

# How do outcome-based competitive relationships shape future risky cooperation?

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## Research Article

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# Abstract

There is growing evidence that cooperative behavior between individuals is regulated by their experience of previous interactions with others. However, it is unclear how a relationship that stems from the evaluation of outcomes from competitive interactions can affect subsequent cooperation between these individuals. To address this issue, we examined how participants cooperated with a partner having just competed with them. While competing, participants ( $N = 164$ ) were randomly assigned to receive one of four types of outcome feedback regarding their performance (win vs. loss vs. uncertain vs. control). We found that both the experience of loss and of uncertainty as competitive outcomes exerted a negative impact on the extent to which participants then engaged in mutually cooperative behavior toward their opponents. Moreover, these effects operated in a context-dependent manner: they were only found when we manipulated the relational context to imply a high potential for incurring personal costs rather than imply no risk for incurring personal costs and mutual gains. Finally, our mediation analysis further revealed that the effect of the loss outcome was mediated by the intention of participants to cooperate and their level of interpersonal trust, while the effect of uncertain competitive outcome was mediated only by the extent to which participants intended to cooperate. This suggests the presence of distinct psychological processes underlying the effects of these two types of competitive outcome. Taken together, these findings offer novel insight into how risky cooperation may cascade from previous exposure to competitive settings.

## 1. Introduction

Mutually cooperative behavior is a basic form of cooperation, which is characterized by the universally positive outcomes brought about by an interaction between individuals (Bshary & Bergmueller, 2008; West et al., 2007). The vast majority of existing research has focused on the impact of cooperative decisions between individuals that have no prior history of interactions. Such an approach fails to fully capture the essence of typical cooperative interactions since, in daily life, interactions between individuals are generally relationally-dependent (Rusbult & Van Lange, 2003). Cooperative behavior between individuals is likely to vary as a consequence of who is involved and the nature of their relationships. One type of human social relationship that exerts a particularly pervasive influence on a wide range of human behaviors is one that involves interpersonal competition (Kilduff et al., 2010; Snyder-Mackler et al., 2020). For this reason, increasing efforts have been devoted to determining the extent to which mutually cooperative behavior between individuals is regulated by the nature of their competitive relationships (Deutsch, 2011; Fehr & Schmidt, 1999).

With the recognition that competitive relationships with others typically originate through direct competition, one line of research has advanced our understanding on this matter by showing that individuals are often less cooperative toward their opponents during direct competition (Bissey et al., 2003; West et al., 2006). Moreover, the nature of competitive relationships between individuals can be determined by the evaluation of outcomes from previous competitive interactions. This highlights the need to explore the degree to which competitive outcome-driven relationships can influence mutually

cooperative behavior. A preliminary study revealed that, compared to a control group and a group of participants who had won in a competitive scenario, those who had lost and those who had participated in competition, beyond a specific competitive outcome, showed lower levels of subsequent cooperation toward others who were not involved in the previous competition (Buser & Dreber, 2016). Although encouraging, this somewhat indirect evidence does not go far enough in investigating the question of whether and how much competitive outcome-driven relationships are able to affect individuals' subsequent mutually-cooperative behavior toward their opponents.

We thus designed the present study to promote our understanding of this question. In this study, participants engaged in two key stages: a competition stage and a cooperation stage. In the first stage, once participants had competed against their opponents on a competitive task, they were given one of four types of outcome feedback (win vs. loss vs. uncertain competitive outcome vs. control). Outcome feedback relating to whether participants won or lost during a competition condition has been revealed to determine the nature of their competitive relationships with opponents. For example, prevailing over one's opponent (win) signals relative competitive advantage (dominance), while conceding defeat signals (loss) relative competitive disadvantage (deference) (Casto & Mehta, 2019; Rustichini, 2008). In addition, previous work showed the impact of competition participation in the absence of explicit relative performance feedback (uncertain competitive outcome) on subsequent social behavior (Black et al., 2019; Moyal & Ritov, 2020). This is also akin to a typical everyday competitive scenario in which people are never explicitly informed about the outcome of their competitive performance. We thus included this type of outcome feedback to explore its possible role in the subsequent cooperation of participants toward their opponents. Performance-based competition has been found to regulate both self-evaluations of one's own abilities such as self-confidence (Caruso et al., 1990) and interpersonal relationships such as closeness and trust (Huck et al., 2012; Lee et al., 2016). Consequently, immediately after outcome feedback, we asked participants to provide a rating of self-confidence as well as ratings of their feelings of interpersonal closeness and trust toward their opponents. In the second stage, participants performed alongside their previous opponent in playing a modified version of the two-person public goods game (PGG). Together with their actual cooperative behavior toward their opponents, participants also provided a number of self-report measures. This included an assessment of their intention to cooperate preceding each decision as well as a prediction of the intention of their opponents to cooperate and the amount that they would contribute. Previous work regarding the PGG has shown that, by increasing the factor that is used to multiply the contribution from players and thus collective gains, it is possible to produce higher levels of cooperation among individuals (Isaac et al., 1994). We manipulated this variable to create three distinct relational contexts. These contexts meant that, when participants contributed, they would face either a high risk for incurring personal costs, no risk of incurring personal costs or mutual gains.

