Games as frames

By AXEL OCKENFELS[a,b,*], AND UTA K. SCHIER[a,b]

We show that economic games per se *can provide contextual cues and thereby impact behavior. In two laboratory experiments, we examine whether deliberating on trust games versus stag-hunt games without feedback changes cooperation behavior in a subsequent game. First, we find that subjects who play trust games without feedback hold more pessimistic beliefs about other players' cooperation in a subsequent game than subjects who played stag-hunt games without feedback. We also observe that deliberation on trust games versus stag-hunt games accordingly affects behavior in a subsequent, unrelated game. While stag-hunt games align interests between players, trust games pose a conflict of interest between players. Such (mis-)alignments induced by the game potentially explain our findings, because they may offer cues that affect beliefs and behavior in subsequent games.*

[a] *Department of Economics, University of Cologne, Germany*
University of Cologne, Department of Economics, Albertus-Magnus-Platz, 50923 Cologne, Germany
(e-mail: ockenfels@uni-koeln.de, schier@wiso.uni-koeln.de)

[b] *Center for Social and Economic Behavior (C-SEB), University of Cologne, Germany*

* *Corresponding author (ockenfels@uni-koeln.de, +49 221 470 5761)*

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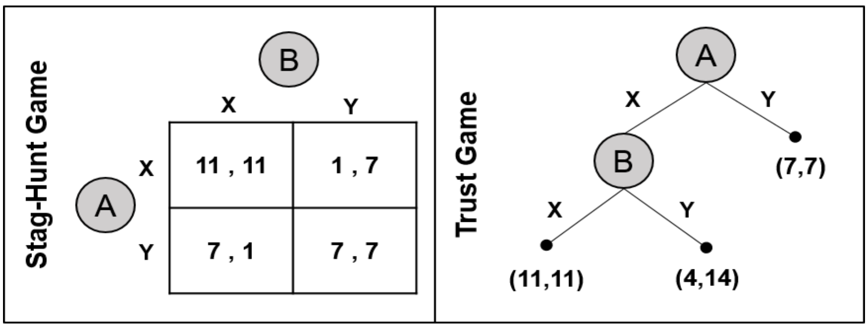
Introduction

People's choice depends on how it is presented. This is called framing effect (1, 2). One important line of research shows the importance of framing in social decision making (3-15). For instance, framing a Prisoner's Dilemma as a cooperation game, highlighting team decision making, or as a competition game, emphasizing conflicting interests amongst players, affects players' willingness to cooperate (14). In this and all other cases, the game and its strategy spaces and payoff functions remain unchanged, yet the language that the choices are presented in affects game outcomes. One reason why framing matters is that language provides contextual cues that may influence beliefs about others' behavior (16, 17).

In this paper, we take a reverse approach. While keeping the natural language constant, we show that a game with its strategies and payoffs can *per se* provide contextual cues, even when presented in neutral terms, which subsequently affect beliefs and behavior. To illustrate our point, take the trust and the stag-hunt game (as shown in Figure 1), two widely-used games in behavioral economics and, increasingly so, in psychology (e.g. refs. 18, 19). In both games, two players (A and B) each decide between two options (X and Y). In the stag-hunt game, players choose simultaneously and may coordinate either on the payoff-dominant but riskier Nash equilibrium in pure strategies (both players choose X and receive each a payoff of 11), or on the risk-dominant Nash equilibrium in pure strategies, which pays less for both players (both players choose Y and earn 7 each). In the trust game, the first-mover (A) has to decide whether

Figure 1: Example of a stag-hunt game (left) and a trust game (right).



to trust the second-mover (X) or to end the game (Y). In case of trust, the second-mover (B) decides whether to reciprocate the trust (X, in which case both earn 11), or to behave selfishly (Y, in which case B receives 14 and A receives 4). Hence, for payoff-maximizing players, the trust game only knows one Nash equilibrium, in that the first-mover ends the game (and both players receive a payoff of 7). However, in both games, behavior is typically heterogeneous, and all options are chosen with positive probability (e.g. refs. 20-22).

For our purpose, the key difference between these two games is that the stag-hunt game perfectly aligns interests between players, while the trust game creates a conflict of interest in that the first-mover has good reason to distrust the second-mover. We hypothesize that such (mis-)alignments induced by the game *per se* can serve as cues that affect the 'mindset' of players, and thus affect beliefs and behavior in subsequent choice tasks.[1] Games that pose a conflict of interest (such as the trust game, where there is reason to distrust the second-mover) induce more pessimistic beliefs and more cautious behavior than games that align interests (such as the stag-hunt game, where there is no reason to distrust the other player). Specifically, we hypothesize that trustors in trust games form more pessimistic beliefs about others' cooperation in a subsequent game than subjects playing stag-hunt games (which is our Hypothesis 1). Similarly, subjects who deliberate on others' decision to trust subsequently behave more cautiously and cooperate less than subjects who deliberated on others' stag-hunt game behavior (Hypothesis 2).

