**Supplementary Information**

*SI Appendix A – Operationalization of power*

Using the framework of interdependence theory (1,2), it is possible to show that, for the parameters used throughout the study, the degree of asymmetric dependence (a method of assessing power asymmetry) increases monotonically with $\alpha$ (Methods; Figure S4). In other words, the greater the asymmetry ($\alpha$), the more a low-power individual's outcome is influenced by their partner's choice to cooperate or not. For simplicity, throughout the paper we refer to $\alpha$ as power asymmetry. This definition of power is consistent with theoretical work that suggests that the ability to allocate greater rewards is an expression of power (3–5).

Interdependence theory provides the means of quantifying the exact amount of power asymmetry of an interaction described by a given payoff matrix (1,2). The variance in outcomes of an interaction can be divided in three distinct components: actor control (AC), partner control (PC), and joint control (JC). These values indicate to what extent the variance in outcomes is determined, respectively, by the player's choices, by their partner's choices, or by the importance of coordination (that is, the difference between making the same choice as one's social partner or doing the opposite of what they do).

Let $\mathrm{G}_1 = \begin{pmatrix} \mathrm{a}_1 & \mathrm{b}_1 \\ \mathrm{c}_1 & \mathrm{d}_1 \end{pmatrix}$ be the payoff matrix for player 1. Then, $\mathrm{AC}_1 = \frac{1}{2}(\mathrm{a}_1 + \mathrm{b}_1 - \mathrm{c}_1 - \mathrm{d}_1)$, $\mathrm{PC}_1 = \frac{1}{2}(\mathrm{a}_1 - \mathrm{b}_1 + \mathrm{c}_1 - \mathrm{d}_1)$, and $\mathrm{JC}_1 = \frac{1}{2}(\mathrm{a}_1 - \mathrm{b}_1 - \mathrm{c}_1 + \mathrm{d}_1)$. These quantities can be used to calculate the degree of mutual dependence (MD) of an interaction, which quantifies to what extent player 1's payoff depends on player 2's choices:

$$\mathrm{MD}_1 = \frac{\mathrm{PC}_1^2 + \mathrm{JC}_1^2}{\mathrm{AC}_1^2 + \mathrm{PC}_1^2 + \mathrm{JC}_1^2} \tag{4}$$

Mutual dependence varies between 0 (no dependence) and 1 (total dependence). In asymmetric interaction, this quantity can differ between the two players; for example, if $\mathrm{MD}_1 > \mathrm{MD}_2$, player 2's choices affect player 1's outcome to a greater extent than player 1's choices affect player 2's outcome. The degree of asymmetric dependence, the difference in mutual dependence between the two players ($\mathrm{MD}_1 - \mathrm{MD}_2$), indicates the asymmetric ability to control another person's outcomes. As shown in Figure S1, this quantity increases monotonically with power asymmetry (α) as we defined it in the context of the asymmetric donation game.

*SI Appendix B – Transition probabilities in a 3-strategy Moran process with mutation*

Let $(k, p, q)$ denote a state with $k$ individuals adopting $(C, C, C)$, $p$ individuals adopting $(D, D, D)$ and $q$ individuals adopting $(C, C, D)$. Let $x = k/N$, $y = p/N$, and $z = q/N$ be the frequencies of these strategies in the population, and $f^{CCC}$, $f^{DDD}$, and $f^{CCD}$ their *relative* fitness in state $(k, p, q)$, i.e., $f^X = F^X/\bar{f}$ (where $F^X$ is the absolute fitness of strategy $X$ and $\bar{f} = xF^{CCC} + yF^{DDD} + zF^{CCD}$ is the average fitness in the population). Therefore, $xf^{CCC} + yf^{DDD} + zf^{CCD} = 1$.

Assuming that strategies evolve according to a Moran Process, the transition probability from $(k, p, q)$ to $(k + 1, p - 1, q)$ is the probability that a $(C, C, C)$ individual replaces a $(D, D, D)$ individual without mutating, or that a $(D, D, D)$ individual is replaced by either a $(D, D, D)$ or a $(C, C, D)$ individual which mutates to $(C, C, C)$. This can be written as:

$$
\begin{aligned}
T_{k,p,q\to k+1,p-1,q} &= \frac{p}{N}\left[(1-U)\frac{k}{N}f^{CCC} + \frac{U}{2}\frac{p}{N}f^{DDD} + \frac{U}{2}\frac{q}{N}f^{CCD}\right] \\
&= y\left[(1-U)xf^{CCC} + \frac{U}{2}yf^{DDD} + \frac{U}{2}zf^{CCD}\right] \\
&= y\left[xf^{CCC} - Uxf^{CCC} + \frac{U}{2}(yf^{DDD} + zf^{CCD})\right] \\
&= y\left[xf^{CCC} - Uxf^{CCC} + \frac{U}{2}(1 - xf^{CCC})\right] \\
&= y\left(xf^{CCC} - Uxf^{CCC} + \frac{U}{2} - \frac{U}{2}xf^{CCC}\right) \\
&= xy\left(1 - \frac{3}{2}U\right)f^{CCC}(k,p,q) + \frac{U}{2}y
\end{aligned}
$$

