Local Competition Promotes Hurtful Behaviour Towards Unknown Others

Timothy N. Cason*
Department of Economics, Purdue University. 100 S. Grant Street West Lafayette, IN 47907-2076, U.S.A. (cason@purdue.edu)

Arno Riedl
Department of Microeconomics and Public Economics, School of Business and Economics, Maastricht University. P.O. Box 616 6200 MD Maastricht, the Netherlands (a.riedl@maastrichtuniversity.nl)

Arthur Schram
Amsterdam School of Economics, University of Amsterdam. P.O. Box 15867, 1001 NJ Amsterdam, the Netherlands (schram@uva.nl)

Aljaž Ule
Amsterdam School of Economics, University of Amsterdam. P.O. Box 15867, 1001 NJ Amsterdam, the Netherlands; and Faculty of Mathematics, Natural Sciences and Information Technologies, University of Primorska. Glagoljaška 8, SI-6000 Koper, Slovenia (a.ule@uva.nl)

Abstract

Humans frequently cooperate to achieve benefits unattainable through selfish behaviour. Punishment of free-riders is key for sustaining cooperation but also costly, raising questions about the origins of such behaviour. Some evolutionary models suggest that individuals may be willing to hurt unknown others in competitive environments. However, empirical evidence about the effect of the *scale* of competition on strategies involving hurtful behaviour in human groups, such as spite, retaliation for hurting, and punishment of free-riders, is missing. Using a laboratory experiment, we manipulate the scale of competition to investigate its influence on hurtful and helpful behaviours, between unknown humans in an indirect reciprocity game. We observe distinct behavioural patterns between local and global competition. When competition is local and thus confined to take place within isolated groups we find frequent hurting as an expression of spite and retaliation. In contrast, when competition extends globally across several groups, hurting is used primarily for punishment of free-riders whereas helping behaviour is rewarded, which together promotes cooperation. Thus, while isolated competition fosters inefficient, antisocial behaviour, global competition encourages prosociality and cooperation.

Keywords: Spite, Generosity, Punishment, Cooperation, Isolationism, Competition

Supplementary information. Electronic supplementary material is available online at http://.

Acknowledgements. We gratefully acknowledge funding from the University of Amsterdam's Research Priority Area Behavioral Economics. The software used in the experiment was developed at CREED by Jos Theelen.

*Corresponding author. All authors contributed equally to this work.

1. Introduction

Humans cooperate in groups to realize greater joint rewards than individuals can obtain on their own. Examples range from cooperative hunting among hunter gatherers to collaborative activities in large societies that bring together individuals with diverse talents [1-3]. Various mechanisms can support human cooperation [4], such as direct reciprocity, in the forms of direct rewarding [5,6] and direct punishment [7-9]. These refer to rewarding those from whom a helpful act was received and punishing those from whom a hurtful act was received. Direct reciprocity typically requires some degree of stability in relationships and is therefore much less likely to occur in infrequent or one-shot interactions between individuals who do not know each other, as is common in large-scale societies. In such environments it is uncertain whether and when one's actions will be reciprocated. Even if people do meet again, they may be unable to identify each other or recall past behaviour. In such cases, cooperation can be sustained via indirect reciprocity [10-13], which entails rewarding and punishing, respectively, those who help and free-ride on others. Indirect rewarding and indirect punishment require access to some record of previous behaviour, such as by gossip or online rating systems.

Importantly, the use of indirect rewarding alone may not be sufficient to sustain cooperative behaviour in the aggregate because it is costly to the individual and does not provide immediate individual benefits. Indeed, it has been shown that indirect punishment is crucial for the success of a rewarding strategy, as it can ensure that rewarders are not exploited by free riders. Interestingly, only a small fraction of individuals willing to punish is needed to turn rewarding into a profitable strategy, supporting cooperation even among strangers [14]. On the other hand, the existence of indirect punishment is puzzling in and of itself, especially since it has been shown to be among the least profitable strategies [14,15]. One explanation for its persistence is suggested by evolutionary models that show how hurtful behaviour may emerge when relatedness between individuals is very low [16-18]. These models focus on the relative performance of various strategies competing over a closed pool of resources for a fitness advantage in an isolated environment. When humans interact in such antagonistic conditions, hurting may emerge as a form of competition instead of a norm enforcement device [19]. Indeed, there is some suggestive evidence that hurting is not solely used pro-socially to promote cooperation but may also serve anti-social motives [20,21]. Rather than deterring future free-riding, hurting can reflect a desire to equalize or surpass others' payoffs or status [19,22]. If competition is sufficiently local and the cost

of hurting low relative to its effect, hurting can be used to change the payoff differentials to one's own advantage [23-26]. Small, isolated groups competing over a fixed resource may then favor *spite*, a strategy of indiscriminate hurting [27]. Spite can, in turn, be moderated with *retaliation*, a strategy of hurting those who hurt others [28]. However, retaliation may reduce cooperation because it hurts those who are pro-socially punishing free-riders, and may lead to cycles of retaliatory hurting [29-32].

Pro-social behaviour might alternatively be promoted by external competition between groups, which introduces selection on multiple levels [33-36]. In theory, group competition may reduce anti-social behaviour [24], though empirical evidence for its effect on spite, retaliation and punishment in humans is very scarce. There is only evidence that global competition can decrease rejections in one-shot ultimatum games and reduce hurting in one-shot money-burning games [37,38]. To date, there is no evidence on how different competitive environments affect the emergence and success of hurtful strategies.