[1] This is related to a literature in cognition research that has shown that human information processing differs under a 'trust state of mind' compared to a 'distrust state of mind'. In a seminal paper, Schul, Mayo and Burnstein (ref. 23, p. 668) conclude from their research that "the cognitive system reacts to distrust by automatically inducing the consideration of incongruent associations — it seems designed to ask 'and what if the information were false?'". Further research shows that distrust increases cognitive flexibility, creativity (24, 25), and more elaborate information processing (26), and reduces stereotyping (27). To our knowledge, the only paper in economics that is related to this hypothesis (28) investigates whether betrayal aversion, typically ascribed to behavior in trust games, can also be found in stag-hunt games. For this, the authors disentangled strategic risk from natural risk in a stag-hunt game experiment, in which participants either play against a computer (natural risk) or a human (strategic risk). To their surprise, the authors found the opposite of betrayal aversion in that cooperation is higher with strategic risk, and they hypothesized (but did not provide evidence) that this might be due to different mindsets that are triggered by the different game forms. Our study's hypotheses were developed behind this background, before we ran our experiments.

Other explanations for our results are in principle conceivable. However, as we will describe below, we carefully control for potentially confounding learning and all forms of spill-over effects that rely on feedback. Also, cognitive learning and spill-over effects, which do not rely on feedback, do not easily produce the specific behavioral patterns that we observe. Indeed, unlike in most other previous studies of spill-over effects, the two phases in our experiment involve very different games and strategic reasoning. For instance, they differ in what is elicited (behavior versus beliefs), the number of Nash equilibria and the sequence of play (sequential versus simultaneous). These differences minimize the scope for simple models of spill-over of behaviors and beliefs, which have been shown to influence behavior across other decision contexts and games (29), to capture our findings.[2]

We find statistically and economically strong support for both hypotheses. We conclude that there is no such thing as a 'neutral' game description. Games with aligned vs. misaligned incentives create *per se* contextual cues that in turn affect how people approach social interaction.

Study 1: Effect on beliefs

Subjects were randomly allocated to one of four treatments, which specified the content of each of two parts. In the first part of treatments "TgTb" and "TgSb", subjects played five different trust games, whereas in the first part of treatments "SgSb" and "SgTb", subjects played five

[2] Another reason why we did not choose, say, a prisoners' dilemma game to compare with the stag hunt game, is that the trust game arguably makes the misalignment of interests more salient (which is the key for testing our hypothesis). The reason is that the payoff-maximizing first-mover action in the trust game depends critically on the second mover's response to trust. Thus, the first mover should be keenly interested in whether the second mover's interests are (mis-)aligned when making a decision and when forming beliefs. On the other hand, in the standard prisoner's dilemma game, players have a dominant strategy, and, in this sense, whether interests are aligned or not, as well as beliefs about the opponent's behavior, are irrelevant for decision making. Thus, from this perspective, the prisoner's dilemma game does not seem to be ideally suited for a study on how (mis)aligned interests affect beliefs and behavior. That said, we note that when subjects have social preferences, they will care about (mis)aligned incentives when playing a prisoners' dilemma. When subjects are conditional cooperators, for instance, there may be two equilibria, one with mutual defection and one with mutual cooperation (see, e.g., Bolton and Ockenfels 1999, for an analysis; other social preference models come to similar conclusions). But the resulting game, when taking into account social utility, looks much like the stag hunt game, which we included in our study. Looking directly at the stag hunt game, instead of studying the prisoners' dilemma, has the advantage for the experimenter and the subjects of not having to deal with the uncertainty about the nature and strength of subjects' social preferences.

different stag-hunt games. In the second part, we elicited subjects' beliefs about other subjects' behavior in a previously conducted experiment. Here and elsewhere, the subscript "g" indicates that we elicited behavior in the respective *game*, and the subscript "b" indicates that we elicited *beliefs*. In treatments "TgTb" and "SgTb", subjects predicted behavior in a trust game, whereas in treatments "SgSb" and "TgSb" subjects predicted stag-hunt game behavior.

