Coarse-graining and Control of Networked Dynamical Systems

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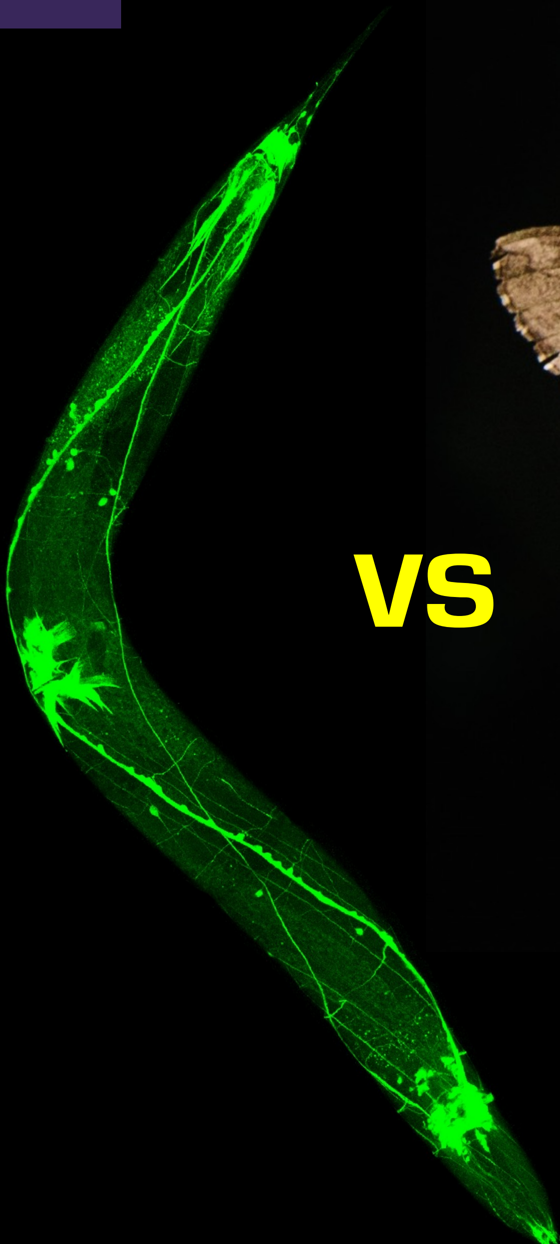