Here we explore anti-social strategic behaviour in a laboratory experiment with human subjects in environments characterized by local and global competition, respectively. Specifically, we investigate the effect of the scale of competition on the success of various strategies that involve hurtful behaviour, such as spite, retaliation and punishment. We also examine how indirect punishment affects the success of rewarding strategies in local competition within a single group versus global competition across multiple groups. Beyond identifying a source of human anti-social behaviour, the results of our study may have practical implications. For instance, the recent shift toward more localized trade reduces competition between countries, potentially leading to a world where competition occurs primarily in isolated groups within countries. While the economic and political consequences of autarky are well understood, less is known about its impact on social behaviour involving strategies of, for example, rewarding, punishment or spite. To explore this, our experiment isolates the social impact of reduced cross-group competition by shutting down other economic and political channels through which trade typically affects micro-level dynamics.

In our experiment we stimulate competition with tournament incentives that reward individuals in a group according to their relative success. That is, an individual's share in the fixed reward pie depends on her performance relative to the performance of the other individuals to whom she is compared. The set of these individuals varies with the scale of competition (local versus global) implemented in the experimental treatments. Such incentives mimic the theoretical

conditions for the emergence of hurtful behaviour and are widespread, for instance, in the workplace when earnings are affected by how an individual's performance ranks among the performance of others in the group [39,40]. Promotion tournaments and winner-take-all markets where the best performers reap the highest benefits are also prominent examples [41]. Such tournament incentives may reduce the benefits from cooperation and create a highly competitive environment. In promotion tournaments, for example, workers may be motivated to outperform their peers and may even resort to harmful sabotage [42], as their relative performance is evaluated by superiors when making promotion decisions [39]. These comparisons can occur both within and across organizational divisions.

2. The Indirect Reciprocity Game

Matching groups of six human subjects each play 100 periods of an indirect reciprocity game with punishment [14]. In each period the subjects in a matching group are randomly matched into three donor-recipient pairs, with each subject involved in one game per period. The donor can help, snub, or hurt their recipient. Per period payoffs (in points) to the donor and receiver in a pair are shown in Table 1.

Table 1: Per period payoffs (in points) for donor choices in the indirect reciprocity game with hurting

	donor	recipient
donor helps	-200	250
donor snubs	0	0
donor hurts	-50	-250

As illustrated in Figure 1, the donor and recipient role assignment is determined randomly for each pairing, so each individual is a donor in about half of the 100 periods (half were donors between 48 and 53 times.) Donors decide after observing the recipient's three most recent decisions when the recipient was in the role of a donor, indexing her *reputation*. When the donor helps this increases the recipient's period payoff with 250 points but reduces the donor's period payoff by 200 points and thus is relatively costly and challenging to sustain. When the donor snubs,

this changes neither the donor's nor the recipient's period payoff. Finally, when the donor hurts this reduces the donor's and recipient's period payoff with 50 and 250 points, respectively, and is thus harmful individually and socially. Individual earnings in points are accumulated across the 100 periods. Importantly, points are not directly translated into payoff. Instead, participants earn money according to a *tournament* scheme, based on their relative position in the final point rankings.

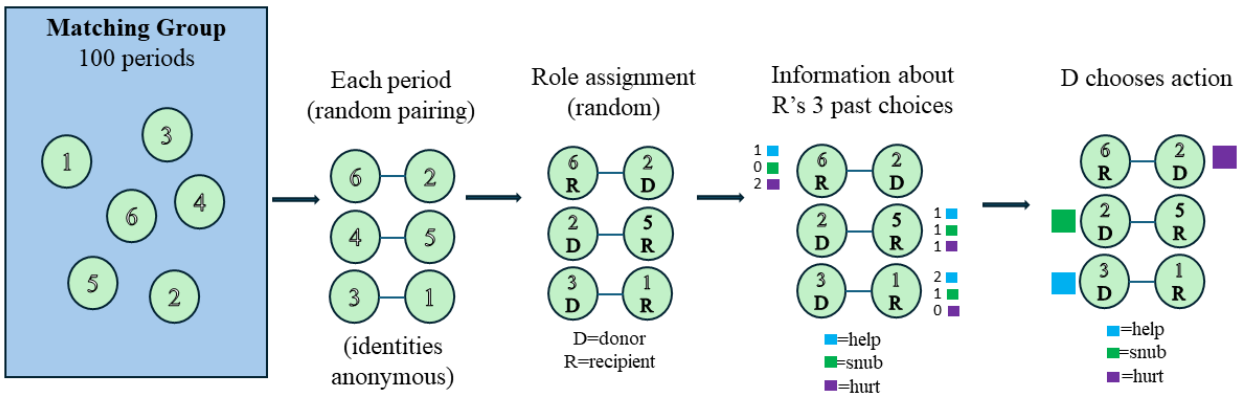

Figure 1: Illustration of an individual period of the Indirect Reciprocity Game

We implemented two treatments that differ in only one respect, namely how point rankings determine monetary earnings, reflecting a difference in the scale of competition. In *Local Competition (LOC)*, points rankings are determined within each group of six. Participants are ranked from 1 to 6 according to their accumulated points. The participant ranked r earns $34 - 4r$ euros. In the *Global Competition (GLO)* treatment, four groups of six play the game in parallel. Each subject only interacts with members of their own group but the accumulated point earnings of all 24 participants are ranked and monetary earnings depend on these ranks. The four participants with the highest accumulated points all earn according to rank 1, the four participants with the next highest accumulated points all earn according to rank 2, etc. Thus, the final distributions of payoffs are the same by construction in the two treatments, making them directly comparable (see the Methods section). The design choice to limit interactions in the *GLO* condition to the members of their own group, instead of all members of the four groups, allows us to isolate

