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Hierarchy, Power, and Strategies to Promote Cooperation in Social Dilemmas

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Abstract: Previous research on cooperation has primarily focused on egalitarian interactions, overlooking a fundamental feature of social life: hierarchy and power asymmetry. While recent accounts posit that hierarchies can reduce within-group conflict, individuals who possess high rank or power tend to show less cooperation. How, then, is cooperation achieved within groups that contain power asymmetries? To address this question, the present research examines how relative power affects cooperation and strategies, such as punishment and gossip, to promote cooperation in social dilemmas. In two studies involving online real-time interactions in dyads (N = 246) and four-person groups (N = 371), we manipulate power by varying individuals' ability to distribute resources in a dictator game, and measure punishment, gossip, and cooperative behaviors in a multi-round public goods game. Findings largely replicate previous research showing that punishment and gossip opportunities increase contributions to public goods in four-person groups. However, we find no support for the hypotheses that power directly affects cooperation or the use of punishment and gossip to promote cooperation. We discuss the implications of these findings for understanding the influence of hierarchy and power on cooperation within dyads and groups.

Keywords: experimental games; power; cooperation; punishment; gossip

1. Introduction

Cooperation is essential to myriad aspects of our social lives, from well-functioning interpersonal relationships and successful organizations, to harmonious international relations and sustainable environmental policies. However, achieving mutual cooperation can be challenging, especially in situations where individuals' self-interests conflict with collective interests (i.e., social dilemmas) [1,2]. Prior work has identified key strategies that effectively promote cooperation in social dilemmas, including sanctioning non-cooperators (costly punishment) [3–5] and cooperating with others who have a positive reputation (indirect reciprocity via gossip) [6,7]. However, existing research has focused on cooperation within egalitarian dyads and groups, overlooking a pervasive feature of social organization: hierarchy and asymmetric power.

Outside the lab, human groups are commonly organized in hierarchies, in which some individuals have higher power than others. Traditionally, power has been seen as involving the ability to influence others based on various factors, including respect, expertise, and legitimacy [8,9], as well as actual control over resources and outcomes [10,11]. Here, we use a narrower but concrete definition of power in terms of control over valued resources and the provision of benefits and costs [12,13].

Functional theories of hierarchy have posited that power differentiations can improve intra-group coordination and performance, ultimately enhancing group success [14,15]. However, a large body of research has revealed detrimental consequences of power on group functioning [11,16], such as high power leading to self-serving behavior in social dilemmas [17,18]. Therefore, it remains unclear how cooperation can be promoted and sustained within asymmetric power interactions that involve conflicting interests.

Here, we address this topic by examining how power asymmetries influence cooperation, as well as the use of punishment and gossip to promote cooperation in social dilemmas. Aiming to reconcile functional theories of hierarchy [14] with empirical evidence on the corruptive effects of power [11,16], we argue that punishment and gossip can be mechanisms that allow the emergence of mutual cooperation in hierarchically organized dyads and groups. We investigate this by observing the effects of power on cooperation across multiple rounds of a standardized experimental game that involves a conflict of interest—the public goods game. In this game, we manipulate opportunities to punish interaction partners and gossip about them within one's group. Therefore, we examine how power affects the use of these strategies and their effectiveness in promoting cooperation in hierarchically organized dyads and groups.

1.1. Asymmetric Power and Cooperation

Despite the benefits of hierarchical organization for group success [14,15], asymmetric power can have negative consequences for interpersonal relationships. In particular, high power has been associated with decreased perspective-taking and responsiveness to others' suffering [19,20], making the powerful less attentive to the states and needs of the powerless. In social dilemmas, people who possess power feel entitled to extract larger portions of a common resource [18] and tend to make decisions that increase their own outcomes at the expense of collective outcomes [17]. That said, while increases in power are typically associated with more selfish behavior [21,22], power can sometimes evoke feelings of responsibility in the face of completely powerless others [22].

By definition though, those who possess favorable positions or high power within social hierarchies have increased access to valuable resources [12], and thus their lower-power counterparts are more dependent on them to gain benefits. Given such asymmetric dependence, low-power individuals should be motivated to behave in a more other-oriented manner, in order to win the favor of high-power others. Reversely, given their heightened ability to confer benefits, powerful individuals would *not* need to be as cooperative as low-power individuals to maintain reciprocal relationships. Based on these arguments, we propose that:

H_1: High-power individuals will be less cooperative than low-power individuals.

1.2. Asymmetric Power and Strategies to Promote Cooperation

But if the powerful are inclined to disregard the powerless and behave in self-serving ways, how is cooperation achieved and sustained in hierarchical dyads and groups? We suggest that this apparent inconsistency can be resolved by examining the strategies available to both the powerful and the powerless in asymmetric interactions. Specifically, we forward hypotheses regarding the strategies that high- and low-power individuals use to promote cooperation in dyadic and group interactions. We focus on two types of strategies—costly punishment and gossip—that can up-regulate cooperative behavior in social dilemmas [4,6,23].

