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Chapter 4 - Unpredictable Futures, Parochial Pro-Sociality, and Intergroup Conflict

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Abstract

Groups experience carrying-capacity stress when returns from local club goods become unpredictable which may threaten group prosperity. Although we know that humans dislike uncertainty and find unpredictability stressful, how groups respond to unpredictable futures is unclear: A small body of work has found that carrying-capacity stress associates with increased group solidarity and parochial cooperation, but also with competition and intergroup conflict. Here we reconcile these seemingly contradictory findings in experiments in which individuals could contribute to local club goods with (un)predictable returns, and to conflict by investing in either out-group attacks or in-group defense. We find that individuals contribute less to their club goods and invest more in out-group attack when club goods provide unpredictable rather than predictable returns. As a result, individuals invest more in in-group defense and less in local club goods when their neighboring rivals have club goods with unpredictable returns. Findings reveal how increasing uncertainty, also arising in the wake of global climate change and geo-political volatilities, relate to cooperation within and competition and conflict between groups of people. Helping groups to reduce their carrying-capacity stress and to sustain themselves can prevent intergroup conflict and violence.

Keywords: behavioral ecology, cooperation, intergroup conflict, social welfare

Introduction

Climate change and geo-political instabilities at the global level can create local carrying-capacity stress – situations in which groups of people expect to have fewer resources than needed or are uncertain whether they can support themselves and their groups in the future (Read & LeBlanc, 2003; Kenneth & Marwan, 2015). For example, increased likelihood of flooding or prolonged droughts makes agricultural yields more unpredictable and create uncertainty about food supply. Price inflation and macro-economic volatilities can undermine the expected returns from collective pension funds, creating uncertainties about future income at both the individual and group-level (Bloom, 2009).

How groups respond to carrying-capacity stress is poorly understood. Climate science and studies in political geography have repeatedly observed associations between environmental deterioration and unpredictability – key factors underlying carrying-capacity stress – and increased prevalence of intergroup conflict and violence (De Dreu, Gross & Reddmann, 2022; Ember & Ember, 1992; Hsiang, Burke, & Miguel, 2013; Lee, 2018; O'Loughlin, Linke & Wimer, 2014; Schleussner, Donges, Donner & Schellnhuber, 2016; Von Uexkull, Croicu, Fjelde & Buhaug, 2016). At the same time, environmental disasters alongside threat of physical harm can provide a 'common fate' that binds individuals to their groups, resulting in increased group cohesion and solidarity (Calo-Blanco, Kovářík, Mengel, & Romero, 2017; Lojowska, Gross & De Dreu, 2023). It thus seems that carrying-capacity stress deteriorates intergroup relations and sparks conflict while at the same time, increases solidarity and cooperation within and perhaps between groups of people.

To reconcile these seemingly contradictory findings, and to uncover the behavioral mechanisms producing (macro-level) linkages between carrying-capacity stress, conflict and cooperation, we examined social decision-making in experimental contests between small groups that allow to systematically manipulate uncertainty, cooperation opportunities, and

conflict success functions in a controlled environment. Our findings suggest that carrying-capacity stress deteriorates intergroup relations when and because individuals selectively care for in-group survival and prosperity. With such parochial pro-sociality emerging as a root cause of intergroup conflict, results also may shed light on how different policies and institutions can help groups to reduce carrying-capacity stress and prevent social unrest and political violence outside of the laboratory.

Carrying-Capacity Stress and Parochial Pro-sociality

To sustain and support themselves and their members, groups need resources such as food and territory alongside club goods that provide, e.g., for healthcare, education, and group defense. Carrying-capacity stress emerges when group members' individual and collective needs and desires exceed resource availability. This can happen when resources are no longer supplied, for example when trade relations break down or when harvests fail. It can also happen when territories shrink because of rising sea-levels or deteriorate because of global warming (see e.g., Tyler et al., 2021). Carrying-capacity stress emerges too when resource supply and returns from club goods become erratic and unpredictable (Bloom, 2009; Duncan, 1972; Ellis, Figueredo, Brumbauch & Schlomer, 2009). Previous research on decision making has shown that individuals usually dislike unpredictability and invest cognitive and physical energies to reduce uncertainties and create stable and predictable futures (Kruglanski, Pierro, Mannetti, & De Grada, 2006; Landay, Kay & Whitson, 2015). This aversion to risks and uncertainty may also play an important role for group behavior. For example, when collective pastures provide for future returns to individual herders that are certain and predictable, each may contribute time and energy to its maintenance. But when such returns become unpredictable, for example because of prolonged draughts or excessive rainfall, individual herders may become more hesitant to contribute time and energy to the maintenance of their collective pastures. When returns on local club goods become

unpredictable, individuals may consider and invest in alternative means that serve themselves rather than the collective (e.g., Gross, Veistola, De Dreu & Van Dijk, 2021).

In sum, when future returns from local club goods become unpredictable (providing sometimes excellent and sometimes meager group benefits), individual contributions to their local club goods may decrease, ultimately leading to a classic 'tragedy of the commons' in which group members are worse off collectively than when they had made contributions. If true, we would see that carrying-capacity stress undermines group-level cooperation to the degree that groups may dissolve (e.g., Gustafsson, Biel & Gärling, 2000; Messick et al., 1988; Rapoport et al. 1993; Van Dijk et al., 1993; Wit & Wilke, 1998). And yet, research has also provided some evidence that environmental disasters and external threats can increase rather than reduce parochial pro-sociality – external threat and unpredictability increases within-group commitment and solidarity (De Dreu, Gross & Reddmann, 2022; Hogg, 2002; Barth, Masson, Fristsche & Ziemer, 2018) alongside willingness to contribute personal resources to group-benefitting club goods (Lojowska, Gross & De Dreu, 2023).

