

# Non-Vertical Cultural Transmission, Assortment, and the Evolution of Cooperation

Dor Cohen<sup>1</sup>, Ohad Lewin-Epstein<sup>2</sup>, Marcus W. Feldman<sup>3</sup>, and Yoav Ram<sup>1,4,5,\*</sup>

<sup>1</sup>School of Computer Science, Interdisciplinary Center Herzliya, Herzliya, Israel

<sup>2</sup>School of Plant Sciences and Food Security, Faculty of Life Sciences, Tel Aviv University, Tel Aviv, Israel

<sup>3</sup>Department of Biology, Stanford University, Stanford, CA

<sup>4</sup>School of Zoology, Faculty of Life Sciences, Tel Aviv University, Tel Aviv, Israel

<sup>5</sup>Sagol School of Neuroscience, Tel Aviv University, Tel Aviv, Israel

\*Corresponding author: yoav@yoavram.com

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## Supplementary material

PRSB\_figures/fig\_s1.pdf

**Figure S1: Reduction principle for interaction-transmission association.** Consecutive fixation of modifier alleles that reduce interaction-transmission association  $\alpha$  in numerical simulations of evolution with two modifier alleles (Eq. D1). When an invading modifier allele is established in the population (frequency  $> 99.95\%$ ), a new modifier allele that reduces interaction-transmission association by 5% is introduced (at initial frequency 0.5%). **(a)** The frequency of the cooperative phenotype  $A$  over time. **(b)** The frequency of the invading modifier allele  $m$  over time. **(c)** The population mean fitness ( $\bar{w}$ ) over time. Here,  $c = 0.05$ ,  $b = 1.3$ ,  $T_A = 0.4 < T_B = 0.7$ , initial interaction-transmission association  $\alpha_1 = 0.7$ , lower interaction-transmission association threshold  $\alpha_2 = 0.605$ .

PRSB\_figures/fig\_s2.pdf

**Figure S2: Evolution of cooperation in a structured population with local selection.** The expected frequency of cooperators in a structured population after 10,000 generations is shown (red for 0%, green for 100%) as a function of both the cost of cooperation ( $c$ ) on the y-axis, and the symmetric horizontal transmission rate ( $T = T_A = T_B$ ) on the x-axis of panel (a), or the transmission bias  $T_A - T_B$  on the x-axis of panel (b). Cooperation and horizontal transmission are both local between neighbouring sites, and each site had 8 neighbours. Selection operates locally (see Figure 4 for results from a model with global selection). The black curves represent the cost thresholds for the evolution of cooperation in a well-mixed population with interaction-transmission association, where  $\alpha = 1/8$  in inequality 14 for panel (a) and in Eqs. 12 for panel (b). The population evolves on a 100-by-100 grid. Simulations were stopped at generation 10,000 or if one of the phenotypes fixed. 50 simulations were executed for each parameter set. Here, benefit of cooperation,  $b = 1.3$ ; perfect vertical transmission  $v = 1$ . (a) Symmetric horizontal transmission,  $T = T_A = T_B$ . (b) Horizontal transmission rate  $T_A$  is fixed at 0.4, and  $T_B$  varies,  $0.3 < T_B < 0.5$ .