Can transitive inference evolve in animals playing hawk-dove game?

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If no information for the strength of opponent is available for animals competing for food or a mate, the rational player would choose a mixed strategy as in the classical hawk-dove game. However, even when the resource-holding power (RHP) is not directly assessable, it may be inferred from the past games played in the population. Here we consider the repeated hawk-dove game in which each turn is played between a randomly chosen pair of members, and examine the evolutionary stability of strategies which may utilize the results of games played so far in the population. We introduce ambiguity in winning an escalated game, though the player with the larger RHP tends to win. The strategies we examined include the classical mixed strategy, the 'winner-loser effect' strategy in which an individual raises its aggressiveness when it wins and descends when it loses (as found in invertebrates), and 'transitive-inference' which infers the relative strength of the opponent which itself has never fought, through a third member with which both of them have fought before.

The invasion analysis for various pairs of strategies reveal that (i) the transitive-inference strategy can invade the mixed strategy and the 'winner-loser effect' strategy; (ii) an advantage for the transitive-inference is the largest when the number of turns played per individual is small or when the cost of losing escalated game is large (by which players tend to play doves and produce the game results not reflecting the RHPs).

We propose the idea that the transitive inference, which human has the cognitive ability of, would evolve when individuals estimate its own relative strength in the society where each individual struggle for the resources like foods in less abundant information of others' ability to fight.