the social consequences of the competition level, abstracting from confounding effects linked to direct interactions with the members of the other groups.

One potential limitation of our setup is the choice to use groups of only six participants. This protocol was chosen to be able to collect data from a sufficient number of parallel groups at reasonable costs. With 100 periods of interaction, however, there is the possibility that participants might recognise others through their previous decisions. To minimise this risk, the identity of the interaction partner is not revealed in any period, nor can participants be paired with the same individual in consecutive periods. It is well-established that cooperation in social dilemma games breaks down rather quickly in settings of so-called random stranger matching as the one we implemented ([8],[43]) suggesting that repeated-game effects are rare under such matching schemes. Moreover, a comparison of random strangers matching [8] and perfect strangers matching, a protocol wherein no pair meets twice [44], reveals no substantial differences in behaviour between the two environments.

Subjects were informed about the ranking procedure and earnings calculation before the first period. As is common in experiments with competition across groups [45-47], subjects received no information about any others' accumulated point earnings until the end of the experiment. In each round the recipients received only the information about the action chosen by their donor in their own pair. Further details on the experimental procedures and instructions are presented in the methods section and in the supporting online material [48].

3. Results

Figures 2 and 3 display the overall action frequencies by period in the two treatments, pooled across all experimental sessions. The (blue) Help frequency is clearly much higher in the GLO treatment than the LOC treatment for nearly all periods, and the (purple) Hurt frequency is clearly higher in the LOC treatment. Treatment differences are even evident in the initial periods.

