Keywords: Neural coding, Feedback, Quantization, Cricket Cercal System

Introduction

In previous work we have demonstrated that it is possible to quantize joint sets of neural stimulus-response data into a small number of informative classes (Dimitrov, *et al*, 2003). Here we extend that work by demonstrating that we can drive the responses of the cell by presenting the stimulus features extracted through quantization.

Methods

Identified, wind-sensitive interneurons in the terminal abdominal ganglia of the Cricket *Achaeta domesticus* were stimulated with 5-10 minutes of 5-150 Hz Gaussian white noise air currents. After stimulation was over, the recorded spike train was probed for instances of two distinct 'response classes': short (~2-4 ms) doublets, and well-isolated single spikes (no other spikes in the preceding or succeeding 10 ms). The decision to consider these as distinct patterns was based on the observation that in quantization analysis (Dimitrov, *et al*, 2003) these two types of responses fall into different classes consistently across different animals and across all levels of quantization.
After all instance of these two response patterns were found in the data, the corresponding stimulus waveforms were extracted and averaged to produce two distinct templates of 'stimulus classes'. The resulting waveforms were then injected back into the original stimulus as it was played a second time to the cricket.
To evaluate our success in driving the neuron, we compared the relative frequencies of the response patterns conditioned on their having been an insert presented. For control we also measured the relative frequency of occurrence of these patterns in the same time periods in the original recording (i.e. elicited by the same stimulus, but without the inserts).

Results

An typical result is shown in Figure 1. Three hundred samples of the doublet-conditioned mean stimulus were inserted into the feedback file, which was then presented to the same neuron as the original stimulus. The responses elicited by these inserts were then collected, along with the responses 'naturally' occurring in the original recording at the same points in time relative to stimulus onset. Responses were categorized into four classes- singlets, short doublets, long doublets, and no spikes. We found that the number of singlets elicited increased from 61 in the original recording to 89 in the feedback recording (46% increase), short doublets increased in frequency from 2 to 39 (1850% increase), long doublets increased from 3 to 60 (1900% increase), and the number of 'no spike responses' decreased from 234 to 112 (52% decrease).

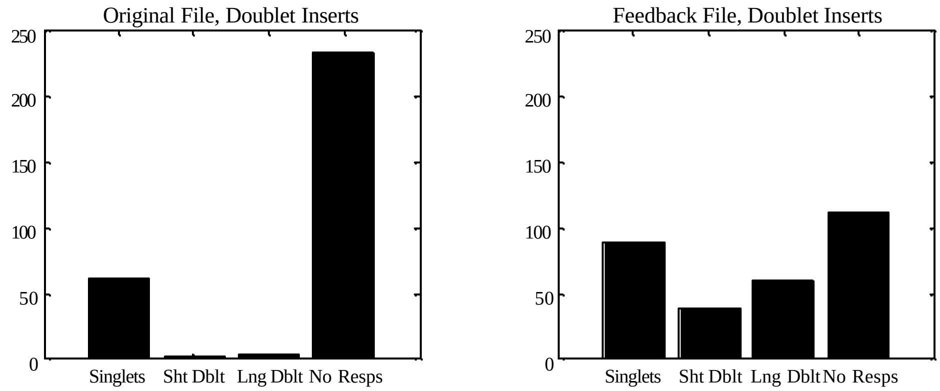

Fig. 1. Histograms of 300 response events from the original (A) and feedback (B) recordings. The events correspond with the instances were short doublet-conditioned stimuli were added into the feedback stimulus. The responses are divided into four classes: ‘singlets’, single spikes elicited with no preceding or succeeding spikes within 10 ms; ‘short doublets’, corresponding to 2-4 ms ISIs with no other spikes in the preceding 10 ms; ‘long doublets and triplets’, representing all other spiking responses with no other activity in the preceding 10 ms; and finally ‘no spiking responses’.

Conclusion

The ability to drive the cell towards a desired type of response (in this case short doublets) tests our understanding of the functioning of this sensory system. It also allows us to quickly and efficiently explore the stimulus parameter space corresponding to that response.

References:

Dimitrov AG, Miller JP, Gedeon T, Aldworth Z, Parker AE. Analysis of Neural Coding through Quantization with an Information-Based Distortion Measure. *Network: Comput. Neural Syst.* **14** (2003) 151-176

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