Punishing Free-riders: Direct and Indirect Promotion of Cooperation

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Abstract. Human cooperation in a large group of genetically unrelated people is an evolutionary puzzle. Despite its costly nature, cooperative behaviour is commonly found in all human societies, a fact that has interested researchers from a wide range of disciplines including biology, economics, and psychology to name a few. Many behavioural experiments have demonstrated that cooperation within a group can be sustained when free riders are punished. We argue that punishment has both a direct and an indirect effect in promoting cooperation. The direct effect of punishment alters the consequences of cooperation and defection in such a way as to make a rational person prefer cooperation. The indirect effect of punishment promotes cooperation among conditional cooperators by providing the condition necessary for their cooperation — i.e., the expectation that other members will also cooperate. Here we present data from two one-shot, n-person Prisoner's Dilemma games, demonstrating that the indirect effect of punishment complements the direct effect to increase cooperation in the game. Further, we show that the direct and indirect effects are robust across two forms of punishment technology; either when the punishment is voluntarily provided by game players themselves or when it is exogenously provided by the experimenter.

Key Words: Cooperation; Punishment; Expectation; Conditional cooperation; Prisoner's dilemma

1. Introduction

One of the most distinguishing features of human societies is large-scale cooperation among non-kin. Examples of such cooperation include hunting and meat sharing and collaborative childcare in hunter-gatherer societies, contributions to public goods, such as an irrigation system in agriculturalist societies, and market exchanges in industrialized societies. Cooperation produces mutually beneficial outcomes, and yet is costly for the individual. Some cooperative behaviour can be understood by kin selection (Hamilton, 1964) – helping others can enhance the benefactor's inclusive fitness when the beneficiary is a genetic relative – and direct reciprocity between those who are willing to trade-off the roles of benefactor and beneficiary (Trivers, 1971). These two mechanisms can account for much of the cooperative behavior observed among the animals including humans, but are insufficient to explain costly cooperation in sizeable human groups consisting of genetically unrelated individuals in the absence of long-term relationships. While free-riding on a public good is expected from the kin-based and reciprocal altruism under these circumstances, experimental studies have shown nontrivial contributions in anonymously played one-shot games with genetically-unrelated participants (Andreoni & Petrie, 2004; Issac & Walker, 1988; Marwell & Ames, 1981; Orbell, Dawes, & Van de Kragt, 1988; Rapoport, 1987; Yamagishi, 1988).

One possible explanation for cooperation in human groups is the punishment of free-riders. Experimental studies have consistently demonstrated that punishment (monetary and symbolic alike) promotes cooperation (Fehr & Fischbacher, 2003; Fehr & Gächter, 2002; Masclet, Noussair, Tucker, & Villeval, 2003). Not only do people show a propensity to cooperate under the threat of punishment in experimental games, they are also willing to absorb costs for administering punishment to free riders (Anderson & Putterman, 2006; Casari & Plott, 2003; Price, Cosmides, & Tooby, 2002). Given the power of punishment to promote cooperation, it is surprising to us that many theorists have generally overlooked the reason for punishment's efficacy. We speculate that the paucity of effort to address this question is at least partly based on the fact that the answer seems self-evident; administration of punishment transforms outcomes of cooperation and defection such that cooperation is more profitable than free-riding. This *direct effect* of punishment could be the sole factor in explaining cooperation if, and only if, one assumes that humans are strictly self-regarding with no consideration for

the consequences to others. Olson (1965) clearly follows this logic when he wrote "… rational, self-interested individuals will not act to achieve their common or group interests" (p. 2) and "only a separate and selective incentive will stimulate a rational individual in a latent group to act in a group-oriented way" (p. 51).

In this paper, we argue that the direct effect – transformation of incentives for potential targets of punishment – alone is limited in its ability to explain the robust effect of punishment. The limitation arises from the fact that punishment incurs a cost to the punisher, whereas the benefit of punishment – public welfare generated by greater cooperation – is shared equally by all members. Thus, the provision of punishment involves a free-rider problem in itself; self-regarding individuals should not pay the cost associated with imposing penalties on free-riders. This problem is called the second-order public good dilemma (Oliver, 1980). Faced with this difficulty, some researchers have argued that the cost of punishment becomes smaller in higher-order public good dilemmas (e.g., punishment of non-punishers; punishment of those who don't punish non-punishers; etc.) than in the original public good dilemma (Boyd & Richerson, 1992; Boyd, Gintis, Bowles, & Richerson, 2003; Henrich & Boyd, 2001; Henrich, 2004; Sober & Wilson, 1998). Once the cost is reduced sufficiently for the provision of punishment at a higher level, it should eventually stabilize cooperation in the original public good dilemma.

We claim below that this cost-reduction argument can be augmented by an efficiency-enhancement argument. In addition to the possibility that the cost associated with providing punishment is smaller than that associated with providing the original public good, we suggest that an *indirect* effect of punishment further enhances the efficiency of punishment. There is a robust finding that an overwhelming majority of players in the public goods game behave as conditional cooperators – individuals who cooperate if (and only if) other members cooperate – rather than as unconditional cooperators or unconditional defectors (Andreoni & Miller, 1993; Boehm, 1993; Kurzban & Houser, 2005; Page & Putterman, 2005). Although players almost always defect in response to defection in a public goods game, the majority of players choose to cooperate when other players cooperate (Cho & Choi, 2000; Clark & Sefton, 2001; Fischbacher, Gächter, & Fehr, 2001; Hayashi, Ostrom, Walker, & Yamagishi, 1999; Kiyonari, Tanida, & Yamagishi, 2000; Watabe, Terai, Hayashi, & Yamagishi, 1996).

Moreover, numerous studies have demonstrated a relationship between the expectation of cooperation and cooperative behaviour; the stronger the expectation that others will cooperate, the more likely it is that a player will choose to cooperate him or herself (Charness & Dufwenberg, 2006; Dawes, 1980; Pruitt & Kimmel, 1977). Conditional cooperators seek mutually beneficial opportunities, but only when their effort is unlikely to be exploited by free-riders. For them, the expectation that others will cooperate is a necessary (though not sufficient) antecedent for a cooperative venture. The threat of punishment for free-riding provides reassurance to conditional cooperators that other group members will also cooperate. This reassurance that others will also cooperate satisfies their condition for cooperation. Punishment promotes cooperation among conditional cooperators through the reassurance it provides rather than by the fear of being a target of penalization (the direct effect of punishment). We call this the *indirect effect* of punishment.