Rather than reducing group-level cooperation, one possible alternative response to carrying-capacity stress may be for individuals to seek alternative means to sustain individual and group prosperity. Next to reducing their contributions to the maintenance of their common pastures, the herders in our example may expand their territorial reach and venture into new areas to feed their livestock to provide for additional and perhaps more predictable group-level income (Sharif et al., 2019). Possibly, these new feeding areas belong to no one and can be freely accessed. Possibly, however, the resources needed to relax the group's carrying-capacity stress are held and used by other groups and capturing them may require hostile attacks on neighboring out-groups (De Dreu, Gross, Farina & Ma, 2020). If true, we would see that carrying-capacity stress, while reducing cooperation towards local club goods with uncertain returns, increases participation in collective aggression of out-groups.

Evidence for this possibility would provide a mechanistic explanation for the observed associations between global climate change and environmental shocks on the one hand, and political violence and intergroup conflict on the other (De Dreu, Gross & Reddmann, 2022; Ember & Ember, 1992; Hsiang, Burke, & Miguel, 2013; Lee, 2018; O'Loughlin, Linke & Wimer, 2014; Schleussner, Donges, Donner & Schellnhuber, 2016; Von Uexkull, Croicu, Fjelde & Buhaug, 2016).

The Present Study: Overview and Hypotheses

To examine the possibility that individuals in groups under carrying-capacity stress, operationalized as more uncertain returns from their group's club goods, increase their energy in competing for resources with other groups, we created an experimental model in which six individuals were nested in two groups of three. Within each group, individuals were given an endowment from which they could make contributions to their local club good. Contributing to the club good was personally costly, yet benefitted group welfare (creating the classic social dilemma of group cooperation). Individuals made investment decisions across a series of trials. Across trials we manipulated whether the group benefit from club good provision was predictable or unpredictable, as a manipulation of the group's carrying capacity stress. Importantly, across trials, the expected value of the group's club good was identical. We therefore only manipulated the (un)predictability of cooperation returns.

In addition to their club goods, individuals could also contribute to a contest with the other group. One group within this intergroup contest was designated the 'attacker' and the other the 'defender' (De Dreu et al., 2016, 2022; Gross et al., 2022). Individual investments in conflict were non-recoverable, yet when individuals in the attacker group collectively invested more than individuals in the rival defender group, the attacker group would win the contest and earn the defenders' revenues from their local club good, alongside any non-invested resources. When investment in out-group attack did not exceed that in in-group

defense (i.e., defender groups were successful in defending themselves), individuals on both sides kept their non-invested resources and revenues from their local club good.

Grounded in the idea that humans are risk averse (Kahneman & Tversky, 1979), we predicted lower contributions to club goods with unpredictable rather than predictable group benefit for both attacker (Hypothesis 1a) and defender groups (Hypothesis 1b). Earlier studies have shown that individuals invest on average less in out-group attack than in in-group defense, and that out-group attacks are often unsuccessful (i.e., defenders 'survive' roughly 7/10 attacks; De Dreu, Gross, Meder et al., 2016, De Dreu et al., 2022; Gross, De Dreu & Reddmann, 2022; Zhang, Gross, De Dreu & Ma, 2019). We expected to replicate that attacker groups are less often victorious than defender groups (Hypothesis 2) because group-level investment in out-group attack is less strong than in in-group defense (Hypothesis 3). Crucially, however, we also predicted that individuals invest more in out-group attacks when their local club good provides unpredictable rather than predictable returns (Hypothesis 4a). Because more intense out-group attacks force defenders to invest more in conflict, we anticipated stronger in-group defense (Hypothesis 4b), and reduced contributions to the defender group's local club good (Hypothesis 4c), when the attacker group's local club good provided unpredictable rather than predictable returns.

Method

Ethics and Participants

The experimental design and hypotheses were preregistered (https://aspredicted.org/FPM_YJ8) and approved by the Psychology Research Ethics Board of Leiden University (Protocol #CEP19-0909/455). Participants provided written informed consent and received full debriefing upon conclusion of the study. The experiments did not involve deception and participants received a €9.50 show-up fee and an additional performance-based payment (on average €6.40, range between €0.95 and €12.50; see below).

For each experimental session we invited six participants and randomly allocated them to a three-person aggressor and a three-person defender group. Individuals made decisions (contributions to their local club good, and investments in the intergroup contests) in four blocks of 20 trials each. The four blocks orthogonally manipulated whether the own and the other group's local club good provided predictable or unpredictable returns, and this was common knowledge to all participants.

Sample size was set a priori in line with earlier intergroup contests and public good provision experiments, with a target of 25 sessions of 6 persons each (De Dreu et al., 2016; De Dreu et al., 2022; Gross et al., 2022). In total we recruited 168 participants (130 female; age M = 21.88, SD = 3.17, range 18–36 years), resulting in 26 experimental sessions.

Experimental Procedures and Treatments

Upon arrival in the laboratory, participants were seated at computers in individual cubicles. After providing informed consent and demographic information about age and gender, participants in groups of six were randomly divided into a three-person attacker and a three-person defender group. Participants were informed that they would make a series of decisions about how to allocate an endowment of 30 Monetary Units (MU). It was explained that MU would be converted into additional payout after the session was completed, and that participants could keep their MU or contribute some or all of it to a local club good and to the intergroup contest.

Contributing to Club Goods with (Un)predictable Returns. For the local club good, it was explained that any MU contributed would provide a return to each member of their three-person group, themselves included. In two blocks of 20 trials each, the return would be set to 1.5, such that each unit contributed gave each group member 0.5 MU (the individual marginal per capita return, MPCR). Thus, when all three group members contributed their full endowment, the participants' earnings from the local club good with certain returns

(return multiplier = 1.5) would be 3 x 30 x 0.5 = 45 MU. When the participant would not contribute anything, and the other two would contribute their full endowment, the participant would earn 2 x 30 x 0.5 = 30 MU added to their own endowment of 30, thus totaling 60 MU, while the two contributors would earn 30 MU each. Hence, while investing units to the club good was beneficial for the group, such cooperation could also be exploited by free-riding on the investments of other group members.