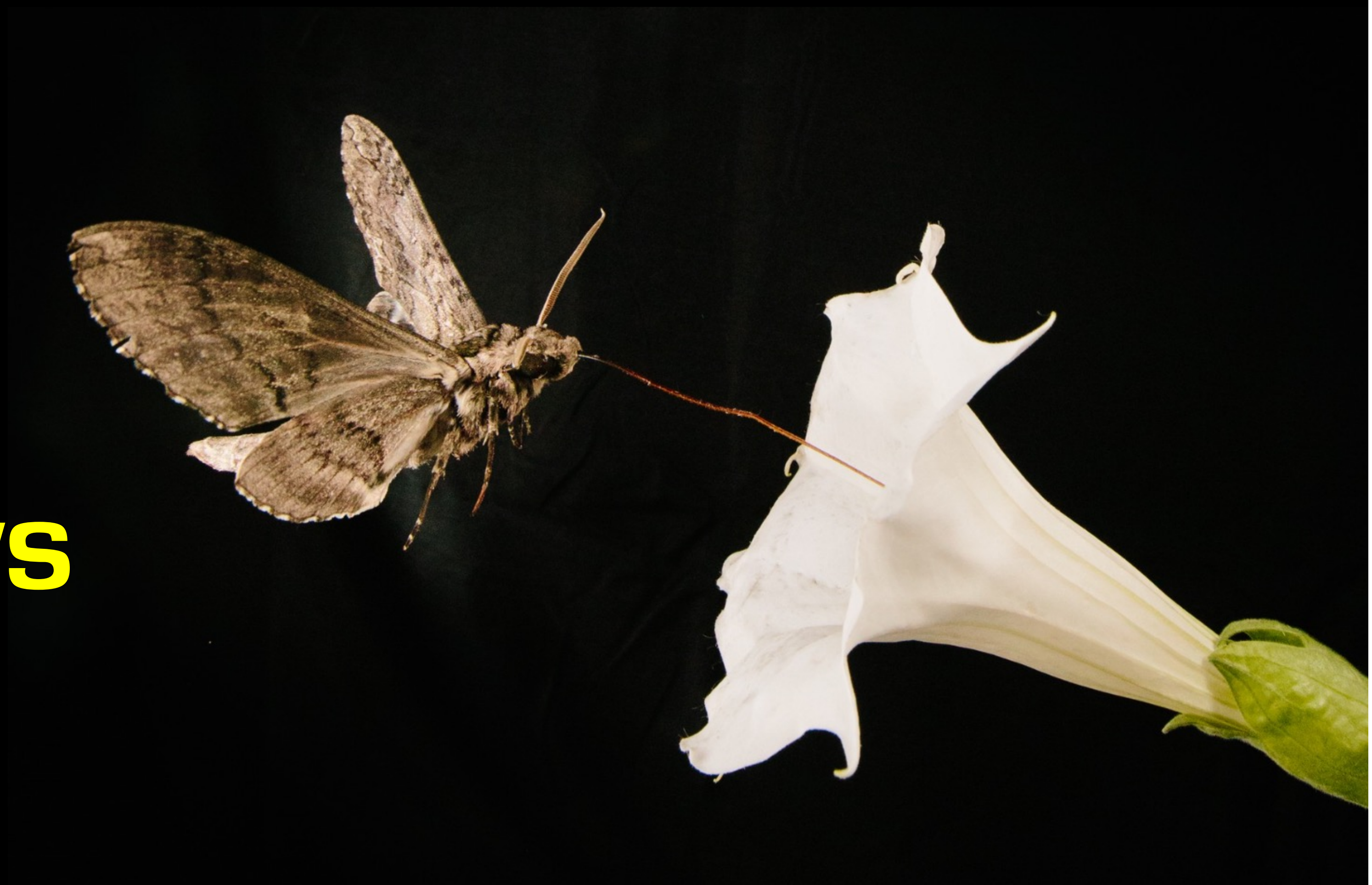
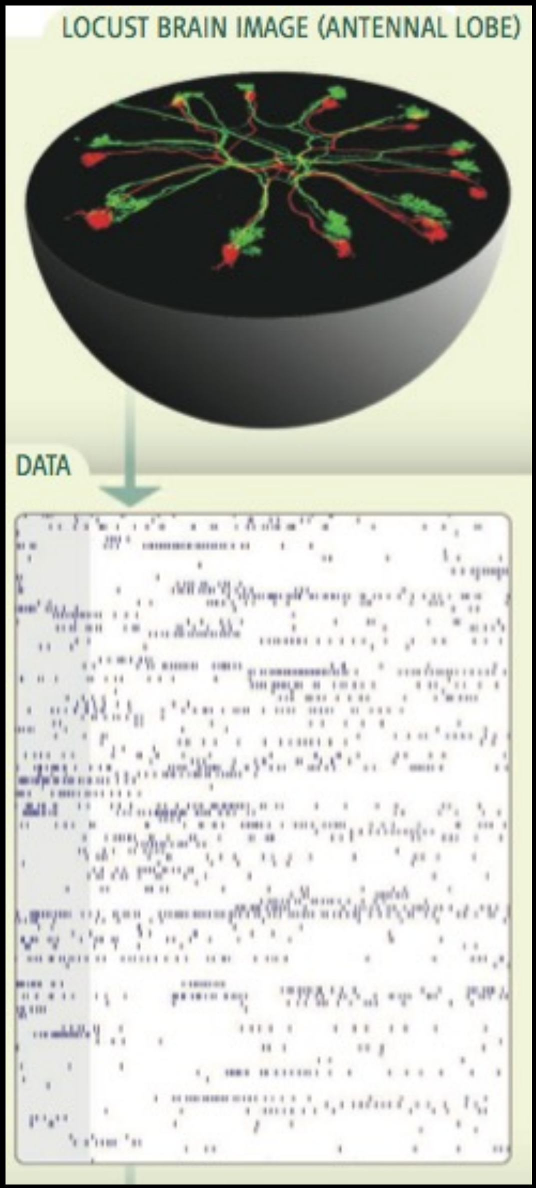
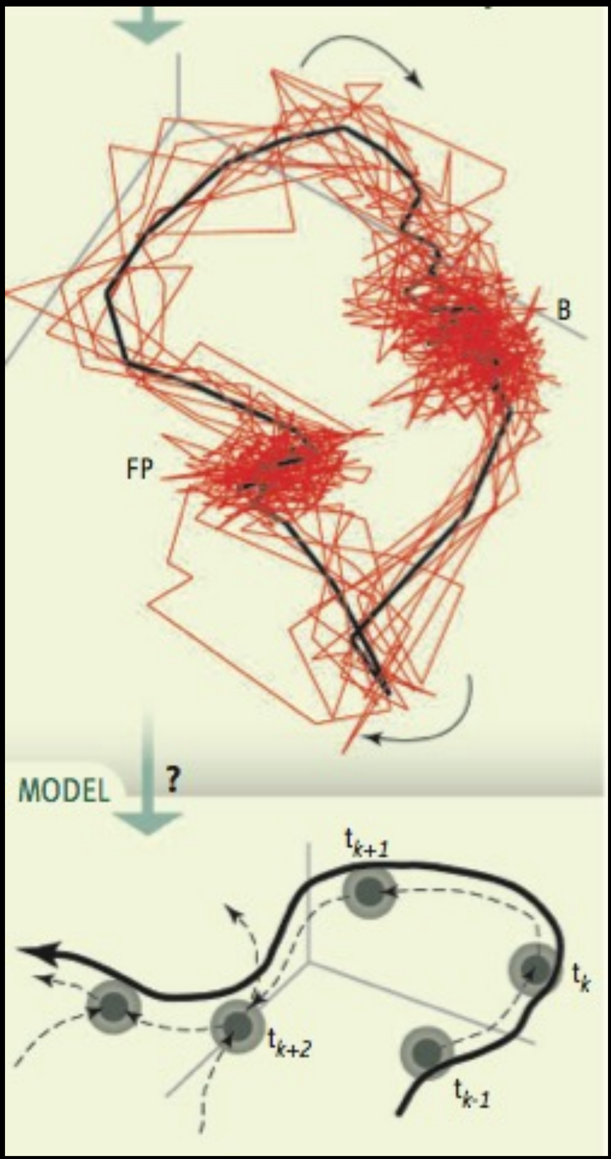