Most experimental studies of punishment (e.g., Fehr & Gächter, 2002; Ostrom, Walker, & Gardner, 1992: Yamagishi, 1986) do not appreciate the possibility that indirect effect supplements the direct effect of punishment, and, instead, analyze the *combined effect* (including both direct and indirect effects) of punishment for promoting cooperation. The purpose of this study is to demonstrate the augmentative nature of the indirect effect, such that the combined effect of punishment is greater than the level expected from the direct effect alone. For this purpose, we compare the size of punishment's combined effect with the size of the direct effect alone. Specifically, we design a one-shot, three-person PD game with three between-subjects conditions: the no-punishment condition, the direct effect (of punishment) condition, and the combined effect (of punishment) condition. We adopt a one-shot rather than repeated game design often used in the study of punishment (Anderson & Putterman, 2006; Fehr & Gächter, 2002; Ostrom et al., 1992; Yamagishi, 1986). The reason for the use of a one-shot instead of a repeated game is that measurement of the direct effect, in its pure form free from the contaminating influences of indirect effects, is an indispensable part of this study. In repeated games, those who are afraid of receiving a penalty (i.e., those who experience the direct effect of punishment) and thus cooperate at a higher level may unwittingly promote cooperation of the other players who are conditional cooperators. The improved level of cooperation of the other players might, in turn, improve the

original players' level of cooperation. That is, the direct effect of punishment in repeated games can engender an indirect effect through the other players' behavior, and thus identifying the direct effect of punishment in its pure form is theoretically impossible. This difficulty of identifying the direct effect can be avoided in one-shot games in which changes in one player's behavior are not reflected in other players' behavior. On the other hand, whether or not punishment has an effect in the absence of the actual experience of being punished has been debated, and no firm conclusions have yet been reached (Eek, Loukopoulos, Fujii, & Gärling, 2002; Loukopoulos, Eek, Gärling, & Fujii, 2006; Walker & Halloran, 2004). The current study thus aspires, first, to provide evidence for the effect of punishment in the absence of the actual experience of punishment, and, second, to sort out indirect and direct effects of punishment from their combined effect.

We conducted two experiments, the major difference between the two residing in the punishment mechanism. In the first study, punishment was provided exogenously. That is, penalties were imposed by the experimenter, requiring no cost to be paid by players themselves. In contrast, punishment in study two was endogenous, dispensed by individual game players themselves who had to pay a cost for its provision. In both experiments, each player of a three-person PD game first decided what portion of an initial endowment they would contribute to benefit the other two players. Afterwards, players faced the possibility of punishment for free-riding. In the direct effect condition, the participant alone faced the possibility of punishment. Since no penalties were administered to other players, they could free-ride with impunity. Thus, only the direct effect of punishment could influence the participant's decision to cooperate. In the combined effect condition, all players were subject to punishment. Thus, in addition to the direct effect of punishment for free-riding, participants could expect greater cooperation (on average) from their fellow group members who also faced the possibility of penalization. In the no-punishment condition, there was no penalty for free riding. Thus, any difference in the sum contributed between the direct effect and no-punishment conditions must be due to the direct effect of punishment alone. In this sense, any additional contribution in the combined effect condition, over and above that observed in the direct effect condition, can be regarded as evidence for the indirect effect.

2. Study 1

2.1. Methods

A total of 157 freshmen (79 men and 78 women) at Hokkaido University in Japan participated in this experiment for monetary rewards. They were recruited from a large subject pool consisting of freshmen from various disciplines, and were randomly assigned to one of three conditions (n = 52 in the no-punishment condition, 51 in the direct effect condition, and 54 in the combined effect condition). Two of the participants misunderstood the instructions and were removed from the analysis.[1] Participants were assured that their contributions would remain anonymous to both the other participants and to the experimenter with whom they met in person.

In all three conditions, participants played a one-shot, three-person PD game. Participants were escorted to individual rooms without seeing or talking to other participants. Each member of the three-person group was provided with an endowment of 800 yen from the experimenter, and was asked to contribute some portion of that endowment to the other group members. The actual amount was left up to each player. Each player received the total amount contributed by the other two players. Thus, if everybody contributed the full endowment of 800 yen, each player received 1,600 yen (800 from each of the other players). Since each player decided on the sum to contribute without knowing the value of the other contributions, contributing nothing was the most profitable choice regardless of the amount other members decided to contribute. In the event that all three players adopted this strategy of contributing nothing, each would retain their original endowment of 800 yen. Thus, the monetary payoff for each participant *i* in the no-punishment condition is given by

$$\pi_i = y - g_i + a\sum_{j \neq i} g_j \quad \text{.....(1)}$$

where *y* is the endowment and *a* is the benefit generated by another member's cooperation (*y* = 800, and *a* = 1; note that the participant's own contribution does not generate any benefit to him or herself, as implied by $j \neq i$).

Players in the no-punishment condition neither faced punishment nor were they informed that punishment was even a possibility. Conversely, players in the remaining two conditions were informed that they might be punished if they did not contribute the entire sum of their endowment to the other group members. Furthermore, players in the two punishment conditions were informed that there was an increasing probability of punishment as the value of their contribution decreased; however, players were not told of the specific probabilities[2]. We chose to implement a punishment mechanism with incomplete information regarding the probability of being punished, since the exact probability of punishment at various level of cooperation is hardly available in the real world. Punishment was imposed exogenously by the experimenter, though this method of administrating punishment was changed in the second study. While we used the term "punishment" in the instructions of the first experiment, we omitted the term in the second study. We discuss the implications of using (or not using) the term "punishment" in the general discussion.

When a player was penalized, he or she lost half of the portion of the endowment he or she kept at hand. Thus, the monetary payoff for each participant *i* when he or she is punished is given by

$$\pi_i^* = \pi_i - (y - g_i)/2 \quad \text{.....(2)}$$

The monetary payoff for the participant who was not punished is given by equation (1).

