Information Processing in Quorum Sensing Circuits

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Cell-to-cell communication in bacteria – a process known as quorum sensing – relies on the production, detection, and response to the extracellular accumulation of signaling molecules called autoinducers. Often, bacteria use multiple autoinducers to obtain information about the vicinal cell density. However, how cells integrate and interpret the information carried by multiple autoinducers remains a mystery. Using single-cell fluorescence microscopy, we quantified the signaling responses to and analyzed the integration of multiple autoinducers by the model quorum-sensing bacterium *Vibrio harveyi*. We found a coherent response across the population with little cell-to-cell variation, indicating that the entire population of cells can reliably distinguish several distinct conditions of external autoinducer concentration. We developed a framework for analyzing signal integration on the basis of information theory and used it to explain the experimentally observed input–output relation. Our results suggest that the need to limit interference between input signals places strong constraints on the architecture of bacterial signal-integration networks, and that bacteria have evolved active strategies for minimizing this interference. To explore these strategies, we have constructed a variety of mutants lacking specific feedback loops internal to the quorum-sensing circuit. Single-cell microscopy studies of these mutants reveals that cells carefully control the dynamic range of both the inputs and outputs of quorum sensing.