Burst spiking as a neural code in insect auditory receptors

Hugo G. Eyherabide\textsuperscript{1,2}, Ariel Rokem\textsuperscript{1}, Andreas V. M. Herz\textsuperscript{1}, and Inés Samengo\textsuperscript{2}

\textsuperscript{1} Institute for Theoretical Biology, Department of Biology, Humboldt University, and Bernstein Centre for Computational Neuroscience, 10115 Berlin, Germany, \textsuperscript{2} Centro Atómico Bariloche and Instituto Balseiro, 8400 San Carlos de Bariloche, Argentina

Based on the characteristics of the ionic channels that compose the cellular membrane, some neurons have a tendency to alternate high frequency periods with silent intervals. This is called burst firing. In order to characterize the type and amount of auditory information transmitted through burst firing in insects, the activity of grasshopper acoustic receptor neurons was recorded, for several stimulating sound waves. The analysis of these data reveals that the probability of generating bursts is strongly influenced by the statistical properties of the acoustic stimulus. Hence, the tendency to burst is not only determined by intrinsic neuronal properties, but also by the way in which those properties interact with the temporal structures in the stimulus.

These findings imply that there is a selective correspondence between specific stimulus features and particular response patterns. We characterized this correspondence, showing that bursts containing a specific number of spikes are usually found shortly after stimulus segments that share common features. Reciprocally, bursts containing different number of spikes are associated with stimuli that are qualitatively different from each other. Hence, the number of spikes in a burst conveys information about specific characteristics of the stimulus. In addition, the time at which a burst is initiated allows one to locate the relevant stimulus in time. In order to provide a quantitative measure of the relevance of burst firing in information transmission, we developed a new method to quantify the mutual information rate between stimuli and responses. We find that bursting grasshopper receptors encode 47\% of the total information they transmit in burst-like patterns.

Acknowledgments

This work was supported by the Alexander von Humboldt foundation, the Consejo de Investigaciones Científicas y Técnicas, the Deutsche Forschungsgemeinschaft (SFB 618) and the Secretaría de Ciencia y Tecnología.

References


