Stimulus-dependent tuning of neuronal subthreshold oscillations

Martin Tobias Huber[1] and Hans Albert Braun[2]

[1]*Department of Psychiatry and Psychotherapy, University of Marburg, Rudolf-Bultmannstraße 8, D-35033 Marburg, Germany and* [2]*Institute of Normal and Pathological Physiology, University of Marburg, Deutschhausstraße 1, D-35033 Marburg, Germany;*
email: huberm@staff.uni-marburg.de; braun@staff.uni-marburg.de

We investigate the stimulus-dependent tuning properties of a noisy ionic conductance model for intrinsic subthreshold oscillations in membrane potential and associated spike generation. On depolarization by an applied current, the model exhibits subthreshold oscillatory activity with occasional spike generation when oscillations reach the spike threshold.. We consider how the amount of applied current, the noise intensity, variation of maximum conductance values and scaling to different temperature ranges alter the responses of the model with respect to voltage traces, interspike intervals and their statistics and the mean spike frequency curves. One example is shown in the figure below. The simulations demonstrate that temperature scaling of the ionic components has a *monotonic* effect on the oscillation frequency (increases with increasing T; figure a and b) but a *nonmonotonic* effect on the mean spike frequency (maximum curve with respect to T). Altogether, we demonstrate that subthreshold oscillatory neurons in the presence of noise can be sensitively and also selectively tuned by stimulus-dependent variation of model parameters.

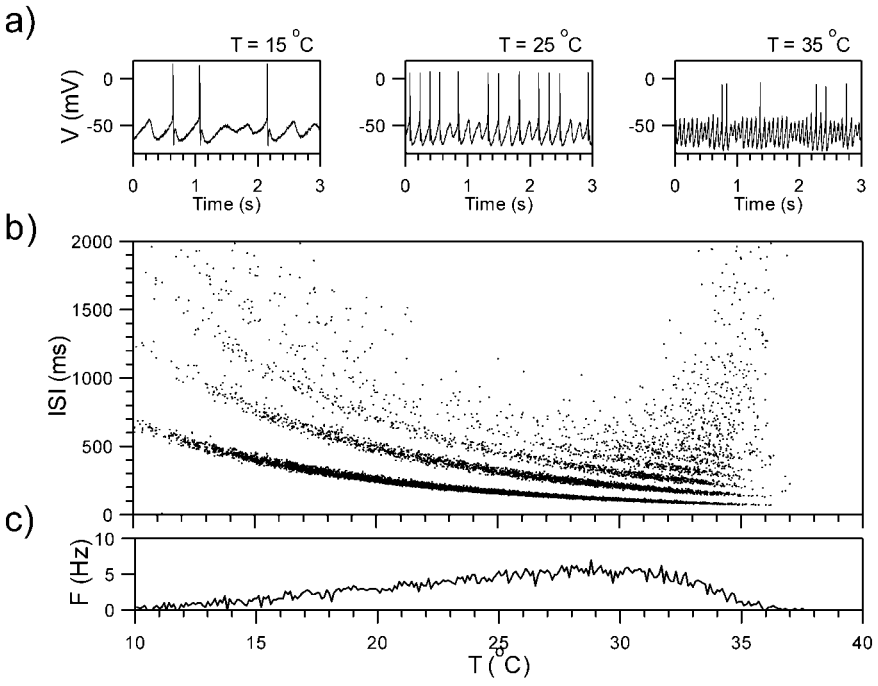

Figure: Effect of temperature. a) voltage traces for T = 15, 25, 35 °C, b) time plot of successive interspike intervals (ISIs) and c) mean spike frequency (F) on response to a ramp-shaped change of T (time = 1000 s, increment $\Delta T = 0.03$ °C/ms, noise intensity D = 0.1).

Acknowledgment: We acknowledge financial support by the EU Network of Excellence NoE 005137 BioSim (RA5WP10).