Based on recent findings (Buser & Dreber, 2016), we can predict that, after receiving negative (loss) or uncertain competitive outcome regarding their performance in competition, participants would subsequently decrease their intention to cooperate with opponents as well as their contribution to the public good. Moreover, previous work revealed how these outcome feedback affected subsequent decisions under risky situations. In the presence of them, individuals subsequently tended to take risks if

risky choices can offer a chance of receiving a potential gain (Brooks & Sokol-Hessner, 2020; Spadoni & Potters, 2018; Suhonen & Saastamoinen, 2018; Thaler & Johnson, 1990). Consequently, we would also predict that the effect of loss and uncertain competitive outcome would only be observed in the relational context implying a high risk for incurring personal costs, but not in other two relational contexts. Finally, the notion that the performance of a behavior is determined by an individual's intention to engage in that behavior (Ajzen, 1991), leads us to predict that the intention of participants to cooperate may play a mediating role in how loss and uncertain competitive outcome affect their actual cooperative behavior toward their opponents. Meanwhile, the evaluation of interpersonal relationships has been found to be crucial in determining individuals' own cooperative behavior in social dilemmas (van Dijk & De Dreu, 2021). This leads us to further predict that interpersonal relationships modulated by loss or uncertain competitive outcome could also act as potentially mediating variables.

## **2. Materials And Methods**

### **2.1 Participants**

To ensure adequate power in the current research, we performed a power analysis using G\*Power Version 3.1 (Faul et al., 2007) to determine the sample size. We calculated that, to maintain 80% power for an alpha level of 0.05, then the sample size needed to detect a medium effect size (Cohen's  $f = 0.25$ ) (Cohen, 1988, 1992) was at least 27 participants per condition. We based the assumption of the medium effect size on previous research regarding the impact of competition on social behavior (Balas & Thomas, 2015; Liu et al., 2021). In reality, we recruited 41 participants per condition in order to ensure robustness of the present study. In total, 164 right-handed adults (87 females,  $M_{age} = 20.82$  years,  $SD = 2.13$ ) took part in the study. All participants gave written informed consent prior to participation. This study was approved by the local Institutional Review Board.

### **2.2 Procedure**

#### **2.2.1 Pre-competition measures**

Consistent with a recent study (Liu et al., 2021), we administered several questionnaires with the aim of controlling for potential individual differences and how they might relate to task performance. These questionnaires comprised of the Chinese version of the Self-Report Altruism Scale (C-SRA) to examine altruistic attitudes among participants (Tang et al., 2011), the Chinese version of the Cooperative and Competitive Orientation Scale (C-CCO) to assess how inclined participants were to compete (Chen et al., 2011) and the Chinese version of the Domain-Specific Risk-Taking Scale (C-DOSPRT) to test risk-taking inclinations among participants (Hu & Xie, 2012).

#### **2.2.2 Competition with outcome feedback manipulation**

We employed a between-participants design to manipulate outcome feedback. Participants were randomly assigned to receive one of four types of outcome feedback (win vs. loss vs. uncertain

competitive outcome vs. control). In line with the protocol adopted by the recent study (Liu et al., 2021), we used a standard version of the Deese–Roediger–McDermott (DRM) paradigm (Deese, 1959; Roediger & McDermott, 1995) as the competitive task. This task included three phases: a study phase, a distractor phase and a test phase. During the study phase, participants were asked to learn ten lists of 15 related words with each list strongly associated with an absent critical lure. Prior to being tested, participants performed the distractor phase. These were made up of five-minute buffer activities in which they were asked to solve simple arithmetic problems (e.g.,  $3 \times 4 + 5 = ?$ ). Immediately after this, participants performed the test phase. This comprised of a recognition memory test in which participants were required to respond “yes” or “no” to each word from a 60-item test list depending on whether they believed the word appeared in a list from the study phase. The list contained 30 target words from the study phase as well as 10 related distractor words and 20 unrelated distractor words.

To simulate competition, participants were led to believe that they were playing against an opponent on the DRM paradigm via two connected computers. To intensify their sense of competition, we also informed them that if they outperformed their opponent, they would get a bonus payment of €10. Otherwise, they would only obtain the standard payment for their participation in the study (€10). At the end of the competition, participants were immediately given information about their performance. Specifically, they received one of three types of outcome feedback (win vs. loss vs. uncertain competitive outcome). Regarding the uncertain competitive outcome, participants were informed of their own task performance yet had no information about the performance of their opponents. In this way, participants had no way to directly evaluate their performance relative to their opponents. In reality, the outcome feedback that participants received was pre-determined and was counterbalanced between participants. For the other two outcome feedback, participants received them at the end of the competition that was appropriate to their group, i.e., that they had beaten (“you win”) or lost (“you lose”) against their opponents. After receiving outcome feedback, participants were asked to provide a rating on a nine-point Likert scale of their perceived competition (the intensity they felt about the competition) (1 = not at all, 9 = extremely), self-confidence (1 = not at all confident, 9 = completely confident), the degree of closeness that they felt toward their opponents (1 = not at all close, 9 = completely close) and the level of trust that they felt toward their opponents (1 = not at all trust, 9 = completely trust).

