Questions to guide your reading – Week 3

Paper 1. Braun, Hurtak et al. “Descending networks transform command signals into population motor control.” *Nature.* 2024

Q1: What is the paradox between the number of descending neurons (~1300) and the number of behaviors that they control? hint: it arises due to observations from neural activation versus neural recording experiments in behaving flies.

Q2: How did the authors try to resolve this paradox (which experimental approach)? And what did they discover using this approach? What were the implications?

Q3: What is the “brain connectome” and how did the authors use it to further investigate the implications from Q2? What did they observe

Q4: What is the difference between how DNs work together drive different behaviors (forward walking, antennal grooming, backwards walking)? How did the authors observe this difference (i.e., using which experimental approach)?

Q5: What continuum did the authors hypothesize in the types of DN networks used to control different kinds of behaviors?

Q6: What did the authors do to test this hypothesis (Q5)?

Q7: When the authors looked the entire DN network in the brain, what did they find in terms of the interaction between DN networks that control one behavior versus other DN networks that control other behaviors? What do they propose is the purpose of this architecture?

Paper 2. Kadakia et al. “Odour motion sensing enhances navigation of complex plumes.” *Nature*. 2022

Q1: How do odor “direction sensing” and “gradient sensing” differ from one another in the context of odor taxis?

Q2: What kind of stimulation system and approach allowed the authors to distinguish between the contribution of odor direction versus wind direction during odor taxis?

Q3: What is the “classical Hassenstein–Reichardt correlator (HRC)” model for visual motion processing and how does it work?

Q4: What three manipulations did the authors perform the HRC odor direction detection model to confirm that the temporal precision of Odor Receptor Neurons (ORNs) is sufficiently robust to encode odor direction?

Q5: How did the authors manipulate the presentation of natural plumes to confirm that odor motion might be used by flies to find odor sources in natural environments?

Q6: Based on the results of this paper, how might you improve robotic odor taxis algorithms for complex plume navigation?