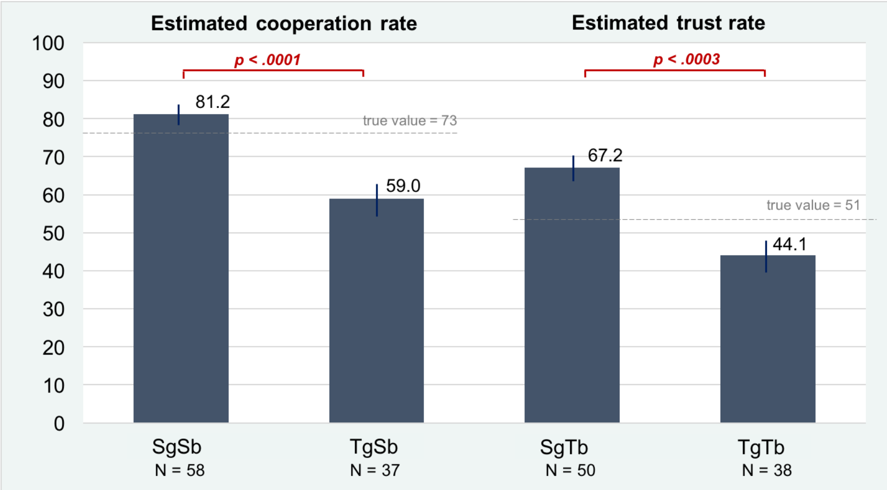
For the first part of the experiment, subjects were randomly matched in pairs and assigned either the role of player A or player B. The structure of the games in the first part was similar to the games displayed in Figure 1 but the payoffs varied (Figure B3 in Appendix B provides more details). Before each game, players were informed of the exact payoff structure and then had to choose between option X and option Y. Player B in the trust game, the second-mover, decided for the case that player A chose X. The outcome of the five games played in the first part was only revealed to subjects at the end of the experiment.

In the second part of the experiment, subjects were informed that another experiment had been conducted some months earlier in the same laboratory with different participants. Subjects had to predict how many players A in the previous experiment, which took place in April 2017 with 134 subjects, chose option X, on a scale from 0 to 100%.

Results: Study 1

All statistical tests were performed at a 5% significance level, and differences in the continuous belief measures between subjects were tested using two-sided Mann-Whitney U tests. For our analyses, we considered all observations from the treatments SgSb and SgTb, but only decisions by the first-movers (player A) from treatments TgTb and TgSb (in sum: N = 183, with 58 observations in SgSb, 50 in TgSb, 37 in SgTb, and 38 in TgTb).

Figure 2: Games-as-frames effect on beliefs: estimating others' behavior is driven by previous game experience.



Notes. Estimating others' cooperation rate (SgSb/TgSb) or trust rate (SgTb/TgTb) from 0-100%, depending on own previous game experience with stag-hunt games (SgSb/SgTb) or trust games (TgSb/TgTb). P-values are from Mann-Whitney U tests, with standard errors bars.

Our Hypothesis 1 is strongly confirmed, both with respect to effect size and statistical significance.[3] Beliefs about cooperation in the stag-hunt game (SgSb vs. TgSb) are much more optimistic when stag-hunt games were played before compared to trust games (81% vs. 59%, MWU: $p < .0001$; see Figure 2). Similarly, beliefs about trust rates in the trust game (SgTb vs. TgTb) are significantly higher when subjects previously played stag-hunt games compared to trust games (67% vs. 44%, MWU: $p < .0003$).[4]

One potential explanation for our games-as-frames effect on beliefs is learning: Subjects in the first part might learn something from being exposed to the five phase 1-games, even when no feedback is given (see ref. 31). Since learning (if any) would seem more useful when the game

[3] Here, we only focus on first movers in the trust games in part I. However, we find similar results for second-movers, in that they have more pessimistic beliefs than stag-hunt game players about cooperation in a stag-hunt game (60% vs. 81%, MWU: $p < .0002$), as well as in a trust game (55% vs. 67%, MWU: $p < .03$).
[4] OLS regressions confirm the effect. Playing stag-hunt games compared to trust games in the first part significantly increases beliefs in the second part (ß_0 = 51.5, $p < .001$, ß_1 = 23.2, $p < .001$), and the effect remains significant if we control for which game subjects estimate in the second part. The treatment effect is robust to controlling for variations in the session size, as well as average profit made in the games in the first part (not known to subjects until the experiment is over), and if we control for age, gender, prior game theory knowledge and prior experience with stag-hunt and trust games. See Table S1 in the Supplementary Material for details.

being played in both phases is the same, this might potentially cause our treatment effect.[5] However, we find no evidence that beliefs in the treatments in which subjects predict the same game as they played before (treatments SgSb and TgTb) are more accurate. Specifically, we look at how much beliefs deviate from the true value, defined by actual behavior in the pretest. For beliefs about stag-hunt game behavior, we do not find that subjects' beliefs in the treatment SgSb deviate in absolute terms less from the true value than in TgSb ($m_{SgSb} = 20$ vs. $m_{TgSb} = 24$, MWU: $p < 0.563$). Also, subjects' beliefs in TgTb do not deviate in absolute terms less from the true value than beliefs in SgTb ($m_{TgTb} = 25$ vs. $m_{SgTb} = 27$, MWU: $p < 0.625$).[6]

We conclude that the evidence is consistent with a games-as-frames-effect on beliefs, driven by the different incentive structures – aligned vs. misaligned interests – of the games *per se*.