VS

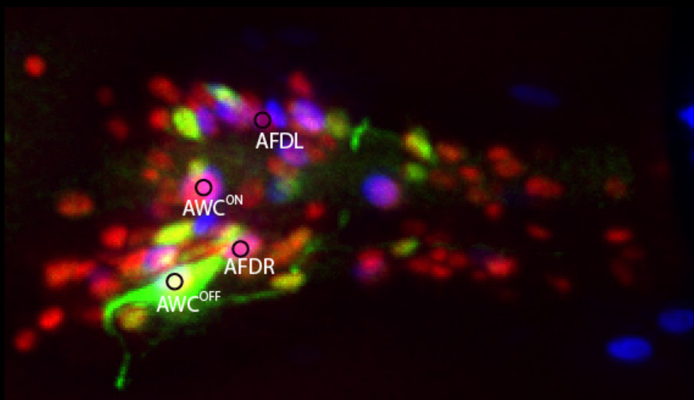


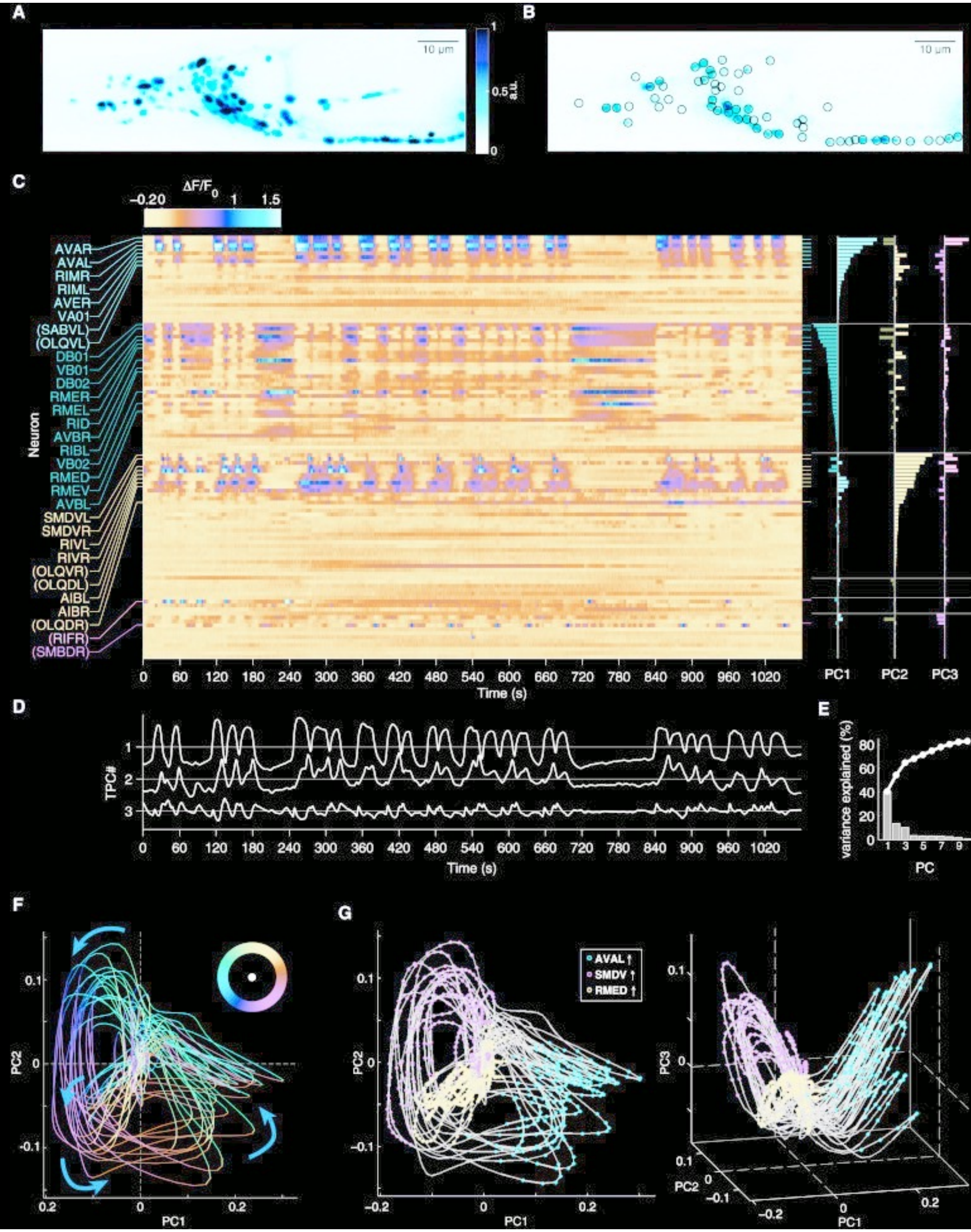
Encoding Dynamics





Laurent & co-workers 2008





Manuel Zimmer
et al 2012-present

Manduca
Low-Dimensional Subspaces

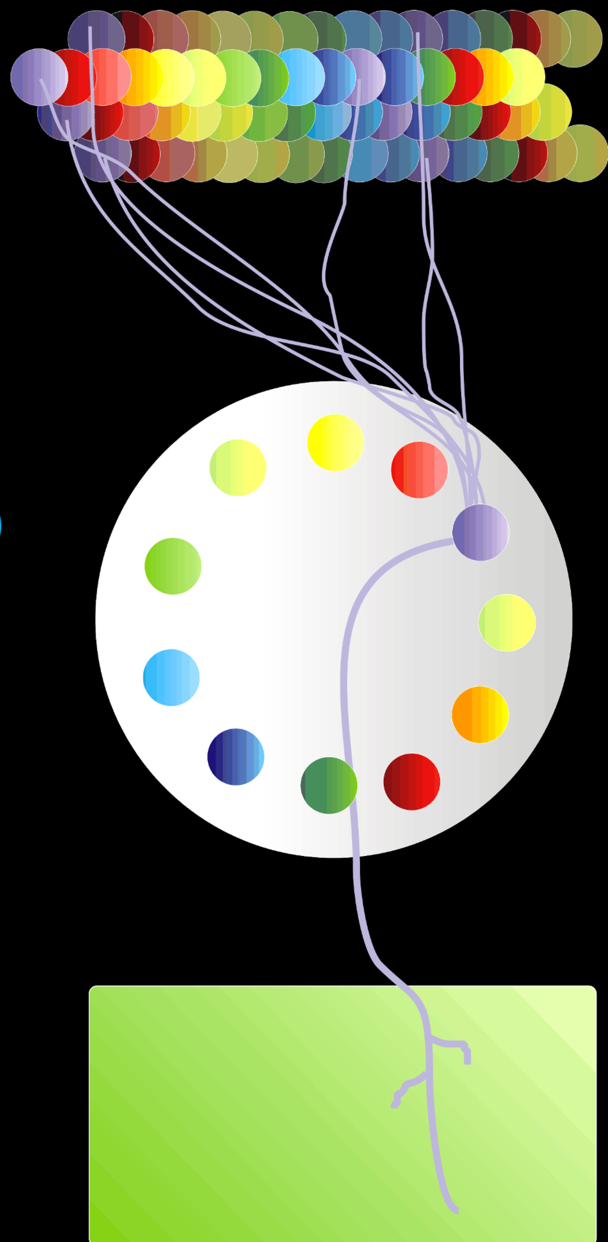
Olfactory receptor cells

10^6 neurons

Antennal lobe (AL)

