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Running head: Framing prisoners and chickens

Framing Prisoners and Chickens:  
Valence Effects in the  
Prisoner's Dilemma and the Chicken Game

Peter de Heus, Niek Hoogervorst, and Eric van Dijk

Peter de Heus and Eric van Dijk, Department of Psychology, University of Leiden, the Netherlands. Niek Hoogervorst, Department of Business-Society Management, Rotterdam School of Management, Erasmus University, the Netherlands.

Correspondence concerning this article should be addressed to Peter de Heus, Department of Social and Organizational Psychology, Leiden University, P.O. Box 9555, 2300 RB Leiden, The Netherlands. E-mail: DEHEUS1@fsw.leidenuniv.nl, Telephone: + 31 71 5273716.

## Abstract

In an experimental study we investigated how decisions in social dilemmas are affected by the valence of outcomes that are at stake. Prospect theory states that individuals are risk averse when outcomes are framed as gains, and risk seeking when outcomes are framed as losses. On the basis of this framework, previous research on social dilemmas has addressed the question of whether people are more cooperative in the negative domain than in the positive domain, but this research has led to inconsistent results. A possible explanation for this is that in many social dilemmas it is unclear whether cooperation or defection is the risky choice. In the current paper we compare the well-studied prisoner's dilemma with the less studied chicken game. Whereas in the prisoner's dilemma it is unclear what constitutes the risky option, in the chicken game the risky option is quite clear. Consistent with predictions, we found in the chicken game more defection in the gain frame than in the loss frame, but no difference between the gain and loss frame in the prisoner's dilemma. Moreover, choices were affected by risk attitude in the chicken game, but not in the prisoner's dilemma.

*Key words:* social dilemmas, prospect theory, framing, valence effects

## Framing Prisoners and Chickens: Valence Effects in the Prisoner's

## Dilemma and the Chicken Game

As social beings, we frequently encounter situations where our own interests conflict with the interests of others. Social dilemmas are situations in which personal and collective interests are at odds (for overviews, see e.g. Komorita & Parks, 1995; Kopelman, Weber, & Messick, 2002; Messick & Brewer, 1983). In the current article we argue that how people deal with such dilemmas depends on (a) the valence of outcomes that are at stake, and (b) the type of dilemma people face.

Sometimes the conflict between personal and collective interests concentrates on negative outcomes. For example, in the original description of the prisoner's dilemma, two prisoners have to make a decision that determines for how many years they will be sentenced. On other occasions, the outcomes may be positive, for example, when fishermen have the choice between harvesting more or less fish from a sea in danger of over-fishing. Are people more cooperative when the social dilemma is about negative rather than positive outcomes? In the present study we argue that the effect of valence on cooperation is dependent on the structural characteristics of the dilemma. Following prospect theory (Kahneman & Tversky, 1979, 1984) we will argue that the effect of valence will be most pronounced when the dilemma involves a clear choice between a risky and a non-risky decision. To demonstrate this, we compare behavior in two types of dilemmas: the prisoner's dilemma and the chicken game.

*Prisoner's Dilemma and Chicken Game*

In the *prisoner's dilemma*, two persons have to choose independently from each other between cooperation (*C*) and defection (*D*). If both players choose *C*, they both get the Reward payoff (*R*), which is better than the Punishment payoff (*P*) for mutual defection, so for both players mutual cooperation is better than mutual defection. However, in a one-sided

defection the Temptation payoff ( $T$ ) for the defector is even better than the mutual cooperation payoff, while the Sucker payoff ( $S$ ) for the cooperator in this exchange is even worse than the mutual defection payoff. In brief, a prisoner's dilemma is defined by the payoff structure  $T > R > P > S$  (Figure 1). Because of this payoff structure, for each individual defection always pays better than cooperation, regardless of whether the other chooses cooperation (since  $T > R$ ) or defection (since  $P > S$ ). However, if both players follow their self-interest, both will be worse off than if they both had chosen to cooperate (since  $P < R$ ). Real-life examples of prisoner's dilemmas are two gas stations deciding whether or not to start a price war (Murnighan, 1991), or World War I soldiers in the trenches choosing whether or not to open serious fire at the enemy (Axelrod, 1984).

