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(G*) (POS-56) Comparing perturbation responses of complex biological processes to their stochastic correlations

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Causal connections between biological molecules in reaction networks are often inferred by examining the correlation in the average levels of to component molecules across a range of drug perturbations to cells. At thermodynamic equilibrium, the fluctuation dissipation theorem relates a stochastic system's perturbation responses and correlations between variables in its spontaneous fluctuations. Since biochemical reaction networks do not operate at thermodynamic equilibrium, divergences from the fluctuation dissipation theorem may contain information about the underlying process. We analyzed how correlations in linearized biomolecular systems behave under random, unspecified perturbations to their kinetic parameters. We find that under certain situations the perturbation responses and spontaneous fluctuations share characteristics and that perturbation response correlations can be used to extract information about the parameter perturbations. We also identify the role of feedback in disrupting this correspondence between the two types of correlations. Our results suggest that combining perturbation response data with spontaneous stochastic fluctuations can be used with modern data collection to offer insights into the mechanisms of mammalian cell signalling and size control.

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