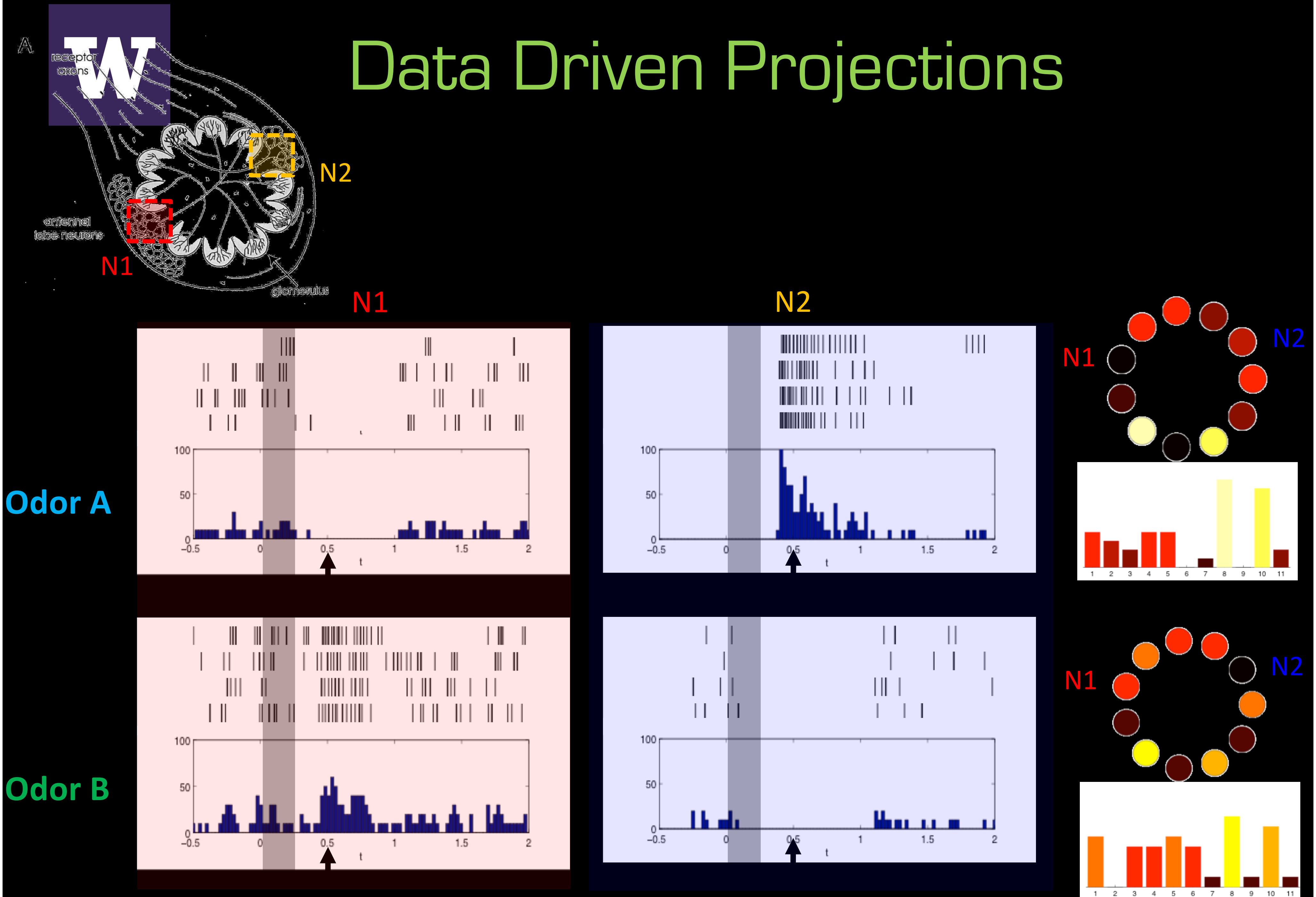
10^3 neurons

Mushroom body

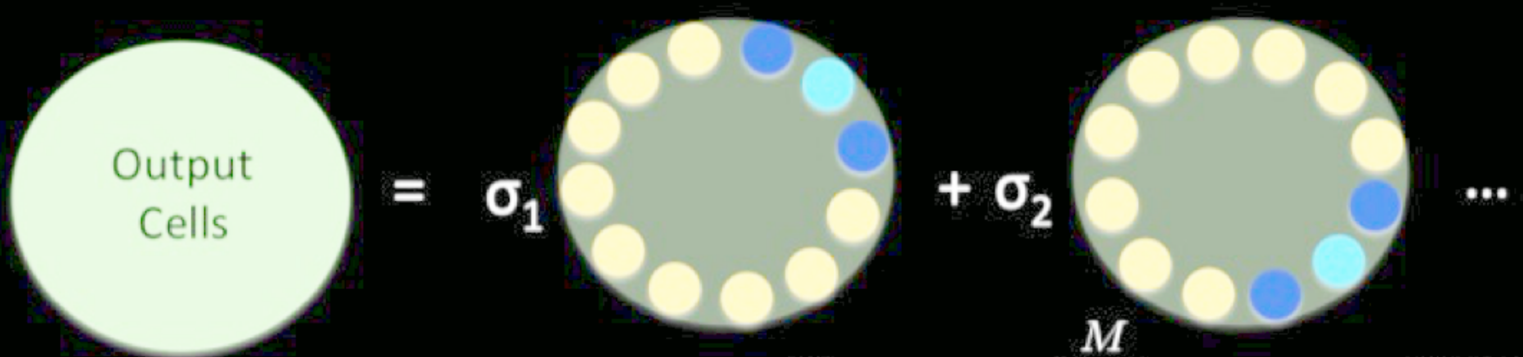


Eli Shlizerman + Jeff Riffell, UW Biology

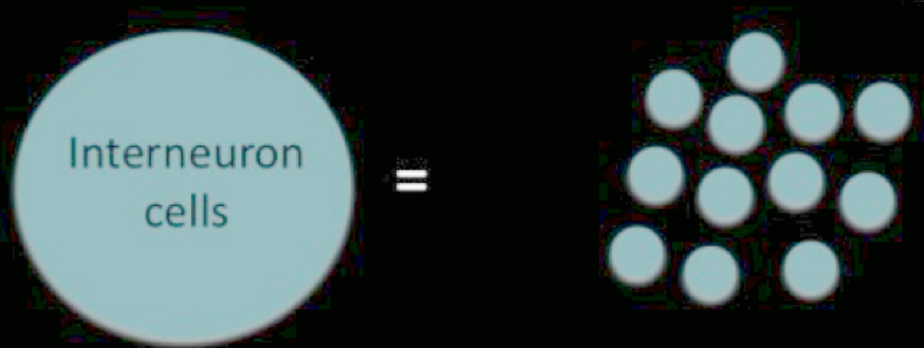
Data Driven Projections



Spatio-Temporal Coding Modes



$$\vec{V}^{out}(t) = \sum_{m=1}^{M} \sigma_m a_m(t) \vec{V}^{PC}$$



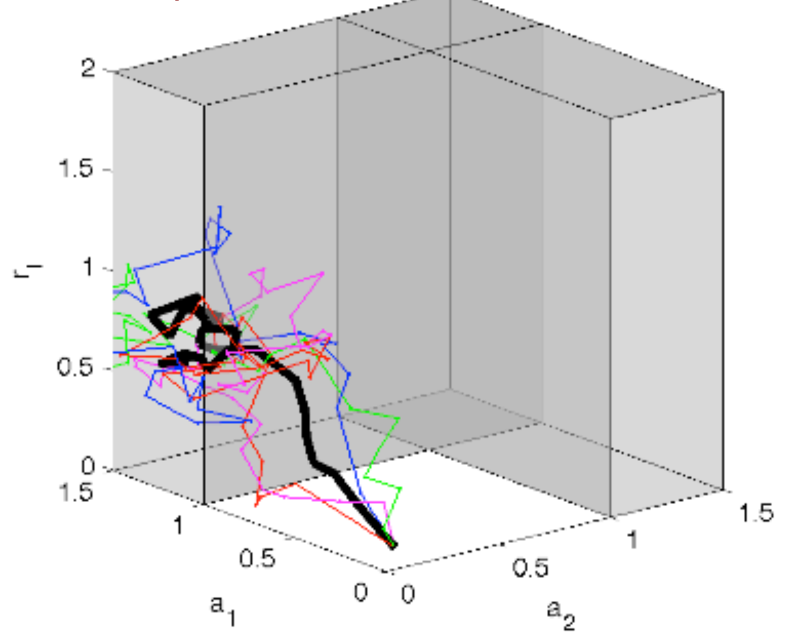
$$\frac{d}{dt} a_1(t) = -a_1(t) + < \phi\Big(-r^I(t), \vec{I}^P_{sen}(t) \Big), \vec{r}_1^{\,PC} >$$

$$\frac{d}{dt} r^I(t) = -r^I(t) + \psi\Big(a_1(t), \vec{r}_1^{\,PC}, I^L_{sen}(t), I^G_{sen}(t) \Big)$$

