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Original Article

No unique effect of intergroup competition on cooperation: non-competitive thresholds are as effective as competitions between groups for increasing human cooperative behavior

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ABSTRACT

Explaining cooperation remains a central topic for evolutionary theorists. Many have argued that group selection provides such an explanation: theoretical models show that intergroup competition could have given rise to cooperation that is costly for the individual. Whether group selection actually did play an important role in the evolution of human cooperation, however, is much debated. Recent experiments have shown that intergroup competitions do increase human cooperation, which has been taken as evidence for group selection as a mechanism for the evolution of cooperation. Here we challenge this standard interpretation. Competitions change the payoff structure by creating a threshold effect whereby the group that contributes more earns an additional prize, which creates some incentive for individuals to cooperate. We present four studies that disentangle competition and thresholds, and strongly suggest that it is thresholds – rather than competitions per se – that increase cooperation. Thus, prior intergroup competition experiments provide no evidence of a unique or special role for intergroup competition in promoting human cooperation, and shed no light on whether group selection shaped human evolution.

1. Introduction

Humans are exceptional in the extent to which they are willing to cooperate with unrelated others at costs to themselves (Melis & Semmann, 2010; Rand & Nowak, 2013). This high rate of cooperative behavior presents an evolutionary puzzle (Nowak, 2006): how can natural selection favor individual sacrifice? There are a number of explanations for why individuals are willing to make sacrifices to provide benefits to non-kin. For example, theories of reciprocal altruism and direct reciprocity (Axelrod & Hamilton, 1981; Delton, Krasnow, Cosmides, & Tooby, 2011; Nowak & Sigmund, 1992; Trivers, 1971) demonstrate how evolution can favor cooperation when individuals interact repeatedly. Indirect reciprocity and reputation models (Barclay, 2006; Boyd & Richerson, 1989; Leimar & Hammerstein, 2001; Nowak & Sigmund, 2005; Ohtsuki, Hauert, Lieberman, & Nowak, 2006) demonstrate that cooperation can evolve via third parties rewarding one individual's generosity toward another. And models of dynamic population structures, where individuals can choose whom to interact with, also allow the evolution of cooperation (Perc & Szolnoki, 2010; Santos, Pacheco, & Lenaerts, 2006; Skyrms & Pemantle, 2000)—a prediction that is borne out in social networks observed in the real world (Wu, Ji, He, Du, & Mace, 2015) as well as those constructed in the laboratory (Barclay & Raihani, 2016; Rand, Arbesman, & Christakis, 2011; Shirado, Fu, Fowler, & Christakis, 2013). These various mechanisms for the evolution and maintenance of cooperation all explain apparent self-sacrifice via long-run self-interest.

There is another mechanism for the evolution of cooperation that has been particularly controversial, in part because it does not require that cooperation be payoff-maximizing for individuals: group (or "multi-level") selection via intergroup competition. Theoretical models show that if cooperative groups out-compete non-cooperative groups, there are conditions under which selection for cooperation at the level of the group can outweigh selection for selfishness at the level of the individual, and cooperation can evolve despite being costly to individuals. Critically, this group-level selection process requires competition between groups, whether such competition is built directly into the payoff structure of the model (e.g., agents make decisions about whether to fight in competitions) (Choi & Bowles, 2007; García & van den Bergh, 2011) or operates via the model's evolutionary dynamic (e.g., successful groups divide, eliminating other groups in the process; or groups compete and replace each other) (Boyd, Gintis, Bowles, &

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Richerson, 2003; Gintis, 2000; Traulsen & Nowak, 2006; Wilson & Sober, 1994). Either way, it is intergroup competition that is driving the evolution of cooperation in these models.

While it is clearly theoretically possible for competition between groups to lead to the evolution of cooperation, it is much less clear whether the conditions needed for group selection were actually met over human evolution. What is contested, therefore, is not whether group selection is theoretically possible, but rather whether (and to what extent) group selection actually contributed to the evolution of human cooperation (Boyd et al., 2003; Burnham & Johnson, 2005; Burton-Chellew, Ross-Gillespie, & West, 2010; Fehr, Fischbacher, & Gächter, 2002; Gintis, Bowles, Boyd, & Fehr, 2003; Sterelny, 1996; West, El Mouden, & Gardner, 2011; West, Griffin, & Gardner, 2007; Wilson & Sober, 1994). In recent years, some researchers have attempted to shed light on this empirical question—for example, by examining anthropological evidence to estimate relevant parameters like levels of mortality in intergroup conflicts and variance between groups (Bell, Richerson, & McElreath, 2009; Bowles & Gintis, 2011; Bowles, 2009).

