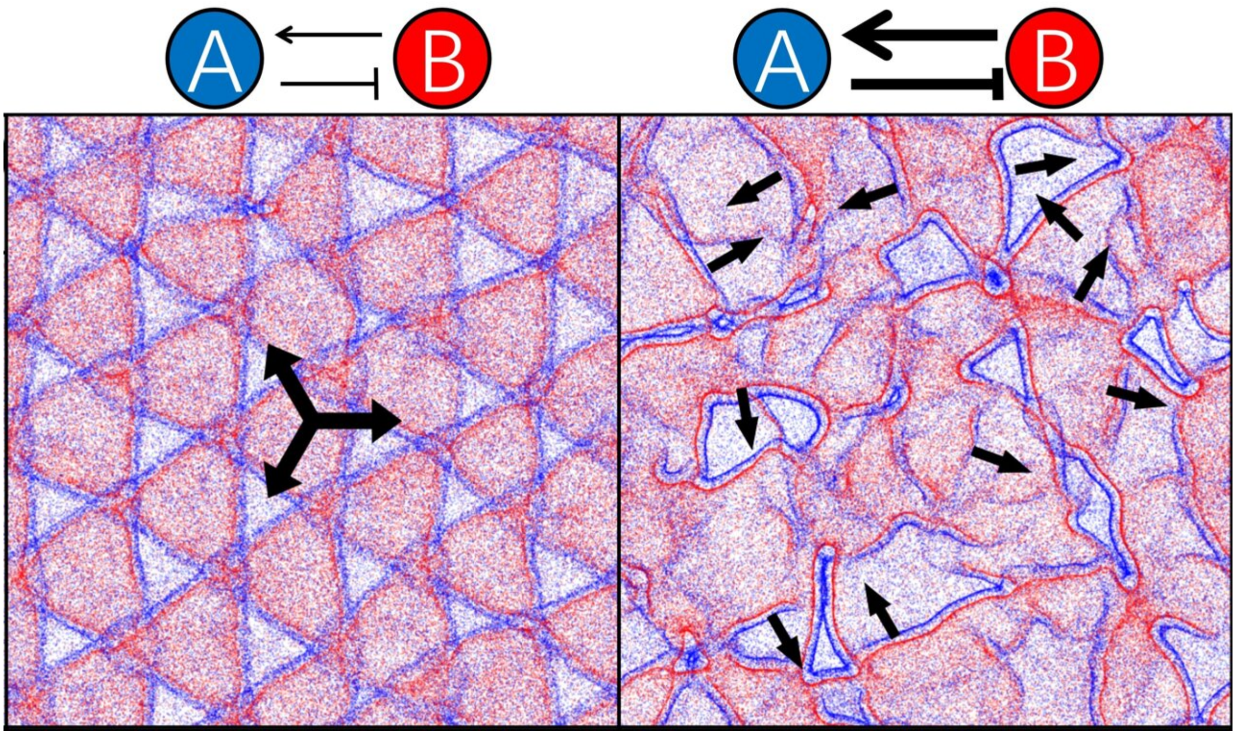
Chasing interactions between bacteria provide insights into collective behavior

October 6 2023



Depending on the chase-and-avoid interaction between two species, A and B, different patterns of self-organization can evolve on the global level Credit: MPI-DS / LMP

A new model demonstrates that chasing interactions can induce dynamical patterns in the organization of bacterial species. Structural patterns can be created due to the chasing interactions between two bacterial species.

In the new model, scientists from the Max Planck Institute for Dynamics and Self-Organization (MPI-DS) describe how interactions on the individual level can result in a global self-organization of species. Their findings provide insights into general mechanisms of collective behavior. The findings are published in the journal *Physical Review Letters*.

In a recent study, scientists from the department Living Matter Physics at MPI-DS developed a model describing communication pathways in bacterial populations. Bacteria show an overall organizational pattern by sensing the concentration of chemicals in their environment and adapting their motion.

The structure only becomes visible on a higher level

"We modeled the non-reciprocal interaction between two bacterial species," first author Yu Duan explains. "This means that species A is chasing species B, whereas B is aiming to repel from A," he continues.

The researchers found, that just this chase-and-avoid interaction is sufficient to form a structural pattern. The type of the resulting pattern depends on the strength of the interaction. This complements a previous study, where a model was proposed that also included intraspecies interactions of the bacteria in order to form a pattern.

In the new model, which also includes the effect of bacterial motility, neither adhesion nor alignment are required to form complex super-structures encompassing millions of individuals.

"Although the bacterial population dynamics show a global order, this is not the case on the individual bacterial level. In particular, a single bacterium seems to move in a disordered way, with the structure becoming visible only on a higher level, which is very fascinating," summarizes Benoît Mahault, group leader in the department Living Matter Physics at MPI-DS.

A general model for collective behavior

The model also allows to consider more than two species, increasing the amount of possible interactions and emerging patterns. Notably, it is also not limited to bacteria but can be applied to a variety of collective behaviors. These include light-controlled microswimmers, social insects, animal groups and robotic swarms.

The study therefore provides general insights on the mechanisms responsible for the formation of large-scale structures in networks with many components.

More information: Yu Duan et al, Dynamical Pattern Formation without Self-Attraction in Quorum-Sensing Active Matter: The Interplay between Nonreciprocity and Motility, *Physical Review Letters* (2023). DOI: 10.1103/PhysRevLett.131.148301

Provided by Max Planck Society

Citation: Chasing interactions between bacteria provide insights into collective behavior (2023, October 6) retrieved 28 April 2024 from https://phys.org/news/2023-10-interactions-bacteria-insights-behavior.html