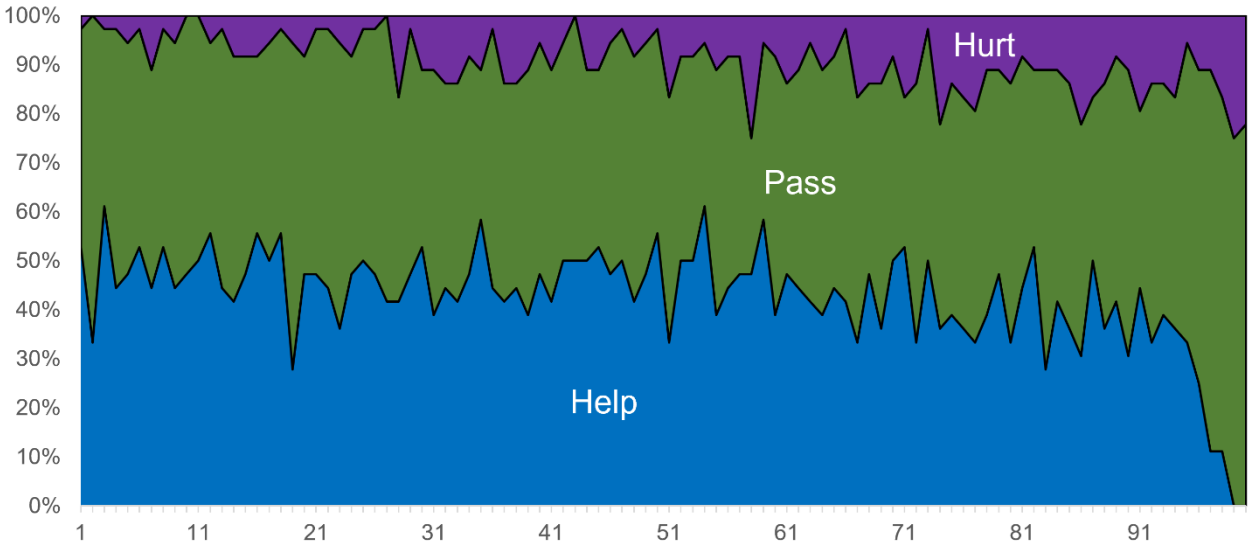

Figure 2: Overall Action Frequency by Period for GLO Treatment

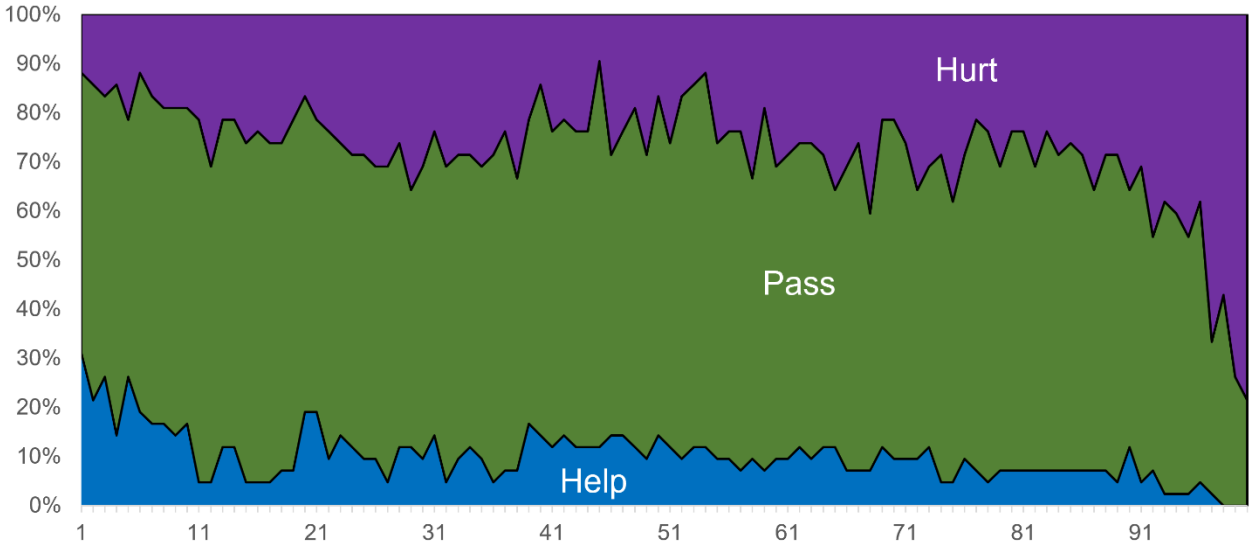

Figure 3: Overall Action Frequency by Period for LOC Treatment

Note that in the final 10 rounds the Help frequency falls dramatically in the GLO treatment, and the Hurt frequency increases substantially in the LOC treatment. We follow common practice in experimental economics and reduce the influence of end-game effects on conclusions by restricting our analysis to behaviour in the first 90 periods (for a similar approach see [13,14,49-

51]). (Our conclusions are qualitatively robust to including all 100 periods; we report the results including all periods in the supplementary online material [48].) At the aggregate level, we find that participants help significantly more often (45% vs. 11%) and hurt significantly less frequently (9% vs 25%) when the tournament competition is at a global level (*GLO*) than when it is at a local level (*LOC*). These differences are statistically significant (Table 2) and show that global competition reduces hurting and increases helping, relative to local competition.

Table 2: Frequency of actions chosen in the indirect reciprocity game by level of competition

	LOC	*GLO*	p-value
help	11%	45%	0.0004
snub	64%	46%	0.1184
hurt	25%	9%	0.0056

Notes: *p*-values (two-tailed) compare *LOC* and *GLO* and are based on Monte Carlo permutation tests with groups of six as unit of observation; *N*=14 in *LOC* and *N*=12 in *GLO*.

Treatment differences are even evident in the initial periods. In period 1 hurting is already four times more frequent in LOC than in GLO, but at a lower level than in later periods. Due to considerable variation across sessions this difference is not statistically significant in period 1. But across all early periods 1 to 10 the hurting rate in LOC is already significantly greater than in GLO (permutation test p-value=0.013), and subjects are also less helpful in LOC in these early periods (p-value<0.001).

To better understand the differences in action frequencies, we examine the underlying strategies used by subjects [10,12,14,51-54]. We distinguish between seven strategies (Table 3) by adapting the method developed in [14] and consider the frequencies with which they are used and the payoffs they generate. Details of our classification procedures are provided in the supplementary online material [48].

Strategies are classified along two dimensions: whether they are ‘self-regarding’ or ‘other-regarding’ and whether they are ‘unconditional’ or ‘conditional’. The simplest three strategies are unconditional, prescribing an action irrespective of the recipient’s reputation, i.e., their recent

actions as a donor. The 'Defector' strategy snubs, the 'Altruist' strategy helps and the 'Spiteful' strategy hurts.

Table 3: Strategies in the indirect reciprocity tournament with hurting

	Self-regarding	Other-regarding	
		Positive	Negative
Unconditional	Defector	Altruist	Spiteful
Conditional	Cautious	Rewarder	Punisher, Retaliator

Conditional strategies make the action choice dependent on the recipient's (or the donor's own) reputation. The 'Cautious' strategy considers just the donor's own history as a recipient and helps only when its own reputation contains many snubs. The 'Rewarder' strategy helps recipients who have often helped but snubs others. The 'Punisher' strategy hurts recipients who fail to help but not those who often hurt others. The latter exclusion is to accommodate the 'Retaliator' strategy, which hurts only the recipients who often hurt. The Altruist, Rewarder and Punisher strategies are pro-social, promoting help and sanctioning snub, respectively. The Defector and Cautious strategies are selfish and free-ride on the other's help. The Retaliator and Spiteful strategies are anti-social, focused on the destruction of receivers' points.

More than 86% of the participants in our experiment can be classified in the categories of Table 3. Figure 4 shows for each treatment the frequency distribution across categories. In *GLO*, we observe many more Rewarders (31%) and Punishers (21%) than in *LOC* (6% and 8%, respectively; comparison between treatments: Rewarders p-value=0.012; Punishers p-value=0.044, permutation tests). These two strategies promote pro-social behaviour and increase social efficiency. We observe no Spiteful and far fewer Retaliator strategies in *GLO* (1%) than in *LOC* (where we observe 10% and 21%, respectively; both p-values<0.01 for cross-treatment differences). These promote anti-social behaviour that involves hurting, destroying resources without inducing helping behaviour in recipients [16,22]. These differences in strategies used lead to less hurting and more helping in *GLO* than in *LOC*, as theorized by [24].