Participants in the direct effect condition were further told that only one of the three participants would be subject to punishment, and that they had been randomly chosen as the sole target of punishment. They were further instructed that the other players would remain uninformed of this fact, having no knowledge about the possibility of punishment. Since the participant alone was subject to punishment, and the other members were not subject to punishment, only the direct effect was possible in this condition. Players in the combined effect condition were told that all three members of the group would face the possibility of punishment. In order to keep the threat of receiving punishment constant across the two punishment conditions, players were told that the probability of punishment would be determined independently for each player, so that the likelihood of punishment was unaffected by the decisions made by other players.

Three players assigned to the combined effect condition were grouped together to constitute a single groups to play a public goods game. Other experimental groups consisted of one player from the direct effect condition and two players from the no-punishment condition. In order to maintain a balance in the number of players assigned to each condition, one player in the no-punishment condition was sometimes paired with more than one player in the direct effect condition when calculating their rewards.[3]

After the experiment, all participants completed a post-experimental questionnaire. Finally, they were informed of their game outcome—how much each of the three members contributed, and whether or not they received a penalty (in the two punishment conditions), and how much they earned. A secretary who knew nothing about the experiment paid each participant individually and then discharged them. The research protocol was approved by the ethics committee for the Department of Behavioural Science at Hokkaido University.

2.2. Results

Because there were no main or interaction effects involving player's sex, the following analyses used the combined data for men and women. The results of the first study (Fig. 1) show that the base-rate level of cooperation (the portion of the initial endowment contributed for other members) in the no-punishment condition was 239.81 yen (*SD* = 197.03), or about 30 percent of the endowment. Cooperation levels in the two punishment conditions were higher than this base-rate level (345.60 yen, *SD* = 223.80, in the direct effect condition, and 435.47 yen, *SD* = 231.17, in the combined effect condition). We conducted a set of regression analyses for cooperation level using two dummy variables; one for the presence of punishment (dummy 1; zero in the no-punishment condition and one in the direct and the indirect effect conditions) and the other for the presence of indirect effect (dummy 2; zero in the no-punishment and the direct effect conditions and one in the indirect effect condition). Column 1 in Table 1 includes only dummy 1; the effect for the dummy variable represents the difference in cooperation level between the no-punishment condition and the two punishment conditions combined. The significant regression effect for this variable in Column 1 shows that punishment increased the cooperation level by 152.04 yen.

Table 1: The effects of anticipated punishment on cooperation in study one. Regression analyses for contribution level on two dummy variables.

Variables	(1)	(2)
Dummy 1	152.04	105.79
	(37.47)	(43.15)
	$P < .0001$	$P = .015$
Dummy 2	.	89.87
		(42.95)
		$P = .038$
Constant	239.81	239.81
	(30.54)	(30.21)
	$P < .0001$	$P < .0001$
N	155	155
R^2	0.10	0.12

Standard errors in parentheses.

The second dummy was then added to the regression equation (Column 2) to decompose the overall effect of punishment into two components: one for the direct effect and one for the indirect effect: The contribution level in the no-punishment condition is represented by the constant in Column 2, since both of the two dummies are zero in this condition. The contribution level in the direct effect condition is the sum of the constant and the regression coefficient for dummy 1 (that takes the value of one), and thus the coefficient for dummy 1 represents the difference in cooperation between the no-punishment condition and the direct effect condition. In Figure 1, this effect corresponds to the dark portion of the bar for the direct effect condition. Similarly, the coefficient for dummy 2 represents the difference in cooperation between the direct effect condition and the indirect effect condition, corresponding to the bark portion of the bar for the indirect effect condition. The two effects are similar in size, indicating that the indirect effect was almost as strong as the direct effect. The interpretation of the relative sizes of these two effects, however, has to be made with caution since effect sizes depend on the parameters used in the experiment, including the cost and benefit for cooperation and the cost and size of punishment.

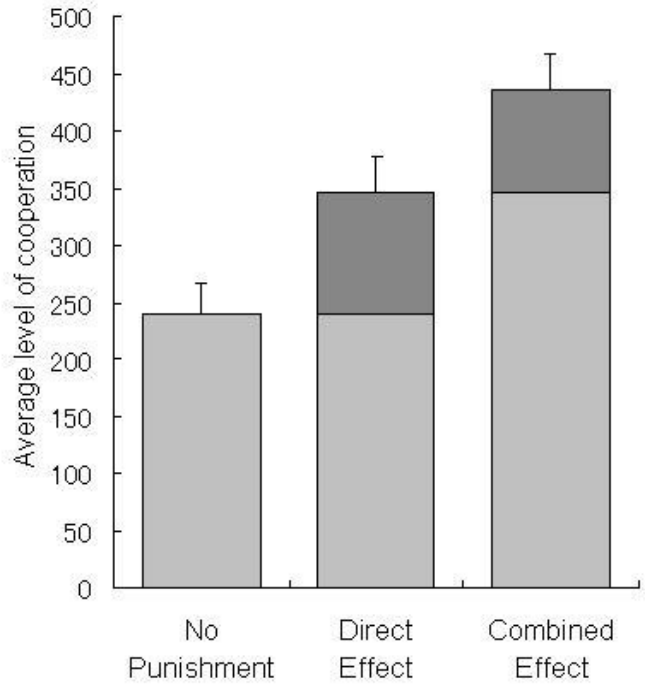

Fig. 1: Direct and indirect effects of punishment in the first study. The left bar estimates the base level of cooperation (sum of contribution) that occurs when free-riding is not punished. The darker portion of the middle bar (105.79 yen) represents the direct effect of punishment – cooperation over and above that observed in the no-punishment condition. The right bar illustrates the combined effect of punishment (direct and indirect) on cooperation; the darker portion (89.87 yen) represents the contribution level over and above that observed for the direct effect of punishment (i.e., the indirect effect of punishment). Error bars represent standard error.

