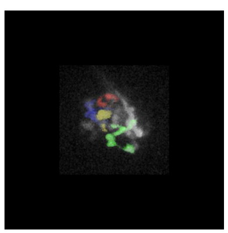


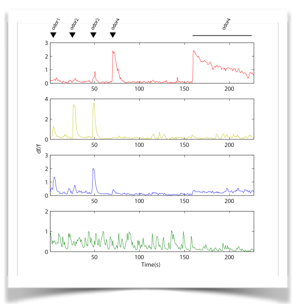




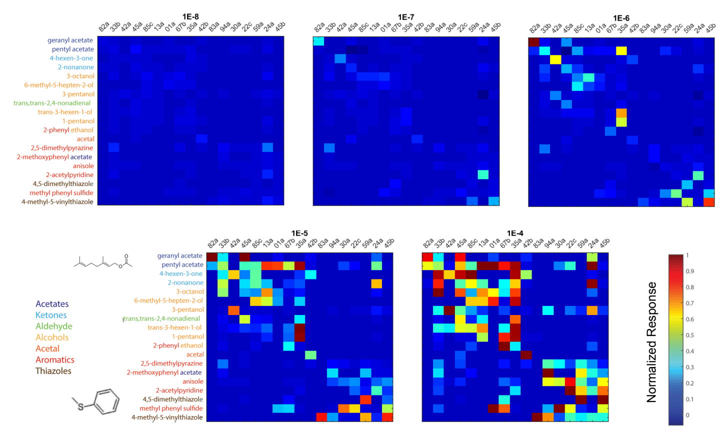
record activity in dorsal organ and antennal lobe



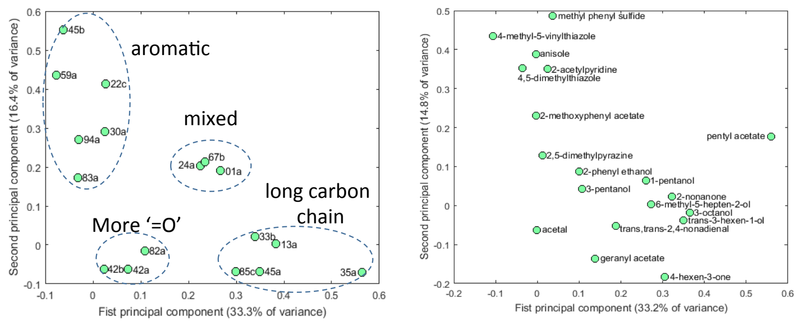




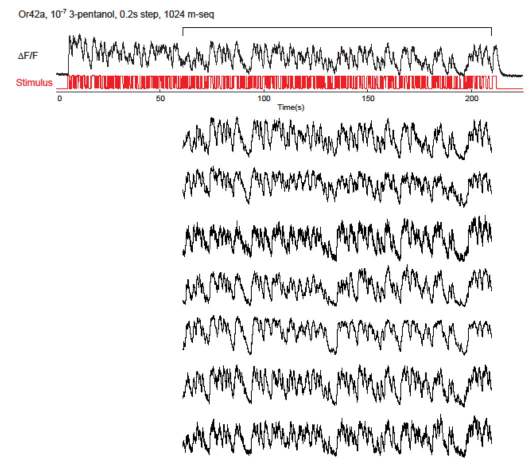
dose response curves across olfactory periphery



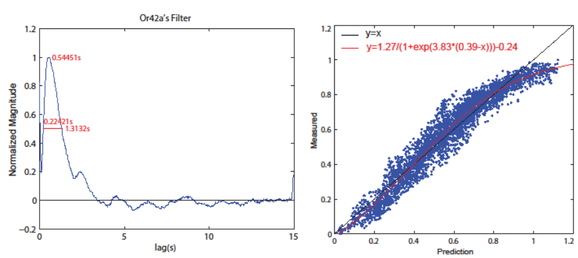
clustering of ORN properties



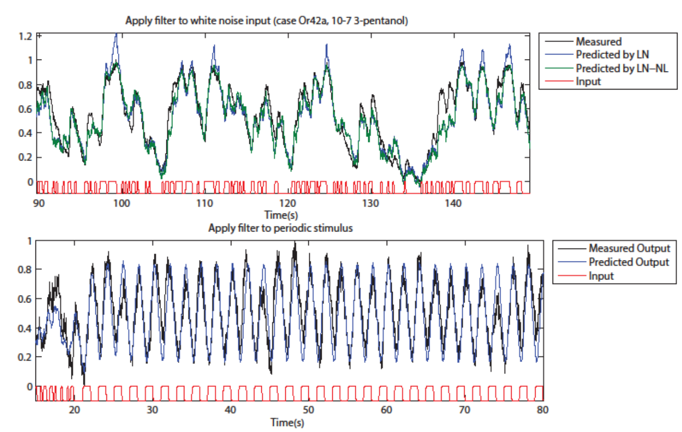
transfer functions



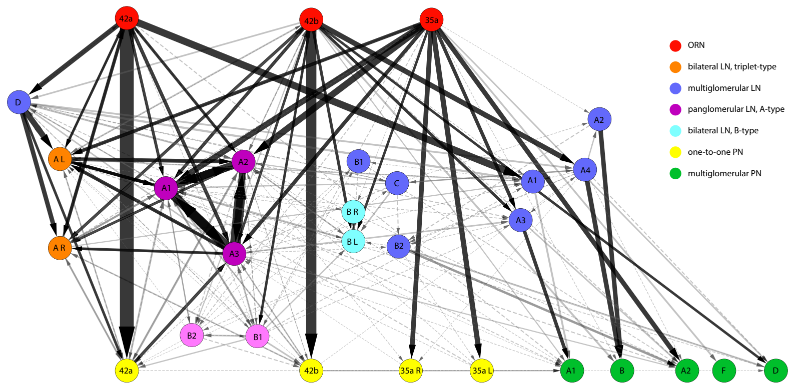
LN models



satisfactory predictions



systematically unravel the logic of the antennal lobe



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Ashley Carter, PI at Amherst
Chris Fang-Yen, PI at UPenn
Chris Gabel, PI at Boston Univ
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Andrew Leifer, PI at Princeton
Linjiao Luo, PI at Nanjing U
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