As mentioned before, we know little about how individuals' relative power in an interaction influences their use of strategies to promote cooperation. Previous work has suggested that high-power individuals should be motivated to maintain their advantageous position within hierarchical structures, by monitoring and, if necessary, coercing their potential rivals. Indeed, high-ranking individuals are more likely to detect cheating among low-ranking individuals compared to vice-versa [24], and the powerful appear particularly sensitive to self-relevant offenses [25]. Additionally, third parties expect that high-ranking individuals are more likely to punish norm violations [26] and, indeed, individuals primed with power motives engage in more punishment in social exchange tasks [27]. Moreover, given their increased access to valued resources, high-power individuals might be less sensitive to the costs of punishment and retaliation (i.e., counter-punishment) [26,28] by low-power others. Therefore, we predict that:

***H*₂:** High-power individuals will engage in more costly punishment than low-power individuals.

***H*₃:** Low-power (but not high-power) individuals will be more cooperative in the presence of punishment.

If high-power individuals are less cooperative and also less sensitive to the costs of punishment by others, what means do low-power individuals have to enforce cooperation among the powerful? Anthropological data point to various informal mechanisms, including gossip, criticism, disobedience, and ostracism, which are designed to protect low-power individuals from exploitation by the powerful [29]. Gossip, in particular, might be preferentially used by low-power individuals to deter cheating among the powerful, because it represents a low-cost strategy that protects the anonymity of the gossiper [23]. Gossip and the exchange of reputational information also play a crucial role in coalition formation [30], and thus low-power individuals might use it to coordinate condemnation of high-power cheaters [31,32]. To the extent that gossip can lead to actual cost infliction via reduced reputational standing in a group and coordinated punishment, high-power individuals are expected to be sensitive to the presence of gossip opportunities among their low-power counterparts. In short, we hypothesize that:

***H*₄:** Low-power individuals will engage in more gossip behavior than high-power individuals.

***H*₅:** Both high-power and low-power individuals will be more cooperative in the presence of gossip opportunities.

1.3. Study Overview

Here, we examined the hypothesized effects of power on cooperation, punishment behavior, and gossip behavior in dyads (Study 1; $N = 246$) and four-person groups (Study 2; $N = 371$) recruited via Amazon Mechanical Turk (MTurk). We employed (a) a novel web-based software (Software Platform for Human Interaction Experiments; SoPHIE) [33] designed for online research with real-time interactions between participants, and (b) established experimental games, involving decisions with monetary outcomes (10 Monetary Units [MUs] = US$0.04 in dyads and US$0.02 in four-person groups). Specifically, we had participants interact in an 8-round public goods game (PGG), in which we varied the availability of a punishment option (*no-punishment* vs. *punishment* condition) and a gossip option (*no-gossip* vs. *gossip* condition)[1]. In the PGG, we measured cooperation, punishment behavior, and gossip behavior. Prior to decision-making in the PGG, we manipulated participants' power (*low* vs. *control* vs. *high*) by informing them about their roles in another task—a one-shot dictator game (DG), which would take place at the end of the interaction. Previous work has followed a similar strategy of manipulating power in a separate task, different from the one in which cooperative and punishment decisions are made (12,30). The manipulation we used, though, had the additional benefit of providing participants with real control over valued outcomes [16].

[1] Throughout our methods and results, we use the terms "punishment option" and "gossip option" to refer to the manipulation of punishment and gossip opportunities. We use the terms "punishment behavior" and "gossip behavior" to refer to the number of deduction MUs participants assigned to their group member(s) and their choice to gossip or not, respectively.

2. Materials and Methods

2.1. Participants

We used G* Power [34] to conduct an a priori power analysis, specifying an ANCOVA with power as an independent variable (with three groups: *low* vs. *control* vs. *high*), punishment option as a covariate, and cooperation as a dependent variable. Based on this power analysis, a sample of $N = 244$ would result in 80% statistical power to detect a small-to-medium effect ($f = 0.20$) of power on cooperative behavior. In Study 1, we recruited 246 participants (57.1% male; $M_{age} = 34.79$ years, $SD_{age} = 11.27$) via MTurk to interact online in 123 dyads. Participants received a baseline compensation of US$0.50 and could earn a bonus of up to US$0.88 based on their own and the other person's decisions. On average, participants earned US$0.58 ($SD = 0.17$) as a bonus and thus received a mean compensation of US$1.08.

Similarly, in Study 2, we aimed to have at least 80 participants in each power condition to attain 80% statistical power to detect a small-to-medium effect ($f = 0.20$) of power on cooperative behavior. Thus, we aimed to recruit 320 participants to take part in asymmetric power interactions (80 *high-power* and 240 *low-power* participants) and 80 participants to take part in symmetric power interactions (i.e., 80 *control* participants). We were able to recruit 371 participants (40.2% male; $M_{age} = 36.52$ years, $SD_{age} = 11.47$) via MTurk to interact online in 96 four-person groups (13 out of 384 participants dropped out during the study). Following previous research [35], to avoid interrupting any sessions due to dropouts, we implemented an experimenter strategy. That is, the experimenter took the participant's role and (a) contributed 5 MUs in each round of the public goods game and (b) did not punish or gossip when there was an opportunity to do so. Experimenter data are not included in our analyses. Participants received a baseline compensation of US$2.00 and could earn a bonus of up to US$0.88 based on their own and others' decisions. On average, participants earned US$0.45 ($SD = 0.14$) as a bonus and thus received a mean compensation of US$2.45.