Laboratory experiments have also been used to investigate the impacts of between-group competition on within-group cooperation, both using real-world conflicts between real groups (Gneezy & Fessler, 2012; Silva & Mace, 2015; Voors et al., 2012) and in-lab competitions between artificially constructed groups (Bornstein, Gneezy, & Nagel, 2002; Cárdenas & Mantilla, 2015; Erev, Bornstein, & Galili, 1993; Gunnthorsdottir & Rapoport, 2006; Puurtinen & Mappes, 2009; Sääksvuori, Mappes, & Puurtinen, 2011; Tan & Bolle, 2007). Typically, these experiments have found that between-group competitions do increase within-group cooperation (but see Silva & Mace, 2015). These results have been interpreted as evidence that intergroup competition did in fact play a role in the evolution of human cooperation via group selection (e.g., Puurtinen & Mappes, 2009; Sääksvuori et al., 2011).

Here, we challenge this interpretation of prior intergroup competition studies. Specifically, we point out that previous studies do not necessarily provide evidence of a specific or unique effect of group competitions on cooperation. Adding group competition to a cooperation game can also introduce a second factor that influences cooperation—threshold effects (Archetti & Scheuring, 2012). Studies in which groups compete over a prize manipulate not only the presence of intergroup competition, but also whether a non-linearity exists in an individual's payoff function: the group that contributes more (i.e., crosses a contribution threshold) wins a prize that is shared equally by that group's members. Because such thresholds mean that contributing increases the probability that one's group, and thus oneself, will earn this prize, contributing in the presence of a threshold can sometimes be self-interested, and it is possible that the threshold alone is what drives increased cooperation. If so, adding a threshold should increase cooperation regardless of the whether or not group competition is involved. Thus, previous intergroup competition experiments confound competition and thresholds, and do not necessarily provide any evidence of a specific causal role of intergroup competition on within-group cooperation (as compared to other thresholds).

Across four studies, we de-confound competition and thresholds for the first time. We ask whether introducing competition between artificial groups has an independent causal effect on cooperation in laboratory experiments, above and beyond the effect of adding a threshold. We do this by comparing Public Goods Game (PGG) contributions in (i) control PGGs that do not involve interacting with other groups, (ii) PGGs that add a competitive, zero-sum threshold in which a prize is won by one of two competing groups (as is typical in PGG experiments on intergroup competition), and (iii) PGGs that add a threshold that is not zero-sum and not competitive, such that group members all receive a prize if their total contribution is high enough to surpass a threshold (without causing another group to not receive a prize).

If the results of previous group competition studies were driven specifically by group competition, we should observe greater contributions in PGGs with competitive zero-sum thresholds than standard PGGs or PGGs with non-zero-sum thresholds, because competitions contain both a threshold and a zero-sum competition. If, on the other hand, thresholds were sufficient to account for previous results, we should observe that competitive and non-competitive thresholds both elicit equal cooperation, and elicit more cooperation than control PGGs.

2. General methods and materials

2.1. Participants

Across four studies, we recruited 2828 participants from Amazon's Mechanical Turk (Amir & Rand, 2012; Horton, Rand, & Zeckhauser, 2011) (53% male, mean age = 34 years). Participants were only permitted to take part in one study and were excluded from all other studies once they had participated.

2.2. Procedure

In each of the four studies we (i) assigned subjects to groups; (ii) provided the instructions for a single one-shot public goods game (PGG) (in which subjects made one cooperation decision); (iii) assigned subjects to an experimental condition (through which we manipulated the threshold structure of the PGG), and then measured (iv) cooperation in the PGG and (v) attitudes toward in-group and out-group members. The four studies all proceeded in this order, although the experimental conditions differed.

Specifically, we began each experiment by assigning participants to groups of size 10. We then asked participants to read instructions and answer comprehension questions about both the PGG and its threshold structure (see Appendix for full instructions and comprehension questions). In the PGG, each participant started with 30 monetary units and decided how much to contribute to their group's public good, in increments of 5 units (units were converted to pay at a rate of 1 unit per cent). All contributions to the public good were doubled and then distributed equally among the group's 10 participants, independent of their individual contributions; thus, contributing everything was payoff-maximizing for the group, but contributing nothing was payoff-maximizing for the individual. On top of this basic PGG structure, we varied across conditions (i) whether there was the possibility of earning an additional prize if the group contributed a sufficient amount, and (ii) the precise form of this threshold (as described in more detail below).