The *chicken game*, also known as hawk-and-dove (Maynard Smith & Price, 1973), resembles the prisoner's dilemma in many respects. Again players have to choose between cooperation and defection. The payoff structure of the chicken game,  $T > R > S > P$ , is like the prisoner's dilemma in the sense that the best and second-best payoff are  $T$  (for one-sided defection) and  $R$  (for mutual cooperation) respectively. The difference is in the ranking of  $P$  and  $S$ . In chicken games the mutual defection payoff ( $P$ ) is worse than the payoff for one-sided cooperation ( $S$ ), so if the other defects, cooperation pays better than defection. Many social situations have the payoff structure of a chicken game. For example, if both parties in marital conflict choose escalation to full conflict in order to get their way (mutual defection), this may be very harmful to both, so trying to reach a compromise (mutual cooperation) is usually preferable over mutual defection. However, one-sided defection can be a very effective power tactic, at least in the short run, if the partner prefers giving-in to full conflict. Nations using the threat of nuclear war, management and unions heading for a strike, children doing dangerous things in order to show their toughness, chicken games can be seen everywhere. Although it is our impression (admittedly hard to prove) that the chicken game is

more ubiquitous in social life than the prisoner's dilemma, it has received much less attention in psychology and other social sciences. Searching for "prisoner's dilemma" or "chicken game" (or "chicken dilemma", or "game of chicken") in the Psycinfo database on February 19, 2010, led to 1133 hits for the prisoner's dilemma, against 49 for the chicken game.

The relatively small difference between the chicken game and the prisoner's dilemma ( $S > P$  versus  $P > S$ ) leads to strongly divergent strategic possibilities. The payoff structure of the prisoner's dilemma, at least in the one-shot version, works strongly in favor of mutual defection. If both you and your opponent always get more after choosing  $D$  than after  $C$ , both fear (for the worst outcome  $S$ ) and greed (for the best outcome  $T$ ) lead to defection. In the language of game theory, defection is the dominant choice in the (one-shot) prisoner's dilemma, because self-interested players will always choose defection. In the chicken game, conditions are more favorable for cooperation. Greed may still lead to defection, but fear no longer does, because in Chicken the safe choice (which avoids the worst possible outcome) is cooperation. In agreement with this analysis, higher cooperation rates have been reported for the chicken game than for the prisoner's dilemma, both in two-person (Rapoport & Chammah, 1969) and in  $N$ -person (Liebrand, Wilke, Vogel & Wolters, 1986; Wit & Wilke, 1992) situations.

#### *Valence effects*

So how will the valence of outcomes affect decisions in prisoner's dilemmas and chicken games? According to *prospect theory* (Kahneman & Tversky, 1979, 1984), people are risk-seeking in the negative domain and risk averse in the positive domain. To predict the effects of valence on cooperation one therefore first of all needs to identify risk-seeking and risk aversive behavior.

In this respect, we will briefly discuss previous social dilemma research, in which prospect theory was primarily invoked to understand differences between public good and

resource dilemmas. In *resource dilemmas* (or take-some dilemmas), people can increase their outcomes by harvesting from a common pool, whereas in *public good dilemmas* (or give-some dilemmas) they decide how many from their own resources they contribute to a common pool (e.g., van Dijk & Wilke, 1995). Both games share a similar conflict between personal and collective interest. If too much is taken from, or not enough is given to the common pool, all will be worse off than when they had shown more restraint or generosity. The games are different, however, in presentation of the outcome structure. The resource dilemma is characterized by a positive frame, the public good dilemma by a negative frame.

