How Framing Influences Strategic Interactions

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Abstract

In many settings, a person's outcome depends not only on her own behavior but also on her counterpart's. Such strategic decisions have traditionally been studied using normative game theory, which assumes that people adopt equilibrium strategies and will reach the same decision regardless of how the problem is described (framed). We examine a potentially-important type of framing effect—focusing on how the *relationship* between players' actions generates joint outcomes. Any strategic interaction can be described by either spelling out the outcomes of all possible action combinations (which we call "outcome framing" or simply "O-framing") or describing what will happen if different players choose the same action or choose different actions (which we call "relation framing" or simply "R-framing"). O-framing has been the typical way to describe a strategic problem in prior work, while R-framing is commonly employed in real-life communications. We propose that these functionally-equivalent frames induce different psychological processes and lead to different decisions: Relative to O-framing, R-framing increases players' beliefs about their counterparts' likelihood of coordinating on a cooperative option. We demonstrate this effect in the context of classic games such as the Prisoner's Dilemma and the Stag Hunt. We find that, compared with O-framing, R-framing significantly increases people's likelihood to choose the action that maximizes collective benefits rather than individual interests, and it does so by increasing beliefs that one's partner will choose the same action as well. We derive conditions when this effect is likely to emerge, and discuss the managerial implications of this research.

Keywords: behavioral game theory, framing effect, Prisoner's Dilemma, Stag Hunt,

Battle of the Sexes, coordination

Many decisions in life involve interactions with others, which require strategic thinking. Game theory has been used to formally study strategic interactions by employing equilibrium analysis to examine how rational players should behave in a given setting. However, a growing behavioral literature has empirically shown that people often deviate from the equilibrium predictions of standard game theory (Camerer 1997, 2003; Crawford 2013).

This research aims to enrich this behavioral literature by studying how framing—which varies the descriptions of the interaction without changing its underlying meaning—influences strategic interactions. Standard models predict that, as long as the underlying payoff and information structure remain the same, people will behave similarly regardless of how a strategic problem is described or *framed* (Fisher 2023; Tversky and Kahneman 1981). Specifically, take an individual facing a choice set that includes information about the payoffs and probabilities of each potential outcome. Traditional economic methods assume that her decisions will be *invariant* to variation in description such as the ordering or the grouping of the choice alternatives. Following Salant and Rubinstein (2006) and Thaler (2016), we refer to such supposedly-irrelevant variations as framing, and refer to its influence on choices—which constitutes a violation of decision invariance—as a framing effect.

Existing behavioral research has documented a variety of framing effects or related effects in strategic interactions; they include using different labels (e.g., “Wall-Street game” versus “Community Game”) to label a game (Columbus, Münich and Gerpott 2020; Ellingsen, Johannesson, Mollerstrom and Munkhammar 2012; Liberman, Samuels and Ross 2004), using different verbs (e.g., “take” versus “claim”) to describe

an action (Larrick and Blount 1997; Leliveld, van Dijk and van Beest 2008), using different valences (positive versus negative) to frame an outcome (Camerer, Johnson, Rymon and Sen 1993; Dufwenberg, Gächter and Hennig-Schmidt 2011; Goerg and Walkowitz 2010), and using different matrixes (e.g., standard versus decomposed) to display a reward structure (Komorita 1987; Pruitt 1967, 1970).[1]

In this paper, we introduce a new and potentially important framing manipulation: describing the same strategic interaction by using either an *outcome frame* or a *relation frame*. We study this distinction because these two frames are arguably the most common ways to describe a strategic interaction, and they reflect two important aspects of a strategic interaction. Every strategic interaction requires the decision-maker to consider the full space of outcomes potentially available to them as well as the relationship between their actions and their counterpart's actions. In our studies, the outcome frame (or simply "O-frame") spells out the outcomes of all possible action combinations independently, and the *relationship* frame (or simply "R-frame") focuses on how the *relationship* between players' actions generates joint outcomes. More specifically, the O-frame describes the outcomes of the scenarios based *orthogonally* on which option one player chooses versus which option the other player chooses. By contrast, the R-frame describes the outcome of the scenarios based on whether the two players choose the same option or the two players choose different options.

[1] Note that the term "framing" is used broadly in this prior literature. It includes not only the classic gain-loss type of framing, but also other types of description manipulations that highlight different aspects of a strategic interaction, such as using the name "Wall Street game" versus "community game," that may convey information about the behavioral norms in a particular setting. We highlight the distinction between "framing" that may convey information versus framing that does not change payoffs nor the informational content, as per the definition of Salant and Rubinstein (2008), when discussing the contribution of our own work.

The O-frame is the standard way to describe a strategic interaction in the game-theory literature and is commonly used in formal analyses. On the other hand, the R-frame is simple to communicate verbally, is common in real-world conversations, and is at least as ecologically important as the O-frame. We present empirical evidence for this claim in the Results and Discussion section of Study 1. Therefore, we believe that it is critical to study how the R-frame affects behavior in strategic interactions.

We propose that these commonly-used and functionally-equivalent frames can produce significantly different decisions: while the O-frame depicts actions as largely independent—each individual acting in their own best interest—the R-frame highlights the potential for coordination on a mutually-beneficial option. Conditional on players having social preferences (e.g., Charness and Rabin 2002; Fehr and Schmidt 1999), the R-frame can change players' beliefs about the prospect of their counterparts coordinating on a cooperative action, which can then lead to more socially-efficient outcomes. We refer to this process as frame-induced belief-change. Notably, the belief-change account may not be the only explanation for the predicted framing effect, but we argue and provide evidence that it is an important one.

Why would the R-frame change beliefs about the prospect of coordination? In the O-frame, each individual's actions are described in isolation, with payoffs corresponding to the outcomes of combining these actions (see the next sub-section for illustration). On the other hand, the R-frame highlights the synergies that result from choosing the same action versus choosing a different action from one's partner. Rather than emphasizing the outcomes of each individual action as in the O-frame, the R-frame makes salient the outcomes from collaborating or not collaborating with one's partner by

either matching their actions or not. This shift in salience creates a focal point around collaboration that is substantially less prevalent in the O-frame; as shown in prior work, shifts in focal points can lead to substantial shifts in beliefs about the behavior of one's partner (Crawford, Gneezy, and Rottenstreich, 2008).