2.2. Design

In Study 1, to test for the hypothesized effects of power and punishment option on cooperation, as well as on different strategies to promote cooperation, we used a 3 (power) × 2 (punishment option) mixed design. Specifically, we manipulated power (*control* vs. *low* vs. *high*) as a between-subjects factor and punishment option (*no-punishment* vs. *punishment* condition) as a within-subject factor.

In Study 2, to test for the hypothesized effects of power, punishment option, and gossip option on cooperation as well as on different strategies to promote cooperation, we used a 3 (power) × 2 (punishment option) × 2 (gossip option) mixed design. The manipulations of power (*control* vs. *low* vs. *high*) and punishment option (*no-punishment* vs. *punishment* condition) were the same as in Study 1. Here, we also included a within-subject manipulation of gossip option (*no-gossip* vs. *gossip* condition).

Both studies were conducted using SoPHIE [33]. An overview of the design and procedure can be found in Figure 1.

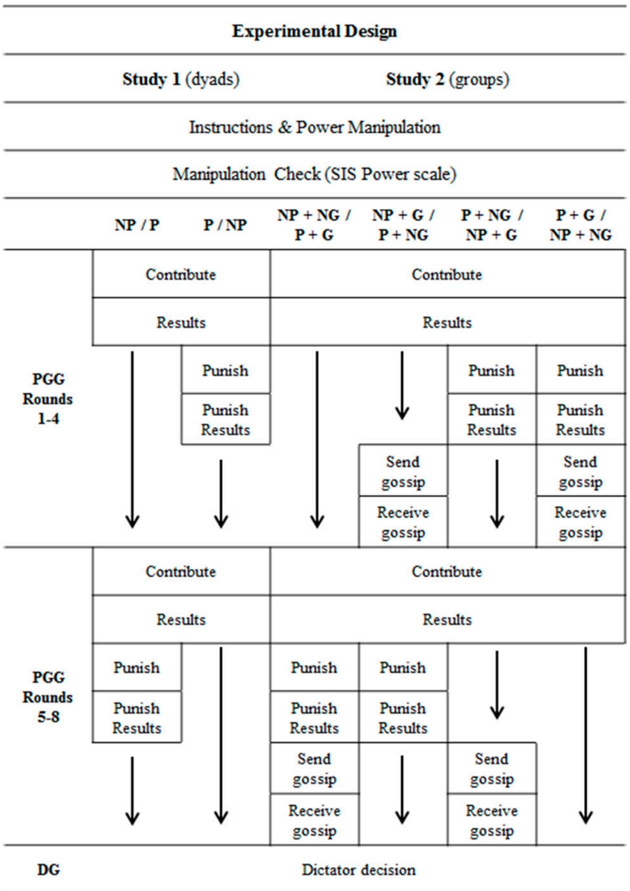

Figure 1. Experimental design for Studies 1 (left panel) and 2 (right panel). NP = No-Punishment condition; P = Punishment condition; NG = No-Gossip condition; G = Gossip condition.

2.3. Procedure

2.3.1. Procedure Overview

Both studies involved online real-time interactions between participants. More information about participant recruitment and assignment in groups is provided in the Supplementary Information (see Participant Recruitment). Participants were initially informed that they would make a series of decisions while interacting in dyads (Study 1) or four-person groups (Study 2). It was made clear to participants that they would be interacting with the same person or people throughout the study (i.e., the dyad and group composition remained constant). Each individual in a dyad or group was randomly assigned a letter; different letters represented different participants and their respective roles.

Then, participants were provided with detailed information about the experimental tasks (e.g., possible earnings per task), and were asked to answer comprehension questions. Specifically, we told participants that the study involved two parts (i.e., nine periods of interaction): (1) **Part 1** (Periods 1–8), during which participants would all make contribution decisions at the same time (see Section 2.3.4 Public Goods Game) and (2) **Part 2** (Period 9), in which one participant would make a decision, while the other(s) would have no active role (see Section 2.3.2 Power Manipulation and Section 2.3.8 Dictator Game). When reading the instructions for **Part 2**, participants found out what their own role would be (i.e., whether they would be making the decision or not). After reading the instructions for both parts of the study, and *before* they made any decisions in either experimental game, we asked participants about their perceptions of power in the upcoming interaction (see Section 2.3.3 Manipulation Check). All materials can be found at: https://osf.io/sphn6/.

2.3.2. Power Manipulation

We used instructions for **Part 2** of both studies to introduce our power manipulation. Specifically, participants assigned to a *high-power* condition (n = 83 in Study 1; n = 75 in Study 2) were informed that they would act as the *allocator* (i.e., they would make the decision in **Part 2**); their role was represented by a capital letter. *Allocators* were told that they could decide how many MUs to allocate to each person in their group. Further, they were informed that they could allocate these MUs in any way they wanted, and that the other participant(s) had no choice over this decision.

In the *low-power* condition, participants (n = 83 in Study 1; n = 217 in Study 2) were instead informed that they would act as a *receiver* (i.e., someone else would make the decision in **Part 2**); their role was represented by a small letter. *Receivers* were informed about whom the allocator was and about the fact that the allocator could independently decide how many MUs to allocate to each person in their group. Further, they were informed that the allocator could allocate these MUs in any way he/she wanted, and that they had no choice over the allocator's decision.