In contrast, the control condition was identical to the three competition conditions, except that participants were told that they and another person would perform the DRM paradigm independently. As such, no competition occurred between them and they were asked to perform the task as well as possible. Once participants completed the task, there were given feedback about their own task performance. They were informed that, if their performance level ranked above a predetermined criterion, then they would receive a bonus payment of €10. Otherwise, they would only get the standard payment for participating in the experiment. Like the three competition conditions, immediately following performance feedback, participants rated on 9-point scales the extent to which they perceived competition, self-confidence, their closeness to the other individuals as well as the level of trust they felt toward them.

## 2.2.3 Mutually cooperating interactions: two-person Public Goods Game

After completing the competition stage, participants then played a modified version of a two-person public goods game (PGG). Using this task, we could assess how participants behaved toward their opponents within a context of mutual cooperation. At the start of the PGG, participants were endowed with 100 tokens with an exchange value of 10 token per  $\text{€}1$ . First, participants were asked to indicate their own intention to cooperate as well as their predictions about the intention of their opponents to cooperate on a 9-point rating scale (1 = not at all to 9 = very much respectively). Given that cooperative decisions are affected by the perspective from which such decisions are made (self vs. others) (Kogut & Beyth-Marom, 2008), we additionally measured participants' predictions about their opponents' intention to cooperate and cooperative behavior to explore the possible influence of self-other discrepancy in participants' decisions to cooperate. We counterbalanced the order of such ratings across participants to prevent order effects. Second, participants had to decide how many tokens they wished to contribute to the public good and also predict how many tokens their opponents would contribute. The order of these were also counterbalanced across participants. Third, the number of tokens that had been donated to the public good was then multiplied by a factor  $N$  that was known to participants before they contributed. Multiplying contributions by a factor larger than the number of players meant that the chance of personal or mutual gains was increased. This produced a final amount that was then evenly divided between the players irrespective of who had contributed the most or the least. As such, personal earnings comprised the sum of tokens that participants did not contribute to the public good plus their share of the payment from the public good. We applied three multiplication factors  $N$ : 1.4, 2 and 3 to amounts contributed. This meant that, when only the participant made a contribution, the higher the multiplication factor  $N$ , the lower the probability of personal loss, and the higher the probability of mutual gains, regardless of whether their opponents contributed or not. In this sense, our modified PGG allowed participants to make decisions about cooperation when faced with their opponents in relational contexts where their cooperative behavior involved either a high risk for incurring personal costs, no risk of incurring personal costs or mutual gains. Specifically, when  $N = 1.4$ , participants run a high risk of personal costs. For example, a contribution of 40 tokens, when multiplied by 1.4, would only bring about an overall amount of 56. Thus, if the opponent decides to contribute nothing, the participant will receive less than their initial contribution ( $56/2 = 28$ ). When  $N = 2$ , there is no risk but gains are not guaranteed. For example, a contribution of 40 tokens, when multiplied by 2, would only bring about an overall amount of 80. Thus, if the opponent decides to contribute nothing, the participant will receive the same as their initial contribution ( $80/2 = 40$ ), while the opponent would benefit from the participant's contribution. When  $N = 3$  however, risk is again 0 but gains this time are guaranteed regardless of whether the opponent decides to contribute. For example, a contribution of 40 tokens, when multiplied by 3, would only bring about an overall amount of 120. Thus, even though the opponent decides to contribute nothing, both the participant and the opponent will still receive more than the participant's initial contribution ( $120/2 = 60$ ).

## 3. Results

## 3.1 Pre-competition measures

We analyzed altruistic attitudes, cooperative and competitive orientation and risk-taking scores using a one-way Analysis of Variance (ANOVA) with outcome feedback (win vs. loss vs. uncertain competitive outcome vs. control) as a between-participant factor. We did not find any significant differences in these personality traits among the four groups (altruistic attitudes:  $F(3,160) = .51, p = .674$ ; competitive orientation:  $F(3,160) = 1.34, p = .263$ ; cooperative orientation:  $F(3,160) = .40, p = .751$ ; gamble risk-taking:  $F(3,160) = .10, p = .961$ ; social-investment risk-taking:  $F(3,160) = .40, p = .753$ ).

## 3.2 Outcome feedback manipulation check and psychological reactions to outcome feedback

As a manipulation check, we analyzed ratings of perceived competition using a one-way ANOVA with outcome feedback (win vs. loss vs. uncertain competitive outcome vs. control) as a between-participant factor. We observed a significant effect of outcome feedback ( $F(3,160) = 18.71, p < .001, \eta^2 p = .260$ ). As expected, post hoc comparisons indicated that participants who received outcome feedback from the three competition conditions reported significantly higher levels of perceived competition (win:  $M = 4.12, SE = .28, p = .019$ ; loss:  $M = 6.05, SE = .30, p < .001$ ; uncertain competitive outcome:  $M = 4.98, SE = .29, p < .001$ ) than those who were in the control group ( $M = 3.17, SE = .25$ ). Moreover, participants in the loss group reported a significantly higher level of perceived competition than those who were in the win ( $p < .001$ ) and uncertain competitive outcome ( $p = .008$ ) groups. In addition, participants in the uncertain competitive outcome group reported a significantly higher level of perceived competition than those who were in the win group ( $p = .035$ ). These results clearly demonstrate the effectiveness of our competition with outcome feedback manipulation.