We expected that participants would cooperate more in the combined effect condition than in the direct effect condition since the expectation that other members would cooperate due to possible punishment would be higher in the former condition than in the latter. We also argued that since there was no possibility that other members would be punished in the no-punishment and direct effect conditions, participants' expectations would not differ between the two. We measured participants' expectations in the post-experimental questionnaire by asking; "How much do you think the other two contributed on average?" The average expectation was 400.57 yen (*SD* = 129.12) in the combined effect condition, 329.00 yen (*SD* = 130.58) in the direct effect condition, and 274.33 yen (*SD* = 157.81) in the no-punishment condition. A regression analysis using a set of two dummy variables (see the analysis of contributions) indicated that both the difference between the direct effect and the combined effect conditions (*b* =

71.57, $t(152) = 2.60$, $p = .01$) as well as the difference between the no-punishment and the direct effect conditions ($b = 54.67$, $t(152) = 1.97$, $p = .05$) were significant. While the former difference provides support for our argument, the unanticipated difference between the no-punishment and the direct effect condition strongly suggests that at least a substantial portion of the participant's responses to the post-experimental questions represents "projection" of their own behavior onto the other members. Participants in the direct effect condition overestimated the other two members' actual contribution (329.00 vs. 239.81 yen) to match their own contribution (345.60 yen), at least in their responses to post-experimental questions, whereas the estimations of those in the no-punishment condition (274.33 vs. 239.81 yen) and in the combined effect condition (400.57 vs. 435.47 yen) did not greatly differ from the actual levels of contribution. We do not know if this overestimation by participants in the direct effect condition occurred in the experiment and affected their decisions or emerged only in their responses to the post-experimental question. However, even if it had affected their decision in the experiment, it should have made their contribution higher rather than lower. The "inflated" level of contribution in the direct effect condition beyond the effect caused by the threat of punishment alone, if existing at all, should have worked against our hypothesis concerning indirect effect. Thus, this result provided stronger support to our conclusion about indirect effect.

3. Study 2

The results of the first study confirmed, first, that the threat of punishment can enhance cooperation in a one-shot PD game. These results further provided evidence that the indirect effect of punishment augments its direct effect. This finding, however, has to be qualified in two important respects. First, the punishment was imposed exogenously by the experimenter, rather than voluntarily administered by players themselves. Second, administration of punishment required no cost from the players. These two features of punishment in the first study are problematic for generalizing the results beyond this particular enforcement mechanism. When players are required to pay a personal cost to impose penalties, the likelihood of punishment of free-riding may be less than that expected when the experimenter acts as requiter. The direct effect of

punishment may thus be reduced when the administration of punishment is costly. Consequently, the expectation that other people will cooperate to avoid punishment may also be reduced. As a result, the promotion of cooperation through the indirect effect would be reduced

We conducted a second study to examine whether the indirect effect of punishment observed in the first study would be replicated under a different enforcement mechanism. In the second study, players decided how much personal cost to bear in order to administer punishment to other players who fail to contribute. In addition, we decided not to use the term "punishment" in the second study. Instead, we choose to use the neutral word "reduce," in order to avoid eliciting normative behaviour associated with the term "punishment."

The use of the endogenous punishment mechanism forced us to give up measuring the pure direct effect of punishment as we did in Study 1. In the first experiment, participants in the direct effect condition were informed that the other two players were unaware of punishment at all. In Study 2 however, the other two players were aware of the existence of punishment because they were able to deliver punishment to the participant in the direct effect condition. Participants in the direct condition in the second study thus face players who may be affected by indirect effect of punishment, since other players face someone (the participant in the direct effect condition) who can be punished. That is, participants in the direct effect condition in the second study may be affected by the expectation of indirect effect that may enhance other players' cooperation—we may call this doubly indirect effect of punishment. We decided to run the endogenous punishment mechanism despite the inability of measuring purely direct effect mentioned above, since the merits of the new design outweigh this potential problem. Furthermore, this doubly indirect effect of punishment should work against our hypothesis concerning the operation of indirect effect, because the test of indirect effect now involves cooperation in the combined effect and "inflated" (due to the doubly indirect effect) level of cooperation in the direct effect condition.

3.1. Methods

A total of 144 freshmen (72 men and 72 women) at Hokkaido University in Japan participated in this experiment for monetary rewards. All participants played the same one-shot, three-person PD game used in the first study. Each member of a three-person group was asked to contribute some portion of their endowment of 800 yen for other group members. Each of the other two players received the amount the player contributed.

Participants were randomly assigned to one of three conditions (n = 48 in the no-punishment condition, 48 in the direct effect condition, and 48 in the combined effect condition). Three of the participants were removed from the analysis because their responses to post-experimental questions made it clear that they failed to comprehend the instructions.[4] The use of an endogenous punishment system forced us to use "extra" participants to avoid deception. Participants in the direct effect condition were the only potential targets of punishment in their group. The other two participants in their group did not face the possibility of receiving punishment. They were informed that punishment option existed in their group. Further, one of the two was given a chance to punish another player (the participant in the direct effect condition). These features disqualified them as players in the no-punishment condition. We did not use these "extra" participants in our hypothesis testing, since they were not relevant to our hypotheses.

Players in the no-punishment condition constituted a group in which no one faced punishment. The monetary payoff for each participant in the no-punishment condition is given by equation (1). Players in the remaining two conditions were informed that they might be punished by other players. We introduced a system of punishment in which one participant could be punished only by one other participant in order to make punishment compatible across the two punishment conditions. If we allowed both of the other two participants to punish the participant in the direct effect condition, he or she would be subject to punishment by two individuals. In contrast, no participant in the combined effect condition was the sole target of punishment by two individuals simultaneously, since each of the other two participants had two potential targets to choose from. As a result, participants in the direct effect condition faced twice as strong punishment as those in the indirect effect condition. This problem was avoided by restricting the number of potential punishers in the direct effect condition to one.

Remember that the group for the direct effect condition included the potential target of punishment, D1, and two “extra” participants; one of the two, DE1, was given an opportunity to punish D1, whereas the other, DE2, did not have such an opportunity. Only the sole target of punishment in this group, D1, qualified for the direct effect condition; the other two, “extra” participants were included in this group to avoid deceiving the participants.

The monetary payoff for the player D1 in the direct effect condition is given by,

$$\pi^{*}_{D_1} = \pi_{D_1} - 2p \quad \text{.....(3)}$$

where p is the amount of money that DE1 pays to punish D1. Player D1 in the direct effect condition may be punished only by DE1. Since D1 did not have an opportunity to punish another player, Eq1uation 3 does not include cost of punishment.