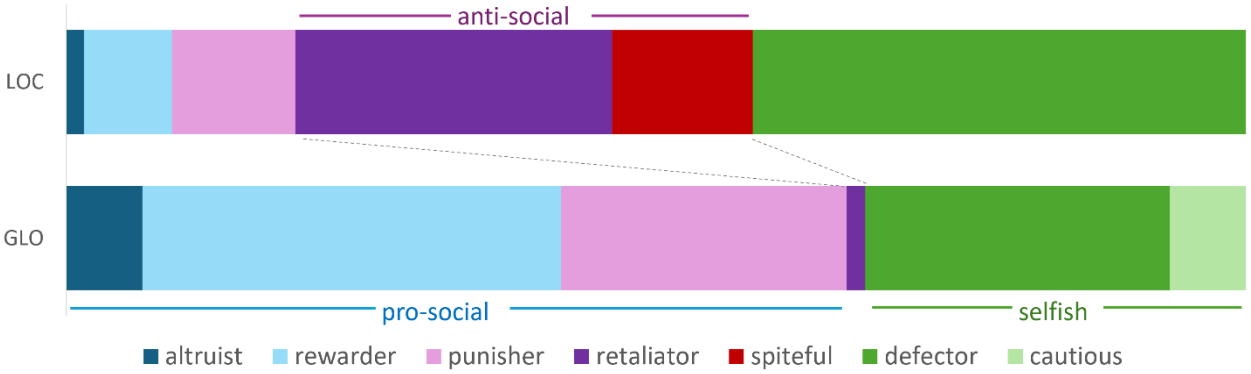

Figure 4: Relative frequencies of strategies used in the two treatments. Based on permutation tests with groups as unit of observation [46], Spiteful and Retaliator strategies are significantly more frequent in *LOC* than in *GLO*; Rewarder and Punisher strategies are significantly more frequent in *GLO* than in *LOC*. Other differences are statistically insignificant; see [48].

Whether these differences in strategy use are sustainable in the long run depends on their fitness, as measured here by the payoff consequences of using them. A strategy is successful if it provides higher earnings than other strategies. The monetary earnings of each strategy shown in Figure 5 are based on the average point earnings received in the donor and receiver roles, normalized with equal weights to each role average. We assign the monetary tournament payoffs based on the rankings of these normalized point earnings, and for each strategy calculate the average of these tournament payoffs across participants who apply the same strategy.

In *GLO*, rewarders earn significantly higher payoffs than any other strategy, suggesting that global competition makes rewarding—and thus conditional pro-sociality—profitable. By contrast, in *LOC* defector and rewarding strategies are equally profitable and earn more than punisher and spiteful strategies. Thus, in isolated groups the rewarding strategy has no advantage over defecting and may not be sustainable in the long run. Thus, with global competition cooperative rewarders have a fitness advantage vis-a-vis the non-cooperative defectors that they do not have in isolated groups. This suggests that in the long run, less pro-social behaviour will occur in isolated groups.