So what is the risky option in these dilemmas? Brewer and Kramer (1986) reasoned that in both types of social dilemmas defection (i.e. taking much or giving little) is the more risky choice, because it makes the worst possible collective outcome more likely. Subsequent theorizing, however, questioned this conclusion, by reasoning that one could also conclude that cooperation is more risky. For example, in a public good dilemma, contributing could be seen as risky because one's contributions will be wasted if the public good is not provided. Based on these considerations, some researchers concluded that it is very difficult or even impossible to generate predictions from prospect theory (e.g. Van Dijk and Wilke, 1995). In line with this reservation, empirical research has shown very inconsistent findings. Whereas some studies (e.g. Brewer and Kramer, 1986; McCusker & Carnevale, 1995) found that participants were less cooperative in public good dilemmas than in resource dilemmas, other studies found no difference (e.g. Rutte, Wilke & Messick, 1987) or even a difference in the opposite direction (e.g. Komorita & Carnevale, 1992, Experiment 3). In a large meta-analysis on framing effects, Kühberger (1998) concluded that game theory designs, as he called the kind of studies described above, do not produce a framing effect at all.

Despite these objection, we will argue that it is possible to apply prospect theory if we are more specific about what constitutes risky behavior in social dilemmas. In contrast to the previous research on differences between public good and resource dilemmas, we do not define risk in terms of the chances of creating the worst possible collective outcome (cf. Brewer & Kramer, 1986). Instead, we define risk in terms of variance, following other research on valence effects (Kühberger, 1998), in which risky decision making involves a choice between at least two options. The *safe option* has one or more possible outcomes with values that are relatively close to each other (low outcome variance), while the *risky option* has two or more possible outcomes of which at least one is better than the best outcome of the safe option, and at least one is worse than the worst outcome of the safe option (high outcome variance). Therefore, in the present article, a *risky decision situation* is defined as one that demands a choice between options with different outcome variances. A *risky choice* is simply a choice for the high-variance option in such a risky decision situation.

In the following, we will argue that framing effects can be expected if and only if the option that might lead to the worst outcome is also the high-variance option. More specifically, we will reason that in terms of high variance of possible outcomes there is no risky option in the prisoner's dilemma, whereas there clearly is such a high-risk option in the chicken game. As a consequence, we expect to find clear and predictable valence effects in the chicken game, but not in the prisoner's dilemma.

#### *Current Study*

In our study we use one-shot (i.e. games played only once) positively and negatively valenced versions of the prisoner's dilemma and the chicken game, for which the payoff structures are shown in Figure 1. What about risk in the *prisoner's dilemma*? Inspection of Figure 1 shows that this prisoner's dilemma is not a risky decision situation as defined above, because the two options (defect or cooperate) do not differ in terms of variance: whether one

decides to cooperate or defect, defection always yields higher outcomes than cooperation. Of course, there is social uncertainty (i.e. uncertainty about the decisions that others will make; Messick, Allison & Samuelson, 1988), because one has to decide without knowing one's opponent's decision. Also, this uncertainty surely matters to the players, because each player will always get two points more if the other player chooses *C* instead of *D*. However, for each individual the *relative* attractiveness of *C* compared to *D* is independent of the uncertain choice by the other player. Regardless of the other's decision, one will always earn one point more by choosing *D* instead of *C*. In terms of outcome variance, there is no risky choice in the sense of a choice between a relatively safe option and a more risky option. Therefore, we see little reason to expect a valence effect.

The *chicken game* is a different story. Here defection is the high-risk (high-outcome variance) option, that might lead to the best, but also to the worst possible payoff, whereas cooperation is relatively low-risk, because it can only bring the two intermediate payoffs. Therefore, taking risk, deciding whether or not to gamble, is more essential in the chicken game than in the prisoner's dilemma. As a consequence, we expect strong and predictable valence effects in the chicken game. Because in chicken games defection is clearly the high-risk option, we expect more defection in the loss frame than in the gain frame.

