Adaptation in a blowfly motion sensitive neuron

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Abstract
Our environment presents us with a mix of predictability and uncertainty. We never know even the near future in every detail, yet we are usually quite confident that we can extrapolate to some extent, thanks to the statistical regularities of our world. Sensory systems measure changes in our environment, and could conceivably exploit these regularities to maximize information transmission, and optimize neural computation. I will discuss examples of adaptive processing in the blowfly visual system where this indeed seems to be the case.
In the blowfly we can record from a large neuron (H1) that encodes wide field motion. The message carried by H1 is computed from signals measured by an array of photoreceptors. This mapping, from raw visual input to neural output, is highly adaptive. In one set of experiments we find that the system tunes its dynamics to pattern speed in a way that suggests adaptively optimal separation of signal and noise. In another type of experiment we find that the relation between motion input and neural output scales to the standard deviation of a random velocity trace, maximizing information transmission. To adapt to the standard deviation, its value must first be estimated, and this measurement requires a certain minimal observation time. The timescale of adaptation is about as long as this limiting time interval.
These results suggest a picture of the brain as a flexible processor, actively tracking important parameters in the environment, and optimizing computational performance, even at the relatively low level of motion computation in a purportedly simple animal.

Joint work with William Bialek, Naama Brenner, Adrienne Fairhall, and Geoffrey Lewen

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