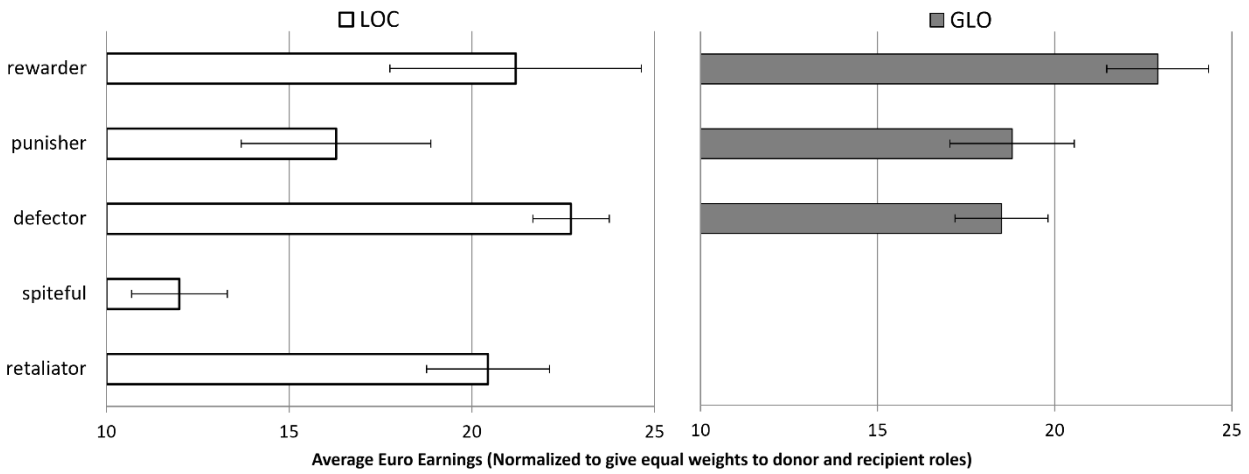

Figure 5: Monetary payoffs of the different strategies used in the two treatments. Only strategies used by at least five participants (in total) are shown. Payoffs in *LOC* are ordered Defector = Rewarder = Retaliator; Defector = Rewarder > Punisher but Retaliator = Punisher; and all 4 strategies > Spiteful, where ">" denotes a statistically significant difference at the 10% level or lower and "=" denotes a statistically insignificant difference with $p>0.1$ (based on cross-sectional regressions with standard errors clustered on matching groups; see the supplementary online materials [48] for p-values). In *GLO* payoffs are ordered Rewarder > Punisher = Defector. Normed earnings are constructed from mean payoffs in each (donor and recipient) role to give equal weights to the roles rather than unequal weights due to random role assignment. The corresponding strategy payoffs in points are presented and discussed in the supplementary online materials [46]. Error bars indicate ±SE of these average payoffs.

The relatively high fitness of the rewarder strategy in *GLO* is likely due to the (near) absence of the anti-social strategies spiteful and retaliator. In contrast, these strategies are frequently observed in *LOC*. The persistence of spite is somewhat surprising given its substantially lower monetary payoffs compared to all alternative strategies. This casts doubts on the evolutionary stability of spite in this environment. Retaliation is more profitable and frequent than spite and may be an alternative source of hurting between humans.

4. Discussion

Success in competition frequently depends on relative performance, as in the form of the tournament rankings introduced in our experiment. Yet the strategies that succeed in such interactions remain poorly understood. In particular, there is limited insight into how human pro-social behaviour fares in competitive environments. Our results highlight that the scale of competition—whether local, within individual groups, or global, spanning multiple groups—plays

a pivotal role in shaping the development of pro- and anti-social behaviour and strategies within this framework. Local competition fosters more hurtful behaviour–based on strategies involving spite and retaliation– compared to global competition. In contrast, global competition promotes pro-social behaviour—based on rewarding and pro-social punishment strategies—and yields the highest relative payoffs to those who engage in helpful behaviour.

The persistence of a spiteful strategy—when competition is local—despite its substantially lower monetary payoff is striking. Evolutionary biology offers several explanations for its persistence. Like altruism, spite can evolve in theory through correlated interactions among kin, though such equilibria tend to be unstable [16, 27]. It can evolve through negative assortment [55] and be maintained in specific interaction structures [56,57]. Our results show that in addition the occurrence and stability of spite depend on the scale of competition. This supports the prediction of the theoretical models regarding the role of the scale of competition for the evolution of spite and cooperation [24].

The adoption of spiteful and competitive behaviour in local competition documented here is reminiscent of some recent studies that observe increased willingness to compete with, and increased aggression towards, in-group members [58,59]. This highlights that in-group favouritism can be context specific. Our experiment demonstrates that the competition over a fixed set of resources within a group can trigger competitive and spiteful in-group behaviour.

Our results also offer new insight to understanding the consequences of the isolationist policies that are becoming increasingly popular around the world. Well-known disadvantages of isolation include economic inefficiencies that arise from trade barriers, reduced trust between nations, and lower collective action between nations aimed at addressing global-level public goods issues. Our findings identify another negative consequence of isolation; it weakens the fitness of pro-social strategies, promotes anti-social behaviour and reduces intra-group pro-sociality. Isolation may thus weaken not only the cooperation *between* nations, but also cooperation *within* nations.

5. Methods

156 subjects participated in the experimental sessions that were conducted at the CREED laboratory of the University of Amsterdam between 2006 and 2019. Participation was voluntary and subjects were recruited through email announcements from a standard university subject pool,

with approval from the Ethics Committee Economics and Business at the University of Amsterdam (approval reference 20190128040115). Each experimental session lasted approximately 60 minutes. Subjects' total earnings in euros were determined by the relative ranking of the points (denoted by 'francs' in the experimental instructions) earned over all the rounds of the indirect reciprocity game. The only difference between the treatments is how the ranking determined these euro earnings, as shown in Table 4. By design, average earnings were 20 euro in both treatments.

Table 4: Euro earnings as determined by points ranking

Local Competition (*LOC*) Separate groups of six participants		Global Competition (*GLO*) four groups of six participants	in parallel
Highest ranked in points:	30 euro	Highest ranked 1-4:	30 euro each
Second-highest ranked in points:	26 euro	Ranked 5-8:	26 euro each
Third-highest ranked in points:	22 euro	Ranked 9-12:	22 euro each
Fourth-highest ranked in points:	18 euro	Ranked 13-16:	18 euro each
Fifth-highest ranked in points:	14 euro	Ranked 17-20:	14 euro each
Lowest ranked in points:	10 euro	Ranked 21-24:	10 euro each

Each subject participated in only one session and none had previously participated in a similar experiment. Subjects were seated in separated cubicles, which ensured anonymity during the experiment. We consider each group of 6 subjects as one independent observation, because subjects only interacted with the other 5 subjects in their group.

The experiment was computerized and all interactions took place anonymously through computers. The supplementary online materials [48] contain the instructions script provided to subjects. At the end of an experimental session subjects were paid their euro earnings in private and in cash. In all treatments, subjects were informed of the matching procedure, the number of rounds, and how to calculate the payoff. The experiment was neutrally framed. The donor's choices were called 'blue' (help), 'green' (snub) and 'purple' (hurt).