Transition probabilities s to all other adjacent states can be calculated in a similar way.

## References


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**Supplementary Figures**

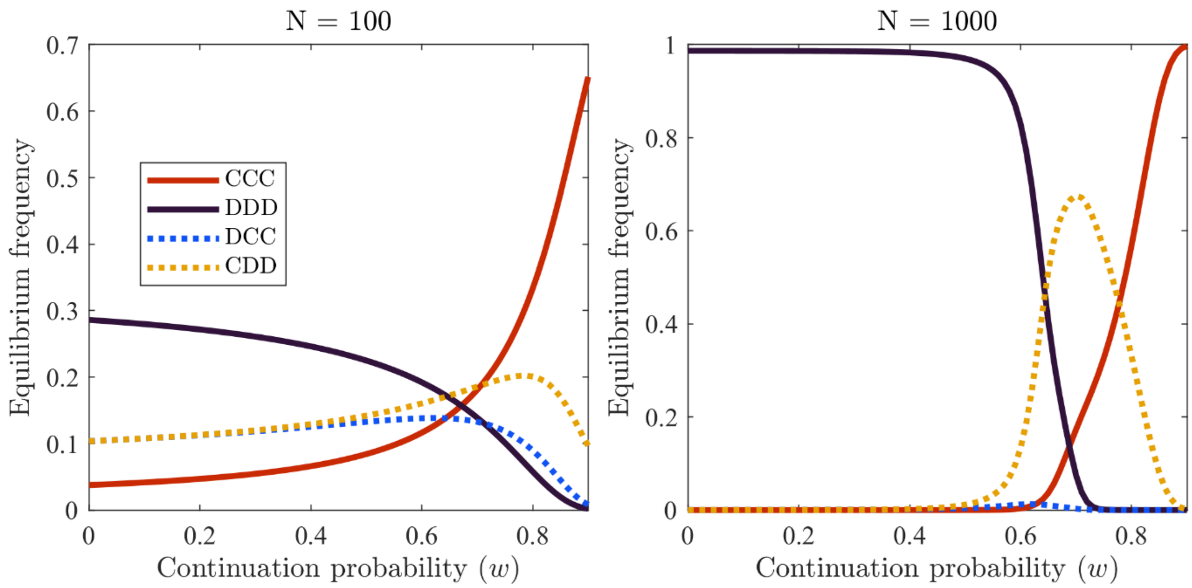


**Fig. S1.** Equilibrium frequency of strategies in the iterated PD. Equilibrium frequency of various strategies in a finite population ($N = 100$ and $N = 1000$) playing the iterated PD, under a small-mutation approximation, as a function of the continuation probability ($w$). Continuous lines indicate power-independent strategies; dotted lines indicate strategies that is conditional on power differences. Of the 8 strategies studied, only ESSs are shown. Other parameters: $\alpha = 0.5$, $b = 1$, $c = 0.4$, $\beta = 0.05$.