Our reasoning leads to *three hypotheses*. The first is basically a manipulation check, but an important one. Participants in the chicken game should see defection as a more risky choice than participants in the prisoner's dilemma (Hypothesis 1). Our second hypothesis is the central one, predicting a framing effect (more cooperation in the gain frame than in the loss frame) in the chicken game, but not in the prisoner's dilemma (Hypothesis 2).

However, even if Hypothesis 1 and 2 are both confirmed, the possibility that a differential framing effect is caused by some other factor than perceived risk, has not been ruled out. One way of clarifying the role of risk is to investigate the role of individual

differences in *risk orientation* (i.e., a general tendency to make risky instead of safe choices; for recent discussions, see, for example, Weber, Blais & Betz, 2002; Meertens & Lion, 2008). Little is known about the predictive power of risk orientation for cooperation in social dilemma games (for exceptions, suggesting rather limited predictive power in the iterated prisoner's dilemma and the trust game respectively, see van Assen & Snijders, 2004; Eckel & Wilson, 2004), but generally we would expect that persons high on risk orientation more often than persons low on risk orientation will choose the more risky option, if there is one. This leads to the expectation that risk orientation predicts cooperative choice (more defection by high risk seekers) in the chicken game, but not in the prisoner's dilemma (Hypothesis 3). Finding such a game x risk orientation interaction in addition to the frame x game interaction predicted by Hypothesis 2 would provide additional support for the idea that the differential framing effects in the prisoner's dilemma and the chicken game are caused by the presence or absence of a risky option.

#### Method

##### *Participants*

Participants were 198 students from the University of Leiden, of which 65 (33 %) were male, with mean age 22.16 years ( $SD = 5.01$ ). Participants were invited to the laboratory for a study on decision making. All participated voluntarily in our study (together with an unrelated study that followed the present study) in exchange for six euros. Data collection for the present study took about twenty minutes.

##### *Design*

The design of the study was a 2 x 2 Game (prisoner's dilemma versus chicken game) x Frame (gain versus loss) factorial design, with random assignment of participants to treatments, and choice between cooperation and defection as the most important dependent variable.

### *Procedure*

Upon arrival, participants were placed in separate cubicles with a PC in it. After starting the computer program, the experimenter explained that all communication with the experimenter and other participants would be via the PC. To begin with, participants completed four questionnaires, of which only one, a measure of risk orientation, is directly relevant to the present study. After completing these questionnaires, participants were informed that in the next task they would play a kind of game with another participant for lottery tickets, which gave a chance of winning a CD gift voucher worth 20 euros (about 25 US dollars). In order to make the game as non-zero-sum as possible, it was pointed out that participant and other would not compete for the same prizes. It was also explained that, to guarantee anonymity, all contact with the other player would be via the computer, without face-to-face contact or disclosure of identities afterwards.

Next, participants received instructions about the game (described below), followed by a single one-shot game (prisoner's dilemma or chicken game) in which one had to choose between *A* (cooperation) or *B* (defection); the words "cooperation" and "defection" were never used in the instructions. After this, without being informed about the other's choice, participants were asked a few manipulation check questions about game comprehension and framing, and a question about which choice (*A* or *B*) they perceive as the most risky one. Finally, all participants were debriefed, paid, and thanked for their participation.

### *Experimental manipulations*

*Framing manipulation.* In the *gain frame*, participants were told that depending on choices by self and other, they could win zero, one, two, or three lottery tickets. In the *loss frame*, they were told that they would start with three lottery tickets, but that depending on their choices, they would lose between zero and three tickets. The exact numbers of points (tickets) gained or lost for both games are depicted in Figure 1. In addition to this general

instruction, the prisoner's dilemma and the chicken game were consistently described in terms of winning (gain frame) or losing points (loss frame).

*Game manipulation.* The instructions for both games consisted of a payoff matrix that was permanently visible on screen, and a verbal explanation of the game. In the description for both games, the instructions from the gain frame will be presented, with alternative formulations from the loss frame between brackets. Both games started as follows.