To test the belief-change account, we introduce the concept of a *collectively-best option*, defined as such an action that if both players choose it, it will yield *equal* payoffs to the players, and there is no other option that can make *both* players better off (i.e., it is Pareto efficient). Notably, the collectively-best option is distinct from options that yield the highest total payoff, because the latter does not necessarily generate *equal* payoffs for the players, and does not necessarily require the players to coordinate by choosing the same option.

We propose that the existence of a *unique* collectively-best option provides a coordination device for potential collaboration. By highlighting the scope for collaboration, the R-frame increases people's beliefs about the likelihood that their counterpart will cooperate as well. The existence of a unique collectively-best option allows the players to then express these beliefs through behavior by increasing the chances that they both collaborate and select this option.

We provide evidence for this prediction using a number of classic games designed to model different types of strategic interactions. Notably, some games have a unique collectively-best option and others do not. The oft-studied Prisoner's Dilemma (PD)—which is the focus of our investigation—has a unique collective-best option: both players choosing to cooperate (instead of defecting).

The Stag Hunt (SH) is another classic two-player social dilemma. The Stag Hunt differs from the Prisoner's Dilemma in several ways—notably the lack of a unique equilibrium—but the Stag Hunt also has a unique collectively-best option: both players choosing to hunt for the stag.

Not all games have a unique collectively-best option. For example, the Battle of the Sexes (BS) does not have a unique collectively-best option (both equilibria generate asymmetric payoffs). Likewise, the standard pure Coordination Game (CG) does not have unique collectively-best options either.

These games allow us to explicitly test our theory by showing that the framing effect changes behavior in games with a unique collectively-best option (e.g., PD and SH) and not in games without one (e.g., BS and CG). We next elaborate on how this framing effect operates in the context of these games and outline our hypotheses in greater detail.

Framing in Games

Prisoner's Dilemma (PD). We first examine the PD—a game with a unique collectively-best option. Assume that you and someone named Ze choose independently between two actions—C (cooperation) and D (defection). The outcomes are as follows, where $o_4 > o_3 > o_2 > o_1$ and $o_3 > (o_4+o_1)/2$:

PD O-Frame

	If Ze chooses C	If Ze chooses D
If you choose C	you get o_3 and Ze gets o_3	you get o_1 and Ze gets o_4
If you choose D	you get o_4 and Ze gets o_1	you get o_2 and Ze gets o_2

Of the two actions, C (cooperation) corresponds to the unique collectively-best option because if both of you choose C, both of you will get the same o_3, which maximizes the total pie relative to any other joint outcome. On the other hand, D (defection) is strategically-dominant (assuming that the players care only about self-interests), because regardless of which action Ze chooses, you will be better off by choosing D; namely, o_4 is greater than o_3 and o_2 is greater than o_1.[2]

The PD can be described using one of two frames: an O-frame or an R-frame. The O-frame spells out the potential outcomes of all choice combinations of you and Ze. The above 2 x 2 matrix is the O-frame.

By contrast, the R-frame of the PD describes what will happen if you and Ze collaborate with one another—choosing the same action—versus act asynchronously—choosing different actions, as shown below:

[2] Note that incorporating social preferences into the analysis changes whether D is strategically-dominant (e.g., with inequity aversion, C may be strategically dominant), but does not change that fact that the PD has a unique equilibrium. Without social preferences, (D,D) is the unique equilibrium; with sufficiently strong social preferences, (C,C) is the unique equilibrium. See Copraro, Rodriguez-Lara, and Ruiz-Martos (2020) for a similar discussion. Heterogeneity in social preferences will generate heterogeneity in choices. Importantly, however, the existence of social preferences does not predict the framing effect studied in this paper since the unique equilibrium does not change between the O- or the R-frame versions of the game.

PD R-Frame

If both you and Ze choose C	each gets o_3
If one chooses C and one chooses D	the one choosing C gets o_1 and the one choosing D gets o_4
If both you and Ze choose D	each gets o_2

Although the two frames convey the same underlying information, we posit that they are psychologically distinct and may lead to different choices. Specifically, the R-frame makes salient the scope for collaboration and coordination on the collectively-best option. The shift in salience increases the chances that collaboration is used as a focal point, which can change players' beliefs about their counterpart's propensity to cooperate. Conditional on players having social preferences, this will lead to more socially-efficient outcomes (o_3 for both players).

Stag Hunt (SH). Now, consider the SH, another game with a unique collectively-best option. Assume that in the SH, you and Ze can either choose either option R (rabbit) or option S (stag), and the outcomes, when presented in the O-frame, are as follows, where $o_2 > 2 \times o_1 > 2 \times o_3$:

SH O-Frame

	If Ze chooses R	If Ze chooses S
If you choose R	you get $o_1/2$ and Ze gets $o_1/2$	you get o_1 and Ze gets o_3
If you choose S	you get o_3 and Ze gets o_1	you get $o_2/2$ and Ze gets $o_2/2$

Between the two actions, S (stag) can potentially maximize collective benefits because if both players choose it, they will each get $o_2/2$—more than twice as much as if both choose R. On the other hand, action R (rabbit) is the safer action for the self, because regardless of which action Ze chooses, you will always get at least $o_1/2$.

Alternatively, the SH can be described in the following R-frame:

SH R-Frame

If both you and Ze choose R	each gets $o_1/2$
If one chooses R and one chooses S	the one choosing R gets o_1 and the one choosing S gets o_3
If both you and Ze choose S	each gets $o_2/2$

The same analysis as in the PD generates the prediction that the R-frame will result in more collectively-best options being chosen in the SH. This hypothesis is not obvious because the opposite effect may also arise; namely, the R-frame could engender social comparison and competition and thereby *decrease* the likelihood of cooperation.

