

A comparative approach to study collective behavior across biological scales

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Abstract

The study of collective behavior asks how individual actions combine to produce a group response. Research questions encompassing self-organization, collective motion, and decision-making apply to study systems ranging from cellular systems to animal groups and human organizations. Recently, technological advancements have enabled an unprecedented increase in our ability to measure, quantify, and analyze collective behavior. However, despite similar inquires and the wealth of data available, it is difficult to make general statements about principles of collective behavior that apply across scales. Here we describe a hierarchical approach for comparing collective systems that uses the intermediate link of “mechanisms” to connect individual to group behavior. With this, we argue that an effective way to understand collective behavior across different systems is to ask the complementary questions of how individual behavior implements certain mechanisms, and how various mechanisms contribute to overall function of the group. We apply this framework to compare two systems at very different scales - honey bee colonies and cells of the body - and discuss how the mechanisms of specialization, distributed processing, feedback, and others contribute to function in each. Through this comparison, we demonstrate how the hierarchical approach can be used to compare and contrast different systems, and lead to new hypotheses forming a basis for common research questions of collective behavior.

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