“In the next part, you will play for points, and each point represents a lottery ticket. How many points you will win [lose], will be determined not only by your own choice, but also by the choice of the other person. At the same time, his or her points are also partly determined by your choices. The game will be played as follows. You will have to make a choice between two possibilities, called *A* and *B* (the other will have to make the same choice). At the moment you make your choice, you don't know the choice of the other, and the other does not know your choice. The number of points that each of you wins [loses] is determined by the combination of choices by you and the other. As you can see in the figure below, there are four possible outcomes.” Next, one of the four payoff matrices from Figure 1 was shown (with *A* and *B* instead of *C* and *D*), which remained on screen until participants had played their game. In addition, outcomes for the four possible combinations of choices were also explained in words. To make sure that participants understood the games, an explanation about the strategic implications of the payoff structure was given to the participant. In the *prisoner's dilemma* conditions it was explained that choosing *B* always leads to a higher gain [smaller loss] for oneself than choosing *A* (regardless of the other's choice), but that if both players choose *B*, both will be worse off than if both had chosen *A*. Participants in the *chicken game* were told that choosing *B* might lead to the best possible outcome (if the other chooses *A*), but also to the worst possible outcome (if the other chooses *B*) for oneself, whereas choosing *A* can only lead to the second-best and second-worst outcomes.

*Risk orientation.* As a measure of risk orientation, we administered the *Risk Orientation Questionnaire* (ROQ; Rohrman, 2002). The ROQ contains twelve domain-independent items (e.g. “Even when I know that my chances are limited, I try my luck”), each with a seven-point answering scale from 1 = “does not at all apply to me” to 7 = “very much applies to me”. The ROQ consists of two moderately negatively correlated (correlations around -.35) subscales for Risk Propensity (seeking risks) and Cautiousness (avoiding risks). Our final measure of risk orientation was the average of all twelve items (with reversed scoring of all Cautiousness items), so higher scores indicated a higher willingness to take risks.

*Dependent measures.* The two dependent measures were *cooperative choice* (did one choose cooperation or defection in the one-shot game?) and *most risky option* (did one indicate that cooperation (A) or defection (B) was the more risky option in this game?).

## Results

### *Manipulation checks*

According to chi-square tests, there were no significant differences in understanding between the prisoner’s dilemma (PD) and the chicken (CG) game. Most participants correctly indicated in both games that one-sided defection brought the best possible outcome for self (78.0 % and 80.6 % in the PD and CG respectively), that one-sided cooperation in the PD and mutual defection in the CG led to the worst outcome for self (83.0 % and 76.5 %), and that in both games mutual cooperation brought the best joint outcome for self and other (87.0 % and 93.9 %), so generally game understanding appeared to be adequate. The framing manipulation was checked by comparing the gain and loss conditions on the question whether they felt they could gain or lose something by playing the game. Participants in the gain frame condition predominantly reported that they could gain something (87.9 %), whereas participants in the loss frame condition predominantly reported that they could lose something (67.7%). These findings show that the manipulations were perceived as intended.<sup>1</sup>

*Risky choice*

To check if defection was recognized as the more risky option in the CG, but not in the PD, a chi-square test (with continuity correction) was performed on the 2 x 2 crosstable of game (PD vs. CG) by the question about the most risky option (cooperation vs. defection). The chi-square test was highly significant,  $X^2(1) = 76.60, p < .001$ , indicating that defection was much more often seen as the most risky choice in the CG (87.8 %) than in the PD (25.0%), so Hypothesis 1 was confirmed.