In two other blocks of 20 trials, the club good provided uncertain returns. The return multiplier by trial was randomly set at either 0.5 or 2.5, yielding an MCPR of 0.16 and 0.83 respectively, with an average expected return of (0.16 + 0.83) / 2 = 0.5. Here, earnings per participant would be between 15 MU and 75 MU when all participants contributed fully. In the situation where one participant would contribute nothing while the other two contributed fully, the total pay-off for the non-contributing participant would be between 10 + 30 = 40 MU and 50 + 30 = 80 MU while the contributing participants would earn either 10 MU or 50 MU. Because the MPCR was high (low) in half of the trials within these blocks, the expected value from contributing across all trials is identical to that in the blocks with a fixed return of 1.5 on each trial. Hence, from a simple expected value perspective, average potential club good returns across trials were identical across the blocks. What we manipulated was the predictability of these returns – whether they were fixed across trials or could vary from one trial to another.

Participants were informed about the return multiplier at the beginning of each block. Hence, they would know whether the MPCR was fixed or would randomly vary between the lower and upper value. They were also explained that the other group also had a local club good to contribute to, and that for each block of trials they would be informed also whether the other group's local club good would have a fixed or variable MPCR.

Investing in Attacker-Defender Contests. Following the instructions about club good

provision, participants were informed that in addition to their local club good, they could also invest MU in out-group attack or in-group defense (depending on which group-role they were assigned to). Instructions used neutral language throughout (e.g., groups were referred to as Group A and B, contributions were labeled investments, and we referred to out-group attack as group challenge and to in-group defense as group protection). We explained to individuals in the attacker group that investments in 'group challenge' would be wasted, yet that they would get all the MU earned in the other group (i.e., MU not invested + revenues from their local club good) when their investment in group challenge exceeded the other group's investment in group protection. Otherwise (i.e., when group protection was equal to or larger than group challenge), individuals on both sides would earn the revenues from their local club good, plus whatever they had not invested. Following these instructions, participants completed several comprehension checks that consisted of two complete scenarios for one round of the contest from the perspective of their role, with their group winning and losing the episode, respectively.

After all participants successfully completed all comprehension checks, they made decisions in 80 trials (four blocks of 20 trials each, see below). For each trial, they received 30 MU and indicated how much they want to keep for themselves, how much they want to contribute to their group's club good (i.e., within-group cooperation) and how much they want to invest in out-group attack (or in-group defense; i.e., the between-group conflict). In-between trials, participants received full feedback about how many MU their own and the other group invested into both club goods and conflict, the outcome of the conflict, how much the groups earned from club good provision and from conflict, and how much the individual had earned on that trial.

The 80 decision trials were divided in four blocks of 20 each. In one block, both the participant's own club good and the other group's club good had a fixed MPCR of 1.5. In a

second block, the in-group's MPCR was fixed but the out-group's MPCR varied unpredictably. In a third block, the in-group's MPCR varied unpredictably, while the out-group's MPCR was fixed. In the fourth block, both the in-group's and the out-group's MPCR were unpredictable. The order in which blocks were presented was counterbalanced across groups.

After the main task, participants completed an incentivized Staircase Risk Elicitation Task to measure their risk preferences (Falk et al, 2016). Because individual-level risk preferences had no statistically significant relationship to participants' behavior in the main task, this measure is further ignored. Finally, participants were debriefed and paid. For the main task, the outcome of eight randomly selected rounds of decision-making were summed and then converted into Euro at a rate of 1 MU = 0.20€ (range €0.95 to €9.50; M = €4.76). For the additionally included Staircase Risk Elicitation Task, the conversion rate was 1 MU = 0.01€ (range €0.00 to €3.00; M = €1.64).

Dependent Variables. For each trial, we recorded how much of their 30 MU individuals contributed to their local club good (henceforth *club good contribution*), and contributed to conflict (henceforth *out-group attack*, or *in-group defense*, depending on the group-role). At the within-group level, we additionally computed (a) attacker and defender group's earnings from the local club good; and for attacker groups (b) *victory rates* (i.e., how often did out-group attack exceed in-group defense) and (c) *earnings from winning* the contest. Finally, we computed (d) *overall social welfare* relative to the maximum possible (i.e., 6 individuals x 30 units invested in local club goods x 1.5 expected return = 270 units), and (e) post-conflict *inequality* in earnings between attacker and defender groups.

Results

Hypotheses were tested with 3-level random intercept models with contribution and investment decisions (level 1) nested within participants (level 2) and participants nested

within groups (level 3). The block in which both the attacker and defender group's club good provided certain returns (MPCR fixed at 1.5 for each trial, abbreviated as "C" for certain) served as our baseline (CC), while the attacker uncertain-defender uncertain (UU; "U" for uncertain), attacker uncertain-defender certain (UC), and attacker certain-defender uncertain (CU) conditions were included as dummy-coded variables. Formally, our statistical model can be expressed as:

$$\text{OutcomeVar}_{ijk} = \beta_{0jk} + e_{ijk},\ e_{ijk} \sim \text{N}(0, \sigma_e^2) \quad \text{(level 1)}$$

$$\beta_{0jk} = \gamma_{00k} + u_{0jk},\ u_{0jk} \sim \text{N}(0, \sigma_u^2) \quad \text{(level 2)}$$

$$\gamma_{00k} = 0_{000} + 0_{001} * \text{UU}_k + 0_{002} * \text{UC}_k + 0_{003} * \text{CU}_k + v_{00k},\ v_{00k} \sim \text{N}(0, v_u^2) \quad \text{(level 3)}$$

where i = investment decisions, j = participants, and k = teams.