Finally, in the *control* condition, participants (n = 80 in Study 1; n = 79 in Study 2) had no a priori knowledge of their roles (i.e., they only learnt whom the allocator was after the public goods game); they were all represented by capital letters.

2.3.3. Manipulation Check

After participants read the instructions for both experimental games, and before they made any decisions, we assessed their perceived power in the upcoming interaction, using six items from the Situational Interdependence Scale (SIS) [36]. The SIS measures perceptions of a situation in terms of five dimensions: mutual dependence, conflict, power, future interdependence, and information certainty. Here, we focused on perceived power, which was measured with six items (e.g., *"Who do you feel was most in control of what happens in this situation?"*) scored on 5-point Likert scales (1 = *definitely the other*, 3 = *neutral*, 5 = *definitely myself*). We explicitly asked participants to indicate how each statement described themselves and the other(s) across *both* parts of the study (e.g., "For each item, please think of the interaction you are about to have with **Person X**, and indicate how each statement describes yourself and **Person X** in Parts 1 and 2 of this study."). We computed an aggregate score for perceived power (α = 0.97 in both studies), with higher scores indicating higher relative power.

2.3.4. Public Goods Game

In **Part 1**, participants made decisions in an 8-round public goods game. Based on their own and others' decisions, they could earn up to US$0.48. In each round, participants received an endowment of 10 MUs (equal to US$0.04 in dyads and US$0.02 in groups). They could choose how many of these MUs they wanted to contribute to a collective account and how many they wanted to keep for themselves. The sum of contributions to the collective account was multiplied by 1.5 (dyads) or 3 (four-person groups) and was then divided equally among the dyad or group members. Following previous research [37,38], we chose different multipliers for contributions to the collective account in dyads (Study 1) and four-person groups (Study 2). This ensured that the private return for contributions would remain constant across the two studies (i.e., MPCR = 0.75). Participants' payoff in each round consisted of (a) the MUs they kept for themselves and (b) their private return from the collective account. In each round, participants received information on their own and the others' contributions, the sum of contributions, as well as each person's payoffs.

2.3.5. Punishment Manipulation

Each participant played two 4-round public goods games, one without punishment opportunities, and the other with punishment opportunities. The order of these two conditions was counter-balanced. In the *no-punishment* (NP) condition, participants played the public goods game as described above. In the *punishment* (P) condition, each round had a second decision stage, during which participants could punish others by assigning 0 to 5 deduction MUs. Following previous research, punishment behavior was costly: each deduction MU cost the punisher 1 MU and reduced the punished individual's payoff by 3 MUs [4]. Punishment decisions were made simultaneously and publicly; in group interactions, participants learned about the deduction MUs assigned to them by *each* group member.

2.3.6. Gossip Manipulation (Study 2 Only)

In Study 2, we also manipulated gossip opportunities (*no-gossip* condition vs. *gossip* condition) in the public goods game as a within-subject factor. The order of the two gossip conditions, which lasted for four consecutive rounds, was counter-balanced. In the *no-gossip* (NG) condition, participants played the public goods game with or without punishment opportunities, as described above. In the *gossip* (G) condition, they had an extra opportunity to send a text message about *any* group member to the rest of the group. Specifically, at the end of each round, participants could choose which member, if any, to write about, and include anything they wanted to convey in their message [37]. By definition, the content of each message was available to all group members except for the one that was the target of gossip.

2.3.7. Treatment Overview

In summary, Study 1 included two treatments: (1) NP / P, in which participants played the PGG first without and then with punishment opportunities, and (2) P / NP, in which participants played the PGG first with and then without punishment opportunities (see Figure 1; left panel). Study 2 included four treatments: (1) NP + NG / P + G, in which participants played the PGG first without punishment or gossip opportunities and then with both, (2) P + G / NP + NG, in which participants played the PGG first with punishment and gossip opportunities and then without, (3) P + NG / NP + G, in which participants played the PGG first with *only* punishment (but no gossip) opportunities and then with *only* gossip (but no punishment) opportunities, and (4) NP + G / P + NG, in which participants played the PGG first with *only* gossip (but no punishment) opportunities and then with *only* punishment (but no gossip) opportunities (see Figure 1; right panel).

2.3.8. Dictator Game

In **Part 2**, participants played a one-shot dictator game, in which they were randomly assigned to the roles of *allocator* and *receiver*. The allocator unilaterally decided how much of $0.40 (i.e., 100 MUs in dyads, 200 MUs in four-person groups) each person was to receive. The receiver(s) had no control over this decision. Role assignment in the dictator game was determined at the beginning of the study when participants read instructions for all consecutive tasks, and this role assignment was used to manipulate participants' power (*high* vs. *low* vs. *control*).

3. Results

3.1. Study 1

3.1.1. Power Manipulation Check

Participants were matched with a partner to form a dyad. One third of recruited dyads were assigned to the *control* condition. Participants in these dyads had no knowledge of their role in the DG when playing the PGG. In the remaining dyads, both participants found out their role in the DG before playing the PGG—one participant was randomly assigned to the *high-power* condition (i.e., allocator) and the other was assigned to the *low-power* condition (i.e., receiver). Participants responded to the SIS measure of perceived power [36], which was used to check if the power manipulation had the intended effect on perceptions of power. Indeed, there was a statistically significant effect of the power manipulation on perceived power, $F(2, 243) = 229.68$, $p < 0.001$, $R^2 = 0.65$. As expected, participants reported higher relative power in the *high-power* condition ($M = 4.13$, $SD = 0.79$), as compared to the *low-power* condition (M = 1.68, SD = 0.75). On average, participants in the *control* condition perceived that the situation contained equal power between themselves and the other person (M = 3.13, SD = 0.67).