Participant C1 in the combined effect condition was a target of potential punishment by C2, C2 by C3, and C3 by C1. Therefore, the monetary payoff for each participant in the combined effect condition is given by,

$$\pi^{*}_{i} = \pi_{i} - 2p_{ji} - p_{ik} \quad \text{.....(4)}$$

where $j \neq i$, $i \neq k$, $k \neq j$ and pik is the amount of money that group member i pay to punish group member k.

After all participants decided how much to contribute in the three-person PD game, each participant in the combined effect condition (and the extra participants in the direct effect condition) was informed of how much the target of his or her punishment contributed. Then, they were given an opportunity to reduce the earnings of that member. They were told that monetary costs were required to use the option; each yen the participant paid reduced the target member’s earnings by two yen. The maximum amount they could pay to reduce another’s earnings was 200 yen, the amount they were paid before the experiment as a show-up fee (in addition to the endowment of 800 yen they were given in the experiment). After deciding how much to pay to reduce the earnings of that member, all participants completed a post-experimental questionnaire. Finally, they were informed how much they earned in the PD game and, if they were

subjected to punishment, how much their earnings were reduced. Finally, participants were paid their earnings individually, less the penalty, and dismissed.

3.2. Results

We found no main or interaction effects involving the sex of the participants and, therefore, data was pooled across sexes for all subsequent analyses.

Cooperation. As shown in Fig. 2, the results of the second study largely replicated those of the first study. On average, the contribution level was lowest (237.71 yen, SD = 264.56) in the no-punishment condition, highest (414.13 yen, SD = 256.13)

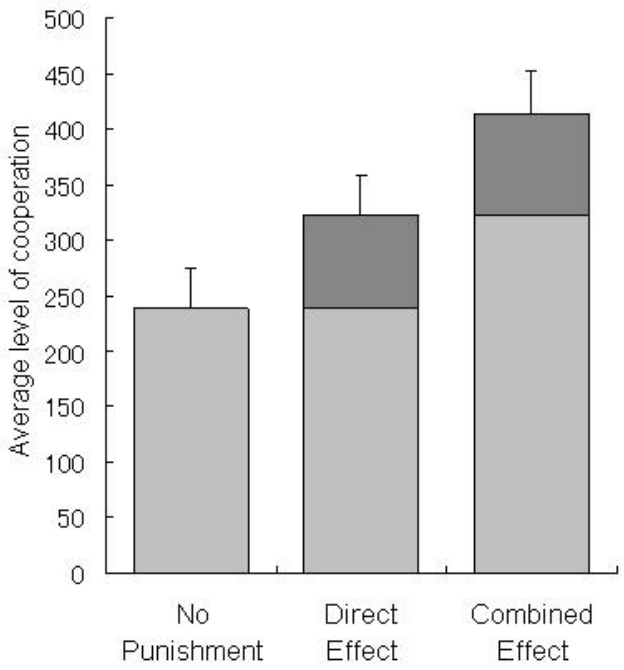

Fig. 2: Direct and indirect effects of punishment in the second study. The left bar estimates the base level of cooperation (sum of contribution) that occurs when free-riding is not punished. The darker portion of the middle bar (85.91 yen) represents the direct effect of punishment – cooperation over and above that observed in the no-punishment condition. The right bar illustrates the combined effect of punishment (direct and indirect) on cooperation; the darker portion (90.73 yen) represents the contribution level over and above that observed for the direct effect of punishment (i.e., the indirect effect of punishment). Error bars represent standard error.

in the combined effect condition, and intermediate in the direct effect condition (323.62 yen, SD = 240.95). We used the same set of regression analyses used in Study 1 to examine, first, whether punishment had a positive overall effect on cooperation and, second, whether the predicted indirect effect manifested. Column 1 in Table 2 includes only dummy 1. The significant effect for this dummy variable in Column 1 represents the difference in cooperation level between the no-punishment condition and the two punishment conditions combined. As was the case with exogenous punishment, the results of Study 2 clearly show that endogenous punishment can increase cooperation level even in a one-shot game. The dummy variable for the indirect effect was then added to the regression equation (Column 2) to decompose the combined effect of punishment into two components: the direct and indirect effects. In Column 2, either dummy 1, representing the direct effect (the dark portion of the bar in Figure 2 for the direct effect condition), or dummy 2, representing the indirect effect (the dark portion of the bar for the indirect effect condition) reached the statistical significance at $\alpha = 0.05$. These results demonstrate, first, that punishment has a positive effect on contribution, and second, that the positive effect of punishment can be decomposed into direct and indirect effects of roughly equivalence sizes, although each of the effect was not as strong as in the first study.

Table 2: The effects of anticipated punishment on cooperation in the second study. Regression analysis contribution on two dummy variables.

Variables	(1)	(2)
Dummy 1	130.79	85.91
	(45.48)	(52.15)
	$P = .005$	$P = .102$
Dummy 2	.	90.73
		(52.71)
		$P = .087$
Constant	237.71	237.71
	(36.94)	(36.68)
	$P < .0001$	$P < .0001$
N	141	141
R^2	0.06	0.08

Standard errors in parentheses.

Expectations of other players' contributions were also similar to the pattern observed in the first study. We measured participants' expectations using the same post-

experimental question used in the first study. The average expectation was 370.65 yen (SD = 182.75) in the combined effect condition, 286.17 yen (SD = 172.17) in the direct effect condition, and 236.04 yen (SD = 177.89) in the no-punishment condition. A regression analysis using a set of two dummy variables (see the analysis of contributions) indicated that the difference between the direct effect and the combined effect conditions was significant ($b = 84.48$, $t(138) = 2.29$, $p = .02$), whereas the difference between the no-punishment and the direct effect conditions ($b = 50.13$, $t(138) = 1.38$, $p = .17$) was not significant.

