Cooperation Enhancing Effects of Dynamic Networks in Humans

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Introduction

Human cooperative behavior is still in many aspects an evolutionary puzzle since defectors often benefit from cooperative interactions without bearing the associated costs. Theoretical work has shown that network structure can promote the evolution of cooperation. Lately theoretical research has focused on dynamic social networks which are predicted to enhance cooperation further than static network structures. We present an experimental study where humans played iterated prisoner's dilemmas (IPD) with multiple partners simultaneously in either a static or a dynamic social network. The dynamic network is created by the active linking mechanism of Pacheco and colleagues [1, 2, 3].

Method

- static and dynamic network treatment
- 10 groups per treatment of 10 individuals
- All groups started with the same network structure see Fig. 1A
- Each individual had three partners
- 30 rounds IPD , with all partners simultaneously
- Each round the players had to decide whether to play orange or blue with the following payoff matrix:

		partner	
		orange	**blue**
focus Player	**orange**	0.25 €	-0.10 €
	blue	0.40 €	0.00 €

- In every second group the payoffs for blue/orange were reversed
- Participants did not know the duration of the game
- In the dynamic network groups the players had the option to actively end their social links to their partners after each prisoner's dilemma interaction.

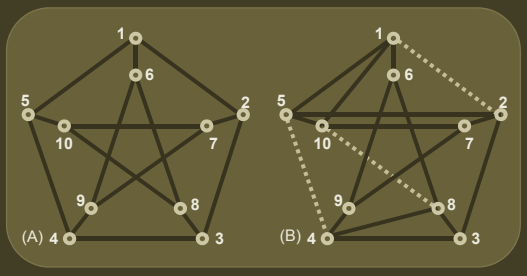

Fig. 1 (A) Initial network topology (B) Example of active link breaking where the network has changed
- circles = individuals
- lines = present links
- dotted lines = former links

Results

We show that cooperation is significantly higher in for human societies much more natural settings of dynamic social networks compared to the static social networks. Our results support the theoretical assumption that more cooperative pairs are found in a dynamical network.

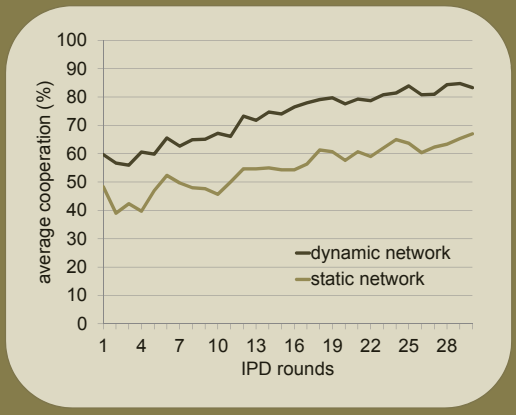

Fig. 2 Average cooperation (group level) in the IDP rounds

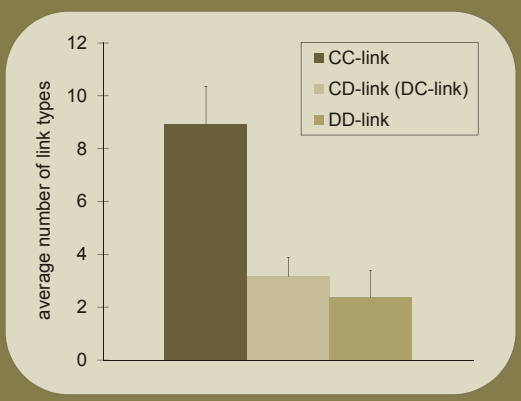

Fig. 3 Number of pairs in the dynamic network treatment. Players could play C or D. CC-link = both players played C (CD/DC/DD respectively).

Summary

Our findings are in line with theoretical models on dynamical linking [1, 2, 3] on which we based our experiment. In accordance with higher levels of cooperation in the dynamical network treatment, we found a much higher number of cooperative pairs than pairs consisting of one or two defectors, which supports the evolution of cooperation [1, 2, 3]. In the dynamical networks participants had the opportunity to break existing links to partners. This and the associated self-organizing processes **(see poster of Katrin Fehl)** lead to higher cooperation.
Interestingly, unknown duration of the game removes the dilemma from the iterated prisoners dilemma. After 30 experimental rounds cooperation remained very high.

[1] Pacheco, JM, Traulsen, A & Nowak, MA (2006a). Active linking in evolutionary games. *J.Theor.Biol.*, 243, 437-443.
[2] Pacheco, JM, Traulsen, A & Nowak, MA (2006b). Coevolution of strategy and structure in complex networks with dynamical linking. *Phys.Rev.Lett.*, 97, 258103.
[3] Pacheco, JM, Traulsen, A, Ohtsuki, H & Nowak, MA (2008). Repeated games and direct reciprocity under active linking. *J.Theor.Biol.*, 250, 723-731.

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