*Cooperation*

To test our central prediction of a framing effect (more cooperation in gain frame than in loss frame) in the chicken game, but not in the prisoner's dilemma, a hierarchical logistic regression analysis was performed, with game and frame as independent variables, and cooperative choice as the dependent variable. The analysis was performed hierarchically, because in logistic regression analysis, regression weights and significance tests of predictors can not be interpreted as main effects when their products (interaction terms) are also predictors in the analysis (Jaccard, 2001). Because interactions in logistic regression analysis might lead to inconsistencies between interpretation of proportions (which fit with how humans tend to think about effects) and interpretation of logits (i.e., the natural logarithms of the odds for those proportions, which fit with the estimated parameters in logistic regression; Ganzach, Saporta & Weber, 2000), the amount of cooperation is given both in proportions and in logits of cooperative choice. The results are presented in Table 1 (regression weights, odds ratios, and significance tests) and Table 2 (proportions and logits).

In step 1, only the main effect for Game was significant,  $B = -.988, Wald(1) = 10.01, p < .01$ , indicating that cooperation was more often chosen in the chicken game (74.5 %) than in the prisoner's dilemma (53.0 %). In step 2, the Frame x Game interaction proved to be significant,  $B = -1.46, Wald(1) = 4.90, p < .05$ . Inspection of cell proportions (Table 2)

showed that while there was a strong framing effect in the chicken game (87.5 % cooperative choice in the gain frame vs. 62.0 % in the loss frame), there was no framing effect in the prisoner's dilemma (52.9 % vs. 53.1 %), with logits showing the same pattern as proportions (Table 2). Separate chi-square tests (with continuity correction) for the relationship between frame and choice in the two games, showed that the difference between gain and loss frames was highly significant in the chicken game,  $X^2(1) = 7.092, p < .01$ , but absent in the prisoner's dilemma,  $X^2(1) = .000, p > .99$ . These results are in agreement with Hypothesis 2.

### *Risk orientation*

To test hypothesis 3 (higher risk orientation leads to more defection in the chicken game, but not in the prisoner's dilemma), the hierarchical logistic regression analysis described above was extended with three more steps. In step 3 risk orientation was added as a predictor, followed in step 4 by the Game x Risk orientation and Frame x Risk orientation interactions, and in step 5 by the threeway interaction (Table 1).

The main effect of risk orientation in step 3 was significant,  $B = -.62, Wald(1) = 6.48, p < .05$ , indicating that a higher willingness to take risks leads to less cooperative choices. This main effect was moderated by a significant Game x Risk Orientation interaction (step 4),  $B = 1.45, Wald(1) = 6.40, p < .05$ , which demonstrated that the effect of risk orientation on cooperation was different in the PD and the CG. Separate logistic regression analyses for the two games, with frame and risk orientation as predictors and cooperative choice as the dependent variable, revealed that a higher risk orientation led to less cooperative choice in the CG,  $B = -1.48, Wald(1) = 9.74, p < .01$ , but not in the PD,  $B = -.197, Wald(1) = .45, p > .50$ .

An alternative, more ANOVA-like way of describing the interaction is that in the CG defectors were higher in risk orientation than cooperators ( $M = 4.90$  versus 4.32), while there was no such difference in the PD ( $M = 4.41$  versus 4.32). The Frame x Risk orientation (step

4) and the threeway (step 5) interactions were nonsignificant (Table 1). These results are consistent with Hypothesis 3.

### Discussion

Are cooperation and defection related to valence? Our comparison between the prisoner's dilemma and the chicken game was supportive for our idea that to find valence effects in social dilemmas, the dilemma must offer a choice between a relatively sure and a relatively risky option. Participants identified defection as the more risky option in the chicken game, but not in the prisoner's dilemma (Hypothesis 1). Moreover, this difference between the two dilemmas also was related to choice behavior, as high risk orientation led to more defection in the chicken game, but not in the prisoner's dilemma (Hypothesis 3). Most importantly, a valence effect (more cooperation in the gain frame than in the loss frame) was found in the chicken game, but not in the prisoner's dilemma (hypothesis 2).