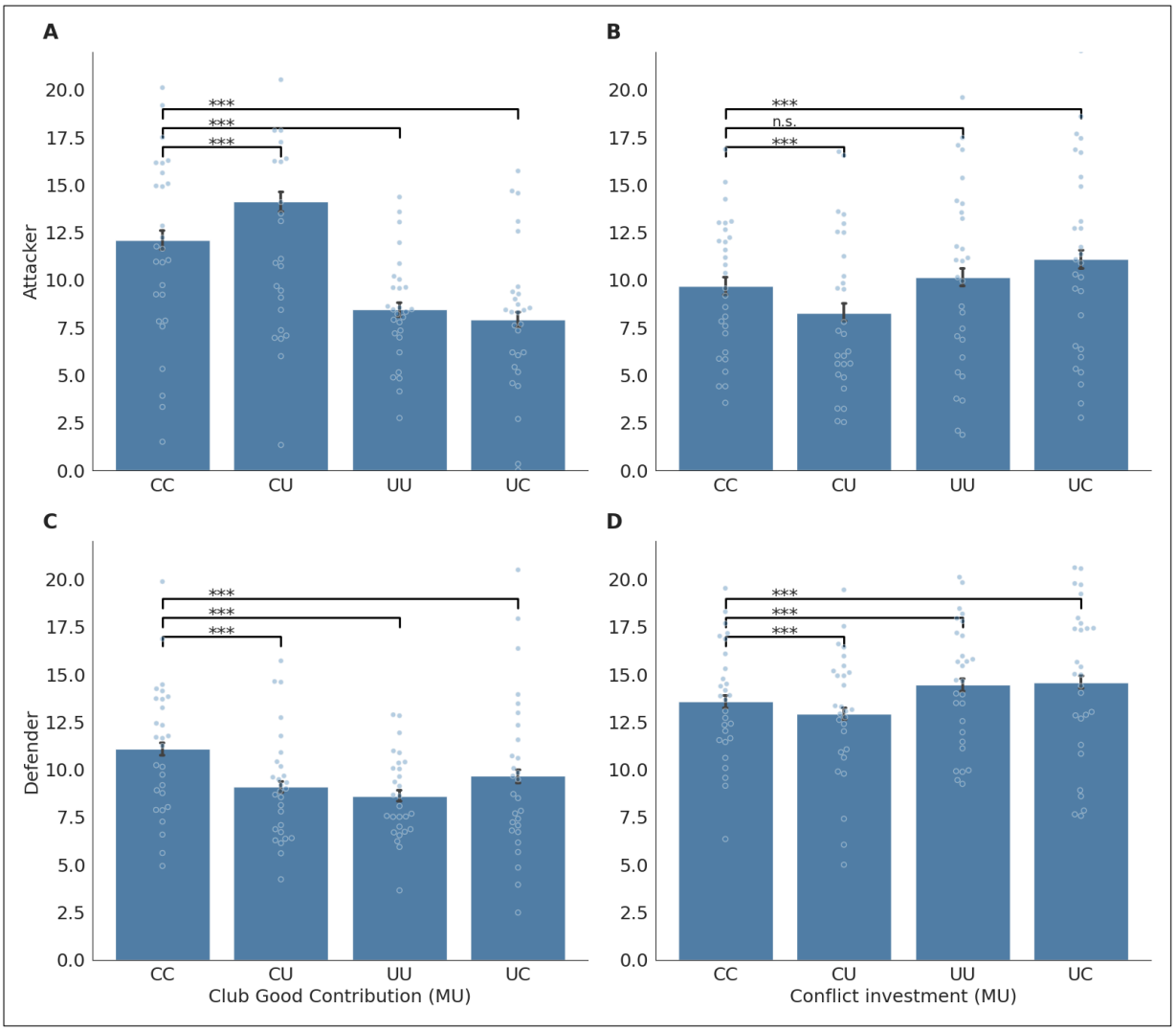
We performed our analyses using Python 3.9.16 for data processing and plotting, and R.351 for model fitting (Team, 2016). Linear mixed models were fitted using the lme4 package (Bates et al., 2015) and *p*-values were obtained using the lme4 extension package lmerTest (Kuznetsova et al., 2017).

Contributions to Club Goods and Conflict

Table 1 summarizes the regression models and results for participants' club good contributions and conflict investments. Focusing first on attacker groups, we find that when local club goods had uncertain rather than certain returns, individuals contributed less to their local club good (b = -4.17, t = -14.78, $p < 0.001$) and more to out-group attack (b = 1.40, t = 4.62, $p < 0.001$) (Fig 1A and 1B). This supports Hypotheses 1a and 4a. Interestingly, we also find that individuals invested more in their local club good (b = 2.01, t = 7.15, $p < 0.001$) and less in out-group attack (b = -1.40, t = 4.62, $p < 0.001$) when their defender group's local club good provides defenders with uncertain rather than certain returns (Fig 1A and 1B). This suggests that defender groups with reliable club goods become a more attractive target for aggression.

Figure 1

Average club good contributions and conflict investment for attacker and defenders



*Note***.** Average club good contributions and conflict investment for attackers (A and B, respectively) and defenders (C and D, respectively) when their groups' club goods had both certain (CC), certain and uncertain (CU), uncertain and certain (UC), or both uncertain (UU) returns. Shown are mean values (bars), standard errors (± 1 SE), aggregated investment by subject (dots). Contrasts are significant at *p < .05, **p < .01, and ***p < .001.

