Emergence of stable foraging strategies on the cooperation-competition spectrum in a continuous action space

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Résumé

Real-life social interactions unfold continuously in time and space, and involve a variety of competitive and cooperative behaviors. Yet, most social decision-making studies rely on discrete game approaches that do not capture the dynamic sensorimotor nature of continuous decisions. To address this gap, we introduce the Cooperation-Competition Foraging (CCF) game a novel dyadic interaction paradigm designed to investigate continuous, real-time social foraging strategies in humans under face-to-face action visibility. We found that most dyads spontaneously converge to specific stable strategies along the cooperation-competition spectrum, forming three similarly-sized groups: cooperative, intermediate, and predominantly competitive. Using a computational model that integrates cooperation/competition-weighted path minimization and dynamics across interaction cycles, we predict dyadic decisions with 87% accuracy, despite the complexity of the behavioral repertoire. Using this model, we show how emergent sensorimotor communication facilitates ongoing spatiotemporal coordination and how decision uncertainty can lead to coordination failures. We examine how sensorimotor quantities ubiquitous to continuous action spaces, such as movement speed effects and skill differences, alter the theoretically optimal strategies derived from simulations. Finally, we quantify the cost of cooperation associated with cooperative strategies, particularly among participants with superior skills, demonstrating that avoiding competition has intrinsic value. This approach offers a versatile framework for studying dynamic social interactions, suggesting an efficient set of metrics for relating personality measures to distinct behavioral strategies and for elucidating the neural basis of these interactions.

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