Battle of the Sexes (BS). Now, consider the BS, a game without a unique collectively-best option. In the BS, suppose that you and Ze can each choose either option U ("you better") or Z ("Ze better"). In the O-frame, the outcomes of the BS are as follows, where $o_1 > o_2 > o_3$:

BS O-Frame

	If Ze chooses U	If Ze chooses Z
If you choose U	you get o_1 and Ze gets o_2	you get o_3 and Ze gets o_3
If you choose Z	you get o_3 and Ze gets o_3	you get o_2 and Ze gets o_1

Alternatively, the BS can be presented in the following R-frame:

BS R-Frame

If both you and Ze choose U	you get o_1 and Ze gets o_2
If one chooses U and one chooses Z	each gets o_3
If both you and Ze choose Z	you get o_2 and Ze gets o_1

The BS does not have a unique collectively-best option, because regardless of whether both players choose U or both players choose Z, it will not yield equal payoffs to the two players. According to our theory, the R-frame (vs. the O-frame) is not predicted to change actions because there is no collectively-best option to coordinate on, and collaboration is no longer focal. In both frames, the inequality in payoff may lead to coordination failures (Crawford, Gneezy, and Rottenstreich, 2008).

Pure Coordination Game. The pure Coordination Game (CG)—another game without a unique collectively-best option, can be considered a special case of the above BS, in which, $o_1 = o_2 = o > o_3$. In the O-frame, the outcomes are:

CG O-Frame

	If Ze chooses U	If Ze chooses Z
If you choose U	you get o and Ze gets o	you get o_3 and Ze gets o_3
If you choose Z	you get o_3 and Ze gets o_3	you get o and Ze gets o

Alternatively, the CG can be described in the following R-frame:

CG R-Frame

If both you and Ze choose U	each gets o
If one chooses U and one chooses Z	each gets o_3
If both you and Ze chooses Z	each gets o

Although the CG has collectively-best options, they are not unique: Both U and Z are collectively best; that is, regardless of whether both players choose U or both players choose Z, they will get equally high payoffs. Therefore, as in the BS, there is no collectively-best option in the CG for the players to coordinate on, and we do not expect our framing manipulation to influence choices in the CG.

Summary. In short, we predict that in games with a unique collectively-best option (e.g., PD and SH), the R-frame, relative to the O-frame, will increase the

likelihood of people choosing this option. This framing effect arises because the R-frame, relative to the O-frame, increases people's beliefs that their counterpart will select the unique collectively-best option.

Moreover, our theory predicts that in games without a unique collectively-best option (e.g., BS and CG), the framing manipulation will not affect choice because there is no focal collectively-best option for players to coordinate on.

To reiterate, our proposed belief-change mechanism is not the only factor that can produce the O/R framing effect. The O/R framing can be caused by other factors (see the General Discussion). However, we propose and provide empirical support for the belief-change channel as a significant factor.

Relationship to Prior Work

As noted earlier, prior work has shown that behavior in the PD is significantly affected by labeling. In the classic study by Liberman, Samuels and Ross (2004), participants in the PD were more likely to cooperate when it was labeled as a Community Game than as a Wall-Street Game. Follow up work by Ellingsen et al. (2012) argued that this "social framing" may impact behavior by changing people's expectations about what their counterpart would do. The authors provide indirect evidence for this hypothesis by ruling out other potential factors such as the labels making people more altruistic.

However, the labeling manipulation may have also changed the meaning and the expected behavior in the game. Specifically, the labeling manipulation may not have been a pure framing manipulation as commonly defined (Salant and Rubinstein 2008)

because it may convey different information: Calling the PD a Community Game may lead people to think about cooperation because people typically cooperate in a community, whereas calling the PD a Wall-Street Game may lead people to think about competition and defection, because stereotypically people on the Wall Street are selfish and competitive. In that sense, labeling the PD as either a “Wall-Street Game” or a “Community Game” is akin to labeling a risky choice (e.g., a choice between $100 for sure or a 50% chance at $200) as either a “Gambling Game” or a “Savings Game”: the two labels provide different meanings and information. On the other hand, our framing manipulation is more akin to the classic gain/loss framing manipulation that does not change the meaning (Kahneman & Tversky 1979). This distinction is important because the meaning-based explanation implies that changes in behavior are driven by changes in expectations or norms, such that people are compelled to act differently so as to avoid feelings of guild (Gneezy, Imas, and Madarasz, 2014). By contrast, we argue that our framing manipulation shifts behavior by changing people’s beliefs about their counterpart’s behavior.

To empirically test our propositions that the labeling manipulation conveys different meanings while our framing manipulation does not, we conducted a pilot study (N = 206; 103 females, M_{age} = 39.82, recruited on CloudResearch) to examine how research participants themselves view the two types of manipulations (see Appendix A). The study consisted of two between-subjects conditions—the labeling condition and framing condition. In the labeling condition, participants were shown two identical versions of a PD, except that the PD was labeled as a “Community Game” in one version and labeled as a “Wall Street Game” in the other version. In the framing

condition, participants were also shown two identical versions of a PD (the same as in the one in the labeling condition), except that the outcomes of the PD were presented in the O-frame in one version and presented in the R-frame in the other version.[2] In each condition, participants were asked whether the two versions conveyed the same meaning or different meanings. In the labeling condition, only a minority of the participants (17.1%) considered the two versions conveying the same meaning, but in the O/R framing condition, the majority of the participants (83.2%) found the two versions conveying the same meaning. These results suggest that the framing manipulation in our research operates through a different mechanism than the labeling manipulation in the prior work.

With regard to our contribution to the understanding of strategic interactions more broadly, we should note that while standard models assume that framing does not affect preferences, they are silent on whether and how framing may affect beliefs.[3] Specifically, in the case of multiple equilibria, different frames may shift focal points to facilitate coordination. Our findings suggest that framing can affect behavior even in the cases with unique equilibria, as in the PD game used in the majority of our studies.