3.1.2. Analytic Strategy

Prior to conducting our main analyses, we examined the distributions of cooperation and punishment behaviors in the PGG; neither variable was normally distributed. Across all rounds, participants on average contributed 6.34 MUs (SD = 3.97) to the collective account, and they assigned a mean of 0.62 deduction MUs (SD = 1.39) to the other person. Out of all contribution decisions, 46.6% were fully cooperative (i.e., participants contributed 10 MUs to the collective account), whereas 18.4% were fully uncooperative (i.e., participants kept all MUs for themselves); in 16.3% of cases, participants contributed half of their endowment to the collective account. For punishment decisions, in 79.8% of all cases, participants did not engage in any punishment; in 9.3% of cases, they punished the other person with 1 or 2 MUs, and in 10.9% with 3 to 5 MUs. Given these non-normal distributions, we decided to recode cooperation (0–4 MUs = 0, 5 MUs = 1, 6–10 MUs = 2) and punishment behavior (no deduction MUs assigned = 0, 1–5 deduction MUs assigned = 1).[2]

Then, to test for the hypothesized effects of power on cooperation and punishment behaviors, we ran ordinal logistic and binary logistic regression models respectively, using generalized estimating equations (GEEs) with robust estimation in SPSS 23. We used observations from the same participants across multiple rounds of the PGG; thus, repeated measurements of cooperation and punishment behavior from the same participants were not independent. Further, because participants interacted in the same dyads across multiple rounds of the PGG, repeated measurements of their own and their group member's cooperation and punishment behavior were also not independent (i.e., we would expect the behavior of one group member to influence the behavior of the other group member over time). To account for this non-independence, we defined a structure in which measures of cooperation (i.e., contributions in the PGG) and punishment behavior were nested within participants who were nested within the dyads in which they interacted. We used an auto-regressive correlation matrix, specifying that observations of cooperation and punishment behavior collected closer in time (e.g., in immediately consecutive rounds) would be more correlated than observations collected further away in time (e.g., in the first versus the last round) [39].

3.1.3. Power, Punishment Option, and Cooperation in Dyads

We first examined the effects of power and punishment option on repeated measures of cooperation (among N = 246 participants, including k = 1949 measurements). We specified an ordinal logistic regression model that included time (i.e., a variable specifying round number in the PGG), a variable coding the order of punishment conditions (0 = NP/P; 1 = P/NP), power, punishment option, and the Power $\times$ Punishment option interaction term as predictors of cooperation. Results showed that only time had a significant effect on cooperation, Wald $\chi^2(1) = 5.11$, $b = -0.04$, $p = 0.024$, such that cooperation decreased across rounds of the PGG. Contrary to predictions, the effects of power, punishment option, and the Power $\times$ Punishment option interaction were of negligible size and did not reach statistical significance (all ps > 0.190; for detailed results, see Table S1a,b in Supplementary Materials). There was also no statistically significant effect of the order of punishment on cooperation, p = 0.874. Therefore, power did not influence decisions to cooperate in dyadic interactions, and this was the case irrespective of the presence of punishment opportunities.

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2 Results were virtually the same when using the original continuous variables for cooperation (0–10 MUs) and punishment behavior (0–5 deduction MUs), and when using an alternative binary coding for cooperation (0 MUs = 0; 1–10 MUs = 1). These results are reported in detail in the Supplementary Materials (see Tables S2a,b, S3a,b, and S5a,b).

We then examined the effects of power on repeated measures of punishment behavior in the PGG (N = 246; k = 980). We ran a binary logistic regression model with time, a variable coding for the order of punishment conditions (0 = NP/P; 1 = P/NP) and power as predictors of punishment behavior. Further, following previous research [4], we also controlled for the cooperation levels of participants' group member, as well as the positive and negative deviations of the group member's cooperation from participants' own cooperation. This analysis showed that neither time (p = 0.588), order of punishment conditions (p = 0.423), or power (p = 0.225) influenced punishment behavior in dyadic interactions (see Table S4a,b). Consistent with previous work [4], we observed that participants engaged in more punishment the lower their group member's cooperation, Wald $\chi^2(1) = 7.89$, $b = -0.10$, $p = 0.005$. Further, we observed both 'altruistic' punishment (i.e., participants punishing group members whose contributions negatively deviated from their own), Wald $\chi^2(1) = 6.15$, $b = 0.09$, $p = 0.013$, and 'antisocial' punishment (i.e., participants punishing partners whose contributions positively deviated from their own), Wald $\chi^2(1) = 18.38$, $b = 0.16$, $p < 0.001$.