Punishments delivered. Enforcement of punishment by participants was relatively sparse, possibly because of the relatively high contribution levels of players who were subjected to the threat of penalization, or perhaps because punishment was costly. Only 26 % of the participants in the combined effect condition (12 of 46 participants) delivered some level of punishment. Those who punished spent an average of 87.5 yen (SD = 62.25) to reduce another's earnings. As in previous studies (Fehr & Gächter, 2002; Falk, Fehr, & Fischbacher, 2005), punishment was more severe when the target's contribution level was less than the punisher's. In this case, an average of 105.71 yen (SD=71.61) was spent on penalties to 39% of potential targets. When the target of punishment contributed more than the punisher, an average of 62.00 yen (SD=39.62) was spent on penalties to 18 % of potential targets5. The total cost of punishment (i.e., the amount participants spent on punishment) was relatively small, compared to the benefit of increased cooperation. On average, each participant contributed 176.64 yen more in the combined effect condition than in the no-punishment condition. This extra contribution generated a benefit of $176.64 \times 2 = 353.28$ yen for the other two members. That is, each participant generated a net benefit of 176.64 yen (353.28 yen of total benefit for the cost of 176.64 yen), while spending an average of 22.83 yen on punishment. Since punishment reduced the earnings of the target by 45.66 yen, each participant in the combined effect condition was better off, on average, than those in the no-punishment condition by $176.64 – 22.83 – 45.66 = 108.15$ yen. In the direct effect condition, the participant's average contribution level was higher than that in the no-punishment condition by 85.91, thus producing an extra net benefit of 85.91 yen. The matched extra participant spent an average of 22.34 yen for punishment6. Thus, the overall benefit of punishment in the direct effect condition was

18.89 yen. Supplementing the direct effect with the indirect effect thus made the administration of punishment much more cost effective.

Other findings. "Extra" participants (DE1 and DE2) were used to avoid the use of deception. They did not face threat of punishment, and yet, they knew that one of the three players would possibly face punishment. Thus, their contributions may possibly be influenced by the indirect effect of punishment. On the other hand, they were also aware that two of the three players were exempt from punishment. This would make the indirect effect much weaker than the one observed in the combined effect condition in which all three members faced possible punishment. Their responses to the post-experimental question concerning the expectations of the other players' contributions suggest that their average expectations were higher than those in the no-punishment condition (236.04 yen). One of the two "extra" participants, the one who was given a chance to deliver punishment (DE1) expected that the other two would contribute an average of 326.46 yen (SD=206.40), while the other "extra" participant (DE2), who was neither punished nor given an opportunity for punishment, expected 313.89 yen (SD=126.96). Despite these heightened expectations, their contributions were not larger (270.00 yen, SD=294.39 for DE1; 198.33 yen, SD=232.49 for DE2) than in the no-punishment condition (237.71 yen). There results indicate the lack of an indirect effect among those participants. We discuss the implications of this finding in the discussion section.

4. Discussion

The results of the two experiments support our argument that the direct effect of punishment is augmented by an indirect effect to enhance cooperation. This is evident in the fact that the level of cooperation in the combined effect condition was greater than that observed in either the no-punishment condition or the direct effect punishment condition.

As described earlier, the indirect effect of punishment has long been overlooked despite its importance in solving the second-order dilemma. Eek and his associates are among the few who recognized the importance of the indirect effect—which they called the "spill-over effect"—of punishment (Eek et al., 2002; Loukopoulos et al., 2002).

They found evidence of an indirect effect of punishment, but the indirect effect was observed in their study only when the direct effect of punishment exogenously imposed by the experimenter was strong enough to make cooperation a more profitable choice than free-riding (i.e., when the size of the imposed penalty exceeds the cost of cooperation). In this case, participants in their experiments cooperated at a higher level when one of the other members of a 5-person group was under the threat of such strong punishment than when no penalties were administered. However, their studies failed to demonstrate that the direct effect of weak punishment—i.e., not strong enough to make cooperation a more profitable choice than free-riding—is augmented by an indirect effect. The current study is the first to demonstrate that the direct effect of weak punishment, which by itself is not strong enough to make self-regarding people cooperate, is augmented by an indirect effect.

Our success in demonstrating an indirect effect of punishment when the penalty was less than the cost of cooperation suggests that the symbolic or social nature of punishment (Blau, 1964; Masclet et al., 2003; Noussair & Tucker, 2005) may play an important role in producing indirect effects. In the Study 1, we explicitly used the term "punishment," whereas Eek and associates (Eek et al., 2002) expressed their penalty as a "fee of 1000 SEK for [choosing non-cooperation]" (p. 809). When participants encountered the term "punishment" in the instructions in our first study, they may have taken note of the social implications of being a target of punishment, in addition to the monetary cost imposed by the punishment itself. Recognition of the social implications of punishment then may have made them more aware of social norms and obligations for cooperation, and of the fact that others also operate under the normative pressure for cooperation. This could in turn have strengthened the indirect effect of punishment. This seems to be a reasonable account for the difference between our findings in the first study and those reported by Eek and associates. However, we replicated the same effects in the second study in which the term "punishment" was not used. The use of the term "punishment," thus, is not a necessary condition for the indirect effect of punishment. On the other hand, there is a further possibility that the social implications of punishment may have played an important role in enhancing the indirect effect. It is possible that the inter-personal nature of endogenous punishment used in Study 2 made the social nature of punishment—that is, the fact that punishment is something others

would want to enforce—salient to the participants. Whether or not the social aspects of punishment are necessary for the indirect effect of "weak" punishment is an important topic for future studies.

Another topic for future studies is the lack of indirect effects observed among the "extra" participants in the second study. We used these participants mainly to avoid the use of deception in the direct effect condition. That is, one of the two "extra" participants, D_{E1}, punished the "real" participant, D_1, in the direct effect condition, while he or she was not subject to punishment. Another "extra" participant, D_{E2}, knew that D_{E1} could punish D_1. In short, they knew that one of the other two players was subject to punishment, and thus, would possible improve his or her cooperation level. This might produce an indirect effect. On the other hand, the presence of another player who was immune from punishment might have discouraged cooperation. Given the finding by Kurzban, McCabe, Smith, & Wilson (2001), that conditional cooperators are sensitive to the presence of non-cooperators, the presence of the immune player is likely to prevent the indirect effect of punishment from taking place. Another possible explanation for the lack of an indirect effect among these "extra" participants is that indirect effect of punishment augments the weak direct effect of punishment, rather than taking place by itself in the absence of a direct effect. That is, the nature of the indirect effect is supplementary. Whether the indirect effect of punishment emerges by itself, or requires the presence of a direct effect, is an important topic for future studies.