Study 2: Effect on behavior

As in Study 1, the experiment consisted of two parts and subjects were randomly allocated to one of four treatments that we refer to as "TbTg", "TbSg", "SbSg", and "SbTg". In contrast to Study 1, we reversed the experimental design for Study 2: In the first part, subjects estimated behavior in five previously played trust games (treatments "TbTg" and "TbSg") or stag-hunt games (treatments "SbSg" and "SbTg"). In the second part, subjects now played a game themselves, which was either a trust game (treatments "TbTg" and "SbTg") or a stag-hunt game (treatments "SbSg" and "TbSg"). For the estimations in the first part, subjects estimated

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[5] In principle, there might also be spillover effects across different games. Evidence shows that proposers in repeated ultimatum games learn not only from playing the same game but also from playing other games (32). Experiencing trustworthiness in repeated trust games with a partners matching seems to spill over to trust behavior in a subsequent trust game with strangers matching (33). Similarly, trust behavior might not be driven by stable preferences but can be affected by experiencing fair und unfair treatment in a previous, unrelated game 34). Moreover, cooperation in infinitely repeated Prisoners' dilemmas can spill over to more prosocial behavior in subsequent ultimatum games, dictator games, trust games and public good games (35). Similarly, successful coordination can spill over from median-effort to minimum effort games (36). However, in all these studies, spillover effects in behavior or beliefs rely on feedback about other players' behavior, which in our case is ruled out by design. But even if feedback would have been given, the overall behavioral pattern that we find is not explained by systematic spill-over of trust(worthiness) or any other given first phase experiences.

[6] Neither is the compound difference significant ($m_{SgSb+TgTb} = 22$ vs. $m_{TgSb\_SgTb} = 26$, MWU: $p < 0.223$).

previous behavior in the five games played in Study 1. For the second part, subjects were matched in pairs and assigned the role of player A or B, and then played one of the games from Figure 1.

Results: Study 2

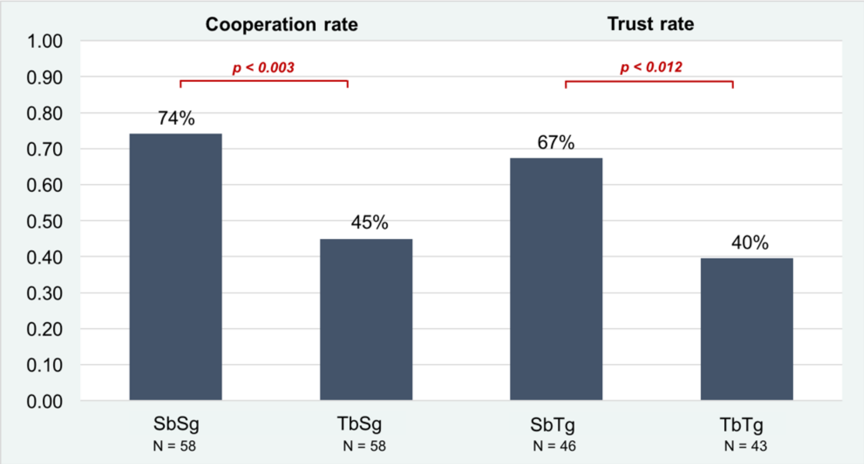
All statistical differences in behavior in the games between subjects are tested using two-sided Fisher's exact tests, as behavior is a binary measure. For our analyses, we consider all observations from the treatments SbSg and TbSg, but only decisions by first-movers (player A) in the trust game in treatments SbTg and TbTg (in total: N = 205, with 58 observations in SbSg, 58 in TbSg, 46 in SbTg, and 43 in TbTg).[7]

In line with our second hypothesis, we observe that the kind of game subjects estimate in the first part of the experiment strongly affects game behavior in the second part. As illustrated in Figure 3, subjects substantially cooperate more in the stag-hunt game, when they previously deliberated on stag-hunt games than on trust games (74% vs. 45%, FET: $p < .003$). Similarly, first-movers in the trust game trust more, when they previously estimated stag-hunt games compared to trust games (67% vs. 40%, FET: $p < .012$).[8]

Similar to Study 1, we examined whether there is a learning effect in the sense that subjects in the treatments SbSg and TbTg have an advantage over subjects in the treatments SbTg and TbSg. However, we find no evidence that the beliefs within the first part become more accurate in TbTg/SbSg compared to SbTg/TbSg from the first to the fifth game (i.e.

[7] For second-movers in the trust game, we find that second-movers behave more trustworthy when they previously deliberated on stag-hunt games than on trust games (61% vs. 37%, FET: $p < .022$).
[8] Probit regression support the results. Estimating stag-hunt games compared to trust games in the first part significantly increases cooperation in the second part (ß_0 = 0.19, $p < .137$, ß_1 = 0.75, $p < .001$). Moreover, this effect is robust to controlling for the kind of game subjects play in the second part, and to controlling for variations in session sizes, as well as for belief (in-)accuracy in the first part (ß_1= -0.55, $p < .002$), which might be interpreted as how rational subjects' expectations about others are. Lastly, we added age, gender, prior game theory knowledge and prior experience with stag-hunt and trust games as control variables, but, none of these variables significantly determine behavior, nor do they eliminate the games-as-frames effect on behavior. See Table S2 in the Supplementary Material for details.