After making their contribution decisions, participants answered several questions designed to investigate their regard for members of their own group, and of other groups. Specifically, participants reported how happy they would be if (i) an in-group and (ii) an out-group member (a) lost and (b) won money in a future study. We then computed participants' regard for in-group members (happiness if an in-group member won money, minus happiness if an in-group member lost money), and the same for out-group members. See Appendix for details.

Participants received a show-up fee immediately after finishing the study. Then, after all data were collected, we grouped participants together and calculated their payoffs, which were paid as "bonuses" through Mechanical Turk. These studies were approved by the institutional review board at Yale University. All participants consented prior to participation.

3. Study 1

3.1. Methods

In our first study, we manipulated the threshold structure of the PGG across three experimental conditions: control PGG (standard PGG game), Competition (a threshold PGG game involving a zero-sum competition with another group), or Social Threshold (a threshold PGG game involving a non-competitive *comparison* to another group). (See Appendix for exact instructions).

In the *Control* condition, participants did not have an opportunity to earn any additional money beyond what they earned in the PGG.

In the *Competition* condition, participants were told that they were competing with another group for an additional monetary prize of 10 units per participant. If their group contributed more in total than the other group, then they would win and each member of their group would receive 10 extra units, while the other group would receive nothing extra (and vice versa if the other group contributed more). Thus, participants in the Competition condition engaged in a zero-sum interaction with another group, where only one of the two groups could win the prize.

Similarly, in the *Social Threshold* condition, participants were told that each member of their group would receive a 10-unit prize if they contributed more than another group had previously contributed. Critically, however, the payoffs of this comparison group would *not* be affected in any way by the amount that the participants' group contributed. Thus, participants in the Social Threshold condition attempted to meet a threshold set by another group in a *non*-zero-sum, non-competitive interaction—it was possible for the Social Threshold groups to win the prize without causing another group to not receive a prize.

In both the Competition and Social Threshold conditions, groups had to exceed a level of total contribution (as determined by another group) in order to earn an additional prize. If competition per se, and not simply the presence of a threshold, promotes cooperation, we should expect to find that participants in the Competition condition give more to the public good than those in the threshold condition because the only relevant difference between the two conditions is the competitive (i.e., zero-sum) nature of the interaction.

3.2. Results and discussion

We first examined the effect of our manipulations on average fraction contributed in the PGG (Fig. 1A). An ANOVA revealed a significant effect of condition, $F(2,401) = 4.72$, $p = 0.009$, with participants in the Control condition contributing less ($M = 0.517$, $SD = 0.455$) than those in the Competition condition ($M = 0.648$, $SD = 0.433$) and the Social Threshold condition ($M = 0.696$, $SD = 0.412$). Pairwise *t*-tests revealed a significant difference between the Control condition and the (combined) Competition and Social Threshold conditions, $t(400) = 2.932$, $p = 0.004$, but no significant difference between the two threshold conditions, $c301) = -0.937$, $p = 0.349$, indicating that there was no additional effect of competition beyond the threshold effect. (The results are qualitatively equivalent when controlling for comprehension, or when excluding participants who failed the comprehension checks; see Appendix for further details).

Study 1 thus replicates previous findings that competition increases cooperation (Bornstein et al., 2002; Erev et al., 1993; Gunnthorsdottir & Rapoport, 2006; Puurtinen & Mappes, 2009; Sääksvuori et al., 2011; Tan & Bolle, 2007) but suggests that this effect does not require competition per se. Instead, our results suggest that competition effects can be fully explained by the presence of a threshold (which is present equally in the Competition and Social Threshold conditions): our Social Threshold condition elicited just as much cooperation as the Competition condition even though the Social Threshold condition was not competitive (i.e., zero-sum).

One possibility, however, is that our Social Threshold condition implicitly activated psychological mechanisms designed for intergroup competition, even though competition was not actually present. It might be the case that what sets off intergroup competition psychology is group comparison generally, rather than group comparison in the context of a zero-sum competition, and Study 1 simply documented a spillover effect (Peysakhovich & Rand, 2015) from zero-sum to non-zero-sum threshold interactions. In order to address this concern, in Study 2 we introduced a *Non-Social Threshold* condition which could not plausibly activate intergroup psychology. This condition involved a threshold, but no other group. If our previous results captured a spill-over effect from zero-sum to non-zero-sum threshold games, then the non-social threshold should look more like the Study 1 control PGG than the Competition or Social Threshold conditions. However, if our interpretation is right that any threshold increases cooperation (regardless of if it involves a group comparison), the Non-Social Threshold should induce just as much cooperation as the other treatment conditions.