To examine psychological reactions to outcome feedback, we performed three separate one-way ANOVA on the ratings of self-confidence, closeness and trust. Regarding self-confidence, we found a significant effect of outcome feedback ( $F(3, 160) = 6.17, p = .001, \eta^2 p = .104$ ) (Fig. 1A). Post hoc comparisons revealed that the ratings were significantly lower in the loss group ( $M = 5.71, SE = .27$ ) than the other three groups (win:  $M = 7.12, SE = .21, p < .001$ ; uncertain competitive outcome:  $M = 6.44, SE = .21, p = .028$ ; control:  $M = 6.41, SE = .24, p = .033$ ). Moreover, ratings were significantly higher in the win group than in the uncertain competitive outcome ( $p = .039$ ) and control ( $p = .033$ ) groups. Such ratings did not significantly differ between the uncertain competitive outcome and control groups ( $p = .941$ ). Likewise, we found a significant effect of outcome feedback on ratings of perceived closeness ( $F(3, 160) = 6.27, p < .001, \eta^2 p = .105$ ) (Fig. 1B). Post hoc comparisons found that participants in the loss group ( $M = 5.29, SE = .29$ ) perceived less closeness to their opponents than those in the win ( $M = 6.59, SE = .21, p < .001$ ) and control groups ( $M = 6.17, SE = .21, p = .009$ ). Furthermore, participants in the uncertain competitive outcome group ( $M = 5.56, SE = .22$ ) perceived less closeness to their opponents than those who were in the win group ( $p = .002$ ). Finally, we also observed a significant effect of outcome feedback on ratings of interpersonal trust ( $F(3, 160) = 7.13, p < .001, \eta^2 p = .118$ ) (Fig. 1C). Post hoc comparisons indicated that participants in the loss group ( $M = 5.02, SE = .27$ ) rated their opponents less trustworthy than those in the

other three groups (win:  $M = 6.27$ ,  $SE = .23$ ,  $p < .001$ ; uncertain competitive outcome:  $M = 5.71$ ,  $SE = .21$ ,  $p = .032$ ; control:  $M = 6.29$ ,  $SE = .18$ ,  $p < .001$ ).

## 3.3 Effects of competitive relationships on subsequent mutual cooperation

### 3.3.1 Intention to cooperate

We analyzed ratings of intention to cooperate using a three-way mixed ANOVA with outcome feedback (win vs. loss vs. uncertain competitive outcome vs. control) as a between-participant factor, perspective (self vs. opponent) and the multiplication factor (1.4 vs. 2 vs. 3) as the within-participant factor. We observed a significant main effect of both outcome feedback ( $F(3,160) = 3.81$ ,  $p = .011$ ,  $\eta^2 p = .067$ ) and the multiplication factor ( $F(2, 320) = 89.97$ ,  $p < .001$ ,  $\eta^2 p = .360$ ), which was further qualified by a significant interaction ( $F(6,320) = 6.04$ ,  $p < .001$ ,  $\eta^2 p = .102$ ) (Fig. 2A). A simple effects analysis revealed that, when the relational context implied a high risk for incurring personal costs ( $N = 1.4$ ), participants in the loss group ( $M = 4.77$ ,  $SE = .31$ ) showed less intention to cooperate with opponents than those from the win ( $M = 6.10$ ,  $SE = .31$ ,  $p = .002$ ) and control ( $M = 6.74$ ,  $SE = .31$ ,  $p < .001$ ) groups. Likewise, under the same context, participants in the uncertain competitive outcome group also showed less intention to cooperate with opponents than those who were in the control group ( $p = .005$ ). In contrast, when the relational context implied no risk of personal loss but personal gain depending on the opponent's contribution ( $N = 2$ ), participants in the loss group ( $M = 6.43$ ,  $SE = .24$ ) still exhibited less intention to cooperate with opponents than those who were in the win ( $M = 7.28$ ,  $SE = .24$ ,  $p = .014$ ) and control ( $M = 7.16$ ,  $SE = .24$ ,  $p = .035$ ) groups. However, when the relational context implied mutual gains from participants' contributions ( $N = 3$ ), we found no significant differences in ratings across the four groups (all  $ps > .05$ ). In addition, we observed a significant main effect of perspective (self vs. opponent) ( $F(1, 160) = 32.70$ ,  $p < .001$ ,  $\eta^2 p = .170$ ), which was qualified by a significant interaction between perspective and outcome feedback ( $F(3, 160) = 3.96$ ,  $p = .009$ ,  $\eta^2 p = .069$ ). Our simple effects analysis revealed that participants in the win and uncertain competitive outcome groups showed more intention to cooperate with opponents when they rated their own intention to cooperate (win:  $M = 7.20$ ,  $SE = .21$ ; uncertain competitive outcome:  $M = 6.81$ ,  $SE = .21$ ) than when they predicted the cooperative intentions of their opponents (win:  $M = 6.89$ ,  $SE = .21$ ,  $p < .001$ ; uncertain competitive outcome:  $M = 6.20$ ,  $SE = .21$ ,  $p = .006$ ). Finally, no other significant effects were found (all  $ps > .05$ ).