We now proceed to test our predictions on how the O-frame versus the R-frame affects beliefs and behavior.

[2] In the labeling condition, the PD was always presented in the O-frame, as is typically the case in game theory studies; in the framing condition, the PD was not labeled.
[3] We would like to thank an anonymous reviewer for highlight this point.

Study Overview

We tested our hypotheses in five studies. See Table 1 for an overview. All studies, except for Study 2 (which was largely exploratory), were pre-registered: Study 1 at https://aspredicted.org/3WS_TPS; Study 3A at https://aspredicted.org/236_SN4; Study 3B at https://aspredicted.org/B47_7GQ; Study 4 at https://aspredicted.org/LKP_8F6; Study 5 at https://aspredicted.org/KKZ_P4L. We have reported all measures, conditions, data and exclusions. The sample size of each study was pre-determined as specified in the pre-registrations. We have posted study materials, data and analysis codes on https://osf.io/vuge5/?view_only=cefbb4ce03bc4412bfa3e930b5fe87b5.

Table 1. Study Overview

Study 1	Demonstrates the framing effect in the Prisoner's Dilemma
Study 2	Replicates the framing effect in the Prisoner's Dilemma, and explores its underlying reasons
Study 3A	Part 1 of a two-stage causal chain study: testing the effect of framing on belief
Study 3B	Part 2 of a two-stage causal chain study: testing the effect of belief on choice
Study 4	Tests the boundary condition of the framing effect by showing that the effect occurs in the Prisoner's Dilemma, but not in the Battle of the Sexes
Study 5	Tests the boundary condition of the framing effect by showing that the effect occurs in the Stag Hunt, but not in a pure Coordination Game; also explores the underlying psychology by eliciting players' beliefs about their counterparts' actions

Study 1

Demonstrating the Framing Effect in a Context-Rich Prisoner's Dilemma

Study 1 tested our hypothesized framing effect in a business-relevant Prisoner's Dilemma, in which the CEOs of two regional airlines decide independently whether to set a low price (defect) or set a high price (cooperate).

Method

We aimed to recruit 300 workers on CloudResearch's MTurk Toolkit by using CloudResearch-approved participants and the final sample included 300 workers (124 females, M_{age} = 42.04). They were assigned to either an O-frame condition or a R-frame condition. All participants read the following:

> You and Ze are the CEOs of two regional airlines. Both airlines will fly a new route starting next month. Each of you wants your own route to make as much profit as possible. Since your new route and Ze's new route are the same, passengers who fly your route won't fly Ze's, and passengers who fly Ze's won't fly yours. You and Ze each need to set an airfare for your new route, and each of you may set either a low airfare or a high airfare. Due to antitrust regulations, you two must make your price decisions independently; you are not allowed to collude. The following table describes the estimated monthly profits (in millions of dollars) from the new routes in different scenarios. You and Ze have the same information.

In the O-frame condition, participants saw the following:

	If Ze sets a low price	If Ze sets a high price
If you set a low price	Your route will make $2M, and Ze's route will make $2M	Your route will make $5M, and Ze's route will make $1M
If you set a high price	Your route will make $1M, and Ze's route will make $5M	Your route will make $4M, and Ze's route will make $4M

In the R-frame condition, participants saw the following:

If both you and Ze set a low price	both your route and Ze's route will make $2M
If one of you sets a low price, and one of you sets a high price	the low-priced route will make $5M, and the high-priced route will make $1M
If both you and Ze set a high price	both your route and Ze's route will make $4M

All participants were then asked to make a binary choice between setting a low price and setting a high price. Note that in this study, setting a high price corresponded to cooperation (a unique collectively-best option), while setting a low price corresponded to defection.

Results and Discussion

We found the predicted framing effect: the proportion of participants choosing a high price (i.e., cooperation) was significantly higher in the R-frame condition than in the O-frame condition: 51.3% vs. 24.0%, χ^2 (1, N = 300) = 23.87, p < .001.

In addition to the main study, we conducted a separate study to see which frame people are more likely to spontaneously adopt. We presented participants (N = 101; 38 females, M_{age} = 41.45, recruited on CloudResearch) with the O-frame and R-frame of the same game as Study 1. Participants were asked the following three questions: 1) which frame is the more natural method to communicate the information, 2) which frame they would use if they are to communicate the information to other people, and 3) which frame they would use if they are to do a formal analysis. The results showed (1) that 56.4% of the participants considered the R-frame more natural than the O-frame (χ^2 = 1.67, p = .196, compared with 50%), (2) that 59.4% of the participants would use the R-

frame in verbal communication (χ^2 = 3.57, p = .059, compared with 50%), and (3) that 47.5% of the participants would use the R-frame in formal analysis (χ^2 = 0.25, p = .619, compared with 50%). These results suggest that the R-frame is at least as popular as the O-frame in both verbal communication and formal analyses.

Study 2

Replicating the Framing Effect with Reason Exploration

Study 2 was a replication of Study 1 using another ecologically-valid business context: investing in a company. To probe for the underlying psychology, we included some reason-exploration questions at the end.

Method

We aimed to recruit 500 workers on CloudResearch's MTurk Toolkit by using CloudResearch-approved participants and the final sample included 500 workers (249 females, M_{age} = 40.87). They were assigned to either an O-frame condition or an R-frame condition. All participants received the following instructions:

> You and Zay are the owners of two different companies. Each of you is making an investment decision for your own company. The two of you have the same information, and face the same investment options—investing in either project A or project B. You and Zay have to make your choices independently; your choice won't influence Zay's choice, and Zay's choice won't influence yours. The following table describes the expected outcomes (in millions of dollars) in different scenarios:

In the O-frame condition, participants saw the following:

	If Zay chooses A	If Zay chooses B
If you choose A	you will earn $2M and Zay will earn $2M	you will earn $6M and Zay will earn $1M
If you choose B	you will earn $1M and Zay will earn $6M	you will earn $5M and Zay will earn $5M

In the R-frame condition, participants saw the following:

If both you and Zay choose A	each of you will earn $2M
If one of you chooses A and one of you chooses B	the one who chooses A will earn $6M and the one who chooses B will earn $1M
If both you and Zay choose B	each of you will earn $5M

Note that in this study, option B corresponded to cooperation (a unique collectively-best option), and option A corresponded to defection.