4. Study 2

4.1. Methods

Study 2 replicated the conditions used in Study 1 and added a *Non-Social Threshold* condition that completely removed the presence of a comparison group. Participants in the Non-Social Threshold condition earned a prize in Stage 2 if their group contributed more than a randomly determined benchmark; thus, they did not compare their group's contributions to those of another group. To constrain expectations about the threshold across our three threshold conditions (Competition, Social Threshold and Non-Social Threshold), we told participants in all three conditions that they could expect the relevant threshold to be around 200 out of a possible 300 units (roughly the mean contribution from the Competition and Social Threshold conditions in Study 1). In the Competition and Social Threshold conditions, we explained that other groups typically contributed around 200 units, and in the Non-Social Threshold condition, we explained that the randomly determined benchmark was typically around 200 units.

4.2. Results and discussion

We predicted that Study 2 (Fig. 1B) would replicate the results from Study 1, and that we would observe similar levels of cooperation in the Non-Social Threshold condition as the Competition and Social Threshold conditions. Indeed, an ANOVA found a significant effect of condition on Study 2 contributions, $F(3,467) = 5.11$, $p = 0.002$, with the Control condition ($M = 0.544$, $SD = 0.455$) contributing less than the Competition ($M = 0.719$, $SD = 0.392$), Social Threshold ($M = 0.747$, $SD = 0.356$) and Non-Social Threshold ($M = 0.713$, $SD = 0.406$) conditions. A *t*-test revealed a significant difference between the Control condition and all other conditions, $t(466) = 3.87$, $p < 0.001$. Furthermore, an ANOVA that excluded the Control condition found no significant differences between the three threshold conditions, $F(2,377) = 0.21$, $p = 0.807$. Thus, the Non-Social Threshold condition elicited as much cooperation as the Social Threshold and Competition conditions.

Together, these data suggest that any threshold, regardless of whether it is zero-sum or social, equally promotes cooperation within groups. Thus, the results observed in the Social Threshold condition are likely caused by the mere presence of a threshold, not the psychology of comparing different social groups.

One final alternative explanation for our results stems from the target we used. By suggesting that participants in all three non-control conditions aim for a concrete target of around 200 units (but not providing a target in the control condition), it is possible that Study 2 artificially inflated the difference between the control and the three non-control conditions. To address the possibility that these conditions elicited increased cooperation because of the target (rather than a threshold effect), Study 3 replicated the conditions of Study 2 and added a 200-unit target to the Control condition. If participants in the three treatment conditions were merely responding to the 200-unit target, rather than the strategic consequences of a threshold, we should observe that adding a 200-unit target to the Control condition induces a similar increase in cooperation as in the three other conditions. However, our theory predicts that subjects in a Control condition with a target but not a threshold will still contribute less than subjects in the three threshold conditions.