### 3.3.2 Cooperative behavior

We also analyzed cooperative behavior using a three-way mixed ANOVA. We found a significant main effect of the multiplication factor ( $F(2, 320) = 99.39$ ,  $p < .001$ ,  $\eta^2 p = .383$ ), which was further qualified by a significant interaction between outcome feedback and the multiplication factor ( $F(6, 320) = 6.40$ ,  $p < .001$ ,  $\eta^2 p = .107$ ). Our simple effects analysis revealed that only when the relational context implied a high risk for incurring personal costs ( $N = 1.4$ ) would participants in the loss group ( $M = 34.15$ ,  $SE = 3.83$ ) contribute significantly less to the public good than those from the other three groups (win:  $M = 55.85$ ,  $SE = 3.83$ ,  $p < .001$ ; uncertain competitive outcome:  $M = 49.52$ ,  $SE = 3.83$ ,  $p = .005$ ; control:  $M = 61.28$ ,  $SE =$

3.83,  $p < .001$ ) (Fig. 2B). Meanwhile, we found that participants in the uncertain competitive outcome group contributed significantly less to the public good than did those in the control group ( $p = .031$ ) in the same context. In addition, we observed a significant main effect of perspective (self vs. opponent) ( $F(1, 160) = 22.98, p < .001, \eta^2 p = .126$ ), showing that participants contributed significantly more to the public good when they were rated their own levels of cooperation ( $M = 66.88, SE = 1.59$ ) compared to when they predicted their opponents' levels of cooperation ( $M = 63.34, SE = 1.47$ ). Finally, no other significant effects were found (i.e., all  $ps > .05$ ).

### 3.4 Potential mechanisms underlying effects of outcome feedback on participants' cooperative behavior

Up to this point, we have observed that outcome feedback only had an impact on participants' cooperative behavior when the relational context implied a high risk for incurring personal costs ( $N = 1.4$ ). We wanted to further explore the potential psychological processes underlying this effect. Thus, we conducted multiple mediation analyses in which self-confidence, closeness, trust, and intention to cooperate were tested as mediating variables. Consistent with a procedure described in previous work (Hayes & Preacher, 2014; Hayes & Rockwood, 2017), loss, win and uncertain competitive outcome groups were dummy-coded and separate comparisons between each were made, while the control group was used as the reference group in our analysis. We obtained bias-corrected bootstrap confidence intervals for the indirect effects. In each model, a total of 10,000 bootstrap resamples were used to estimate confidence intervals.

In comparing the loss group with the control group, we observed the presence of a parallel mediation by the level of trust participants felt toward opponents and their intention to cooperate with opponents (Fig. 3). These two mediators showed a significant negative indirect effect (trust:  $B_{\text{losing}} = -3.09, SE = 1.66, 95\%CI = [-6.61, -.05]$ ; intention to cooperate:  $B_{\text{losing}} = -16.89, SE = 3.88, 95\%CI = [-24.89, -9.66]$ ). Specifically, loss in the competition decreased both trust in the opponents of participants ( $B_{\text{losing}} = -1.27, SE = .32, p < .001$ ) as well as their intention to cooperate with them ( $B_{\text{losing}} = -1.93, SE = .44, p < .001$ ). This in turn led to lower levels of mutually cooperative behavior in participants toward their opponents (trust:  $B = 2.44, SE = 1.22, p = .048$ ; intention to cooperate:  $B = 8.77, SE = .77, p < 0.001$ ). In contrast, when comparing the uncertain competitive outcome group with the control group, we only observed behavior to be mediated by the intention of participants to cooperate (Fig. 3). This mediator showed a significant negative indirect effect ( $B_{\text{uncertain competitive outcome}} = -8.55, SE = 3.40, 95\%CI = [-15.50, -2.26]$ ). Specifically, the uncertain competitive outcome was associated with a decrease in the intention of participants to cooperate with their opponents ( $B_{\text{uncertain competitive outcome}} = -.98, SE = .44, p = .029$ ). This in turn decreased their mutually cooperative behavior toward their opponents ( $B = 8.77, SE = .77, p < 0.001$ ).

## 4. Discussion

In this study, we clearly demonstrate how the prior outcomes of competition shape participants' subsequent cooperative behavior toward their opponents in relational contexts involving different levels

of risk for personal losses and gains. By examining psychological reactions of participants to outcome feedback during competition, we were able to show a detrimental impact of the loss outcome. Specifically, loss exerted a deleterious effect on both the self-confidence of participants and their subsequent interpersonal relationships with opponents as assessed by interpersonal closeness and trust. The expectation that those who suffered from such a relative competitive disadvantage would show reduced levels of subsequent cooperation with their opponents was indeed supported by our findings. By manipulating relational contexts in such a way as to produce a high risk for incurring personal costs, we demonstrated that, relative to other groups, participants in the loss group were less inclined to cooperate with their opponents and contributed less to the public good. Our results add to the growing body of literature supporting the notion that individuals that suffer prior losses, be they financial (Thaler & Johnson, 1990) or competitive (Zhu et al., 2016), become averse to making subsequent risky decisions that offer no chance of receiving a potential gain.