Model of olfaction: ***Spatio-temporal competing modes***

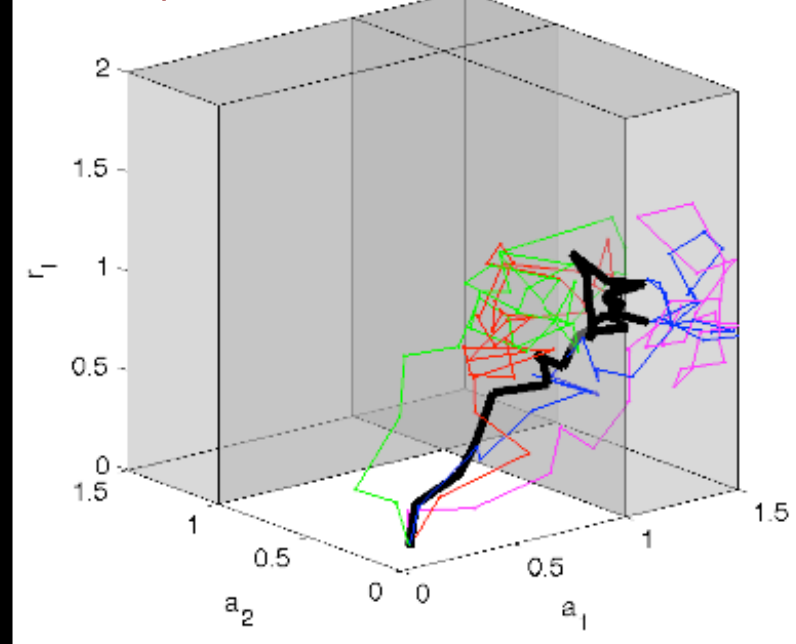
Encoding Competition Dynamics

Theory

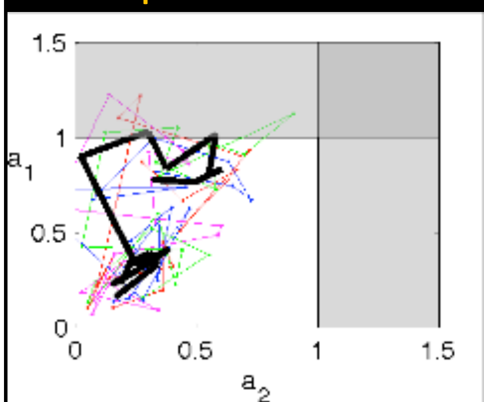


3x3 dynamical system

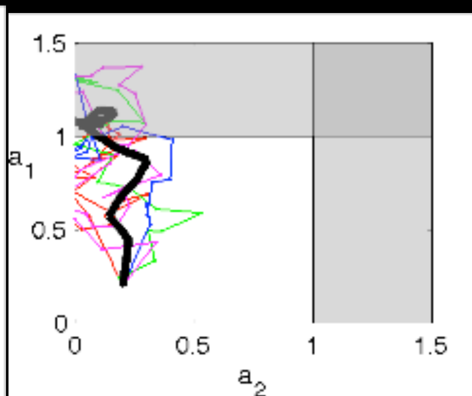
Theory



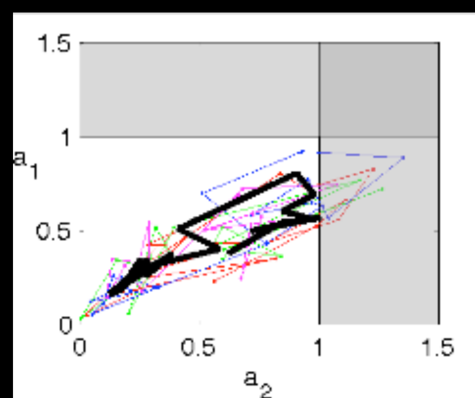
Experiment



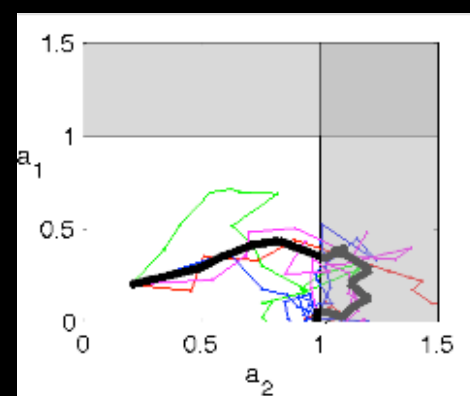
Theory