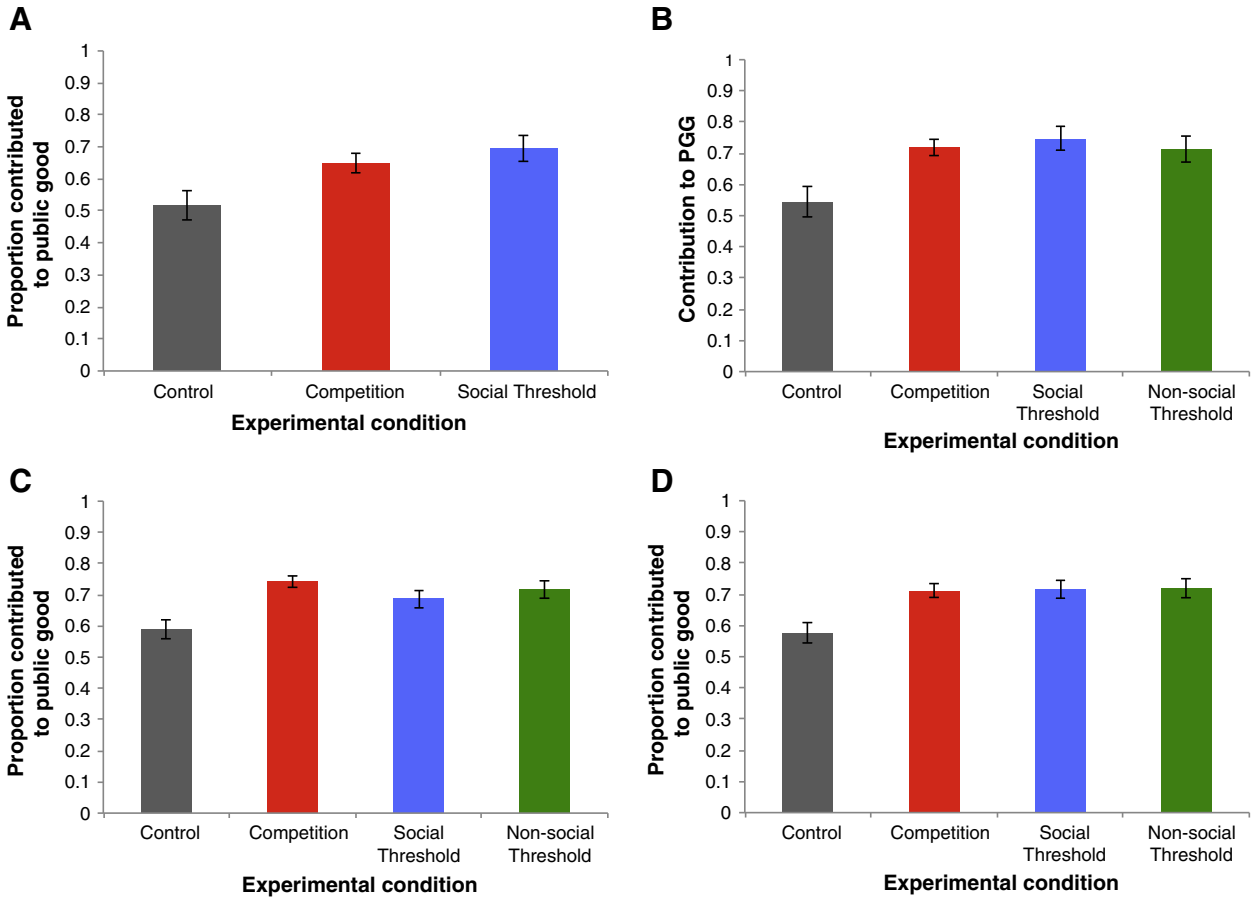

Fig. 1. PGG contributions across conditions for each of Studies 1–4. (Panel A) Contributions in Study 1 show that the Competition and Social Threshold conditions elicit more cooperation than the Control condition, but do not differ from each other. (Panel B) In Study 2, we added the Non-Social Threshold condition, in which there is no other group present. Despite the lack of another group, participants contributed the same fraction of their endowment to the public good as in the Competition and Social Threshold conditions. (Panel C) In Study 3, all participants, including those in the Control condition, were provided with a concrete target of 200 units, yet all three threshold conditions still promoted more cooperation relative to the control condition. (Panel D) In Study 4, despite the replacement of a monetary prize (Studies 1–3) with a symbolic prize, we observe the same pattern of contribution across the four conditions.

5. Study 3

5.1. Methods

Study 3 directly replicated the conditions of Study 2, and added a 200-unit target to the Control condition. In this new Control condition we told participants that groups typically contribute 200 out of 300 units.

5.2. Results and discussion

Study 3 (Fig. 1C) found the same pattern as in Studies 1 and 2. An ANOVA revealed a significant effect of condition on contributions, $F(3,1011) = 6.77$, $p < 0.001$, with the Control condition ($M = 0.589$, $SD = 0.432$) contributing less than the Competition ($M = 0.742$, $SD = 0.390$), Social Threshold ($M = 0.687$, $SD = 0.406$) and Non-Social Threshold conditions ($M = 0.716$, $SD = 0.393$). A t-test revealed a significant difference between the Control condition and all other conditions ($M = 0.722$, $SD = 0.395$), $t(1010) = 4.21$, $p < 0.001$. Furthermore, an ANOVA that excluded the Control condition found no significant differences between the three threshold conditions, $F(2,755) = 1.32$, $p = 0.268$.

The results of Study 3 show that adding a concrete target to the Control condition did not change the observed pattern of findings. Increased cooperation in the threshold conditions thus reflects the presence of thresholds, rather than a contribution target. Together, these three studies suggest that neither zero-sum competitions nor the presence of other groups is necessary to increase within-group cooperation: whenever participants have the opportunity to earn a monetary prize by crossing a contribution threshold, cooperation increases to the same degree.

Finally, we consider the fact that some previous studies have found that group competitions can increase cooperation even when a monetary prize is *not* at stake (Böhm & Rockenbach, 2013; Burton-Chellew & West, 2012; Tan & Bolle, 2007). In other words, simply telling participants that their group is competing with another group has been shown to increase within-group cooperation. Such effects cannot be explained as reflecting a threshold for a material prize (as no material prize is present). Thus, if the threshold effect we observed above is unique to material prizes, the fact that group competition effects extend to non-monetary prizes could reflect the effect of a group-competition psychology that operates above and beyond threshold effects.