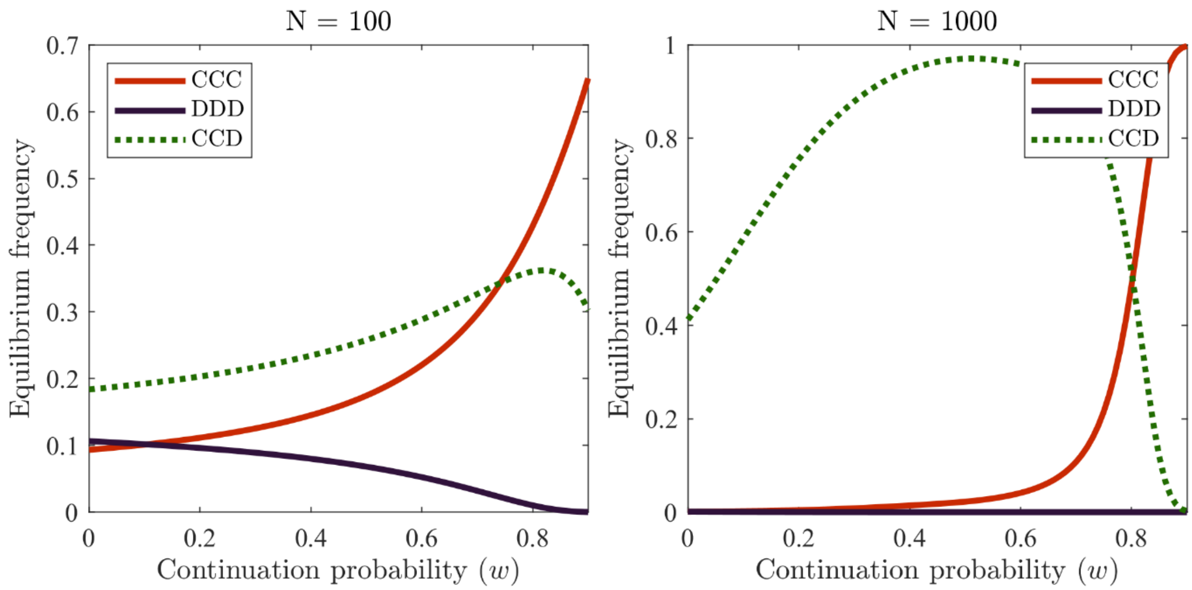


**Fig. S2.** Equilibrium frequency of strategies in the iterated SD. Equilibrium frequency of various strategies in a finite population ($N = 100$ and $N = 1000$) playing the iterated SD, under a small-mutation approximation, as a function of the continuation probability ($w$). Continuous lines indicate power-independent strategies; the dotted line indicates $(C, D, D)$, a strategy that is conditional on power differences. Of the 8 strategies studied, only the two ESSs and AllD are shown. Other parameters: $\alpha = 0.5$, $b = 1$, $c = 0.4$, $\beta = 0.05$.