Taken together, our findings suggest that prospect theory can in fact be meaningfully applied to social dilemmas (cf. van Dijk & Wilke, 1995). The prerequisite for this appears to be that the dilemma should clearly distinguish between more risky and less risky options. This is true in the chicken game, but not in the prisoner's dilemma. If our reasoning about differential framing effects in prisoner's dilemma and chicken game is correct, could this explain the inconsistent results of framing in social dilemmas studies? Although we do not think it is the only explanation, it might help. To see how, let us return to the argument that in public good dilemmas and resource dilemmas, cooperation is relatively safe, whereas defection is relatively risky (Brewer & Kramer, 1986). The underlying rationale for this assumption appears to be that the worst thing that can happen is that the public good is not realized or that the resource becomes depleted. Defection (i.e. giving little or taking much) is the risky choice, because it makes this worst possibility more likely. If individuals are risk-seeking in the loss frame and risk-averse in the gain frame, they should be more inclined

toward defection in a public good game (loss frame) than in an equivalent commons dilemma (gain-frame).

However, as we reasoned before, in order to apply prospect theory to social dilemmas, it should be clear what constitutes the risky option and what constitutes the safe(r) option. Many social dilemmas are like *N-person prisoner's dilemmas*, in which it is ambiguous which is the more risky option: choosing defection with a larger chance that the public good remains unrealized, or choosing cooperation with a (somewhat smaller, but still substantial) chance that the public good remains unrealized despite one's own sacrifices (for which one receives no compensation whatsoever). Perhaps we can not expect framing effects in social dilemmas, unless they are like *N-person chicken games*, in which the worst outcome is for a defector if the public good remains unrealized.

At this point it is also useful to discuss some limitations of the present study. Whereas the results support our idea that reliable valence effects can be observed in social dilemmas when choice options differ in terms of outcome variance, it may of course be relevant to see whether our results will be replicated in future studies. If our reasoning about games with and without a risky option is correct, we would expect our results to generalize beyond the prisoner's dilemma and the chicken game to other experimental games, of which four deserve special mention. The first is generalization to prisoner's dilemmas and chicken games with *continuous choices* (i.e. in which different degrees of cooperation can be chosen). Because binary dependent variables as in the present study are usually bad for statistical power, we would expect stronger effects in such continuous games. The second generalization might be from one-shot to *iterated* prisoner's dilemmas and chicken games against the same opponent. However, because with iterated games the numbers of possible strategies and outcomes grow very fast with the number of repetitions, it remains to be tested whether the distinction between choosing options with high versus low outcome variance (chicken game) versus

choosing options with equal outcome variance (prisoner's dilemma) will generalize to repeated games. The third generalization is to another two-person game, the *trust game* (Dasgupta, 1988), an asymmetric game in which one player (the trustor) has to choose between a risky option (trust) and a completely sure thing (no trust), proving an even sharper test than the present study for our hypothesis that it is the presence or absence of a (relatively) sure thing versus variation in possible outcomes that predicts the presence or absence of framing effects. The fourth generalization is to *larger groups*, from two-person to  $N$ -person prisoner's dilemmas and chicken games. Finding a framing effect in  $N$ -person chicken, but not in the  $N$ -person prisoner's dilemma would provide additional empirical support for our explanation of inconsistent results in the literature on framing in social dilemmas. In such studies, it may also be worthwhile to obtain additional evidence for the assumed underlying *process*, e.g. by measuring the perceived variance of choice options. One should realize, however, that such measurements may neither be necessary (since people may react to circumstances without being able to describe them; e.g. Nisbett & Ross, 1984), nor be easy, as they require participants to "reproduce" what may be considered a rather abstract concept.