However, it may be that people are motivated to win prizes even when they confer no material benefit—and thus that the previously discussed threshold effect *does* extend to non-material prizes. For instance, symbolic labels such as “winner” or “champion” may typically be associated with positive outcomes outside the lab, such as status and reputational benefits. Under this account, competition should still increase cooperation when the only benefit of winning is being labeled a winner, for the same reason that competition increases cooperation when a material prize is at stake: both introduce the possibility of a

desired outcome (be it a material or symbolic prize) if a contribution threshold is crossed. In Study 4, we test this hypothesis by asking if we can replicate the results from the three previous studies when we replace the material prize with one that is purely symbolic.

6. Study 4

6.1. Methods

Study 4 replicated the conditions used in Study 3 with one exception: in all conditions the 10-cent prize for crossing the threshold was replaced with a symbolic prize. Specifically, participants in groups that crossed the threshold were given the label of a "gold-star contributor" (to represent their membership in a high-contribution group). Our theory predicts that we should observe the same pattern of increased cooperation in the presence of a symbolic prize, even in the non-competitive threshold conditions.

6.2. Results and discussion

Study 4 (Fig. 1D) found the same pattern as in Studies 1–3. An ANOVA revealed a significant effect of condition on contributions, $F(3,945) = 5.66$, $p < 0.001$. Again, we found that contributions in the Control condition ($M = 0.576$, $SD = 0.442$) were lower than in the Competition ($M = 0.711$, $SD = 0.408$), Social Threshold ($M = 0.716$, $SD = 0.404$) and Non-Social Threshold conditions ($M = 0.719$, $SD = 0.401$). A *t*-test revealed a significant difference between the Control condition and all conditions, $t(944) = 4.12$, $p < 0.001$. Furthermore, an ANOVA that excluded the Control condition found no significant differences between the three treatments, $F(2,755) = 0.02$, $p = 0.978$. These results show that, even when prizes are purely symbolic, they elicit increased cooperation; and, replicating the results from Studies 1–3, all of our threshold conditions still elicit equal levels of cooperation, regardless of the presence of competition or another group. This suggests that even in settings where there is no material benefit to winning a competition, the positive effect of group competition on cooperation can be explained as a threshold effect. Furthermore, our results from Study 4 demonstrate that a sensitivity to threshold games may "spill over" to contexts where there is no material reward for crossing a threshold. This could suggest that such a spillover process could also explain the finding that mere group comparison (without explicit reference to *any* rewards, even immaterial ones) increases within-group cooperation as well (Böhm & Rockenbach, 2013; Burton-Chellew & West, 2012): these effects may be driven by the implicit promise of immaterial prizes, such as social status and reputation.

7. Aggregated data

Together, our results paint a consistent picture: in each of our four studies, all thresholds promote cooperation equally, regardless of whether or not they are social, and whether or not they are competitive. Because our key finding is a null result (i.e., there is no effect of competition above the effect of non-competitive thresholds), we aggregate the data over all our studies (total $N = 2828$) and demonstrate that there is still no significant difference between threshold conditions in this much larger dataset.

7.1. Contributions

In our aggregated dataset, we still find no difference between the Competition condition and the two non-competitive threshold conditions, $F(2,2243) = 0.06$, $p = 0.939$ (Fig. 2A). We next provide context for this null effect with a power analysis. Our power analysis reveals that our aggregated dataset had 80% power to detect a difference between the competition condition and the combination of the Social Threshold and Non-Social Threshold conditions of 4.84 percentage points or more. Likewise, our dataset had 80% power to detect a difference of 5.67 percentage points and 5.84 percentage points between the competition condition and the Social and Non-Social Threshold conditions, respectively. Therefore, if our null result is due to a lack of power to detect a true effect, these values provide a likely upper bound for how large that effect could have been.

Next, we use Gallistel's (2009) procedure for "proving the null" in order to conduct a Bayesian analysis of the degree to which we should favor the null hypothesis over any alternative hypothesis. The analysis shows that we have strong evidence in favor the null hypothesis that the Social Threshold and Non-Social Threshold are no different than the Competition condition. In particular, the odds in favor of the null were 18.9:1 and 17.9:1 when comparing the Competition condition to the Social Threshold and Non-Social Threshold conditions, respectively. See Appendix for details.