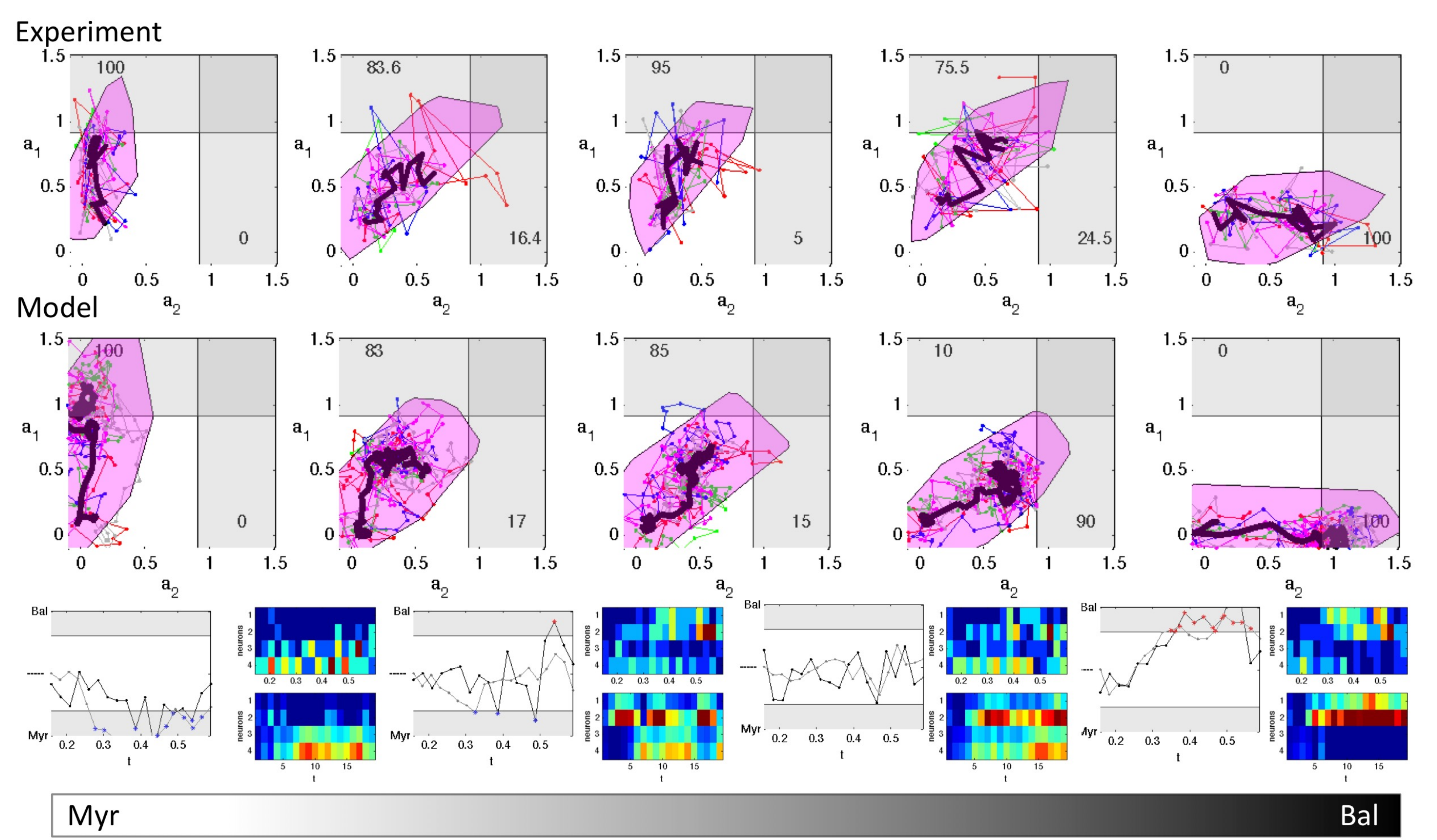
Experiment



Theory



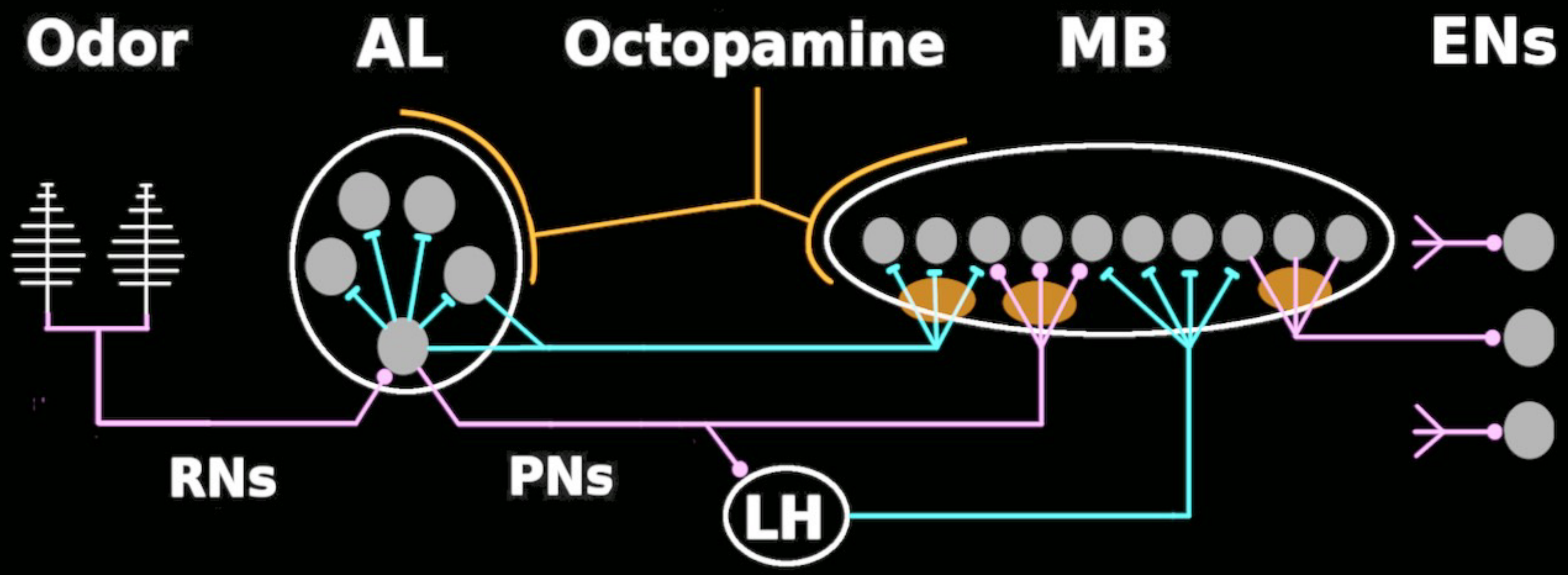
Inhibition Mediates



Manduca

Randomness and sparsity

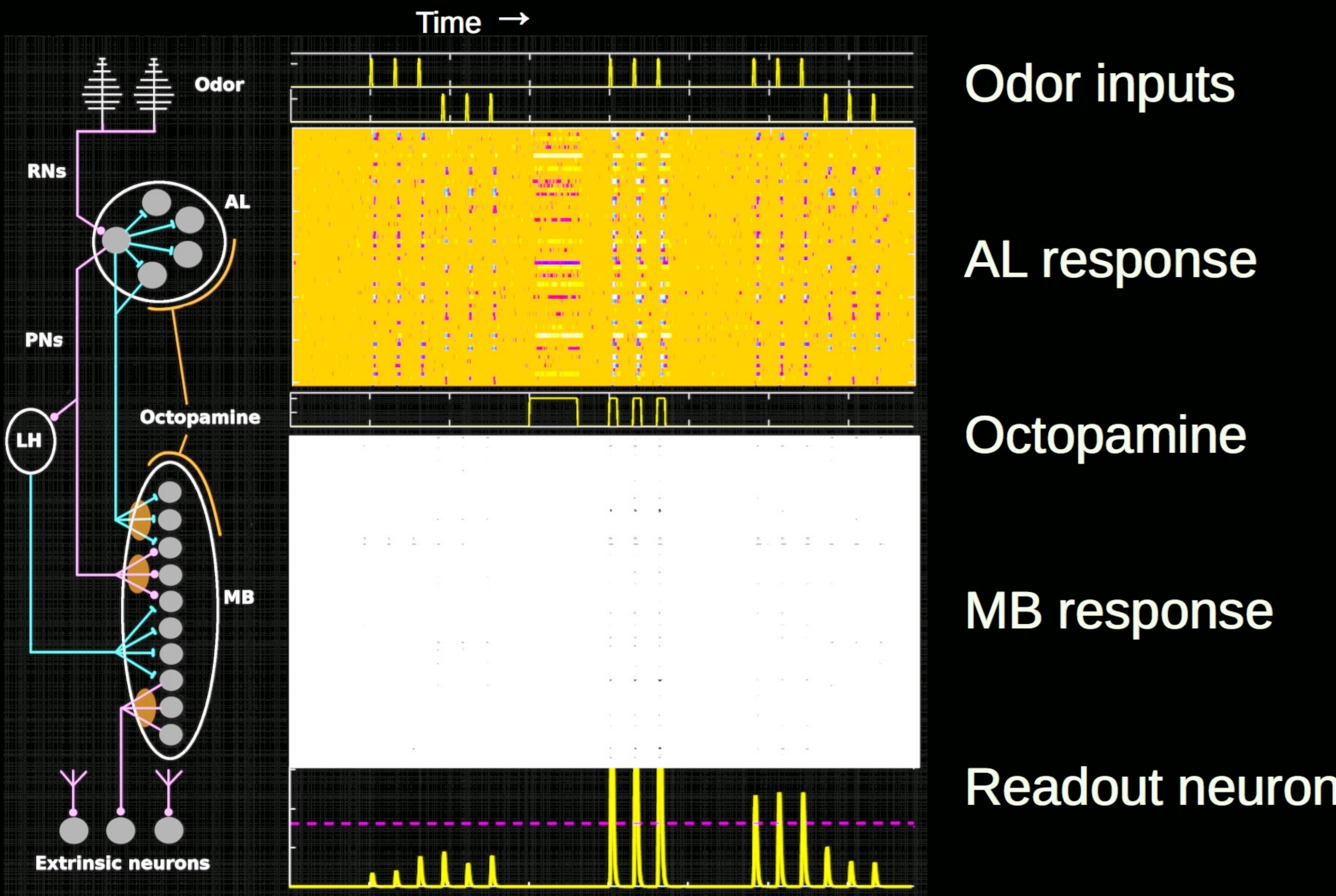
Moth Olfactory System



Riffell et al. Science 2013
Campbell et al. J Neuro 2013
Olson et al. Neuron 2010
Turner et al. J NeuroPhysiol 2008 Hong, Wilson. Neuron 2015

