Correlated dynamics of migrating immune cells enhances the efficiency of their search for pathogens

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Migration of immune cells is believed to be optimized in the course of evolution to reduce their search time. Nevertheless, so far the optimality of the search for pathogens and other targets by immune cells has not been verified. Mediated by retrograde actin flows, the speed of migrating cells is coupled to their directional persistence (i.e. the straightness of trajectories) in such a way that they decelerate to change the direction of motion. We show that such a correlated dynamic enables immune cells to reduce their search time [1]. We introduce a new class of optimal search strategies based on tuning the strength of coupling between factors influencing the search efficiency and prove that the correlated motion is advantageous for optimizing search efficiency when the persistence length of the searcher is much smaller than the size of the environment in which they search. Understanding the mechanisms of adaptive search and clearance in the immune system opens the way toward more effective cancer immunotherapies and vaccine design. Our findings also may open new possibilities to design artificial intelligent searchers.

[1] M. Reza Shaebani, Robin Jose, Ludger Santen, Luiza Stankevicins, Franziska Lautenschläger, Phys Rev Lett 125, 268102 (2020).