Before making their decisions, participants answered some comprehension questions about the instructions, and they would get a 20-cent bonus if they answered all the comprehension questions correctly (see Appendix B for the comprehension questions). After that, all participants made a binary choice between option A and option B.

After participants had made their decision, they were directed to a new screen, reminded of the outcome information they had received (the above table in their respective conditions) and the choice they had made, and asked why they made that choice. We offered eight options and participants chose the option that best described the reason for their choice. The eight candidate reasons were:

Reason 1. I chose X because I predicted Zay would choose A
Reason 2. I chose X because I predicted Zay would choose B
Reason 3. I chose X because it allowed me to earn more money, regardless of Zay's choice
Reason 4. I chose X because I wanted to avoid the risk of getting the worst outcome
Reason 5. I chose X because I wanted to take a risk to have a chance to get the best outcome
Reason 6. I chose X because I didn't want to be taken advantage of
Reason 7. I chose X because I thought my choice could influence Zay's choice
Reason 8. None of the above

In the original survey, "X" was either A or B, depending on the choice the participant made. Note that all the reasons make logical sense if participants choose A but the following reasons make no logical sense if participants choose B: Reason 3 (because A is the dominant option), Reason 4 (because choosing A can avoid getting the worst outcome), Reason 5 (because choosing A can get the best outcome), Reason 6 (because A is the dominant option). We presented all the reasons to participants regardless of their choice for the sake of completeness but we focused on the reasons that make logical sense when conducting the analysis.

Results and Discussion

We replicated our framing effect: The proportion of participants choosing project B (cooperation) was higher in the R-frame condition than in the O-frame condition, 76.1% versus 54.2%, χ^2 (1, N = 500) = 26.37, p < .001. Among the participants, 94.4% answered all comprehension questions correctly (98.8% in the R frame and 90.0% in

the O frame)[5]. Excluding participants who failed any comprehension questions did not significantly change our results, 76.6% versus 55.4%, χ^2 (1, N = 472) = 23.88, p < .001.

To explore why the R-frame could boost cooperation, we focused on participants who chose to cooperate. Table 2 summarizes the results of the post-decision reason-exploration questionnaire of these participants. (For the reason-exploration results from all participants, participants who defected, participants in the O-frame condition, and participants in the R-frame condition, see Appendix C). As Table 2 shows, the most prevalent reason of the participants who chose B (cooperation) was Reason 2—"I chose B because I predicted Zay would choose B." Importantly, the proportion of participants adopting this reason was significantly higher in the R-frame condition than in the O-frame condition. This result suggests that the R-frame (vs. the O-frame) changed participants' belief that the other player would coordinate on the cooperative option. This provides suggestive evidence for our conjecture that the R-frame affects behavior by changing beliefs. Studies 3 further tested our theory by explicitly eliciting beliefs (3A) and then *manipulating* them directly (3B).

[5] Although slightly more participants in the R frame than in the O frame answered the comprehension questions correctly, we do not think the small difference in correction rate could explain the size of our framing effect—especially since the difference stays largely the same and significant after those who did not get the questions correct were excluded.

Table 2: Study 2 Reason-Exploration Results from Participants Who Cooperated

The underlying reason is:	% of such Ps among Ps in the O-frame condition	% of such Ps among Ps in the R-frame condition	Significance level
Reason 1 “I chose B because I predicted Zay would choose A”	2.0%	1.2%	p=.469
Reason 2 “I chose B because I predicted Zay would choose B”	33.3%	45.4%	p=.006
Reason 3 “I chose B because it allowed me to earn more money, regardless of Zay’s choice” (Makes no logical sense)	4.4%	6.4%	p=.333
Reason 4 “I chose B because I wanted to avoid the risk of getting the worst outcome” (Makes no logical sense)	0.4%	3.2%	p=.019
Reason 5 “I chose B because I wanted to take a risk to have a chance to get the best outcome” (Makes no logical sense)	8.4%	13.5%	p=.068
Reason 6 “I chose B because I didn’t want to be taken advantage of” (Makes no logical sense)	0.4%	0.4%	p=.995
Reason 7 “I chose B because I thought my choice could influence Zay’s choice” (Magical belief)	2.0%	0.8%	p=.249
None of the above	3.2%	5.2%	p=.273

Study 3A

Testing the Effect of Framing on Belief

Study 3A and Study 3B are two parts of a two-stage causal chain study that tested the role of beliefs in how our framing manipulation affects behavior. Study 3A manipulated framing and tested its effect on beliefs; Study 3B manipulated beliefs and tested the effects on choice.

Method

Study 3A manipulated framing and measured beliefs. We predicted that the R-frame, relative to the O-frame, would strengthen people's beliefs that the other player would coordinate on the cooperative option.

We aimed to recruit 600 workers on CloudResearch's MTurk Toolkit by using CloudResearch-approved participants and the final sample included 607 workers (318 females, M_{age} = 40.36). They were assigned to either an O-frame condition or an R-frame condition. All participants read the following:

> You are one of two ice cream vendors who will sell ice cream at a large event tomorrow. You and the other vendors are not familiar with each other and do not have each other's contact information. You two sell the same kind of ice cream. Each of you must decide independently whether to set a low price or a high price for your ice cream. You must set the price now and cannot change it. The following table describes the relationship between the price you set and the profit you will make tomorrow.

