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DYNAMIC THRESHOLD CURVES AND RESPONSE PRECISION IN FORCED EXCITABLE SYSTEMS

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ABSTRACT

Phase-locking of ongoing oscillations to a periodic signal is a well-studied phenomenon that can be explored with a variety of analytical approaches. Much less is known about what factors determine the response precision of excitable units that are intrinsically at rest but are activated by periodic forcing and noise. One motivation for considering this issue comes from the behavior of auditory neurons, which fire spikes in a precise range of phases relative to incoming sound waves, a behavior for which the mechanism is unknown. We shed light on this coding precision by introducing a new tool, the dynamic threshold curve (DTC), designed to study the responses of an excitable system to a subthreshold signal. The DTC provides an effective instantaneous threshold that takes into account how the intrinsic dynamics and the input combine with noise or perturbations to generate a response. The DTC effectively summarizes, in a single curve, the information of response precision of the excitable model, as we exhibit showing that the distribution of spike times of the excitable system is well captured by the first passage time of a simple, Gaussian stochastic process to the distance to the DTC. This shows that peaks and troughs of the DTC, but also their slope, convey fine information about spike timings in response to noise. In particular, it captures properties of type 2 and type 3 excitable cells studied previously, and provide a framework to predict the DTC properties necessary to support auditory neurons' response precision, which we show to arise in a well-established auditory neuron model.

This is a joint work with J. Rubin (University of Pittsburgh) and J. Touboul (Brandeis University).

REFERENCES

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