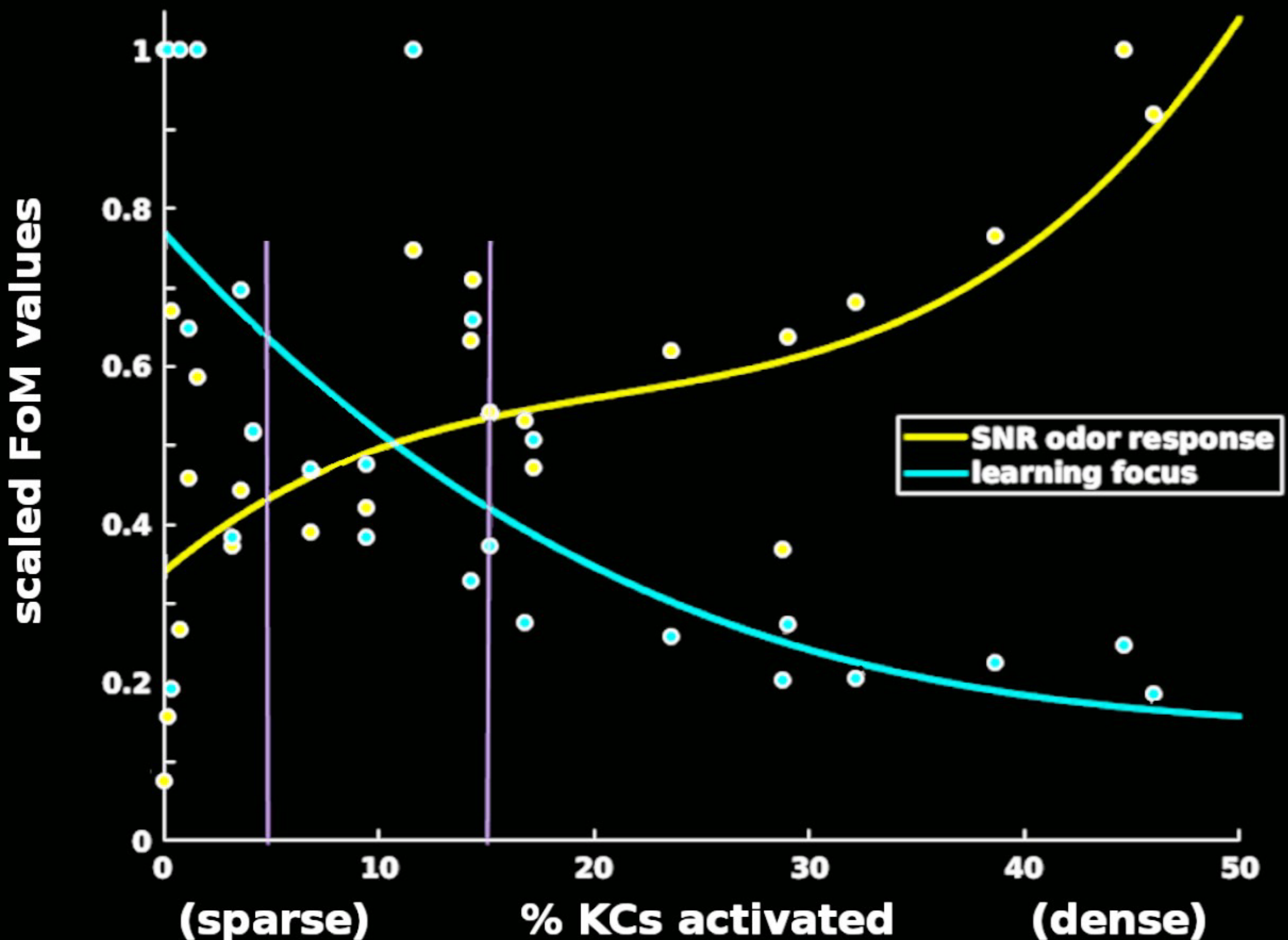
Gupta, Stopfer. J NeuroSci 2012
Silbering et al. J NeuroSci 2003
Galizia. Eur J NeuroSci 2014
Caron et al. Nature 2013

Learning New Odors



Delahunt, Riffell & Kutz (2019)

Sparsity for Learning



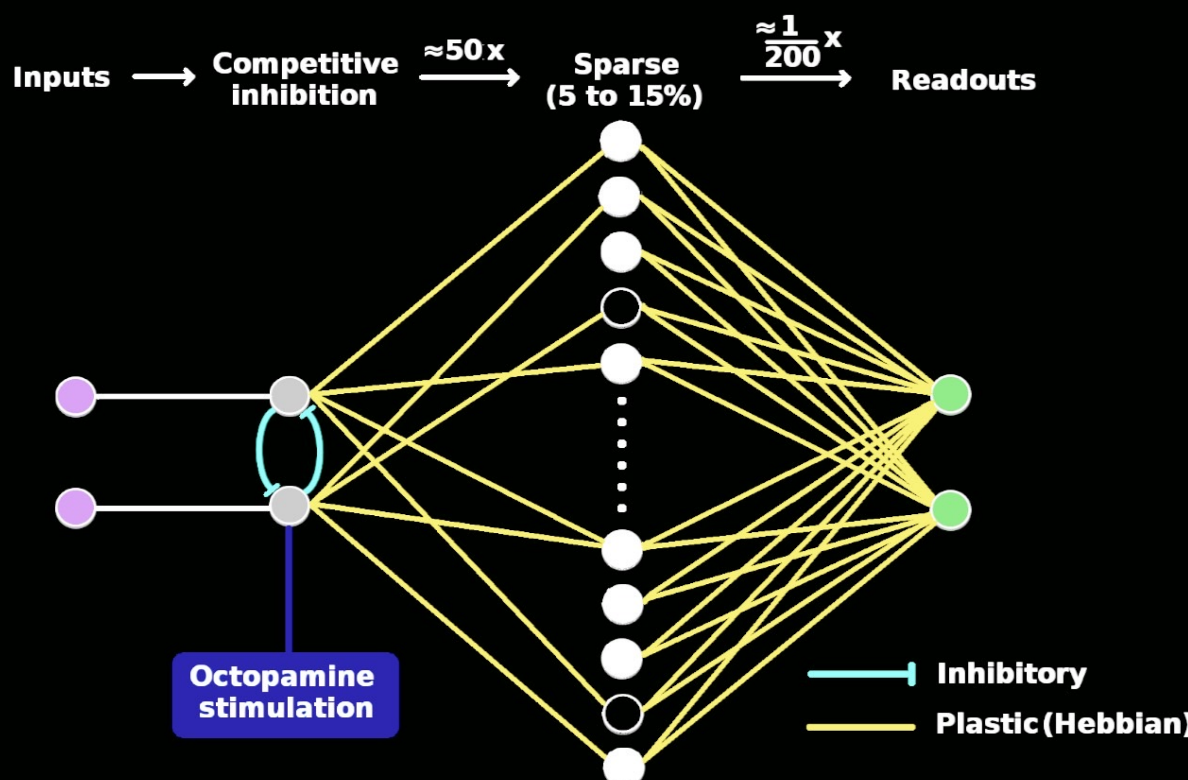
Signal to Noise = μ/σ of odor response.
high → reliable response.

High → good.

Learning focus = ΔTrained / ΔControl.
high → focused learning.