Figure 3: Games-as-frames effect on behavior: cooperation rates by players driven by previous game experience.



Notes. Cooperation rate (SbSg/TbSg) and trust rate (SbTg/TbTg), depending on previous deliberation on stag-hunt games (SbSg/SbTg) or trust games (TbSg/TbTg). P-values are from Fisher's exact tests.

accuracy improvement from game 1 to game 5: $m_{\mathrm{SbSg/TbTg}}$ = -0.04, $m_{\mathrm{SbTg/TbSg}}$ = -0.03, MWU: p = 0.571).[9]

Furthermore, in the second part subjects do not seem to make "better" (i.e. expected value maximization) decisions in treatments SbSg/TbTg than in treatments SbTg/TbSg. For this, we analyzed whether subjects maximized their expected value if they had rational expectations about the second-movers' behavior. In the trust game treatments, 37% of second-movers in TbTg chose option X, compared to 61% of second-movers in SbTg. Hence, first-movers in TbTg with rational expectations about second-movers should prefer option Y ($EV_A(Y) = 7 > EV_A(X) = 6.6 = 0.37*11+0.63*4$), whereas first-movers in SbTg should prefer option X ($EV_A(Y) = 7 < EV_A(X) = 8.3 = 0.61*11+0.39*4$). If we look at the share of player A that actually choose the preferred option, we do not find that first-movers in TbTg make more payoff maximizing decisions than in SbTg (60.5% in TbTg vs. 67.4% in SbTg, FET: $p = .516$). Similarly, in the stag-hunt game treatments players in SbSg chose on average option X with 74% compared to 45% of players in TbSg. Thus, players in SbSg with rational expectations about their partners' behavior should prefer option X ($EV(Y) = 7 < EV(X) = 8.4 =$

[9] See Supplementary Material for more information on belief accuracy.

0.74*11+0.26*1), whereas players in TbSg should prefer option Y (*EV(Y)* = 7 > *EV(X)* = 5.5 = 0.45*11+0.55*1). However, we do not observe that players in SbSg choose the 'better' option more often than players in TbSg (74.1% in SbSg vs. 55.2% in TbSg, FET: $p < .052$). Consequently, we conclude that there is no evidence that subjects in treatments SbSg/TbTg have a learning advantage over subjects in SbTg/TbSg.

Conclusion

It is well-known that the natural language which describes a given game provides contextual cues that affect and guide people's behavior. We show that the game's strategies and payoffs *per se* also provide such cues. There is no such thing as a 'neutral' game. Games with aligned versus misaligned incentives inevitably frame the decision context in different ways, with important consequences for subsequent beliefs and behavior. The different games offer different cues which evoke different information processing modes in terms of a trust or distrust mindset, as suggested by cognition research (23). Second-movers in our trust game have more pessimistic beliefs about others after deliberating on misaligned interests of trust games (Study 1). Moreover, they behave less trustworthily (Study 2) even though they do not face any strategic uncertainty. This suggests that trust and distrust mindsets do not only affect beliefs about others' behavior but also preferences. That is, games are *per se* inherently intertwined with belief and preference formation.

The systematic and non-trivial pattern of behavior and beliefs in the second phase in response to being exposed to the respective first phase is well-organized by our hypotheses, which in turn are based on recently established findings in social cognition but cannot be easily captured by spill-over mechanisms that have been observed before. That said, we cannot exclude the possibility that there are other, probably additional cognitive mechanisms at work; it would thus be useful to test our hypotheses also with more direct measures for the underlying mechanisms and of the associated mindsets. We leave this to future research.

Methods

Study 1: 258 university students were recruited via ORSEE (37) and invited to an experiment at the Cologne Laboratory for Economic Research in May 2017, programmed with zTree (38). By accepting to participate in our experiments the subjects, who sign up voluntarily, agree to the norms and rules of an experiment within our laboratory. Students came from various disciplines, with a mean age of 23 (*sd* = 2.89) and 57% being female. They earned on average 13.16 EUR for 40 minutes of participation (including a 4.00 EUR show-up fee). For the estimations in second part of the experiment, subjects were informed that another experiment had been conducted some months earlier in the same laboratory with different participants. We told subjects that participants from a previous experiment were randomly matched in pairs and assigned a role of player A or B, and then played the game illustrated in Figure 1. Estimations of subjects were incentivized by a quadratic scoring rule (39, 40), so that subjects could earn an amount between 0.20€ and 1.00€ depending on the accuracy of their estimation.[10] At the end of the experiment, subjects answered a short questionnaire about their demographic background, before we revealed the outcome of the five games played in the first part and the accuracy of their estimation in the second part. For subjects' final payoff, one of the five games from the first part was randomly selected and paid out, in addition to earnings from the second part.

