Information transfer during tandem-running behavior of the ant Temnothorax rugatulus: Time scales of leadership?

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When choosing a new nest site, rock ants (*Temnothorax rugatulus*) collectively gather and process information from the environment to determine which potential site offers the best choice for the colony. Despite lacking centralized coordination, these ants are remarkably good at making collective decisions. They solve this problem by combining a few simple behaviors: exploration of the environment to discover potential sites, recruitment of ants to a site by means of tandem runs, quorum sensing, and transport of colony members between sites. These behaviors allow the members of a colony to gather, exchange and process information collectively. Due to its central role, a rigorous quantification of information has the potential to provide a novel perspective on the dynamics of collective decisions. We focus on the tandem running behavior of *Temnothorax* ants and leverage the information-theoretic framework of transfer entropy to study information transfer between leader and follower ants. Tandem runs allow ants informed about potential sites (leaders) to lead uninformed ants (followers) toward their location. Following proceeds in bouts of small, straight segments by the leader and more variable movements by the follower (perhaps while memorizing landmarks) with physical contact of the leader by the follower to trigger a repeat of this sequence. This bidirectional feedback (i.e., follower follows and leader waits) has been postulated to implement a learning process akin to teaching in humans. Using a deep learning approach, we tracked the position in time of leaders and followers performing tandem runs and computed transfer entropy—a measure of the directed transfer of information between a pair of processes which effectively captures asymmetric interactions. By means of transfer entropy we analyze the magnitude and directionality of information exchange and investigate whether a critical time scale exists such that the net flow of information is reversed.