Interestingly, we found that relative to the control group, participants who competed under the uncertain competitive outcome condition were significantly less inclined to cooperate and to contribute to the public good. This was despite the fact that this condition exerted no discernible effect on neither their self-confidence nor their relationship with opponents. This implies that there may be distinct psychological processes at play. This argument is supported by our mediation results. That is, loss has a negative effect on the subsequent cooperative behavior of participants via the mediating role of their own intention to cooperate and the perceived trustworthiness of their opponents. In contrast, the comparable impact of competition participation with individual performance feedback (uncertain competitive outcome) on participants' cooperative behavior was achieved only through the mediating role of the intention of participants to cooperate. These findings not only provide further evidence supporting the theory of planned behavior (TPB) (Ajzen, 1991), but also add to the growing body of literature emphasizing the role that trust toward counterparts plays in determining cooperation within conflicting situations (Balliet & Lange, 2013; Parks et al., 2013). Beyond this, these results demonstrate that participants' intention to cooperate as a mediating role was not dependent upon the outcome regarding their relative performance. In contrast, the mediating role played by the trust of participants in their opponents relies on the explicit outcome regarding their relative performance. In this sense, relative performance feedback during competition seems to act as a signal for evaluating the trustworthiness of others in situations involving conflict such as competition. In addition, these findings are consistent with the claim that trust refers to expectations about the benevolence of another individual during cooperation (Bogaert et al., 2008; Parks et al., 2013; Pletzer et al., 2018; Pruitt & Kimmel, 1977).

In addition to the findings outlined above, our study provides new insight into how competitive relationships determined by loss and uncertain competitive outcome interact with the motive of participants' self-interest to form their decisions to cooperate with their opponents. Specifically, when the relational context implied no risk of personal loss but gains depending on the contributions made by their opponents, only participants in the loss group were still less inclined to cooperate with their opponents (compared to those in the win and control groups). However, we did not observe such an effect for participants' actual contributions to the public good in the same context. Those who suffered from a

relative competitive disadvantage still preferred to prioritize their own interests by offering cooperation in order to take advantage of the opportunity for personal gain. Even though they showed less intention to cooperate, these participants seemingly felt obligated to take the risk associated with free-riding by their opponents and the associated possibility of receiving nothing in return and thus only benefitting their counterparts. Moreover, when the relational context implied that contributions by participants would benefit both themselves and their opponents, we observed that outcome feedback had no significant impact on neither the intention of participants to cooperate nor their mutually cooperative behavior. This indicates that the subsequent behavior of participants toward their opponents tends to be self-serving and mutually-beneficial. These findings add to a small but growing empirical literature that stresses the need to take competition-driven hierarchical relationships into account when attempting to understand how human competitors behave in mutually cooperative situations (Antonioni et al., 2018; Cronin et al., 2015), which is an area which has been extensively investigated in animals (Dale et al., 2020; Melis & Semmann, 2010).

Despite such encouraging evidence, there are some limitations in our study. One particular limitation is that we focused on a two-person PGG in our study. It is unclear whether our findings may be generalizable to other types of mutually cooperative games, such as the prisoner's dilemma game. In addition, the aspect of our study which comprised competition with outcome feedback was performance-dependence. It is thus unclear as to whether our findings would be applicable when outcome feedback is decided by other types of incentive schemes, such as luck. Future research is needed to address these interesting issues.

## **5. Conclusions**

In conclusion, we provide novel evidence showing that individuals' cooperative decisions toward their opponents vary depending on outcome-based evaluations of their prior competition. These decisions are mediated by the degree to which participants intend to cooperate as well as their level of trust in opponents. Moreover, rather than depending on the perspective through which the decisions were made, this effect operates in a relational context-dependent manner. Our results add to emerging research showing that the nature of cooperative interactions can vary depending on social relationships.

## **Declarations**

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### **Conflicts of Interests**

On behalf of all authors, the corresponding author states that there is no conflict of interest.

## Availability of data and material

The data generated and analysed during this study are available from the Corresponding Author on reasonable request.

## Code availability

Not applicable

## Author Contributions

**Zhenliang Liu:** Methodology, Software, Formal analysis, Investigation, Visualization, Writing- Original draft preparation. **Yansong Li:** Conceptualization, Methodology, Resources, Supervision, Writing- Original draft preparation, Writing- Reviewing and Editing, Project administration, Funding acquisition.

## Ethics approval

Approval was obtained from the authors' University Ethics Committee. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

## Consent to participate

Informed consent was obtained from all individual participants of the study.

## Consent for publication

All data is de-identified. Participants were informed of our intention to publish this de-identified data.