Study 2: We recruited 294 university students via ORSEE (37) for an experiment at the Cologne Laboratory for Economic Research in September 2017, programmed with zTree (38). By accepting to participate in our experiments the subjects, who sign up voluntarily, agree to the norms and rules of an experiment within our laboratory. Students were on average 24 years old (*sd* = 4.11) and 64% were female. They earned on average 13.02 EUR for 40 minutes of

[10] Subjects were incentivized according to the following rule: $\pi = 1 - 0.8 * (estimation - actual\ behavior)^2$.

participation, including a 4.00 EUR show-up fee.[11] In Study 2, subjects first made five estimations about behavior in previous experiments, and then played a trust or stag-hunt game themselves. For the estimations in the first part, subjects were given instructions analogue to Study 1. For the second part, subjects played one of the games displayed in Figure 1. Finally, subjects answered a short questionnaire on demographics, and then received information about the accuracy of their five estimations in the first part, the outcome of the game in the second part, and their final payoffs. For subjects' payoffs, one of the five estimations from the first part was randomly selected and paid out, as well as the game from the second part.

Data availability:

Additional information may be found in the Online Appendix for this article on the publisher's website. This includes the complete data set in .dta format, all statistical analyses in a do-file format, and the code for conducting the experiment using the experimental software z-tree.

Author contributions:

AO and US developed the research idea and designed the study; US conducted the experiment and analyzed the data; AO and US wrote the manuscript.

[11] Due to an error in the calculations of profits, 26% of subjects (76 out of 294) were paid 10-30 cents too much or too little. However, this does not affect our data, as payoffs were revealed only at the end of the experiment.

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Supplementary Material

Table S1: Determinants of beliefs about others' behavior in previous experiments (Study 1).

Dependent = beliefs about previous cooperation rate	**(1)**	**(2)**	**(3)**	**(4)**
Trust mindset (playing SHGs)	23.2***	22.6***	23.4***	26.0***
	(4.00)	(3.86)	(4.46)	(4.45)
Estimating previous SHG		14.4***	14.7***	13.3***
		(3.80)	(3.91)	(3.87)
Session size			-0.2	-0.2
			(0.38)	(0.38)
Mean profit from games			0.0	0.1
			(0.90)	(0.89)
Game theory knowledge				-12.2**
				(4.27)
Prior participation in similar studies				3.3
				(4.38)
Female				-1.7
				(3.93)
Age				1.2
				(0.66)
Constant	51.5***	44.4***	47.7***	22.4
	(3.07)	(3.51)	(8.14)	(18.46)
Observations	183	183	183	183
R-squared	0.16	0.22	0.22	0.27

Notes. Results from OLS regressions with standard errors in parentheses. Trust mindset = dummy variable for playing stag-hunt games in the first part (baseline: trust game); Estimating previous SHG = dummy variable for estimating behavior of previous stag-hunt game players in second part (baseline = of trust game players); Mean profit = average profit from playing games in the first part (revealed to subjects after belief elicitation); Game theory knowledge = dummy variable with no previous knowledge of game theory as baseline; Prior participation = dummy variable with no prior experience in playing stag-hunt or trust games as baseline; Female = dummy variable with male as baseline; Age = continuous self-reported variable. P-values: *** ≤ .001, ** ≤.01, * ≤.05.

Table S2: Determinants of cooperation behavior (Study 2).

Dependent = cooperation in stag-hunt or trust game	**(1)**	**(2)**	**(3)**	**(4)**
Trust mindset (estimating SHGs)	0.75*** (0.18)	0.75*** (0.18)	0.64*** (0.19)	0.61*** (0.19)
Playing a subsequent SHG		0.17 (0.18)	0.30 (0.23)	0.40 (0.23)
Session size			-0.01 (0.38)	-0.01 (0.38)
Belief inaccuracy			-0.55*** (0.16)	-0.57*** (0.17)
Game theory knowledge				-0.47* (0.21)
Prior participation in similar studies				-0.15 (0.20)
Female				0.11 (0.20)
Age				-0.01 (0.02)
Constant	-0.19 (0.13)	-0.28 (0.16)	0.62 (0.19)	1.03 (0.83)
Observations	205	205	205	205
Pseudo R-squared	0.06	0.06	0.11	0.13

Notes. Results from Probit regressions with standard errors in parentheses. Trust mindset = dummy variable for estimating others' behavior in previous stag-hunt games in the first part (baseline: previous trust games); Playing a subsequent SHG = dummy variable for playing a stag-hunt game in the second part (baseline = a trust game); Session size = controlling for number of players in each session; Belief inaccuracy = sum of belief deviations in first part; Game theory knowledge = dummy variable with no previous knowledge of game theory as baseline; Prior participation = dummy variable with no prior experience in playing stag-hunt or trust games as baseline; Female = dummy variable with male as baseline; Age = continuous self-reported variable. P-values: *** ≤ .001, ** ≤.01, * ≤.05.