3.2. Study 2

3.2.1. Power Manipulation Check

Participants were placed in four-person groups. One fifth of recruited groups were assigned to the *control* condition. Participants in these groups had no knowledge of their role in the DG when playing the PGG. In the remaining groups, all participants found out their roles in the DG before playing the PGG—one participant was randomly assigned to the *high-power* condition (i.e., allocator) and the other three participants were assigned to the *low-power* condition (i.e., receivers). Participants in the *high-power* condition perceived themselves as having higher power (M = 4.22, SD = 0.71) compared to participants in the *low-power* condition (M = 1.57, SD = 0.64), and those in the *control* condition perceived that the situation contained equal power (M = 2.96, SD = 0.54), $F(2, 363) = 521.29$, $p < 0.001$, $R^2 = 0.74$.

3.2.2. Analytic Strategy

Again, we examined the distributions of cooperation, punishment behavior, and gossip behavior in the PGG and observed a similar pattern of responses to Study 1. Across all rounds, participants on average contributed 7.13 MUs (SD = 3.61) to the collective account, and they assigned a mean of 1.09 deduction MUs (SD = 2.50) to their group members. Out of all contribution decisions, 54.4% were fully cooperative and 11.3% were fully uncooperative; in 14.2% of cases, participants contributed half of their endowment to the collective account. With regards to punishment behavior, 73.5% of participants did not assign any deduction MUs to their group members; the remaining 26.5% assigned between 1 and 15 deduction MUs. Finally, in 86.7% of cases, participants did not gossip; in the remaining 13.3% of cases, participants gossiped about their group members. Since these variables were non-normally distributed, we recoded cooperation (0–4 MUs = 0, 5 MUs = 1, 6–10 MUs = 2) and punishment behavior (no deduction MUs assigned = 0, 1–15 deduction MUs assigned = 1), and coded gossip behavior in a binary format (no gossip sent = 0, gossip sent = 1).[3]

To test for the hypothesized effects of power on cooperation, punishment behavior, and gossip behavior, we then ran ordinal logistic and binary logistic regression models using GEEs in SPSS 23. As in Study 1, we used observations from the same participants across multiple rounds of the PGG; thus, repeated measurements of cooperation, punishment behavior, and gossip behavior from the same participants were not independent. Again, because participants interacted in the same groups across multiple rounds of the PGG, repeated measurements of their own and their group members'

[3] Results were virtually the same when using the original continuous variables for cooperation (0–10 MUs) and punishment behavior (0–15 deduction MUs), and when using an alternative binary coding for cooperation (0 MUs = 0; 1–10 MUs = 1). These results are reported in detail in the Supplementary Materials (see Tables S7a,b, S8a,b, and S10a,b).

cooperation, punishment behavior, and gossip behavior were also not independent. To account for this non-independence, we defined a structure in which the measures of cooperation, punishment behavior, and gossip behavior were nested within participants who were nested within the groups in which they interacted. As in Study 1, we used an auto-regressive correlation matrix, specifying that observations of cooperation, punishment behavior, and gossip behavior that were collected closer in time would be more correlated than observations collected further in time.

3.2.3. Power, Cooperation, and Strategies to Promote Cooperation in Groups

We started by examining the effects of power, punishment option, and gossip option on repeated measures of cooperation ($N = 371$; $k = 2952$). Specifically, we ran an ordinal logistic regression model including time, power, punishment option and gossip option, as well as the Power × Punishment option and Power × Gossip option interaction terms as predictors of cooperation. We also controlled for variables coding the order of punishment conditions (0 = NP/P; 1 = P/NP) and the order of gossip conditions (0 = NG/G; 1 = G/NG). When specifying an auto-regressive correlation matrix, we encountered problems with model convergence and thus opted for an unstructured matrix only for this analysis.

Our findings indicated that time had a significant effect on cooperation, Wald $\chi^2(1) = 7.17$, $b = 0.05$, $p = 0.007$, such that cooperation in groups increased across rounds of the PGG. Further, we observed significantly higher levels of cooperation in the punishment condition compared to the no-punishment condition, Wald $\chi^2(1) = 7.47$, $p = 0.006$, and in the gossip condition compared to the no-gossip condition, Wald $\chi^2(1) = 3.84$, $p = 0.050$. However, the effects of power and the Power × Punishment option and Power × Gossip option interactions did not reach statistical significance (all ps > 0.065; see Table S6a,b). Finally, the variables coding for order effects did not influence cooperation (both ps > 0.055).

Overall, we did not find support for the hypothesis that power reduces cooperation, and this was true irrespective of the presence of punishment and gossip opportunities. As in Study 1, we then examined the effects of power on repeated measures of punishment behavior in the PGG. Specifically, we ran a binary logistic regression model with time, a variable coding for the order of punishment conditions (0 = NP/P; 1 = P/NP), and power as predictors of punishment behavior ($N = 371$; $k = 1484$). As in Study 1, we also controlled for the average cooperation levels of participants' group members, as well as the positive and negative deviations of the group members' cooperation from participants' own cooperation. Replicating the results of Study 1, neither time ($p = 0.945$), nor order of punishment conditions ($p = 0.844$), or power ($p = 0.264$) influenced punishment behavior (see Table S9a,b). However, as in Study 1, we observed a statistically significant effect of group members' average cooperation levels on punishment behavior, such that participants engaged in more punishment the lower their group members' contributions, $b = -0.15$, Wald $\chi^2(1) = 21.04$, $p < 0.001$. Further, we again observed both 'altruistic' punishment ($b = 0.25$, Wald $\chi^2(1) = 29.81$, $p < 0.001$) and 'antisocial' punishment ($b = 0.08$, Wald $\chi^2(1) = 5.94$, $p = 0.015$).