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## Figures

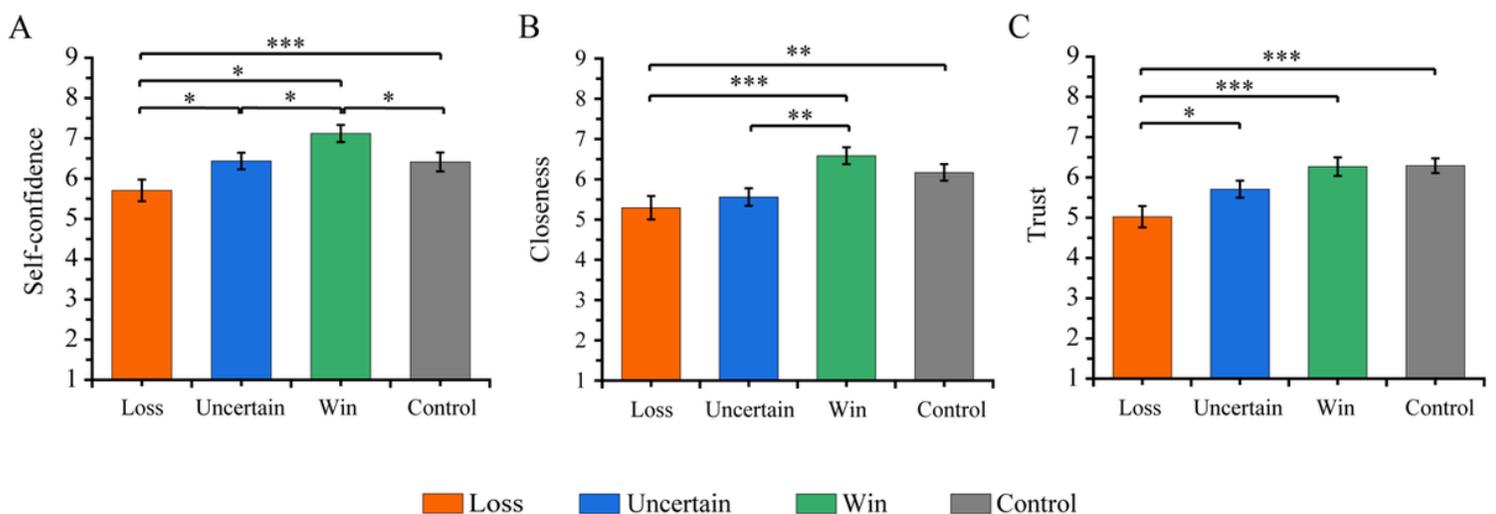
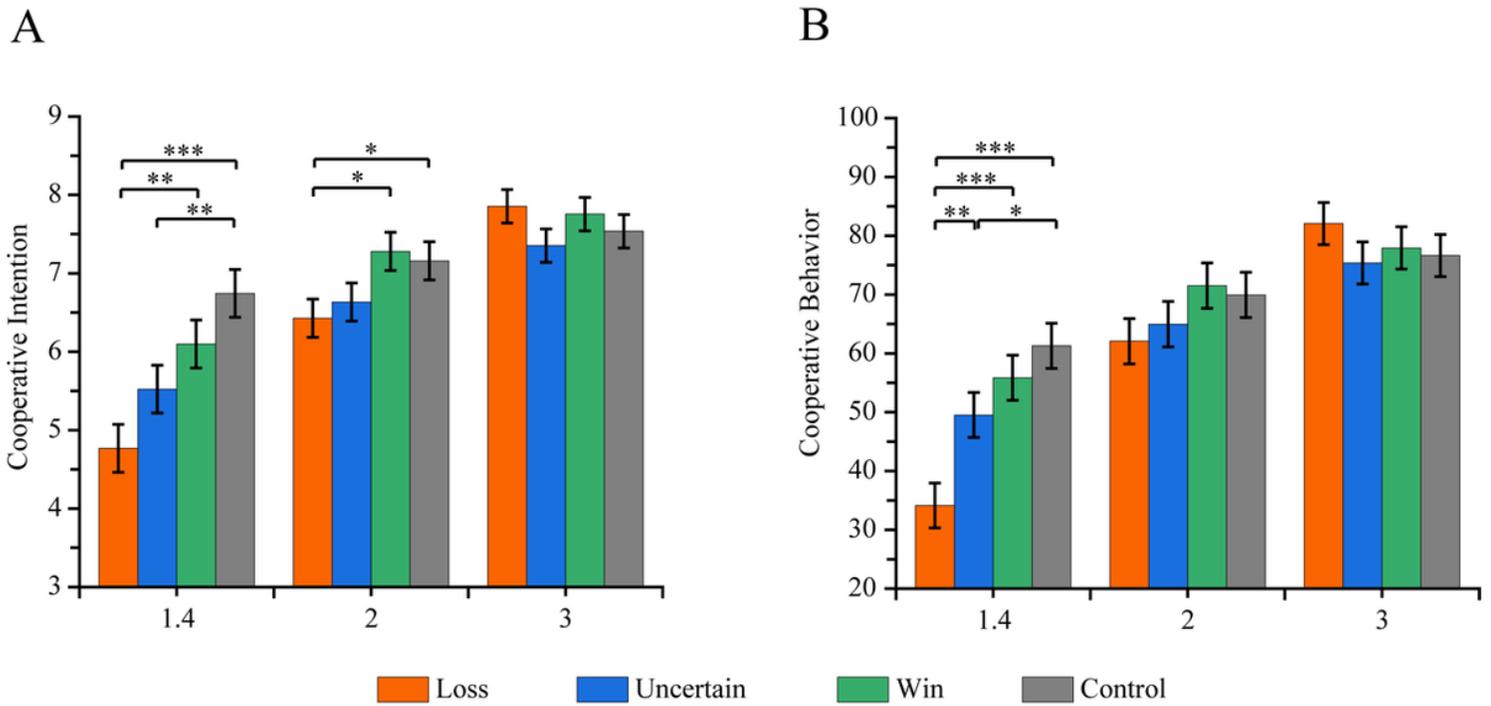