In the O-frame condition, participants saw the following:

	If the other vendor sets a low price	If the other vendor sets a high price
if you set a low price	you will make $200, and they will make $200	you will make $500, and they will make $100
if you set a high price	you will make $100, and they will make $500	you will make $400, and they will make $400

In the R-frame condition, participants saw the following:

If both of you set a low price	each of you will make $200
If one of you sets a low price and one of you sets a high price	the one who sets a low price will make $500, and the one who sets a high price will make $100

If both of you set a high price	each of you will make $400

All participants were asked the following belief-elicitation question, “Before making your own decision, please make a prediction first: What price do you think the other vendor will set?” and gave their answer on a 7-point scale where 1 = “they will definitely set a low price” and 7 = “they will definitely set a high price.”

Although the main purpose of this study was to test the effect of framing on *beliefs*, we also measured participants’ choices at the end, asking them whether they would set a low price or a high price by making a binary choice. Setting a high price corresponded to cooperation (a unique collectively-best option), while setting a low price corresponded to defection.

Results and Discussion

The main dependent variable of this study was participants’ beliefs. Consistent with our prediction, framing had a significant effect in changing beliefs: participants were more likely to believe that the other player would cooperate in the R-frame condition than in the O-frame condition (*M*s = 4.65 vs. 4.30; *SD*s = 1.97 vs. 1.91), $t = 2.21$, $p = .028$.

We also measured participants’ choices. As in the other studies, framing had a significant effect on choice: The proportion of participants choosing to set a high price (i.e., cooperation) was significantly higher in the R-frame condition than in the O-frame condition: 57.6% versus 39.6%, $\chi^2 (1, N = 607) = 19.60$, $p < .001$.

To test whether the participants’ beliefs mediated the relationship between the

frame and their choice, we ran a Bootstrap analysis and found that beliefs indeed mediated the effect, 95% CI [-.6240, -.0350] with 5000 samples.

Study 3B

Testing the Effect of Belief on Choice

While Study 3A was the first part of a two-stage causal-chain study that manipulated framing and measured beliefs, Study 3B was the second part that manipulated beliefs and measured choice. We predicted that the belief that the other player would cooperate (vs. the belief that the other player would defect) would increase players' own likelihood to cooperate. Notably, this is not an obvious prediction because defection is strategically dominant (assuming one only cares about their self-interest).

Method

We aimed to recruit 600 workers on CloudResearch's MTurk Toolkit by using CloudResearch-approved participants and the final sample included 607 workers (321 females, M_{age} = 40.80). Participants were randomly assigned to one of two belief conditions: the other-will-defect condition or the other-will-cooperate condition. All participants read the O-frame version of the ice-cream vignette of Study 3A. We adopted the O-frame version because it is the commonly-used frame in the game theory literature.

In the other-will-defect condition, participants were told that "You have learned from a reliable source that the other vendor sets a low price." In the other-will-cooperate condition, participants were told that "You have learned from a reliable source that the

other vendor sets a high price." Then, all participants decided whether to set a low price or a high price by making a binary choice.

Results and Discussion

As we predicted, the proportion of participants choosing to set a high price (i.e., cooperation) was significantly higher in the other-will-cooperate condition than in the other-will-defect condition, 40.3% versus 14.1%, χ^2 (1, N = 607) = 52.30, p < .001. This result provides direct evidence that beliefs play a causal role in choice.

Together, Study 3A and Study 3B corroborate Study 2 by lending further support to our conjecture that the framing effect operates through a change in people's beliefs. The results are also consistent with previous findings showing that players in the Prisoner's Dilemma who defect (vs. who cooperate) are more likely to believe that others are uniformly competitive (Kelley and Stahelski 1970) and similar to themselves (Kuhlman and Wimberley 1976).

Study 4

Comparing the Battle of the Sexes with the Prisoner's Dilemma

Study 4 tested the boundary of the framing effect. According to our theory, the O/R framing manipulation will change choices only when there is a unique collectively-best option, defined as such an action that if both players choose it, it will yield equal payoffs to the players, and there is no other option that can make *both* players better off. In Study 4, we compared two games: the Prisoner's Dilemma (PD) which has such a unique collectively-best option and the Battle of the Sexes (BS) which does not have

such a unique collectively-best option. We kept the two games similar in all other aspects. We predicted that our framing manipulation would change choices in the PD, but not in the BS.

Method

We aimed to recruit 1000 workers on CloudResearch's MTurk Toolkit by using CloudResearch-approved participants and the final sample included 1001 workers (510 females, M_{age} = 41.64). They were assigned to one of four conditions, which constituted a 2 (frame: O vs. R) x 2 (game: PD vs. BS) between-subjects design. All participants read the following:

> You and Ze are two employees in a small company. The CEO of the company asks each of you to work on a project, and promises each of you a bonus. You and Ze are not personal friends; each of you wants to get as much bonus as possible for the self. The CEO gives each of you two projects to choose from (project C or project D), and asks each of you to decide independently which project to choose. The CEO gives both of you the following information regarding the amount of bonus you will get (where $1k = $1000):

Depending on their assigned conditions, different participants saw a different table. In the PD-O-frame condition, participants saw the following:

	If Ze chooses project C	If Ze chooses project D
If you choose project C	you will get $10k and Ze will get $10k	you will get $3k and Ze will get $12k
If you choose project D	you will get $12k and Ze will get $3k	you will get $5k and Ze will get $5k

In the PD-R-frame condition, participants saw the following:

If both of you choose project C	each of you will get $10k
If one of you chooses project C and one of you chooses project D	the one choosing project C will get $3k and the one choosing project D will get $12k
If both of you choose D	each of you will get $5k

In the BS-O-frame condition, participants saw the following:

	If Ze chooses project C	If Ze chooses project D
If you choose project C	you will get $8k and Ze will get $12k	you will get $3k and Ze will get $3k
If you choose project D	you will get $3k and Ze will get $3k	you will get $12k and Ze will get $8k

In the BS-O-frame condition, participants saw the following:

If both of you choose project C	you will get $8k and Ze will get $12k
If one of you chooses project C and one of you chooses project D	each of you will get $3k
If both of you choose project D	you will get $12k and Ze will get $8k

All participants then decided which project to invest in by making a binary choice.

Note that in the PD conditions, project C corresponded to cooperation (the unique collectively-best option); in the BS conditions, there was no unique collectively-best option.