Each session consisted of 100 rounds of the experimental game. In each round each six-subject cohort was randomly partitioned in three donor–recipient pairs. Therefore, pairing was independent of previous choice, distinguishing it from theoretical models such as [60]. A recipient

received no information about her donor and made no decision. A donor, however, learned the most recent three decisions made by her recipient.

By choosing between the three colours the donor decided whether she would help, hurt or snub the recipient. The recipient learned her donor's chosen colour and her own earnings in each round only after all donors had made and confirmed all their decisions. The round number was always visible and both the donor and the recipient could always access the information they observed and their own decisions in all past rounds. In each round a pair of matched subjects only saw the decision of the donor in their pair.

References

[1] Hong L, Page S (2004) Groups of diverse problem solvers can outperform groups of high ability problem solvers. Proceedings of the National Academy of Sciences 101(46):16385–16389

[2] Page S (2017) The diversity bonus: How great teams pay off in the knowledge economy. In: The Diversity Bonus: How Great Teams Pay Off in the Knowledge Economy. Princeton University Press

[3] Henrich J, Muthukrishna M (2021) The Origins and Psychology of Human Cooperation. Annual Review of Psychology 207-240.

[4] Rand DG, Nowak MA (2013) Human cooperation. Trends in Cognitive Sciences 17(8):413–425

[5] Sefton M, Shupp R, Walker JM (2007) The effect of rewards and sanctions in provision of public goods. Economic Inquiry 45(4):671–690

[6] Milinski M, Rockenbach B (2012) On the interaction of the stick and the carrot in social dilemmas. Journal of Theoretical Biology 299:139–143

[7] Boyd, R., & Richerson, P. J. (1992). Punishment allows the evolution of cooperation (or anything else) in sizable groups. *Ethology & Sociobiology*, 13(3), 171–195

[8] Fehr E, Gachter S (2000) Cooperation and punishment in public goods experiments. American Economic Review 90(4):980–994

[9] Gächter S, Renner E, Sefton M (2008) The long-run benefits of punishment. Science 322(5907):1510–1510

[10] Leimar O, Hammerstein P (2001) Evolution of cooperation through indirect reciprocity. Proceedings of the Royal Society of London Series B: Biological Sciences 268(1468):745–753

[11] Milinski M, Semmann D, Bakker TC, Krambeck, H-J (2001) Cooperation through indirect reciprocity: image scoring or standing strategy? Proceedings of the Royal Society of London Series B: Biological Sciences 268(1484):2495–2501

[12] Nowak MA, Sigmund K (1998) Evolution of indirect reciprocity by image scoring. Nature 393(6685):573–577

[13] Seinen I, Schram A (2006) Social status and group norms: Indirect reciprocity in a repeated helping experiment. European Economic Review 50(3):581–602

[14] Ule A, Schram A, Riedl A, Cason T (2009) Indirect punishment and generosity toward strangers. Science 326(5960):1701–1704.

[15] Dreber A, Rand D, Fudenberg D, Nowak M (2008) Winners don't punish. Nature 452:348–351

[16] Hamilton WD (1970) Selfish and spiteful behavior in an evolutionary model. Nature 228:1218–1220

[17] West SA, Gardner A (2008) Altruism, spite, and greenbeards. Science 327:1341– 1344

[18] Gardner A, West SA, Buckling A (2004) Bacteriocins, spite and virulence. Proceedings of the Royal Society of London Series B: Biological Sciences 271:1529–1535

[19] Raihani NJ, Bshary R (2019) Punishment: one tool, many uses. *Evolutionary Human Sciences* 1, e12

[20] Herrmann, B., Thöni, C., Gächter, S. (2008). Antisocial punishment across societies. *Science*, 319(5868), 1362–1367.

[21] Engelmann, J. B., Schmid, B., De Dreu, C. K. W., Chumbley, J., & Fehr, E. (2019). On the psychology and economics of antisocial personality. *Proceedings of the National Academy of Sciences*, 116(26), 12781–12786.

[22] Jensen, K. (2010). Punishment and spite, the dark side of cooperation. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365, 2635-2650.

[23] Boyd, R. (1982). Density-dependent mortality and the evolution of social interactions. *Animal Behaviour* 30(4): 972–982.

[24] Gardner A, West SA. (2004). Spite and the scale of competition, *Journal of Evolutionary Biology*, 17(6), 1195–1203

[25] Price ME, Cosmides L, Tooby J. (2002). Punitive sentiment as an anti-free rider psychological device. *Evolution and Human Behavior*, 23(3), 203–231.

[26] West SA, Pen I, Griffin AS. (2002). Cooperation and competition between relatives. *Science* 296: 72–75.

[27] Smead, R. & Forber, P. (2013). The evolutionary dynamics of spite in finite populations. *Evolution*, 67(3), 198-707

[28] Johnstone, R.A., & Bshary, R. (2004) Evolution of spite through indirect reciprocity. *Proceedings of the Royal Society of London, Series B: Biologiocal Sciences* 271 (1551), 1917-1922.