The indirect effect of punishment was suggested originally by Hobbes in the 17th Century (Hobbes, 1651). It is a popular misconception that Hobbes was an advocate of the central authority forcing unwilling subjects to disarm (i.e., to use the direct effect of punishment to force people to cooperate) (Kavka, 1983; Taylor, 1976; Yamagishi, 1992). Instead, his argument was focused more on the indirect effect of punishment; the *Leviathan* (the central authority) playing the role of reducing fear of exploitation among those who prefer Peace to War such that they can safely disarm themselves (i.e., cooperate) without fear of being exploited by those who don't. The current study is the first study to demonstrate experimentally the importance of the indirect effect as implied by Hobbes' view in *Leviathan;* punishment is a guarantor of Peace, not (strictly) its enforcer. We have confirmed experimentally that the boost to cooperation commonly observed in studies of punishment is better understood as a consequence of

two separate influences, one altering the payoffs associated with cooperation and defection (the direct effect) and the other enhancing the expectation of cooperation by others (the indirect effect).

The role of the indirect effect of punishment is argued to play a particularly important role in the maintenance of common pool resources through voluntary establishment of social institutions that monitor and sanction their members. Researchers of resource management have alluded to the complementary nature of the direct and indirect effects in field studies of common resources (Dietz, Ostrom, & Stern, 2003); while not ruling out the importance of the direct effect of punishment, they have argued that "ruling by the sword" alone is insufficient to convince people to behave in a mutually beneficial manner (Bewley, 1999; Gardner, Ostrom, & Walker, 1990; Ostrom et al., 1992). This is because the key to a successful sanctioning system is the consent of the people under its regulation (Hardin, 1968); voluntary acceptance assures that those who are regulated want to cooperate, thereby enhancing the efficacy of punishment with the indirect effect. We further suspect that factors such as ideology and shared beliefs also play a positive role in raising expectations that others act cooperatively and, consequently, accentuate the power of the indirect effect. The efficacy-enhancing role of the indirect effect should be pronounced in social institutions perceived to be strong and legitimate. While the direct effect depends more on the actual controlling power of a social institution, the indirect effect depends more on the conviction that other members believe in the legitimacy and efficacy of punishment. A sanctioning system supported by a shared belief system should, thus, be more effective than the same system dependent on the "sword" alone. An efficacious sanctioning system supported by beliefs about its legitimacy would function well to induce people to comply, transforming beliefs into reality; such a system could be self-sustaining (Aoki, 2001).

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FOOTNOTES

[1]One participant in the combined effect condition thought that only one participant faced the possibility of punishment, and another in the direct effect condition thought that the other two members also faced the possibility of punishment.

[2]We randomly administered punishment with a probability of 20 percent when a participant in the combined effect condition failed to contribute their entire endowment of 800 yen. No punishment was administered in the no punishment condition or in the direct effect condition.

[3]When, for example, four participants were involved in a session, two participants, N_1 and N_2, were assigned to the no-punishment condition, and the other two, D_1 and D_2, to the direct effect condition. For calculating rewards for N_1 and N_2, either D_1 or D_2 was randomly selected as a member of their group. For either D_1 or D_2, the other two members were N_1 and N_2. Each of the four participants was thus a part of a three-person group.

[4]Two participants in the combined effect condition believed that only one of the other two participants faced the possibility of punishment, and one participant in the direct effect condition believed that another member also faced the possibility of punishment.

[5]While punishment of cooperators in this study seems to be rather high, punishment of cooperators by defectors was also substantial, 34%, in Falk, Fehr, & Fischbacher's (2005) study.

REFERENCES

Aoki, M. (2001). *Toward a comparative institutional analysis*. Cambridge, Mass: MIT Press.

Anderson, C. M., & Putterman, L. (2006). Do Non-strategic Sanctions Obey the Law of Demand? The Demand for Punishment in the Voluntary Contribution Mechanism. *Games and Economic Behavior, 54*, 1-24.

Andreoni, J., & Miller, J. H. (1993). Rational Cooperation in the Finitely Repeated Prisoner's Dilemma: Experimental Evidence. *The Economic Journal, 103*, 570-585.

Andreoni, J., & Petrie, R. (2004). Public goods experiments without confidentiality: a glimpse into fund-raising. *Journal of Public Economics, 88*, 1605-1623.

Bewley, T. (1999). *Why wages don't fall in a recession*. Cambridge, MA: Harvard University Press.

Blau, P. M. (1964). *Exchange and Power in Social Life*. New York: John Wiley & Sons.

Boehm, C. (1999). *Hierarchy in the forest: The evolution of egalitarian behavior*. Cambridge, MA: Harvard University Press.

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

Boyd, R., Gintis, H., Bowles, S., & Richerson, P. J. (2003). The Evolution of Altruistic Punishment. *Proceedings of the National Academy of Sciences of the United States of America, 100*, 3531-3535.

Casari, M., & Plott, C. R. (2003). Decentralized management of common property resources: Experiments with a centuries-old institution. *Journal of Economic Behavior and Organization, 51*, 217-247.

Charness, G., & Dufwenberg, M. (2006). Promises and partnership. *Econometrica, 74*, 1579-1601.

Cho, K., & Choi, B. (2000). A cross-Society Study of Trust and Reciprocity: Korea, Japan, and the US. *International Studies Review, 3*, 31-43.

Clark, K., & Sefton, M. (2001). The sequential prisoner's dilemma: Evidence on reciprocation. *The Economic Journal, 111*, 51-68.

Dawes, R. M. (1980). Social dilemmas. *Annual Review of Psychology, 31*, 169-193.

Dietz, T., Ostrom, E., & Stern, P. C. (2003). The struggle to govern the commons. *Science, 302*, 1907-1912.

Eek, D., Loukopoulos, P., Fujii, S., & Garling, T. (2002). Spill-over effects of intermittent costs for defection in social dilemmas. *European Journal of Social Psychology, 32*, 801-813.