Table 1

Results of linear random intercept mixed models for club good contributions and investment in conflict

		Attackers		Defenders	
Dependent Variable	Predictor	Estimate (*b*)	Test statistic (*t*)	Estimate (*b*)	Test statistic (*t*)
Resources Kept	(Intercept)	8.19	8.22***	5.33	8.15***
	UC	2.76	9.87***	0.40	2.21*
	CU	-0.59	-2.11*	2.62	14.39***
	UU	3.23	11.51***	1.58	8.69***
Club Good Contributions	(Intercept)	12.11	16.88***	11.09	22.22***
	UC	-4.17	-14.78***	-1.42	-7.53***
	CU	2.01	7.15***	-1.98	-10.49***
	UU	-3.65	-12.97***	-2.47	-13.05***
Conflict Investments	(Intercept)	9.70	14.90***	13.58	25.14***
	UC	1.40	4.62***	1.02	5.63***
	CU	-1.42	-4.69***	-0.64	-3.52***
	UU	0.43	1.41	0.88	4.88***

Notes. The certain-certain (CC) condition serves as the baseline. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

For defender groups, we find that when local club goods provided uncertain rather than certain returns, individuals contributed less to their local club good (b = -1.98, t = -10.49, $p < 0.001$) (Figure 1C), confirming hypothesis 1b. They also invested less to in-group defense (b = -0.64, t = -3.52, $p < 0.001$) (Figure 1D). However, when their rivalling attackers had local club goods with uncertain rather than certain returns, defender groups contributed less to their own local club good (b = -1.42, t = -7.53, $p < 0.001$) and more to in-group defense (b = 1.02, t = 5.63, $p < 0.001$). These results may reflect an adaptive response to the attacker groups' stronger investment in out-group attacks when they had uncertain returns for their club goods. Indeed, while both out-group attack and in-group defense was predicted by previous round defenses and attacks (see Table 2), in-group defense is conditioned by previous round out-group attacks more than the other way around (attacks predicting next round in-group defense, b = 0.18, t = 22.01, $p < 0.001$ versus for in-group defense predicting next round out-group attack, b = 0.13, t = 7.28, $p < 0.001$). Taken together, these results support Hypothesis 4b and 4c.

Table 2

Results of linear random intercept mixed models for attackers' and defenders' investment behavior predicted by the opponents' conflict investment on the previous round

Dependent Variable	Predictor	Estimate (*b*)	Test Statistic (*t*)	*p*
Conflict investment attackers	(Intercept)	10.62	15.96	< .001
	Conflict investment defenders lag 1	0.13	7.28	< .001
	Round	-0.07	-13.45	< .001
Conflict investment defenders	(Intercept)	13.61	28.99	< .001
	Conflict investment attackers lag 1	0.18	22.01	< .001
	Round	-0.04	-10.93	< .001
Club good contributions attackers	(Intercept)	10.80	21.20	< .001
	Conflict investment defender lag 1	-0.09	-10.16	< .001
	Round	-0.01	-2.66	0.007
Club good contributions defenders	(Intercept)	12.22	15.74	< .001
	Conflict investment attackers lag 1	-0.10	-5.45	< .001
	Round	0	-0.99	0.324

Note. Estimates for effects of the opponents' previous round conflict investment on attackers' and defenders' conflict and club good investments using linear mixed models with random effect *team*.

Social Welfare Consequences

At the outset, individuals in both attacker and defender groups had an endowment of 30 MU, for a total collective welfare of 6 × 30 = 180 units. Individuals could increase social welfare by contributing to their local club goods, up to a maximum of 180 × 1.5 = 270, or 45 units per individual. Engaging in conflict, however, also could reduce social welfare, as every unit invested in out-group attack or in-group defense would be wasted. Indeed, if all individuals contributed their full endowment to conflict, social welfare would be reduced to 180 – 180 = 0. However, attacker but not defender groups could increase in-group welfare through successful out-group attacks – whereas units contributed to out-group attack would be wasted, victory would earn attackers the defender's non-invested resources alongside revenues from the defender's local club good. While conflict inherently reduces social welfare at the collective level, it can create wealth inequalities between (and within) groups of people.

Table 3 summarizes results from regression models for earnings and attacker victory rate as dependent variables. Individuals in attacker groups earned significantly from local club good provision (b = 18.36, t = 16.89, $p < 0.001$), although less when the club good gave uncertain rather than certain returns (b = -6.39, t = -13.88, $p < 0.001$) and, interestingly, more when the defenders' club good gave uncertain rather than certain returns (b = 3.02, t = 6.55, $p < 0.001$; Figure 2A). This may follow from out-group attacks being less intense when defender club goods were uncertain, leaving attackers more resources to invest in one's own local club good. Indeed, fitting earlier findings in attacker-defender contests and confirming hypothesis 2 and 3, attacker groups invested less into out-group attacks than defenders into in-group defense (b = 4.08, t = 7.23, $p < 0.001$) and out-group attack was only successful in 25% of the trials, overall. Nonetheless, attackers earned an overall positive return from attack (b = 5.91, t = 11.81, $p < 0.001$). Whereas victory rate was not influenced by the uncertainty of

