Statistical Reliability of a Blowfly Movement-Sensitive Neuron

Rob de Ruyter van Steveninck *
Biophysics Group,
Rijksuniversiteit Groningen,
Groningen, The Netherlands

William Bialek
NEC Research Institute
4 Independence Way,
Princeton, NJ 08540

Abstract

We develop a model-independent method for characterizing the reliability of neural responses to brief stimuli. This approach allows us to measure the discriminability of similar stimuli, based on the real-time response of a single neuron. Neurophysiological data were obtained from a movement-sensitive neuron (H1) in the visual system of the blowfly *Calliphora erythrocephala.* Furthermore, recordings were made from blowfly photoreceptor cells to quantify the signal to noise ratios in the peripheral visual system. As photoreceptors form the input to the visual system, the reliability of their signals ultimately determines the reliability of any visual discrimination task. For the case of movement detection, this limit can be computed, and compared to the H1 neuron's reliability. Under favorable conditions, the performance of the H1 neuron closely approaches the theoretical limit, which means that under these conditions the nervous system adds little noise in the process of computing movement from the correlations of signals in the photoreceptor array.

1 INTRODUCTION

In the 1940s and 50s, several investigators realized that understanding the reliability of computation in the nervous system posed significant theoretical challenges. Attempts to perform reliable computations with the available electronic computers

*present address: University Hospital Groningen, Dept. of Audiology, POB 30.001, NL 9700RB Groningen, The Netherlands