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# Understanding the energy cost of integrating information in a simple sensory neuron

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Molecular components of cells must communicate with each other through physical mechanisms that necessarily consume energy [1]; for example, ion channels communicate electrically, by modulating ionic currents which are sensed as resulting charge accumulation at the membrane by distant voltage gated channels. I will first argue in general that powering such communication must incur large costs to overcome thermal fluctuations, likely dominating the information processing energy budget of cells. I will then report on progress towards understanding the energetic requirements of running a specific sensory system –neurons in the pit organ of certain snakes which sense tiny changes in temperature. In this system, individual thermally sensitive ion channels are molecular thermometers, whose opening is triggered by a roughly 1K change in temperature. However, individual neurons can respond reliably to mK temperature changes, 1000 fold smaller. I will briefly explain our model for how this signal amplification and information integration works mechanistically [2], requiring individual channels to communicate with each other electrically. While some of the details of this system are specific to the task of high-precision thermometry, others are likely general, and we seek design principles for the scale of single-channel currents, the sensitivity of voltage-gated channels, and the density of typical voltage-gated channels in neurons.

[1] SJ Bryant, BB Machta. Physical constraints in intracellular signaling: the cost of sending a bit. PRL, 2023
[2] I Graf, B Machta. A bifurcation integrates information from many noisy ion channels. arXiv:2305.05647, 2023

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