Jan Benda

Eberhard Karls University Tübingen
Germany

No synchrony code without noise

On a first glance intrinsically generated neural noise seems to deteriorate neural information processing, since it makes responses of single neurons less reliable. However, in populations of neurons noise can have a beneficial role for representing and processing sensory stimuli. We study the role of noise in shaping synchrony codes both theoretically and experimentally in the electrosensory systems of weakly electric fish. Our theoretical work shows under which conditions synchronous spikes in a population of neurons emphasize more high-frequency components of a common stimulus in contrast to the more broad-band characteristics of all spikes. In particular, some intermediate level of intrinsic noise is needed in order to make the distinction between synchronous and asynchronous spike events possible. Too much noise desynchronizes the population entirely and too little noise synchronizes all spikes. Thus, intrinsic noise is needed for synchronous spikes to emphasize high-frequency components of the stimulus. Our recordings of electroreceptor afferents confirm this finding. In the active electrosensory system, where the afferents show a high level of spike timing variability, synchronous spikes carry high-frequency information whereas all spikes are tuned to more low-frequency components. On the contrary, in the passive electrosensory system receptor afferents show only little variability and synchronous spikes carry the same information as all spikes. This example demonstrates a fundamental beneficial role of noise in populations of spiking neurons.

Jan Benda, Jan Grewe, Nahal Sharafi, Benjamin Lindner