In the current paper we obtained additional evidence for our reasoning by measuring the participants' risk orientation with the ROQ. There are many different measures for risk orientation, some involving choices between sure things and gambles or between different kinds of gambles (e.g. van Assen & Snijders, 2004), some very domain-specific (e.g. Weber et al., 2002), and some, like the ROQ (Rohrmann, 2004) measuring a general, domain-independent attitude toward taking risks. Future research will have to show whether other measures of risk orientation show the same relationships with cooperation in social dilemmas. In such future research we may also investigate whether risk orientation correlates with other relevant constructs, and whether such relations might (partly) explain our findings. In this context it may be relevant that the willingness to take risks has been related to social

value orientations, i.e., to the relative weights that people put on their own versus other's outcomes. For example, Or-Chen and Suleiman (2003) reported that prosocials (i.e., those inclined to cooperate) are more risk averse. Comparing this to our finding that – only in the chicken game - a high risk orientation was associated with less cooperation, might make one wonder whether this finding reflects a differential concern for other's outcomes. However, the absence of any effect of risk orientation in the prisoner's dilemma does not match with this idea (especially since social value orientations have produced strong and reliable effects in social dilemmas; see Van Lange, De Cremer, Van Dijk, and Van Vugt, 2007). To be sure, we also measured social value orientations in our study, and did not find any relationship with risk orientation or cooperation (see also Kanagaretnam, Mestelman, Nainar, & Shehata, 2009). Nevertheless, for future research it may be useful to investigate the connection between risk orientation and other constructs (e.g., trust, sensation seeking). Such studies may further increase our understanding of how prospect theory can be meaningfully applied to the field of social dilemmas.

## Footnote

- <sup>1</sup> The fact that a minority of the participants in the loss condition did report that they could gain something may reflect that participants also compared outcomes to how they entered the lab (i.e., they could never end up with less money than they possessed when they entered the laboratory).

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## Author note

Peter de Heus and Eric van Dijk, Department of Psychology, University of Leiden, the Netherlands; Niek Hoogervorst, Department of Business-Society Management, Rotterdam School of Management,,Erasmus University, the Netherlands.

Correspondence concerning this article should be addressed to Peter de Heus, Department of Psychology, University of Leiden, Wassenaarseweg 52, 2333 AK Leiden, the Netherlands. E-mail: [deheus1@fsw.leidenuniv.nl](mailto:deheus1@fsw.leidenuniv.nl)

Table 1

*Hierarchical logistic regression analysis effects of Frame, Game, and Risk orientation on cooperative choice.*

Predictor	<i>B</i>	Wald <sup>1</sup>	<i>p</i>	Odds ratio	Model chi-square	Nagelkerke R square
<i>Step 1</i>					13.57 **	.091
Frame	.58	3.52	.061	1.78		
Game	-.98	10.00	.002	.38		
<i>Step 2</i>					18.73 ***	.124
Frame x Game	-1.46	4.90	.027	.23		
<i>Step 3</i>					25.63 ***	.166
Risk orientation	-.62	6.48	.011	.54		
<i>Step 4</i>					33.93 ***	.216
Game x Risk	1.45	6.40	.011	4.25		
Frame x Risk	-.80	2.35	.125	.45		
<i>Step 5</i>					34.00 ***	.216
Game x Frame x Risk	.35	.075	.785	1.42		

\*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$ .

<sup>1</sup> Wald *df* are always 1. Model *df* are 2, 3, 4, 6 and 7 for step 1 to step 5 respectively.

Table 2

*Proportions and logits of cooperative choices for different games and frames.*

Dependent measure	Frame	Game		
		PD	Chicken	Total
Proportions	Gain	.529	.875	.697
	Loss	.531	.620	.576
	Total	.530	.745	.636
Logits	Gain	.116	1.946	.833
	Loss	.124	.490	.305
	Total	.120	1.072	.560

## Figure Captions

*Figure 1.* Gain-framed and loss-framed payoff structures for the prisoner's dilemma and the chicken game.

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*General structure*

		Other	
		C	D
Self	C	R	T
	D	S	P

*Prisoner's dilemma*

		Other	
		C	D
Self	C	2	3
	D	0	1

*Chicken game*

		Other	
		C	D
Self	C	2	3
	D	1	0

*Gain frame*

*Loss frame*

		Other	
		C	D
Self	C	-1	0
	D	-3	-2

		Other	
		C	D
Self	C	-1	0
	D	-2	-3

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