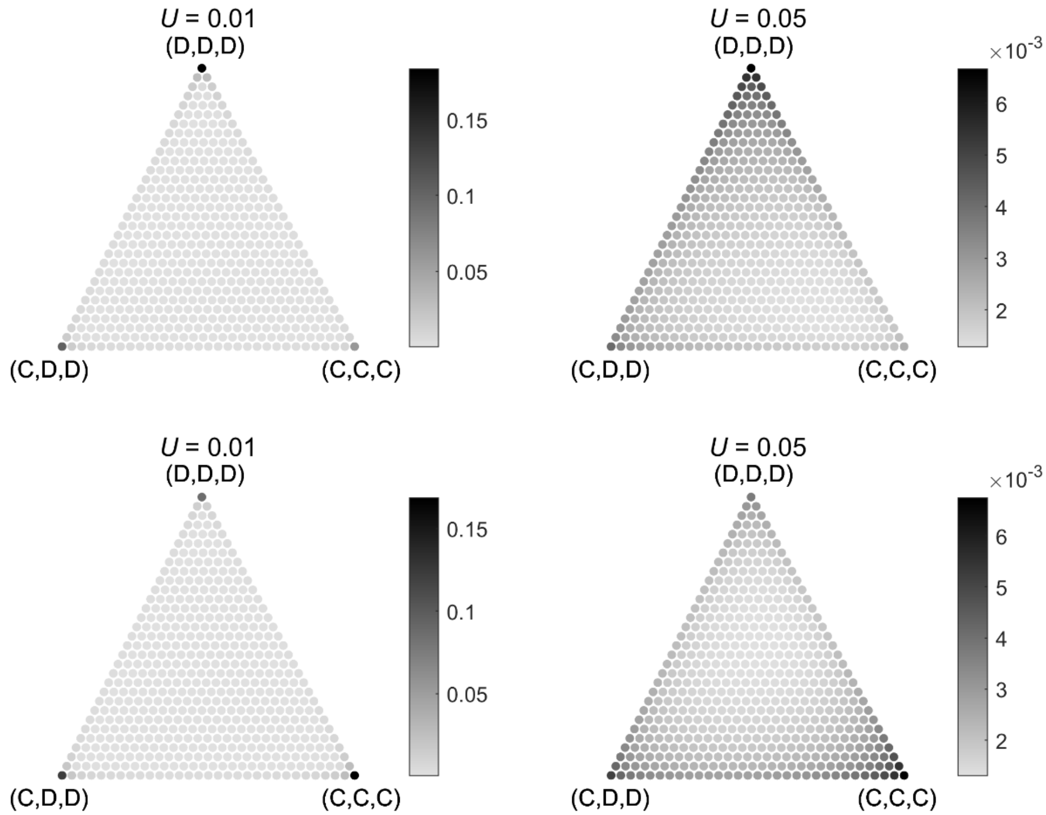


**Fig. S3.** Stationary distribution over strategies in a finite population composed of $(C, C, C)$, $(D, D, D)$, and $(C, D, D)$ and playing the iterated PD. The stationary distributions are calculated as the limiting distribution of a discrete-time Markov chain (which, as long as U>0, is irreducible, thereby has a unique stationary distribution). For a mutation rate $U = 0.01$ (left two graphs), the population spends most of the time in pure states, validating the use of a small-mutation approximation. When the continuation probability is low ($w = 0.1$; upper two graphs), defecting regardless the level of power is the optimal strategy. When the probability of repeated encounters is high ($w = 0.9$), reciprocal cooperation is the optimal strategy, regardless the level of power of an interaction. The fixation probability of $(D, C, C)$ in a population of $(C, C, C)$, $(D, D, D)$, and $(D, C, C)$ is the same as $(C, D, D)$ and therefore not shown as a separate figure. Other parameters: $\alpha = 0.5$, $b = 1$, $c = 0.4$, $N = 30$, $\beta = 0.05$.

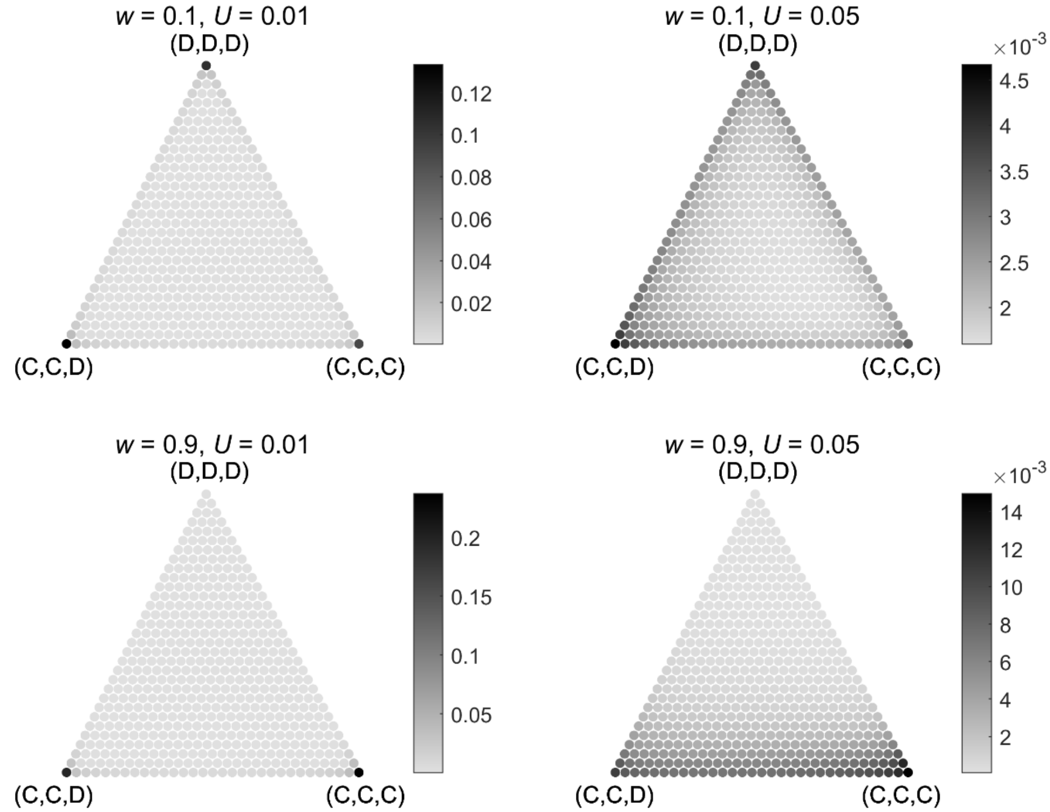


**Fig. S4.** Stationary distribution over strategies in a finite population composed of $(C, C, C)$, $(D, D, D)$, and $(C, C, D)$ and playing the asymmetric, iterated SD. The stationary distributions are calculated as the limiting distribution of a discrete-time Markov chain. For a mutation rate $U = 0.01$ (left two graphs), the population spends most of the time in pure states, validating the use of a small-mutation approximation. When the continuation probability is low ($w = 0.1$; upper two graphs), $(C, C, D)$ is the optimal strategy. When the probability of repeated encounters is high ($w = 0.9$), reciprocal cooperation is the optimal strategy, regardless the level of power of an interaction. Other parameters: $\alpha = 0.5$, $b = 1$, $c = 0.4$, $N = 30$, $\beta = 0.05$.

