Negative feedback may suppress variation to improve collective foraging performance

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S2 Text. Parameters of the models

In our study, the quality $q_i$ is normalised in the range $q_i \in [0, 1]$. The abandonment rate is set to a constant low value $a = 10^{-3}$. The two models have different recruitment rates $r_i$: the model with negative feedback scales linearly with the option’s quality, i.e. $r_i = \rho q_i$, and the model without negative feedback has a quality-independent rate $r_i = \rho$. The scaling factor $\rho$ that tunes the recruitment strength is set in order to have the same average rate $r$ in both models. Therefore, assuming that the expected quality $E(q)$ is the average of the range $[0, 1]$, thus $E(q) = 0.5$, we have that $\rho$ in the model without negative feedback is half of $\rho$ in the model with negative feedback. In every plot of this paper, we indicate $r$, the average value of the possible rates $r_i$. The self-inhibition strength $z$ is tuned through numerical simulation to the best value in terms of speed and accuracy. In particular, we computed the strength of $z$ which took the system to a sum of squared error $SSE < 10^{-4}$. The squared error is computed as the sum of the squared distance from the target distribution for every population. Figure A shows that the best stop signalling strength increases with the positive social feedback $\rho$. Figure 3 of the main text shows how the stop signalling strength influences the speed and the robustness of the system. As documented in previous work [1, 2], stronger signalling leads to quicker but less robust, or less accurate, dynamics.

References


Figure A: The negative social feedback is numerically computed for each tested value of positive social feedback strength $\rho$ and food patch quality $q_1$ (for two-patches environments and $q_2 = 0.5$). The optimal negative social feedback is linearly proportional to $\rho$ and $q_1$. 