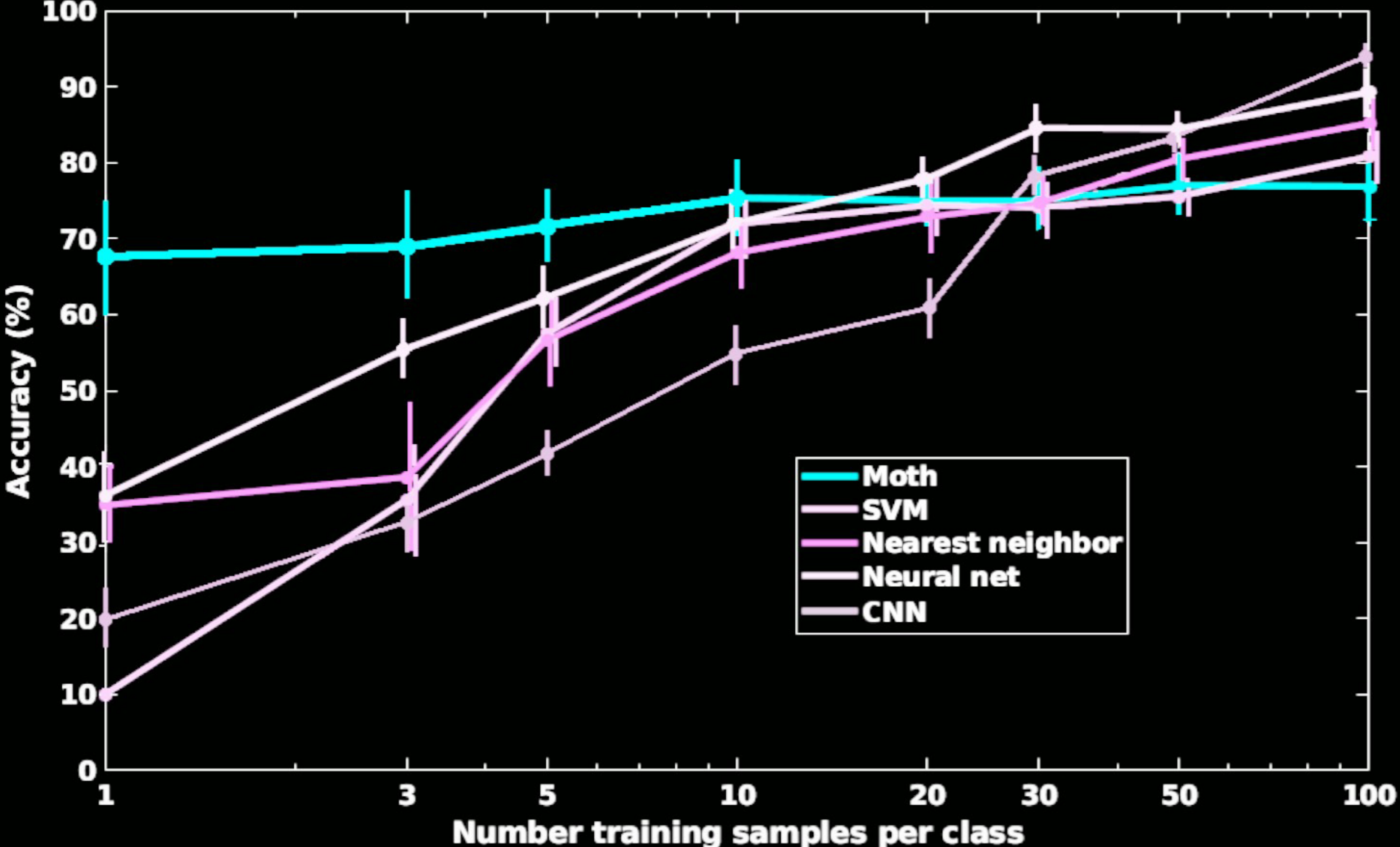
(Huerta, Nowotny; Peng, Chittka)

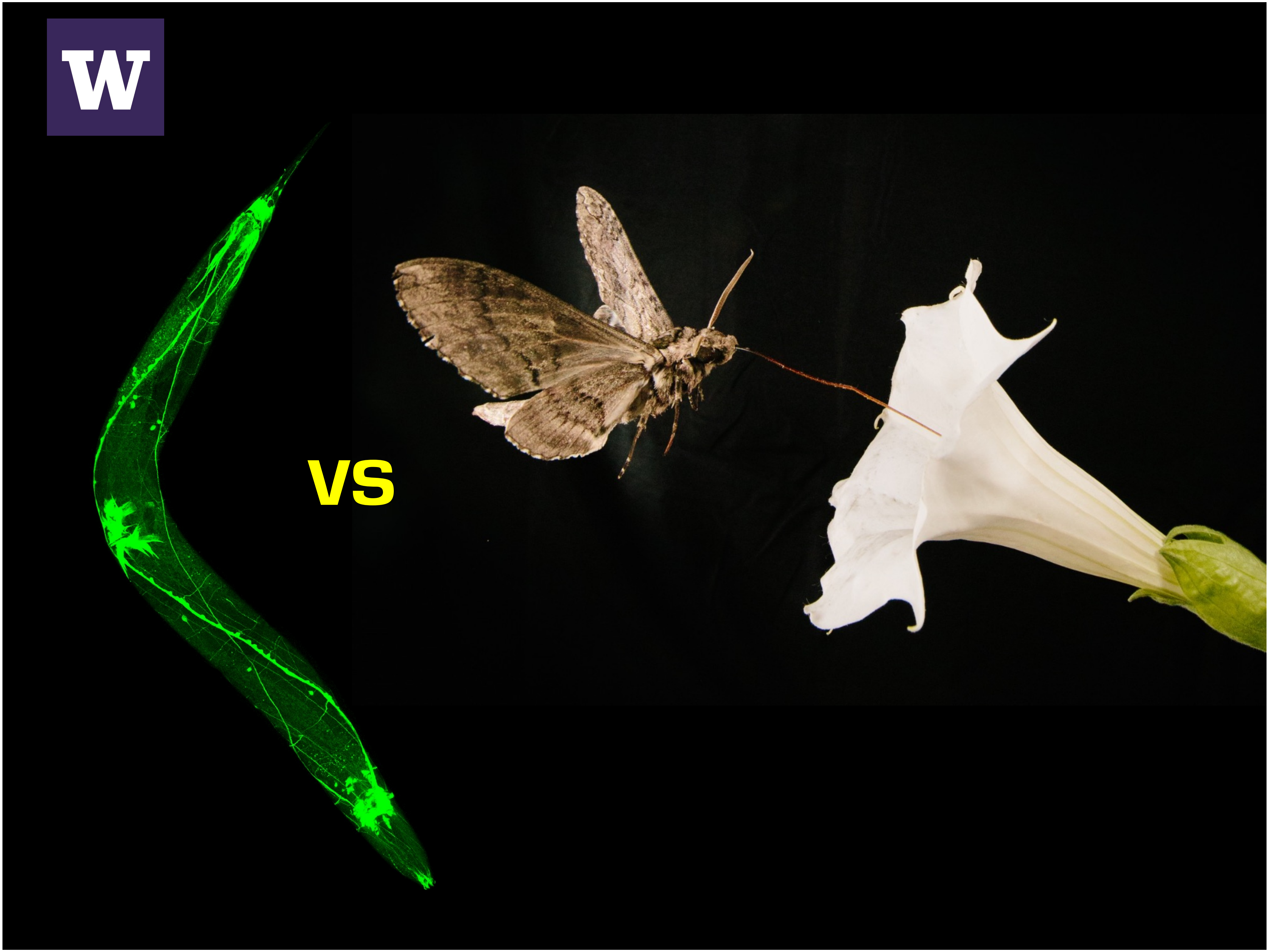
Rapid Learning in NNs



Delahunt & Kutz (2019)

Comparisons

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