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Extrinsic and intrinsic correlations in molecular information transmission

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Cells learn about their environment by measuring concentrations of external ligands. They do so by capturing ligand molecules with cell surface receptors. On one hand, the variation in the numbers of molecules captured by different receptors depends on the spatio-temporal structure of the extrinsic ligand fluctuations. On the other, this variation is affected by the intrinsic stochasticity of chemical processes because a single molecule randomly captured by a receptor cannot be captured by another. Such structure of receptor correlations is generally believed to lead to an increase in information about the external signal compared to the case of independent receptors. We analyse a model of two single-occupancy receptors and show that, contrary to the established intuition, the correlations have a small and negative effect on the information about the ligand concentration. Further, we show that measurements that average over multiple receptors are almost as informative as those that track the states of every individual one.

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