Study 2: Analysis of belief inaccuracy in the first part

Subjects in Study 2 estimated previous stag-hunt game behavior more accurately than previous trust game behavior ($\text{average\_inaccuracy}_{SbSg/SbTg}$ = 21, $\text{average\_inaccuracy}_{TbTg/TbSg}$ = 27, MWU: $p < .0001$). When we regress behavior in the second part on the inaccuracies of beliefs in the first part, a Probit regression suggests that less accurate beliefs decrease cooperation in the second part (β_0= 0.99, $p < .001$, β_1 = -0.67, $p < .001$). Thus, it seems that the better subjects are in estimating other players' behavior in previous games, the more cooperative they behave afterwards in a stag-hunt or trust game. Moreover, the accuracy of beliefs significantly interacts with our games-as-frames effect, in the sense that less accurate beliefs in the first part seem to decrease the games-as-frames effect (β_0= -0.31, $p < .389$, β_{belief_inacc} = 0.09, $p < .718$, $\beta_{estimatingSHGs}$ = 2.09, $p < .001$, $\beta_{interaction\_effect}$ = -1.22, $p < .002$).

Appendix A1. Experimental Instructions for Study 1

GENERAL INSTRUCTIONS

Welcome to the experiment!

Please read the following instructions carefully and from now on, please do not communicate with other participants. If you have any questions during the experiment, please raise your hand and we will come to you and answer your questions.

In this experiment, you can earn money. How much you can earn, depends on your decisions and the decisions of other participants. Regardless of this, you will receive 4 EUR for showing-up to the experiment. At the end of the experiments, all earnings from the experiment will be added, and paid out to you in EUR.

Your decisions during the experiment are anonymous. In addition, your earnings will be kept in confidence.

During the experiment, we ask you to turn off your cell phone and to store it out of reach. All documents not related to the experiment (lecture notes, books, etc.) must not be used. Breach of the rules can lead to exclusion from the experiment and all payments.

On the next page, you are given instructions on the experimental procedure. The experiment starts, as soon as all participants have read and understood the instructions.

INSTRUCTIONS ON THE EXPERIMENTAL PROCEDURE

In this experiment, there are two types of participants: player A and player B. At the beginning, it will be determined randomly whether you are player A or player B and you will be informed about this.

Every player A will be randomly assigned a player B. Both players, each have to choose between two options, X or Y. [*added for treatments TgTb/TgSb:* First, player A decides. Then, player B decides, without knowing player A's decision.]

For each pair of players, payoffs depend on which options both players choose.

For example:

Payoff table *[for treatments SgSb/SgTb]*	
If both player choose option X:	Both players get …€
If player A chooses option X, and player B chooses option Y:	A gets …€ and B gets …€
If player A chooses option Y, and player B chooses option X:	A gets …€ and B gets …€
If both player choose option Y:	Both players get …€

Payoff table *[for treatments TgTb/TgSb]*	
If player A chooses option Y (independent of player B's choice):	Both players get …€
If both player choose option X:	Both players get …€
If player A chooses option X, and player B chooses option Y:	A gets …€ and B gets …€

The exact amounts paid […€] vary per round. In total, there are five rounds.
At the beginning of each round, you will see a payoff table, as the one displayed above, that will inform you about the exact amounts paid. After that, you have to decide whether you want to choose option X or option Y.

The decisions from your partner will only be revealed to you at the end of the experiment. This means between rounds, you do not receive any information about your payoff from the previous round.

For your earnings, one round will be randomly selected at the end of the experiment.

At the end of the experiment, you will receive another question. You will see a similar payoff table to the one above and have to estimate how players from a previous experiment behaved in this game. This experiment was conducted last month in this laboratory with different participants.

For your estimation you have to choose an integer between 0 and 100%. Your payoff for your estimation depends on how accurate your estimation was:

$$Your\ Payoff = 1 - 0{,}8 * Deviation^2$$

The deviation is the difference between your estimation and the actual behavior of players from the previous experiment:

$$Deviation = |Your\ Estimation - Actual\ Behavior|$$

This means that the better you estimate the behavior of the previous players, the higher your payoff will be. Your payoff will be between 0.20€ and 1.00€.

Finally, we ask you to fill out a short questionnaire. After that you will learn about the results of the five games, as well as about how accurate your estimation was. At the end, you will receive an overview of your total earnings from the experiment.

If you have any questions about the instructions, please raise your hand and we will come to you.

Appendix A2. Experimental Instructions for Study 2

GENERAL INSTRUCTIONS

Welcome to the experiment!

Please read the following instructions carefully and from now on, please do not communicate with other participants. If you have any questions during the experiment, please raise your hand and we will come to you and answer your questions.