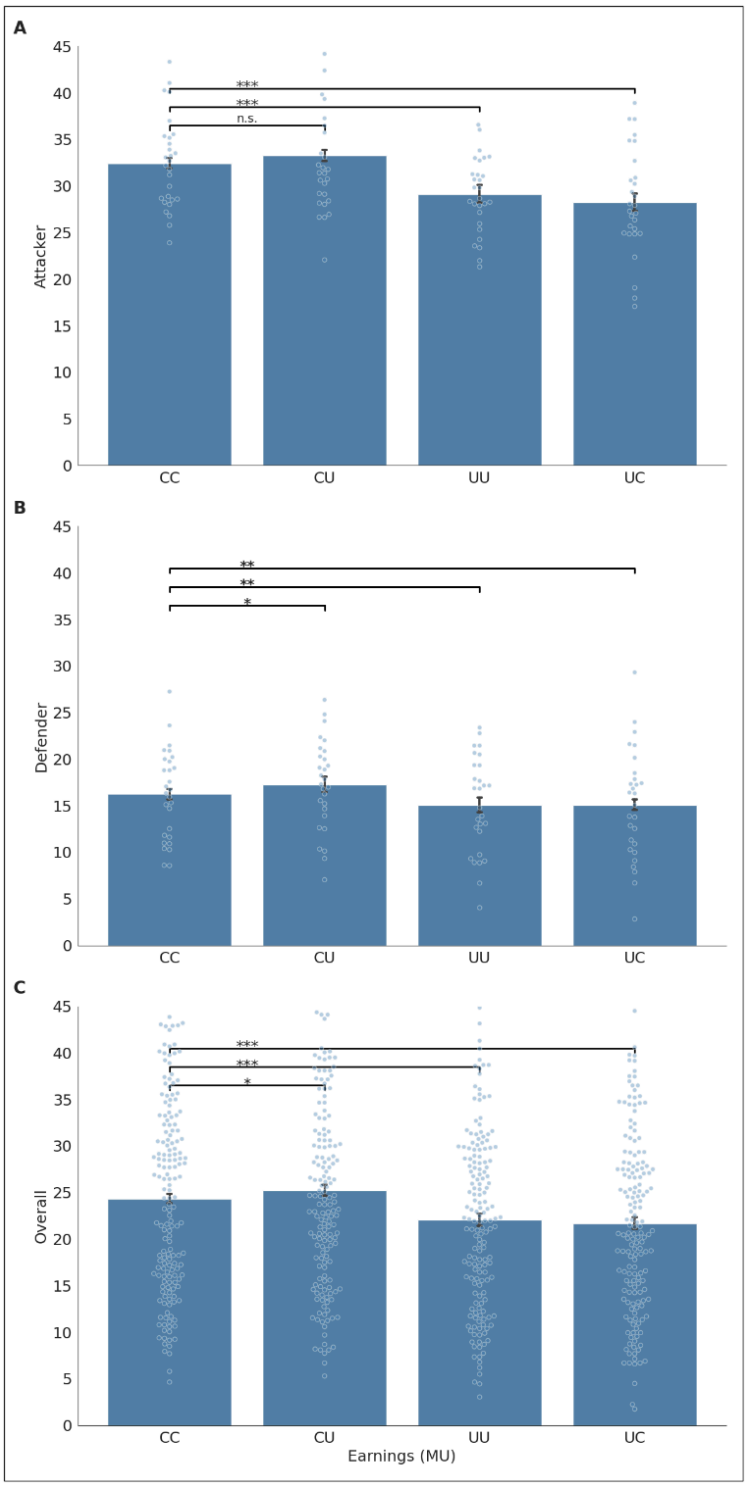
the attacker's local club good ($b = 0.00$, $t < 1$), it was significantly lower when the defender's local club good gave uncertain rather than certain returns ($b = -0.05$, $t = -2.18$, $p < 0.029$). And indeed, the income from victorious out-group attacks was lower when the defender's club good gave uncertain rather than certain returns ($b = -1.62$, $t = -4.42$, $p < 0.001$).

Turning to defender groups, we observed the mirror image for earnings (Figure 2B). Specifically, individuals in defender groups earned significantly from their local club good ($b = 12.31$, $t = 18.09$, $p < 0.001$), yet less when either their own, or the attacker's local club good gave uncertain rather than certain returns ($b = -1.39$, $t = -3.45$, $p < 0.001$, and $b = -1.27$, $t = -3.15$, $p = 0.002$). Whereas the former reduction can be explained by reduced contributions by individual defenders, the latter reduction can be explained by the increased need to invest resources in in-group defense to protect against comparatively intense out-group attacks that were motivated by the attacker groups' uncertain-return local club good.

When considering these dynamics of club good contributions and conflict, overall social welfare was significantly reduced when club good uncertainty to either attacker or defender groups was present (Figure 2C). In particular, average overall earnings declined significantly when both the attacker and defender group faced an uncertain club good ($b = -2.26$, $t = -6.26$, $p < 0.001$) and when the attacker groups' club good returns were uncertain while the defenders' club good returns were certain ($b = -2.66$, $t = -7.39$, $p < 0.001$). In contrast, when attackers' club good returns were certain, but the defenders' club good returns uncertain, overall earnings increased ($b = 0.92$, $t = 2.55$, $p < 0.011$). These results, together with the conflict dynamics, illustrate that the decline in social welfare was specifically caused by attacker groups being confronted with uncertain club good returns, leading them to engage in out-group aggression and more wasteful group conflict.

Figure 2

Average earnings by condition



*Note***.** Average attacker (A), defender (B), and overall (C) earnings when the groups' club goods had certain (CC), certain and uncertain (CU), uncertain and certain (UC), and uncertain (UU) returns, respectively. Shown are mean values (bars), standard errors (± 1 SE), aggregated investment by group (dots). Contrasts are significant at *p < .05, **p < .01, and ***p < .001.

Table 3

Results of linear random intercept mixed models for individual and social welfare

		Attackers		Defenders	
Dependent Variable	Predictor	Estimate (*b*)	Test statistic (*t*)	Estimate (*b*)	Test statistic (*t*)
Earnings from club good	(Intercept)	18.36	16.89***	12.31	18.09***
	UC	-6.39	-13.88***	-1.39	-3.45***
	CU	3.02	6.55***	-1.27	-3.15**
	UU	-5.48	-11.89***	-2.70	-6.68***
Victory rate	(Intercept)	0.25	10.35***		
	UC	-0.05	-2.18*		
	CU	-0.03	-1.24		
	UU	0.00	0.15		
Earnings from Victory	(Intercept)	5.91	11.80***		
	UC	-0.54	-1.49		
	CU	-1.62	-4.42***		
	UU	-1.09	-2.97**		
Overall Earnings	(Intercept)	32.45	40.81***	16.26	21.58***
	UC	-4.17	-7.62***	-1.15	-2.47**
	CU	0.81	1.48	1.03	2.19*
	UU	-3.34	-6.10***	-1.18	-2.51**

Note. The certain-certain (CC) condition serves as the baseline. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Parochial Pro-Sociality or Selfish Freeriding

Results thus far provide support for the prediction that when the local club good provides uncertain rather than certain return on investment, individuals in attacker groups reduce club good contributions and increase contributions to out-group attack. However, external threat and unpredictability may not make individuals more or less selfish, but rather redirect behavior to alternative means to benefit the in-group, out-group attacks included. Both club-good cooperation, as well as out-group attack introduces freeriding incentives. Group members can fare better when others cooperate and invest into their group's club good, while they keep their resources. Similarly, attacking group members can benefit from winning the conflict, even if they contributed little. To see whether unpredictability merely shifts the mode of group cooperation (from in-group, club good cooperation to coordinated out-group attacks), we concluded our analyses by considering the extent of freeriding across conditions in attacking groups. To this end, we define freeriding as not contributing anything to local club goods (i.e., freeriding on the club good) or not investing anything to conflict (i.e., freeriding on conflict participation) on a given round.

