

Neither should competition be assumed

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We thank McNamara *et al.* for their letter [1] discussing our proposal to adopt a novel theoretical approach to understand reproductive social behavior. Our proposal [2] derives from a critique of sexual selection as a whole [3], and presents a modeling component to social-selection theory, our alternative to sexual selection. McNamara *et al.* criticize our use of cooperative game theory, specifically the Nash bargaining solution (NBS), in place of the more customary competitive game theory associated with the Nash (competitive) equilibrium.

McNamara *et al.* describe the NBS as a 'black box' that depends on a set of axioms without any consideration of realistic mechanisms to attain it. However, this is not how we use the NBS; instead, we use it because the product of individual fitnesses intuitively captures the idea of a 'team fitness'. The NBS in our theory is explicitly attained through dynamics that model behavioral mechanisms involving communication and/or physical contact. These behaviors enable actions to be coordinated and cooperating individuals to sense their team fitness function. In other contexts, we have also studied biologically plausible bargaining schemes that lead to the NBS without coordinated actions or perception of team fitness, indeed, without any information about the payoffs of the other participants [4]. Here, we emphasize those species in which direct evidence exists for coordinated actions and physical bonding.

McNamara *et al.* assert that non-cooperative game theory has logical primacy upon its cooperative counterpart, which they call an 'auxiliary discipline'. However, this is not the case and such a position is disputed among game theorists [5]. The two branches of game theory have equal logical status and are alternatives to modeling biological interactions.

Furthermore, we question the assertion that binding contracts cannot exist in animal social systems. It is becoming increasingly clear that cooperative behavior

involves extensive coordination of individuals in real time [6–8]. This makes possible the monitoring and enforcement of pre-agreed contracts; mental adaptations, such as friendship, can facilitate working together by reducing the costs of it. The view that animals cannot negotiate and enforce binding contracts, and hence are necessarily competitive, prevails only because the possibility has not been considered seriously before. This is similar to the situation at the time when John Maynard Smith introduced competitive game theory into biology, when it was not yet realized that natural selection could select for 'rational' behavior in animals.

McNamara *et al.* contend that cooperation should not be assumed. We agree and do not assume it. Competition should also not be assumed as the default under the false premise of logical primacy or by ignoring evidence for cooperative play. Instead, assumptions of competition should themselves be tested against evidence, rather than being given a free pass.

References

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