7.2. Regard for in- and out-group members

We next investigate the psychological consequences of our different threshold treatments, using our aggregated dataset. It is possible that we found no differences between our different threshold treatments on contributions because participants were not paying close enough attention to the differences between them. However, by assessing factors other than cooperation, we are able to show that the different treatments *did* have measurably different effects on some outcomes. Recall that after measuring participants' PGG contributions in Studies 1–4, we also measured their attitudes toward in-group and out-group members. We asked participants how happy they would be if a member of their group, or another group, won or lost money in a future study. We used these data to measure regard for in-group members (difference in reported happiness between if an in-group member won versus lost money) and out-group members (same difference, but for an out-group member), and then explored the effect of our different conditions on these measures (Fig. 2B, C). Specifically, we asked whether competitions are particularly effective, relative to other thresholds, at either engendering antagonism between members of different groups (i.e., decreasing out-group regard) or binding together members of the same group (i.e., increasing in-group regard).

7.2.1. Out-group regard

Beginning with regard for out-group members, we found a significant effect of condition, $F(3,2827) = 10.97$, $p < 0.001$, with participants in the *Competition* condition ($M = 0.068$, $SD = 0.418$) reporting significantly less positively toward out-group members than those in the Control ($M = 0.167$, $SD = 0.359$), Social Threshold ($M = 0.125$, $SD = 0.393$) and Non-Social Threshold ($M = 0.157$, $SD = 0.391$) conditions. A *t*-test revealed a significant difference between out-group regard in the Competition condition and all other conditions, $t(2826) = 5.42$, $p < 0.001$. Furthermore, an ANOVA excluding the Competition condition found no effect of condition on out-group regard, $F(2,1645) = 1.91$, $p = 0.149$. Thus, the Competition condition decreased regard for out-group members relative to all other conditions, indicating that, although there were no differences in cooperation across treatments, the treatments *were* psychologically different in relevant ways.

7.2.2. In-group regard

A different pattern emerged, however, when testing for in-group regard. We again found a significant effect of condition, $F(3,2827) = 3.47$, $p = 0.015$, but this time it was participants in the Control condition ($M = 0.354$, $SD = 0.354$) who reported significantly less positively toward in-group members than those in the Competition ($M = 0.398$, $SD = 0.328$), Social Threshold ($M = 0.408$, $SD = 0.333$) and Non-Social Threshold conditions ($M = 0.411$, $SD = 0.336$). A *t*-test revealed a significant difference between those in the Control condition and all other conditions, $t(2826) = 3.13$, $p < 0.001$. Finally, an ANOVA excluding the Control condition found no effect of treatment, $F(2,2244) = 0.33$, $p =$