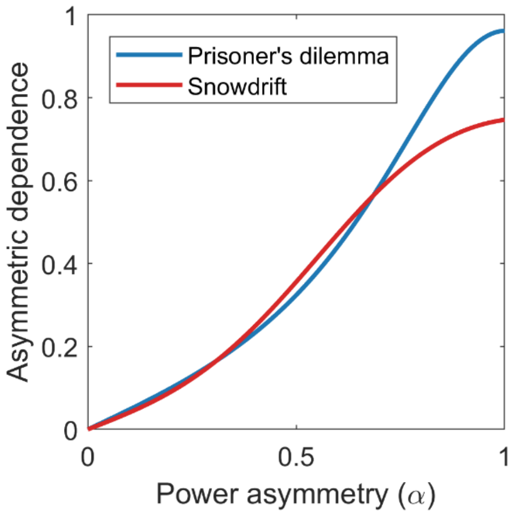


**Fig. S5.** Equilibrium frequency of strategies in the iterated SD. Equilibrium frequency of various strategies in a finite population ($N = 100$ and $N = 1000$) playing the iterated SD, under a small-mutation approximation, as a function of the continuation probability ($w$). Continuous lines indicate power-independent strategies; the dotted line indicates $(C, D, D)$, a strategy that is conditional on power differences. Of the 8 strategies studied, only the two ESSs and AllD are shown. Other parameters: $\alpha = 0.5$, $b = 1$, $c = 0.4$, $\beta = 0.05$.

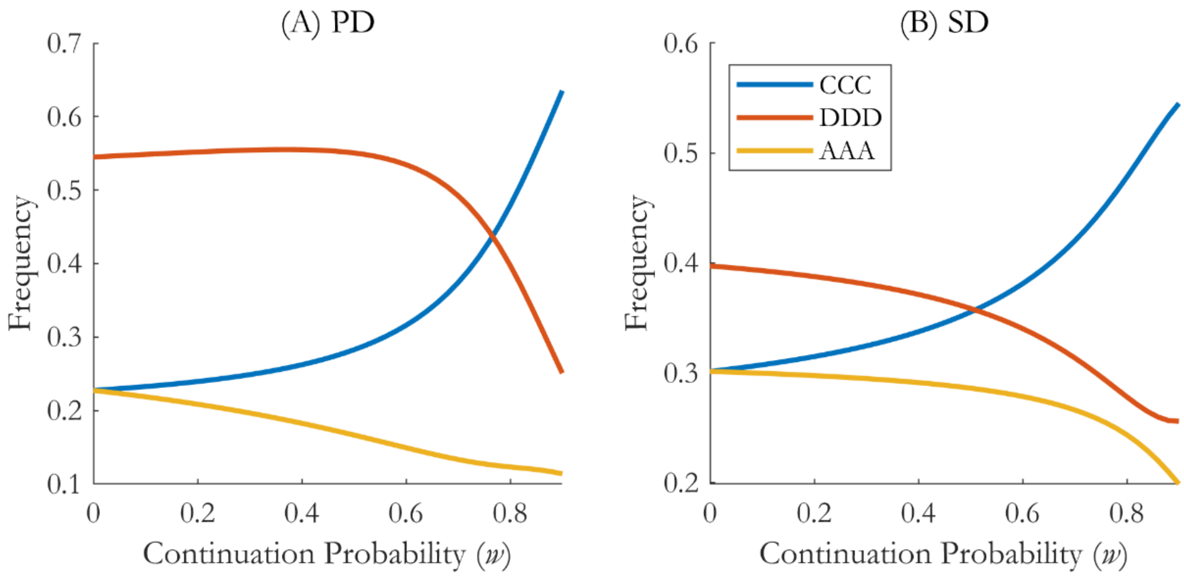


**Fig. S6.** Equilibrium frequency of strategies in the iterated PD (A) and SD (B). Exact equilibrium frequency of various strategies in a finite population ($N = 30$) with three strategies: TFT (CCC), AllD (DDD), and AllC (CCC), as a function of the continuation probability ($w$). Other parameters: $\alpha = 0.5$, $b = 1$, $c = 0.4$, $\beta = 0.05$.