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Increased dimensionality of cell-cell communication can decrease the precision of gradient sensing[1] TYLER SMITH, Department of Physics, Emory University, ANDRE LEVCHENKO, Department of Biomedical Engineering and Yale Systems Biology Institute, Yale University, ILYA NEMENMAN, Department of Physics, Emory University, ANDREW MUGLER, Department of Physics and Astronomy, Purdue University — Gradient sensing is a biological computation that involves comparison of concentrations measured in at least two different locations. As such, the pre- cision of gradient sensing is limited by the intrinsic stochasticity in the com- munication that brings such distributed information to the same location. We have recently analyzed such limitations experimentally and theoretically in multicellular gradient sensing in mammary epithelial cell organoids. For 1d chains of collectively sensing cells, the communication noise puts a se- vere constraint on how the accuracy of gradient sensing increases with the number of cells in the sensor. A question remains as to whether the effect of the noise can be mitigated by the extra spatial averaging allowed in sensing by 2d and 3d cellular organoids. Here we show using computer simulations that, counterintuitively, such spatial averaging decreases gradient sensitiv- ity (while it increases concentration sensitivity). We explain the findings analytically and propose that a recently introduced Regional Excitation - Global Inhibition model of gradient sensing can overcome this limitation and use 2d or 3d spatial averaging to improve the sensing accuracy.

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