Finally, to test for the effects of power on gossip behavior in the PGG, we ran a binary logistic regression model with time, order of gossip conditions (0 = NG/G; 1 = G/NG), and power as predictors of gossip behavior ($N = 371$; $k = 1484$). Results indicated that neither time ($p = 0.119$), nor order of gossip conditions ($p = 0.388$), or power ($p = 0.897$) influenced gossip behavior in group interactions (see Table S11a,b).

4. Discussion

Our research examined the relations between relative power, cooperation, and different strategies to promote cooperation in situations that involve conflicting interests. Findings across two studies, involving real-time dyadic and group interactions, did not support the hypothesis that high-power individuals are less cooperative than their low-power counterparts (H_1). Instead, results indicated that differences in cooperative behavior between high-power individuals, low-power individuals, and those interacting in egalitarian dyads and groups were negligible. These findings are not consistent with previous research showing that power has corruptive effects [11], making the powerful behave in more self-serving ways in social dilemmas [17,18].

Further, contrary to our predictions, our findings indicated that high- and low-power individuals responded similarly to the threat of punishment. That is, we did not observe that low-power individuals were more likely than their high-power counterparts to up-regulate cooperation levels in the presence of punishment opportunities (H_3). Actually, in Study 1, punishment opportunities did *not* lead to an increase in contributions to public goods, and this was the case irrespective of participants' power. There are two potential explanations for this finding. First, coordination on mutually beneficial behaviors might be easier to achieve in dyads as compared to larger groups even (or perhaps especially) in the absence of punishment threats [40]. Second, when punishment threats are realized in dyadic interactions, they can easily lead to retaliation and escalating feuds [28].

The latter point is also informative to interpret results from Study 2. Specifically, in group interactions in Study 2, we replicated the well-established effect of punishment opportunities on the up-regulation of cooperation, but again this effect did not vary with participants' power (H_3). This finding can be potentially explained by the fact that high- and low-power individuals in our study possessed the same means to enforce cooperation—that is, they had equal ability to inflict costs on non-cooperative others (i.e., equal formidability) [41]. In this context, it appears that high-power individuals' increased access to valuable resources, and associated ability to provide benefits (i.e., higher conferral ability) [41], did not reduce the perceived costs of punishment by low-power others. Based on these findings, we believe that future research on power would benefit from investigating how variations in both conferral ability and formidability influence cooperation in social dilemmas.

Importantly, however, our choice to manipulate power by varying individuals' ability to provide benefits, allowed us to examine whether high-power versus low-power individuals are more likely to engage in costly punishment (H_2), while keeping the ability to inflict costs constant across power conditions. Previous theory and research on bargaining adaptations [41] has suggested that high-power individuals might engage in more behaviors that aim to recalibrate others in a way that fits the interests of the powerful. In our studies, we did not find that high-power individuals were more likely to use direct punishment to promote cooperation, compared to either their low-power counterparts or participants in egalitarian groups. Again, this might have to do with our design, in which threats of retaliation were equally strong irrespective of participants' power, and so individuals might have been motivated to avoid counter-punishment across power conditions.

Finally, our findings replicate previous research in showing that gossip opportunities effectively promote cooperation in social dilemmas [6,35]. However, contrary to our hypothesis (H_4), we observed no differences in the use of gossip between high- and low-power individuals. In retrospect, this finding is not that surprising when considering that direct punishment strategies and indirect gossip strategies in our second study were not mutually exclusive. Under these conditions, although low-power individuals might still preferentially use gossip rather than costly punishment to deter non-cooperation, there is no reason why high-power individuals would not use *all* the strategies available to them, including low-cost ones. Future research should attempt to disentangle preferences for punishment versus gossip by making participants choose between them (i.e., not allowing participants to use both at the same time). In any case, our findings corroborate previous work in suggesting that gossip might be a particularly successful means to up-regulate others' cooperation. Consistent with our final prediction (H_5), we found that the presence of gossip opportunities increases cooperation irrespective of individuals' power position.

We believe that our work can be extended and improved by addressing three important issues. First, our studies relied on a power manipulation (i.e., varying participants' role in a dictator game) that was exogenous to the situation where cooperation, punishment, and gossip took place (i.e., the public goods game). This was a deliberate choice which allowed us to cleanly study the use of punishment and gossip by high- versus low-power participants. Nevertheless, using an exogenous power manipulation might be one reason for the discrepancy between our findings and those of other studies on power and cooperation (e.g., studies varying the endowment size available to participants or punishment power [42,43]). Future work could directly test whether endogenous and exogenous power manipulations differentially affect cooperation and strategies to promote cooperation. Relatedly, in our studies, we used random assignment of participants to different power conditions in a relatively artificial decision-making context. We believe that more empirical research is warranted to examine how power differences that are based on non-arbitrary characteristics—such as physical strength and attractiveness [41], and skill or expertise [11,15,44]—might influence cooperation, punishment, and gossip. Finally, we believe future research would benefit from examining how power dynamics unfold over time.