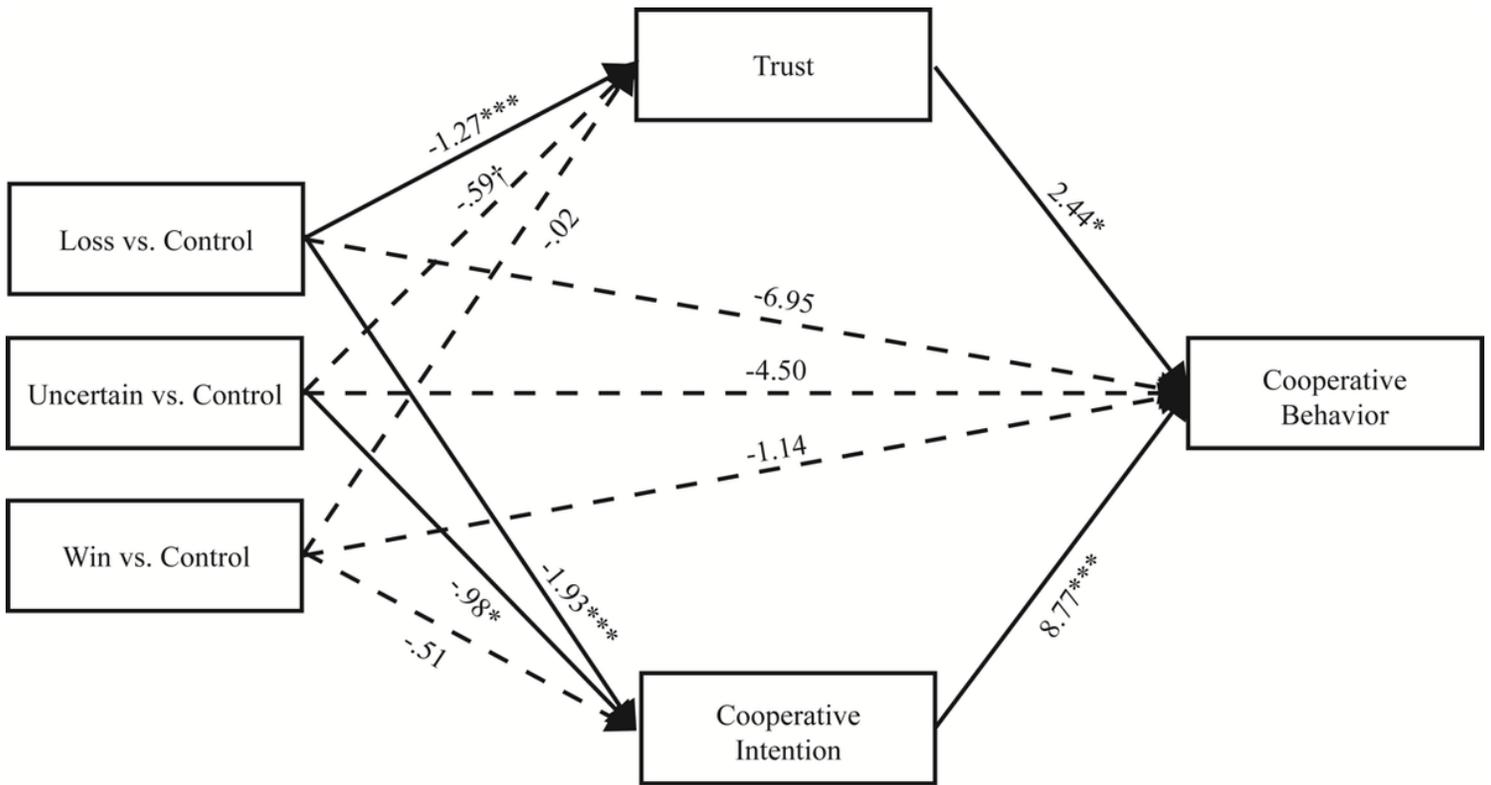
Figure 1

Effect of outcome feedback on participants' self-reported measures. The graphs in (A-C) show mean ratings of self-confidence, closeness and trust as a function of outcome feedback, respectively. \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ . Error bars represent  $\pm 1$  SEM.



**Figure 2**

Effects of outcome feedback and the multiplication factor on participants' intention to cooperate and their cooperative behavior. With regard to participants' intention to cooperate with their opponents (A) and their cooperative behavior (B), an interaction between outcome feedback and the multiplication factor was present. \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ . Error bars represent  $\pm 1$  SEM.



**Figure 3**

Multiple mediation model showing the effects of outcome feedback on participants' cooperative behavior toward their opponents mediated through trust and intention to cooperate. The model refers to behavior within the relational context involving a high risk for incurring personal costs (N = 1.4). Nonsignificant mediating variables were excluded for presentation clarity. Unstandardized regression coefficients (B) were presented on the significant paths as denoted by solid lines. No significant paths were represented by dash lines. †p < .10, \*p < .05, \*\*p < .01, \*\*\*p < .001.