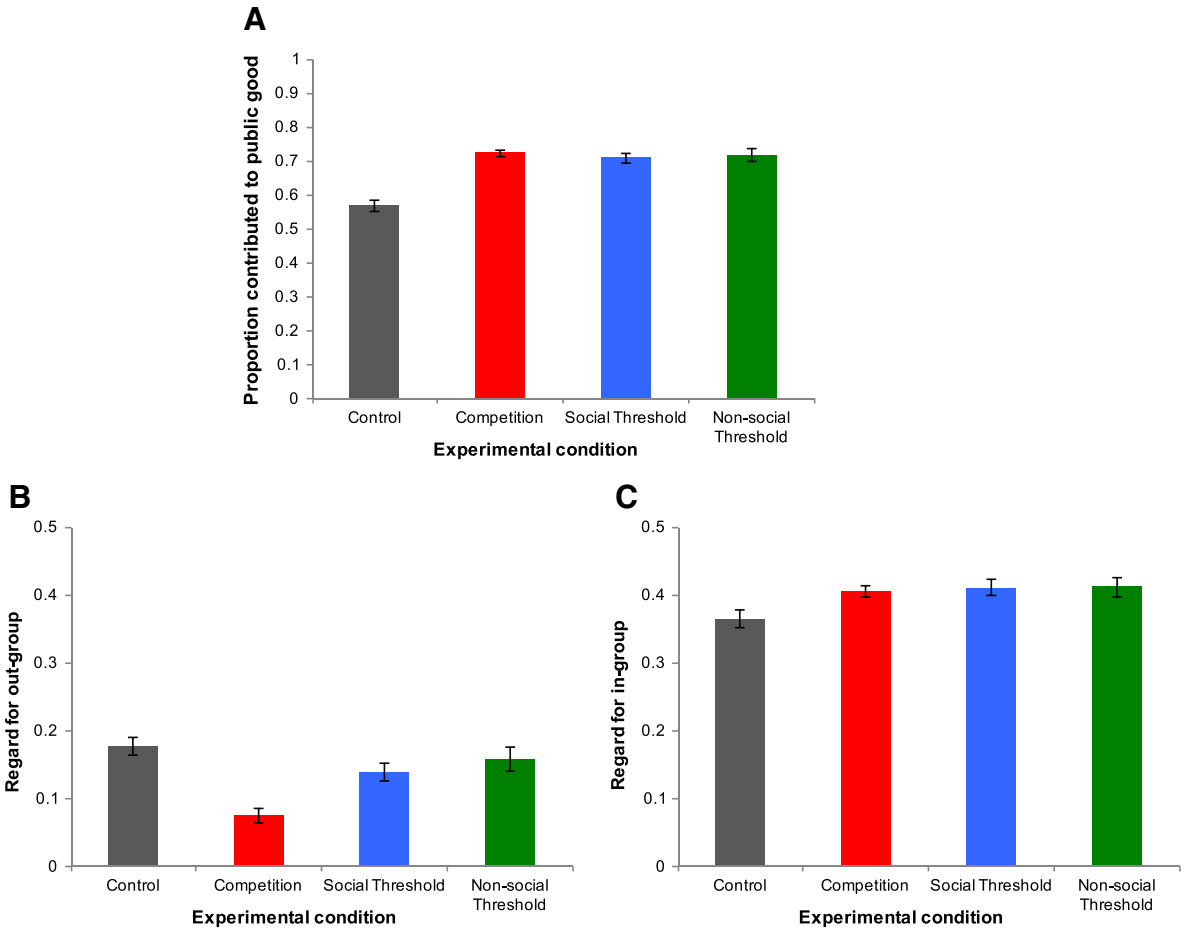

Fig. 2. Analyses of aggregated PGG contribution and in-group and out-group regard data from Studies 1–4. (Panel A) The aggregated PGG contribution data from Studies 1–4. The three treatment conditions were remarkably similar in the degree to which they promote cooperation. (Panel B) Regard for out-group members was reduced in the Competition condition, relative to non-competitive thresholds and the Control condition. (Panel C) The presence of any kind of threshold, competitive or non-zero-sum, promotes in-group positivity more than in the Control condition, which provided no threshold of any kind. Panel

0.719. These results show that all of our threshold conditions induced more positive regard for in-group members than the Control condition, but they did not differ significantly from each other. Thus, our analyses investigating regard for in-group members mirror the results from our analyses of contributions: in-group positivity is driven by the presence of a threshold, not by intergroup competition.

Together, then, these analyses demonstrate that while all thresholds elicit equal regard for in-group members and equal within-group cooperation, competitive thresholds uniquely decrease regard for out-group members.

8. General discussion

Across four studies investigating the effect of artificially constructed group competitions on public goods contributions, we have demonstrated that there is no unique or specific effect of between-group competition on within-group competition. Introducing group competition to a public goods game fundamentally changes its payoff structure, creating a threshold game (Archetti & Scheuring, 2012). In doing so, group competitions create additional individual incentives to cooperate that are unrelated to the fact that groups are competing. We have shown that this general change from a standard PGG to a threshold game can entirely explain any increases in cooperation: we consistently found that all thresholds increase cooperation, and that it is not necessary for the thresholds to be zero-sum competitions, to be social in nature, or to result in monetary rewards.

Our results thus clearly demonstrate that previous intergroup competition experiments do not provide any positive evidence of an independent effect of competitions *per se* on cooperation (i.e., in which conceiving of oneself as competing with another group increases contributions, regardless of the threshold structure of the game). Furthermore, these results suggest that such an effect is unlikely to exist. Our competition condition, which involved *both* an intergroup competition and a threshold structure, consistently elicited *no more* cooperation than our non-competitive threshold conditions. If conceiving of oneself as competing with another group increases cooperation, it would have to be that this effect interacts negatively with the presence of a threshold structure such that it has *no effect* in the presence of a threshold. Otherwise, we would have observed a (second) main effect of competitions, over and above the main effect of thresholds, resulting in higher contributions in the group competition condition than in the non-competitive threshold conditions.

In addition to their implications regarding the evolution of human cooperation, our results also have implications for the way that different kinds of competition play out in modern societies. We found that our three treatment conditions had different consequences for the way participants felt about others: while all treatments resulted in equal levels of regard for in-group members, competitions produced less regard for out-group members than our other conditions. Thus, non-competitive thresholds are as good as competitive thresholds at promoting cooperation with in-group members, as well as regard for in-group members, and may limit the amount of out-group derogation that comes with typical competitions. Therefore, it may be more

effective and socially beneficial to motivate cooperation with non-competitive thresholds rather than intergroup competitions. In other words, although the psychological differences we observed in out-group and in-group regard across conditions did not correspond to behavioral differences in cooperation, they might correspond to differences in other behaviors, like antisocial spite toward outgroups.

In sum, our results show that while inter-group competition robustly increases cooperative behavior, this effect can be entirely explained by the introduction of a threshold effect, and does not require any psychological processes unique to intergroup competition.

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