Co-evolution of pre-play signaling and cooperation

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Abstract

Understanding the evolutionary mechanisms that promote and maintain cooperative behavior is recognized as a major theoretical problem where the intricacy increases with complexity of the participating individuals. Costless pre-play communication [1] with signals that have no preexisting meaning (also known as cheap-talk) might not, on the face of it, be expected to do much. With the current extended abstract, here we would like to present a new analysis of this problem. This analysis has been recently reported in *[Santos, F.C., Pacheco, J.M., Skyrms, B.: Co-evolution of pre-play signaling and cooperation. J Theor Biol 274 (2011) 30-35]* [2].

Here, we show how pre-play signaling leads to profound changes in the evolutionary dynamics of cooperative games, favoring cooperation in finite populations. Cooperation freely emerges from the co-evolution of signals, assigned meanings and actions which are not built-in in the individual, addressing in a general framework the study of central aspects of Human evolution, from the self-organized drive towards an individual adoption of a given signaling system to the emergence of the latter [1].

We analyze two important metaphors of cooperation: The Stag-Hunt (SH) (or coordination) game and the Prisoner's dilemma (PD). We show how, on coordination dilemmas, individuals willing to cooperate learn how to use the information encoded in each signal to identify other cooperators, reducing the risk of facing defection upon a cooperative act. In addition, the existence of a large number of signals enhances the tendency to cooperate, as it enlarges the portfolio of available signals that cooperators may use at profit to coordinate. Since mutual cooperation is always the best possible outcome in coordination dilemmas, cooperators who are able to discriminate between their own strategy and the one of others are robust against the invasion of mutants. Consequently, the emergence of evolutionary stable strategies (and signals) requires that these strategies are *i)* cooperative, *ii)* discriminative and *iii*) self-reinforcing, that is, they cooperate with individuals who adopt the same signal.

Remarkably, the enhancement of cooperation through signaling also applies to games where deception constitutes a profitable option, and where defection is the only stable strategy, as in the PD. In the presence of pre-play signaling, those strategies that opt invariably to defect are no longer stable in the PD. However, the same remains true for any type of cooperative strategy. Let us suppose that mutant arises who can utilize an unused signal. The mutant sends the signal, cooperates with others who send it, and defects against the natives - who do not send it. All goes well for the invaders until another mutant arises who sends the signal and then defects. Thus, in the absence of any evolutionary stable strategy, the fate of cooperation emerges from the conflict between deception by fake signaling and development of reliable "secret handshakes" [3].

Finally, all results are shown to be strongly dependent on the number of signals available. In particular, cooperation can emerge as a result of the arms race between i) the exploration of new signals by cooperators (to avoid being cheated by defectors) and ii) the search of cooperative signals by defectors (to deceive cooperators). By increasing the number of signals, cooperators have a larger portfolio of signals to pick from, something they learn to use to their own advantage. This result illustrates the advantages of a complex signaling system (or incipient language system). Language, even if minimal may open a route to cooperation. Indeed, signaling systems, together with a rich communication portfolio, may give rise to a developing mechanism of intention recognition, from which future behaviors may be assessed and trust bonds established.

References

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