

# Group selection and the evolution of cooperation

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## Structured Abstract

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**Paper type:** Empirical.

**Background(s):** Evolutionary biology.

**Approach:** Game dynamics.

**Context:** Wilson & Wilson (2007) argue that group selection drives the evolution of cooperative behaviours, yet over the past century, many have claimed that group selection is irrelevant to evolution.

**Problem:** We observe examples of cooperation in the biological world, but it is often difficult to be certain that these evolved through group selection.

**Method:** Group selection presupposes that the subjects of evolution are niche constructing (Laland 2024) developmental (Puentedura 2007) processes (evo-eco-devo). In this work, we simulate computationally (Nowak 2006) a mutating population of Prisoner's Dilemma (PD) processes that are selectively punished for exhibiting the cooperative behaviour of *forgiveness* (with probability  $q$ ), unless this forgiveness is *reciprocated* (with probability  $p$ ) by neighbours, in which case, selection rewards the combined interaction of forgiveness with reciprocation. We discuss whether group selection is essential to the evolution of cooperation within this system.

**Results:** In a mutating PD population that initially contains only defectors, cooperation evolves by the following route: Forgiveness remains initially low, while reciprocation rises, whereupon forgiveness also rises to the moderate value of  $q = 0.65$ , following which reciprocation rises to the high value  $p = 0.97$ .

**Implications:** In this simulation, cooperative behaviour arises as reciprocators construct around themselves a mutually reciprocating group within which forgiveness can thrive. This suggests that group selection is central for the evolution of cooperative behaviours, since the reciprocating group constitutes a niche that selectively rewards forgiveness and cooperation among its members.

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## References

- Laland, K. (2024) DIY evolution. *New Scientist* 264(3520): 26–29.
- Nowak, M.A (2006) Evolutionary dynamics. Harvard University Press.
- Puentedura, R.R. (2007) The Baldwin effect in the age of computation. In: Weber, B.H. & Depew, D.J. (eds): *Evolution and learning*. MIT Press.
- Wilson D.S. & Wilson, E.O. (2007) Evolution: Survival of the selfless. *New Scientist* 196(2628): 42–46.