Falk, A., Fehr, E., & Fischbacher, U. (2005). Driving forces of informal sanctions. *Econometrica, 73*, 2017-2030.

Fehr, E., & Fischbacher, U. (2003). The nature of human altruism—Proximate patterns and evolutionary origins. *Nature, 425*, 785-791.

Fehr, E., & Gächter, S. (2002). Altruistic punishment in humans. *Nature, 415*, 137-140.

Fischbacher, U., Gächter, S., & Fehr, E. (2001). Are people conditionally cooperative? Evidence from a public goods experiment. *Economics Letters, 71*, 397-404.

Gardner, R., Ostrom, E., & Walker, J. (1990). The nature of common-pool resource problems. *Rationality and Society, 2*, 335-358.

Greif, A. (1994). Cultural beliefs and the organizational of society: A historical and theoretical reflection on collectivist and individualist societies. *The Journal of Political Economy, 102*, 912-950.

Hamilton, W. D. (1964). The genetical evolution of social behaviour I. *Journal of Theoretical Biology, 7*, 1-52.

Hardin, G. (1968). The tragedy of the commons. *Science, 162*, 1243-1248.

Hayashi, N., Ostrom, E., Walker, J., & Yamagishi, T. (1999). Reciprocity, trust, and the sense of control: A cross-societal study. *Rationality and Society, 11*, 27-46.

Henrich, J. (2004). Cultural Group Selection, Coevolutionary Processes and Large-scale Cooperation. *Journal of Economic Behavior & Organization, 53*, 3-35.

Henrich, J., & Boyd, R. (2001). Why people punish defectors: Weak conformist transmission can stabilize costly enforcement of norms in cooperative dilemmas. *Journal of Theoretical Biology, 208*, 79-89.

Hobbes, T. (1651). *Leviathan*. Cambridge, UK: Cambridge Univ. Press.

Issac, R. M., & Walker, J. M. (1988). Group size effects in public goods provision: The voluntary contributions mechanism. *The Quarterly Journal of Economics, 103*, 179-199.

Kavka, G. S. (1983). Hobbes's war all against all. *Ethics, 93*, 291-310.

Kiyonari, T., Tanida, S., & Yamagishi, T. (2000). Social exchange and reciprocity: confusion or a heuristic? *Evolution and Human Behavior, 21*, 411-427.

Kurzban, R., & Houser, D. (2005). Experiments investigating cooperative types in humans: A complement to evolutionary theory and simulations. *Proceedings of*

the National Academy of Sciences of the United States of America, 102, 1803-1807.

Kurzban, R., McCabe, K., Smith, V. L ., & Wilson, B. J. (2001). Incremental commitment and reciprocity in a real time public goods game. *Personality and Social Psychology Bulletin, 27*, 1662-1673.

Loukopoulos, P., Eek, D., Garling, T., & Fujii, S. (2006). Palatable Punishment in Real-World Social Dilemmas? *Journal of Applied Psychology, 36*, 1274-1279.

Marwell, G., & Ames, R. (1979). Experiments in the provision of public goods, I: Resources, interest, group size and the free rider problem. *American Journal of Sociology, 84*, 1335-1360.

Masclet, D., Noussair, C., Tucker, S., & Villeval, M. (2003). Monetary and nonmonetary punishment in the voluntary contributions mechanism. *American Economic Review, 93*, 366-380.

Noussair, C., & Tucker, S. (2005). Combining monetary and social sanctions to promote cooperation. *Economic Inquiry, 43*, 649-660.

Oliver, P. (1980). Rewards and punishments as selective incentives for collective action: Theoretical investigations. *American journal of sociology, 85*, 1356-1375.

Olson, M. (1965). *The logic of collective action: Public goods and the theory of groups*. Cambridge, MA: Harvard University Press.

Orbell, J., Dawes, R. M., & Van de Kragt, A. (1988). Explaining discussion induced cooperation. *Journal of Personality and Social Pyschology, 54*, 811-819.

Ostrom, E., Walker, J., & Gardner, R. (1992). Covenants with and without a sword: Self-governance is possible. *American Political Science Review, 86*, 404-417.

Page, T., Putterman, L., & Unel, B. (2005). Voluntary association in public goods experiments: Reciprocity, mimicry and efficiency. *The Economic Journal, 115*, 1032-1053.

Price, M. E., Cosmides, L., & Tooby, J. (2002). Punitive sentiment as an anti-free rider psychological device. *Evolution and Human Behavior, 23*, 203-231.

Pruitt, D. G., & Kimmel, M. J. (1977). Twenty Years of Experimental Gaming: Critique,Synthesis, and Suggestions for the Future. *Annual Review of Psychology, 28*, 363-392.

Rapoport, A. (1987). Research paradigms and expected utility models for the provision of public goods. *Psychological Review, 94*, 74-83.

Sober, E., & Wilson, D. S. (1998). *Unto others: The evolution and psychology of unselfish behavior*. Cambridge, MA: Harvard University Press.

Taylor, M. (1976). *Anarchy and cooperation.* New York: Wiley.

Trivers, R. (1971). The evolution of reciprocal altruism. *Quarterly Review of Biology, 46*, 35-57.

Walker, J., & Halloran, M. A. (2004). Rewards and sanctions and the provision of public goods in one-shot settings. *Experimental Economics, 7*, 235-247.

Watabe, M., Terai, S., Hayashi, N., & Yamagishi, T. (1996). Cooperation in the one-shot prisoner's dilemma based on expectations of reciprocity. *Japanese Journal of Experimental Social Psychology, 36*, 183-196.

Yamagishi, T. (1986). The provision of a sanctioning system as a public good. *Journal of Personality and Social Psychology, 51*, 110-116.

Yamagishi, T. (1988). Seriousness of social dilemmas and the provision of a sanctioning system. *Social Psychology Quarterly, 51*, 32-42.

Yamagishi, T. (1992). Group size and the provision of a sanctioning system in a social dilemma. In W. B. G. Liebrand, D. M. Messick & H. Wilke (Eds.), *Social dilemma: Theoretical issues and research findings* (pp. 267-287). Oxford, UK: Pergamon Press.