Results are summarized in Table 4. Compared to situations in which their local club good provided certain returns, individuals in attacker groups more often made zero contribution to the local club good when it gave uncertain returns (b = 0.31, t = 7.31, p < 0.001; Table 1). Importantly, at the same time, they also made less often zero contribution to out-group attack (b = -0.20, t = -3.90, p < 0.001; Table 1). While this suggests that uncertain local club goods indeed shifted the target of one's group behavior, the overall level of freeriding – decision rounds in which individuals kept their full endowment and contributed nothing to either groups' actions – was higher when local club goods provided uncertain rather than certain return (b = 0.14, t = 4.27, p < 0.001).

Table 4

Results of linear random intercept mixed models for club good non-contributions and conflict non-investments and freeriding

		Attackers		Defenders	
Dependent Variable	Predictor	Estimate (*b*)	Test statistic (*t*)	Estimate (*b*)	Test statistic (*t*)
Club Good	(Intercept)	0.63	6.26***	0.26	4.70***
Non-Contributions	UC	0.31	7.31***	0.12	4.28***
	CU	0.36	0.08	0.06	2.14*
	UU	0.12	2.77**	0.05	1.89
Conflict	(Intercept)	1.22	11.32***	0.20	5.67***
Non-Investments	UC	-0.20	-3.90***	-0.10	-4.72***
	CU	0.26	4.89***	-0.05	-2.40*
	UU	-0.16	-2.98**	-0.09	-4.29***
Freeriding	(Intercept)	0.32	4.03***	0.06	3.85***
	UC	0.14	4.27***	-0.04	-3.55***
	CU	0.01	0.32	-0.02	-2.10*
	UU	0.10	3.09**	-0.02	-1.61

Note. The certain-certain (CC) condition serves as the baseline. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Like attackers, defending group members more often contributed zero to their club good (b = 0.06, t = 2.14, $p < 0.033$) and less often invested zero into conflict (b = -0.05, t = 2.40, $p < 0.016$) when their club good provided uncertain returns. The overall level of freeriding for defenders, however, did not increase but even declined somewhat (b = -0.02, t = 2.10, $p < 0.036$). A possible explanation is that unlike for attacker group members, an overall break-down in contributions under uncertainty for defenders is prevented by a continued need to invest into defense against potential attacks.

Coordination on Club Good Contributions and Conflict

Certain club good returns might facilitate coordination on club good contributions within groups. Conversely, uncertain club good might make it easier for group members to focus on conflict, thereby increasing coordination on conflict investment. This should be true especially for attacker groups who have an incentive to gain resources through appropriation. To test for this possibility we computed, as an index of in-group coordination, the within-round intra class correlation for contributions.

Results for coordination are summarized in Table 5. Indeed, compared to baseline, attackers' coordination on club good contributions decreased when the club good provided uncertain returns (b = -0.10, t = -6.58, $p < 0.001$) whereas their coordination on attack increased (b = 0.05, t = 6.72, $p < 0.001$). On the defender side, group members likewise showed decreased coordination on their club good when returns turned uncertain (b = -0.15, t = 12.01, $p < 0.001$). Unlike attackers, however, defenders did not improve their coordination on contributions towards defense (b = -0.04, t = -6.71, $p < 0.011$), possibly due to not having the same incentive of gaining resources by appropriating from their opponent.

Table 5

Results of linear random intercept mixed models for club good and conflict coordination

		Attackers		Defenders	
Dependent Variable	Predictor	Estimate (*b*)	Test statistic (*t*)	Estimate (*b*)	Test statistic (*t*)
Club Good Coordination	(Intercept)	0.25	17.19***	0.20	15.18***
	UC	-0.10	-6.58***	-0.03	-2.19*
	CU	0.08	5.03***	-0.15	-12.01***
	UU	0.21	-13.46***	-0.23	-18.44***
Conflict Coordination	(Intercept)	0.13	12.69***	0.22	12.12***
	UC	0.05	3.41***	-0.04	-2.96**
	CU	-0.01	-1.04	-0.04	-2.54*
	UU	0.09	6.72***	-0.10	-6.71***

Note. The certain-certain (CC) condition serves as the baseline. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Conclusions and Discussion

Here, we confronted two teams with an attacker-defender contest. Both teams had the possibility to also increase their earnings peacefully through separate club goods. These club goods either delivered uncertain or certain contribution returns. Despite the expected value of club good contributions being the same under standard economic theory (assuming risk neutrality), we observed startling differences in behavior for both attackers and defenders. As hypothesized, when faced with uncertain returns from their local club goods, attackers reduced their overall contributions (H1a), displayed decreased coordination, and more frequently opted to invest nothing. In turn, they demonstrated improved conflict coordination and increased their overall investments in out-group attacks (H4a), being less likely to invest nothing into aggression. Not all resources saved from the break-down in club good contributions were moved into attack, however: Overall, attackers kept more resources and exhibited more free-riding when returns were uncertain. Similarly, defenders contributed less to their local club goods when faced with uncertain vs certain returns (H1b), kept more of their resources and increased their free-riding. We replicated earlier findings, showing that attacker groups are less often victorious than defender groups (H2) due to out-group attacks being overall less strong than in-group defense (H3). Indeed, defender groups exhibited a strategic response to increased aggression from attacker groups under uncertainty, investing more in in-group defense (H4b) and less in their local club good (H4c) when rival attackers had uncertain club good returns. Since defenders adjusted their defense spending to the aggression exhibited by attackers, attackers were not more successful under uncertainty despite increasing their attack investments. Due to the breakdown in contribution to their club good and their inability to increase their success at attack, attackers earned less under uncertainty than when club good returns were certain. Defenders' earnings likewise declined when either their own or the attacker's club goods was uncertain. Thus, environmental

uncertainty increased wasteful conflict, leading to a decline in the overall social welfare, particularly when the attacker groups faced an uncertain club good.

