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Cellular mechanisms of temperature compensation in receptor neurons

Processing of information in nervous systems is based upon temperature-dependent electro-chemical processes. If a system's temperature varies with ambient temperature, like in insects, a robustness of neural activity to temperature fluctuations cannot be taken for granted. Temperature compensation in the dynamics of single neurons, however, is currently not well understood. We study an insect receptor neuron, whose neural activity depends surprisingly little on temperature. Computational modeling allows us to identify generic, cell-intrinsic mechanisms of temperature compensation at the level of ion channels that enable neurons to retain their functionality across a wider range of temperatures without increasing the cost of signalling. We show that specific ion channel temperature dependencies favour robustness of firing rate to temperature variations. Moreover, also neuronal noise at the level of spike timing jitter is affected by temperature. Interestingly, noise in spike timing decreases with temperature, which, as we show, can be explained by basic biophysical properties of the neuronal membrane.The identified, general design principles can be expected to bear relevance for higher vertebrates under pathological conditions like fever.