[29] Hopfensitz A, Reuben E. (2009) The Importance of Emotions for the Effectiveness of Social Punishment, *The Economic Journal*, 119(540) 1534–1559,

[30] Janssen, M. A., & Bushman, C. (2008). Evolution of cooperation and altruistic punishment when retaliation is possible. *Journal of theoretical biology*, 254(3), 541–545.

[31] Nikiforakis, N., & Engelmann, D. (2011). Altruistic punishment and the threat of feuds. *Journal of Economic Behavior & Organization*, 78(3), 319–332

[32] Rand, D. G., Armao IV, J., Nakamura, M., & Ohtsuki, H. (2010). Anti-social punishment can prevent the co-evolution of punishment and cooperation. *Journal of Theoretical Biology*, 265, 624-632.

[33] Bornstein, G., & Ben-Yossef, M. (1994). Cooperation in intergroup and single-group social dilemmas. *Journal of Experimental Social Psychology*, 30(1), 52–67.

[34] Boyd, R., Gintis, H., Bowles, S., & Richerson, P. J. (2003). The evolution of altruistic punishment. *Proceedings of the National Academy of Sciences*, 100(6), 3531–3535.

[35] Bowles S. (2006). Group competition, reproductive leveling, and the evolution of human altruism. *Science*, 314(5805), 1569–1572.

[36] Richerson, P., Baldini, R., Bell, A. V., Demps, K., Frost, K., Hillis, V., Mathew, S., Newton, E. K., Naar, N., Newson, L., Ross, C., Smaldino, P. E., Waring, T. M., & Zefferman, M. (2016). Cultural group selection plays an essential role in explaining human cooperation: A sketch of the evidence. *The Behavioral and brain sciences*, 39, e30.

[37] Barclay, P., & Stoller, B. (2014). Local competition sparks concerns for fairness in the ultimatum game. *Biology letters*, 10(5), 20140213.

[38] Barker JL, Barclay P (2016) Local competition increases people's willingness to harm others. Evolution and Human Behavior Volume 37(4): 315-322

[39] Lazear EP, Rosen S (1981) Rank-order tournaments as optimum labor contracts. Journal of Political Economy 89(5):841–864

[40] Sappington DE (1991) Incentives in principal-agent relationships. Journal of Economic Perspectives 5(2):45–66

[41] Frank R, Cook P (1995) The winner-take-all society. In: The Winner-Take-All Society. Simon and Schuster

[42] Harbring C, Irlenbusch B (2011) Sabotage in Tournaments: Evidence from a Laboratory Experiment. Management Science 57(4):611-627

[43] Montero-Porras, E., Grujić, J., Fernández Domingos, E. *et al.* (2022): Inferring strategies from observations in long iterated Prisoner's dilemma experiments. *Science Reports* **12**, 7589.

[44] Fehr, E. and S. Gächter (2002): "Altruistic Punishment in Humans," *Nature* 415, 137-140.

[45] Gunnthorsdottir A, Rapoport A (2006) Embedding social dilemmas in intergroup competition reduces free-riding. Organizational Behavior and Human Decision Processes 101(2):184–199

[46] Puurtinen M, Mappes T (2009) Between-group competition and human cooperation. Proceedings of the Royal Society B: Biological Sciences 276(1655):355–360

[47] Tan JH, Bolle F (2007) Team competition and the public goods game. Economics Letters 96(1):133–139

[48] Cason T, Riedl A, Schram A & Ule A (2025) Supplementary online material for Local Competition Promotes Hurtful Behavior Towards Unknown Others

[49] Fouraker L, Siegel S (1963) Bargaining behavior. In: Bargaining Behavior. McGraw-Hill

[50] Holt C (1985) An experimental test of the consistent-conjectures hypothesis. American Economic Review 75(1):314–325

[51] Huck S, Muller W, Normann HT (2001) Stackelberg beats Cournot: On collusion and efficiency in experimental markets. Economic Journal 111(2):749–766

[52] Kurzban R, Houser D (2005) Experiments investigating cooperative types in humans: A complement to evolutionary theory and simulations. Proceedings of the National Academy of Sciences 102(5):1803–1807

[53] Hagen EH, Hammerstein P (2006) Game theory and human evolution: A critique of some recent interpretations of experimental games. Theoretical Population Biology 69(3):339–348

[54] Wallace B, Cesarini D, Lichtenstein P, Johannesson M (2007) Heritability of ultimatum game responder behavior. Proceedings of the National Academy of Sciences 104(40):15631–15634

[55] Forber, P., & Smead, R. (2014). The evolution if fairness through spite. Proceedings of the Royal Society B: Biological Sciences, 281(1780), 20132439.

[56] Fulker, Z., Forber P., Smead, R., & Riedl, C. (2021). Spite is contagious in dynamic networks. Nature Communications, 12(1), 260.

[57] Hamilton, W.D. (1971). Selection of selfish and altruistic behavior in some extreme models. Man and Beast: Comparative Social Behavior, 57-91

[58] Cornaglia, F., Drouvelis, M., & Masella, P. (2019). Competition and group identity. Journal of Economic Behavior and Organization, 162, 136-145

[59] Romano, A., Gross, J., & De Dreu, C.K.W. (2024). The nasty neighbor effect in humans. Science Advances 10, eadm7968

[60] Kurokawa, S (2024) Evolution of spite versus evolution of altruism through a disbandment mechanism. Theoretical Population Biology 156:131-147.