Second, previous research has shown that the negative effects of power on cooperation may depend on individual differences, such as social value orientation [45,46]. In our studies, an interesting possibility is that low-power individuals' expectations about high-power others' behavior might also be influenced by their motivational orientation [47]. Therefore, low-power participants with a pro-self orientation might expect to receive nothing from high-power others in the dictator game and would thus have no reason to condition their cooperation in the public goods game on their power. In contrast, low-power participants with a pro-social orientation might expect at least some generosity from their high-power counterparts in the dictator game and might thus up-regulate their cooperation during the public goods game to induce reciprocity.

Third, our work only studied the effects of power on cooperation among participants in the US, but previous research has demonstrated cross-cultural variability in the effects of power on cooperation. Whereas individuals from Western cultures may typically understand power in terms of exercising personal freedom, individuals from Eastern cultures may represent power as responsibility. Indeed, US individuals seem to perceive power holders who behave selfishly as fairer, whereas Japanese individuals perceive power holders who behave generously to be fairer [48]. In addition, Hong Kong managers with high power take a smaller share of resources for themselves, compared to managers from Western countries (US, Germany, but also Israel [49]).

Over the past two decades, researchers have made significant progress in understanding how social hierarchies have shaped human psychology [15,24], while illuminating the consequences of power in interpersonal and organizational settings [11,16]. Here, we attempted to integrate this growing literature with existing work on cooperation. Specifically, we investigated the conditions under which cooperation can be fostered and maintained in asymmetric power relationships within dyads and groups. Rather than demonstrating a clear negative relation between power and cooperation, our findings indicate that the powerful are also sensitive to the means that their counterparts have to enforce cooperation. We believe that by focusing on the strategies that the powerful *and* the powerless use to promote cooperation, future research can help unravel the complex dynamics that allow mutual cooperation to emerge within social hierarchies.

Supplementary Materials: The following are available online at http://www.mdpi.com/2073-4336/10/1/12/s1, **Study 1.** *Participant Recruitment; Cooperation and Punishment in the Public Goods Game across Time.* Figure S1: Average contributions across PGG rounds, Figure S2: Average punishment across PGG rounds, Figure S3: Average contributions across PGG rounds (Punishment/No-Punishment Treatment), Figure S4: Average contributions across PGG rounds (No-Punishment/ Punishment Treatment). *Cooperation and Punishment in the Public Goods Game across Power Conditions*. Figure S5: Average contributions across power conditions in the PGG, Figure S6: Average punishment across power conditions in the PGG. *Models Predicting Cooperation in the Public Goods Game*. Table S1a: Significance tests from the ordinal logistic regression on cooperation, Table S1b: Parameter estimates from the ordinal logistic regression on cooperation, Table S2a: Significance tests from the linear regression on cooperation, Table S2b: Parameter estimates from the linear regression on cooperation, Table S3a: Significance tests from the binary logistic regression on cooperation, Table S3b: Parameter estimates from the binary logistic regression on cooperation; *Models Predicting Punishment Behavior in the Public Goods Game.* Table S4a: Significance tests from the binary logistic regression on punishment behavior, Table S4b: Parameter estimates from the binary logistic regression on punishment behavior, Table S5a: Significance tests from the linear regression on punishment behavior, Table S5b: Parameter estimates from the linear regression on punishment behavior; *Behavior and Earnings Across Experimental Games.* **Study 2.** *Participant Recruitment; Cooperation, Punishment, and Gossip in the Public Goods Game across Time.* Figure S7: Average contributions across PGG rounds, Figure S8: Average punishment across PGG rounds, Figure S9: Total number of gossip messages sent across PGG rounds, Figure S10: Average contributions across PGG rounds (Punishment/No-Punishment Treatment), Figure S11: Average contributions across PGG rounds (No-Punishment/Punishment Treatment), Figure S12: Average contributions across PGG (Gossip/No-Gossip Treatment), Figure S13: Average contributions across PGG rounds (No-Gossip/Gossip Treatment), Figure S14: Contributions in the PGG depending on the availability of punishment and gossip options. *Cooperation, Punishment, and Gossip in the Public Goods Game across Power Conditions*. Figure S15: Average contributions across power conditions in the PGG, Figure S16: Average punishment across power conditions in the PGG, Figure S17: Average gossip messages (0–4) sent across power conditions in the PGG. *Models Predicting Cooperation in the Public Goods Game*. Table S6a: Significance tests from the ordinal logistic regression on cooperation, Table S6b: Parameter estimates from the ordinal logistic regression on cooperation, Table S7a: Significance tests from the linear regression on cooperation, Table S7b: Parameter estimates from the linear regression on cooperation, Table S8a: Significance tests from the binary logistic regression on cooperation, Table S8b: Parameter estimates from the binary logistic regression on cooperation; *Models Predicting Punishment Behavior in the Public Goods Game.* Table S9a: Significance tests from the binary logistic regression on punishment behavior, Table S9b: Parameter estimates from the binary logistic regression on punishment behavior, Table S10a: Significance tests from the linear regression on punishment behavior, Table S10b: Parameter estimates from the linear regression on punishment behavior; *Model Predicting Gossip Behavior in the Public Goods Game*. Table S11a: Significance tests from the binary logistic regression on gossip behavior, Table S11b: Parameter estimates from the binary logistic regression on gossip behavior; *Behavior and Earnings Across Experimental Games*.

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