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Exploring neural code in natural environments[1]

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Neurons communicate by means of stereotyped pulses, called action potentials or spikes, and a central issue in systems neuroscience is to understand this neural coding. We study how sensory information is encoded in sequences of spikes, using motion detection in the blowfly as a model system. To emphasize the importance of the environment, and specifically the statistics of its dynamics, on shaping the animal's response, we perform experiments in an environment maximally similar to the natural one. This results in a number of unexpected, striking observations about the structure of the neural code in this system, typically unseen in simpler, more traditional experimental setups. First, the timing of spikes is important with a precision roughly two orders of magnitude greater than the temporal dynamics of the stimulus, which is behaviorally controlled in the natural settings. Second, the fly goes a long way to utilize the redundancy in the stimulus in order to optimize the neural code and encode efficiently more refined features than would be possible otherwise, providing sufficient information about the stimulus in time for behavioral decision making. This implies that the neural code, even in low-level vision, may be significantly context (that is, environment and behavior) dependent. The presentation is based on: I Nemenman, GD Lewen, W Bialek, RR de Ruyter van Steveninck. Neural Coding of Natural Stimuli: Information at Sub-Millisecond Resolution. *PLoS Comput Biol* **4** (3): e1000025, 2008.

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