Results and Discussion

We conducted a logistic regression with participants' choice as the dependent variable, and with frame, game, and their interaction as predictors. The analysis found a

significant effect of frame , $exp\beta$ = 0.386, $p < .001$, *Wald* = 24.41, a significant effect of game, $exp\beta$ = 0.205, $p < .001$, *Wald* = 66.16, and, most importantly, a significant interaction between game and frame, $exp\beta$ = 2.696, $p < .001$, *Wald* = 13.86. This interaction indicates that the effect of framing depends on the type of game.

Specifically, in the PD conditions, we again replicated the framing effect: a higher proportion of the participants chose project C (cooperation) under the R-frame than under the O-frame, 74.5% vs. 53.0%, χ^2 (1, N = 500) = 24.99, $p < .001$. By contrast, in the BS conditions, framing did not influence choices: roughly the same proportion of participants chose project C under the R-frame as under the O-frame, 37.5% vs. 38.4%, χ^2 (1, N = 501) = 0.05, p = .827. These results supported our hypothesis that the framing effect would occur only in the presence of a unique collectively-best option.

Study 5

Comparing the Stag Hunt with a Pure Coordination Game

Study 5 was a conceptual replication of Study 4. While Study 4 tested the boundary of our framing effect by comparing the Prisoner's Dilemma (PD) with the Battle of the Sexes (BS), Study 5 tested the boundary of our framing effect by comparing the Stag Hunt (SH) with a pure Coordination Game (CG). Like the PD, the SH has a unique collectively-best option, and like the BS, the CG lacks a unique collectively-best option. Therefore, we predicted that our framing manipulation would influence behavior in the SH, but not in the CG.

In addition to testing the effect of framing on behavior, Study 5 also explored its underlying mechanism by measuring participants' beliefs about their counterparts'

behavior. We predicted that our framing manipulation would change participants' beliefs in the SH, but not their beliefs in the CG.

Method

We aimed to recruit 1000 workers on Prolific and the final sample included 1001 workers (559 females, M_{age} = 30.16). They were assigned to one of four conditions, which constituted a 2 (frame: O vs. R) x 2 (game: SH vs. CG) between-subjects design. All participants read the following:

> You and Zay are the CEOs of two companies. Each of you is making an investment decision for your own company. The two of you have the same information, and face the same options—investing in either project A or project B. You and Zay must make your decisions independently, and cannot collude with each other. The following table describes the expected outcomes (in millions of dollars) in different scenarios:

Depending on their assigned conditions, different participants saw a different table. In the SH-O-frame condition, participants saw the following:

	If Zay invests in A	If Zay invests in B
If you invest in A	you will earn $2M and Zay will earn $2M	you will earn $ 4M and Zay will earn $0
If you invest in B	you will earn $0 and Zay will earn $4M	you will earn $5M and Zay will earn $5M

In the SH-R-frame condition, participants saw the following:

If both you and Zay invest in A	each of you will earn $2M
If one of you invests in A, and one of you invests in B	the one of you who invests in A will earn $4M, and the one of you who invests in B will earn $0
If both you and Zay invest in B	each of you will earn $5M

In the CG-O-frame condition, participants saw the following:

	If Zay invests in A	If Zay invests in B
If you invest in A	you will earn $5M and Zay will earn $5M	you will earn $0 and Zay will earn $0
If you invest in B	you will earn $0 and Zay will earn $0	you will earn $5M and Zay will earn $5M

In the CG-R-frame condition, participants saw the following:

If both you and Zay invest in A	each of you will earn $5M
If one of you invests in A, and one of you invests in B	each of you will earn $0
If both you and Zay invest in B	each of you will earn $5M

All participants were then asked the following belief-elicitation question: “Which project do you think Zay will invest in?”; their answered on a 6-point scale where 1 = “definitely project A” and 6 = “definitely project B.” Finally, all participants were asked which project they would invest in by making a binary choice.

Note that in the SH conditions, project B corresponded to the “Stag” (the unique collectively-best option), while in the CG conditions, there was no unique collectively-best option.

Results and Discussion

Choice. We conducted a logistic regression with choice as the dependent variable, and frame, game, and their interaction as predictors. The analysis found a significant effect of frame, $exp\beta$ = 0.459, $p < .001$, $Wald$ = 14.66, a significant effect of game, $exp\beta$ = 0.063, $p < .001$, $Wald$ = 152.43, and, most importantly, a significant interaction between frame and game, $exp\beta$ = 1.859, $p = .045$, $Wald$ = 4.02. This interaction indicates that the impact of framing was moderated by the type of game.

Specifically, in the SH conditions, we again replicated the framing effect: a higher proportion of the participants chose project B (stag) under the R-frame than under the O-frame, 79.0% vs. 63.4%, χ^2 (1, N = 502) = 14.96, $p < .001$. By contrast, in the CG conditions, framing did not influence choices: about the same proportion of participants chose project B under the R-frame as under the O-frame, 19.2% vs. 16.9%, χ^2 (1, N = 499) = 0.46, $p = .498$.

Although the games compared in this study (SH vs. CG) were different from the games compared in Study 4 (PD vs. BS), the results of this study were consistent with those of Study 4.

Belief. As reported above, Study 5 also measured participants’ beliefs about their counterparts' actions. A 2 (frame: O vs. R) x 2 (game: SH vs. CG) ANOVA with belief as the dependent variable yielded a significant main effect of frame, F(1, 997) =

4.48, $p = .034$, $\eta^2 = .004$, a significant main effect of game, $F(1, 997) = 313.33$, $p < .001$, $\eta^2 = .239$, and, most importantly, a significant interaction effect, $F(1, 997) = 14.27$, $p < .001$, $\eta^2 = .014$. The interaction shows that the impact of framing on belief was moderated by type of game.