Implications

Our study helps to integrate disparate findings on how groups respond to carrying capacity stress, bridging a gap between contrasting arguments in the literature. On the one hand, prior studies have shown that carrying capacity stress might lead to a classic tragedy of the commons, undermining group-level cooperation and potentially leading to group dissolution (Gustafsson, Biel & Gärling, 2000; Messick et al., 1988; Rapoport et al. 1993; Van Dijk et al., 1993; Wit & Wilke, 1998). On the other hand, research has shown that external threats and unpredictability might provide a 'common fate', enhance group cohesion and solidarity (De Dreu, Gross & Reddmann, 2022; Hogg, 2002; Barth, Masson, Fristsche & Ziemer, 2018), and increase group members willingness to contribute resources to group-benefitting club goods (Lojowska, Gross & De Dreu, 2023).

Our findings lend some support to the notion that uncertainty can contribute to the breakdown of club goods within groups. In our study, both attackers and defenders decreased contributions to their club good, reduced coordination, and increased free-riding when faced with an uncertain environment. And yet, we also found that uncertainty prompted attackers to capitalize on the chance to cooperate and coordinate on out-group aggression, instead, thus supporting the idea that carrying capacity stress and unpredictability can foster group commitment and solidarity when a suitable opportunity is present. Our research thus underscores the notion of parochial prosociality, demonstrating that individuals within groups flexibly contribute to their group's welfare through either peaceful within-group cooperation, or through aggressive intergroup competition. Carrying-capacity stress can, in this sense, tip the balance from pro-social contribution to local club goods, to pro-social contributions to out-group aggression (De Dreu et al., 2020).

Our findings can also provide a mechanistic explanation for the often-observed association between environmental deterioration and volatility – key factors underlying carrying-capacity stress – and heightened prevalence of intergroup conflict and violence (Ember & Ember, 1992; Lee, 2018; O'Loughlin, Linke & Wimer, 2014; Schleussner, Donges, Donner & Schellnhuber, 2016; Von Uexkull, Croicu, Fjelde & Buhaug, 2016). For example, a meta-analysis by Hsiang, Burke, and Miguel (2013), including 60 macro-level studies on climate change and conflict, discovered that a standard deviation change in temperature or rainfall was associated with a 14% increase in the likelihood of intergroup conflict. Our research can help to understand the behavioral underpinnings of this link, demonstrating experimentally how unpredictability in the environment can lead to a break-down of peaceful cooperation on club goods, increased outgroup aggression, intergroup competition, and an overall escalation in wasteful conflict.

Our study therefore underlines the need for governments and international organizations to recognize the interconnected nature of environmental issues that may negatively influence the return on club goods, cooperation within societies, and the potential for violent intergroup conflict. Policymakers and stakeholders might focus on developing strategies that help groups to mitigate environmental stressors and promote sustainable resource management, especially in regions where situational factors suggest that the opportunity for outgroup aggression and conflict is present.

Limitations and Open Questions

Our study tested the impact of (un-)certainty on within-group cooperation and intergroup conflict using a stylized experimental contest game – the 3-vs-3 group attacker-defender contest with club goods – in a controlled laboratory setting. The strength of this approach lies in its internal validity and enables us to draw causal inference about the effects of (un-)certain returns on cooperation and conflict within this setting. While providing

valuable insights, this approach, however, can, of course, not fully capture the intricacies of real-world situations. Factors to think about when generalizing our findings to real-world contexts include multifaceted, ambiguous consequences of environmental and economic change, dynamics within large groups characterized by multilayered social organization, and intergroup relations affected by complex interdependencies and long-standing and nuanced histories. As pointed out, however, our research complements an already existing body of work on the macro-level effects of environmental change and conflict, and thus provides a valuable experimental addition that extends our understanding of the behavioral dynamics at play.

One obvious limitation that group members faced in our experiment was the inability to directly coordinate their contributions towards either their club good or conflict. Indeed, groups in our experiment showed relatively low levels of coordination, an effect that was further exacerbated when club good returns turned uncertain. Thus, a possible extension of our paradigm would be to introduce institutions that might improve group members ability to coordinate, such as leadership in the form of a "first mover" or the ability to communicate between group members. Previous experimental research employing pure intergroup contests has demonstrated that both leadership (e.g., De Dreu et al., 2016) and the ability to communicate (e.g., Cason et al., 2012, 2017) reduce free-riding and lead to an overall escalation of conflict. In our context, an intriguing question is if such institutions could help group members to overcome the observed breakdown in club good contributions under uncertainty (which, after all, have the same expected utility as the certain environment), or, as observed in previous studies, if these mechanisms would simply intensify out-group attacks and exacerbate intergroup conflict further. The former would resonate with previous experimental work showing, for example, that communication and punishment can be

effective means to prevent overharvesting in common pool resource dilemmas (Ostrom et al., 1990).

Conclusion

Our study provides insight into the effects of environmental (un-)certainty and the dynamics of within-group cooperation and intergroup conflict. Our findings reveal that environmental uncertainty leads to a breakdown in club good contributions, reducing coordination and increasing free-riding, while also promoting out-group aggression and leading to an escalation in intergroup conflict. Our research complements existing macro-level research on the association between environmental change and conflict, elucidating the behavioral underpinnings of this relationship. Future research could explore factors that might help groups to peacefully cope with and adapt to the effects of environmental uncertainty, potentially focusing on institutions that improve communication and coordination within groups.