Specifically, in the SH conditions, participants were more likely to believe that the other player would choose project B (i.e., stag) in the R-frame condition than in the O-frame condition (*M*s = 4.90 vs. 4.23; *SD*s = 1.73 vs. 2.04), $p < .001$. By contrast, in the CG conditions, framing did not influence beliefs (*M*s = 2.48 vs. 2.67; *SD*s = 1.62 vs. 1.69), $p = .241$.

We also conducted a bootstrap analysis in each of the game conditions to see whether beliefs mediated choices (although the bootstrap analysis was not in the pre-registration). In the SH conditions, beliefs significantly mediated choices, 95% CI [.2719, .8563] with 5000 samples. In the CG conditions, beliefs did not mediate choices, 95% CI [-.4674, .1000] with 5000 samples.

These belief results shed light on the underlying psychology of the framing effect (or lack of it), providing support for our conjecture that framing changes behavior through changes in beliefs.

Together, Study 4 and Study 5 offer strong converging evidence for our theory by showing that the O/R framing manipulation would influence behavior in games with a unique collectively-best option, and not in games without such an option.

The results of Study 4 and Study 5 also ruled out several alternative explanations for our framing effect. For instance, the R-frame uses the word “both” which might emphasize cooperation but the O-frame does not use the word “both.” Our results cast

doubt on the wording difference as the alternative explanation because the wording difference was held constant between the game with a unique collectively-best option and the game without. Additionally, the frequency of taking the same action is higher in the R-frame (2 out of 3 times) than in the O-frame (2 out of 4 times). Like the wording difference, this frequency difference was held constant across different types of games. Therefore, it cannot explain why the type of game moderates the framing effect.

General Discussion

In many decision situations, one's outcome depends not only on their own actions but also on the actions of others. These situations require strategic thinking rather than individual decisions. While decades of behavioral decision research have taught us much about how framing influences *individual* decisions (see Kühberger 1998; Levin, Schneider and Gaeth 1998; Rothman and Salovey 1997 for reviews) in management, marketing and policy contexts (see Evangelidis and Levav 2019; Evers, Inbar, Blanken, and Oosterwijk 2017; Larrick and Soll 2008; Spiller, Reinholtz, and Maglio 2020; Hsee and Li 2022 for recent examples), we know relatively less about how framing affects *strategic* decisions.

This research contributes to a growing behavioral literature on strategic decisions by introducing a new framing manipulation that describes the outcomes of a social dilemma in either an outcome frame (which is conventionally used in the game-theory literature) or a relation frame (which is often used in verbal and colloquial communication). We find that these functionally-equivalent frames lead to significantly different choices in one of the most important social dilemmas—the Prisoner's Dilemma.

We attribute the framing effect to a change in beliefs, and provide support for this claim through several empirical studies. Furthermore, we demonstrate the generalizability and the boundary conditions of this framing effect by examining its impact in three other classic social dilemmas—the Stag Hunt, Battle of the Sexes, and pure Coordination Game.

As noted in the Introduction, belief change is not the only factor that can produce our framing effect. Another possible factor is the salience of the dominance relationship between the alternative options. In the PD, for example, the O-frame, relative to the R-frame, may increase the salience that defection dominates cooperation in terms of individual interests, and thereby increase people's tendency to defect. This account is consistent with the result of Reason 3 provided by participants who defected in Study 2 (see Appendix C). Although this account applies to the PD, it cannot explain the framing effect in the SH, because there is no dominance relationship between the options in the SH; nor can it explain the causal-chain results or the boundary conditions found in the other studies. In short, dominance salience may be an *additional*, but *not an alternative*, explanation to the framing effect in the PD.

The framing effect may also operate through a shift in perceived norms in the game. For example, by making the prospect of mutual collaboration more salient, the R-frame may lead people to view the associated actions as the "norm" in the game. While we cannot completely rule out this possibility, the results from the study presented in the introduction suggest that, unlike the Wall Street/Community labeling manipulation, our framing manipulation does not change people's perceptions of the game.

Our findings carry practical (including managerial) implications. As discussed

earlier, the O-frame and the R-frame are both commonly used in real life. Our studies show how the two frames can lead companies to set different prices for their products (Study 1), lead CEOs to choose different investment options for their companies (Study 2 and Study 5), lead employees to choose different projects to earn bonuses (Study 4), and lead sellers to choose different markets to earn profits (Study 3A and Study 3B). Let us consider some specific examples. Suppose that the board directors of two rival airlines independently ask their board members to decide whether to set a low airfare or a high airfare for a new flight route, like the situation in Study 1. Then our findings predict that if the directors highlight how outcomes depend on the relationship between actions (R-frame), then the board members will be more likely to set a high price than if the directors merely presented the potential outcomes of each action conditional on the actions of the other firm (O-frame).

As another example, suppose that two employees are deciding independently which project to do in situations like those described in Study 4. Our findings suggest that whether the CEO of the company describes the bonuses of the two projects in the O-frame or the R-frame may or may not influence the employees' choices of the alternative projects—it will influence the employees' choices if the situation resembles the Prisoner's Dilemma (the surplus from collaborating on the same action is split equally), and it will not affect the employees' choices if the situation resembles the Battle of the Sexes (the surplus from collaborating on the same action is split unequally).

Our findings also suggest that if the mediator in a Prisoner's Dilemma-like situation (e.g., the CEO of a company involving a PD-like inter-department conflict, or

the mediator in a PD-like international conflict) wants to encourage the players (e.g., the departments or the countries involved in the conflict) to cooperate, they should construe the interaction in the R-frame. The mediator could also combine the R-frame with other strategies to encourage cooperation, for example, to label the interaction as a Community Game or to encourage the players to consider joint benefits.

The current research highlights the importance of studying strategic interactions not just through normative game-theoretical analysis, but also from a psychological perspective. While normative game theory focuses on the behavior of rational players who are impervious to framing effects, our research joins a growing (but still relatively scant) psychological literature on strategic interactions by examining the behavior of ordinary people with bounded rationality and identifying a hitherto overlooked framing effect. We hope that our work will stimulate further psychological research to better understand how ordinary people think and behave in strategic interactions.

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