In this experiment, you can earn money. How much you can earn, depends on your decisions and the decisions of other participants. Regardless of this, you will receive 4 EUR for showing-up to the experiment. At the end of the experiments, all earnings from the experiment will be added, and paid out to you in EUR.

Your decisions during the experiment are anonymous. In addition, your earnings will be kept in confidence.

During the experiment, we ask you to turn off your cell phone and to store it out of reach. All documents not related to the experiment (lecture notes, books, etc.) must not be used. Breach of the rules can lead to exclusion from the experiment and all payments.

On the next page, you are given instructions on the experimental procedure. The experiment starts, as soon as all participants have read and understood the instructions.

INSTRUCTIONS ON THE EXPERIMENTAL PROCEDURE

This experiment consists of two parts.

<u>In the first part</u>, you are asked to make estimations about how players behaved in five previous experiments. These experiments were conducted last month in this laboratory with different participants.

In each experiment, there were two types of participants: player A and player B. Types were randomly determined and participants were informed about their type at the beginning of the experiment. Every player A was randomly assigned a player B. Both players, each had to choose between two options, X or Y. [*added for treatments TbTg/TbSg:* First, player A decided. Then, player B decided, without knowing player A's decision.]

For each pair of players, payoffs depended on which options both players chose:

For example:

Payoff table *[for treatments SbSg/SbTg]*	
If both player choose option X:	Both players get …€
If player A chooses option X, and player B chooses option Y:	A gets …€ and B gets …€
If player A chooses option Y, and player B chooses option X:	A gets …€ and B gets …€
If both player choose option Y:	Both players get …€

Payoff table *[for treatments TbTg/TbSg]*	
If player A chooses option Y (independent of player B's choice):	Both players get …€
If both player choose option X:	Both players get …€
If player A chooses option X, and player B chooses option Y:	A gets …€ and B gets …€

Your task is to estimate how player A in five of these previous experiments behaved. The exact amounts paid […€] varied between the five experiments. Before each estimation, you will see a payoff table that will inform you about the exact amounts paid.

For each estimation, you have to choose an integer between 0 and 100%. Your payoff for an estimation depends on how accurate your estimation was:

$$Your\ Payoff = 1 - 0{,}8 * Deviation^2$$

The deviation is the difference between your estimation and the actual behavior of players from the previous experiment:

$$Deviation = |Your\ Estimation - Actual\ Behavior|$$

This means that the better you estimate the behavior of the previous players, the higher your payoff will be. Your payoff can be between 0.20€ and 1.00€.

For your earnings, one of the five estimations will be randomly selected at the end of the experiment.

In the second part of the experiment, you will play a game yourself. Again, there will be player A and player B. You will be informed about your type at the beginning of the second part. Types are randomly determined, and each player A is randomly assigned a player B. Both, player A and B, have to choose between two options, X and Y. For each pair of players, payoffs depend on which options both players choose. For this, you will see a payoff table, similar to the one illustrated above that will inform you about the exact payoffs for the second part.

Finally, we ask you to fill out a short questionnaire. After that you will learn about the results of the game in the second part, as well as about how accurate your estimations in the first part were. At the end, you will receive an overview of your total earnings from the experiment.

If you have any questions about the instructions, please raise your hand and we will come to you.

Appendix B. Experimental Screens

Figure B1: Exemplary screens for the first part of Study 1 (left: treatments SgSb and SgTb, right: treatments TgTb and TgSb).

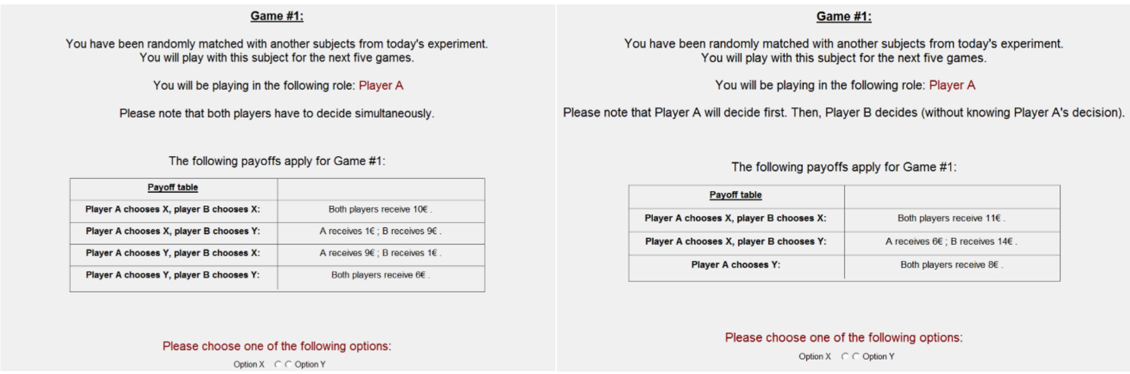
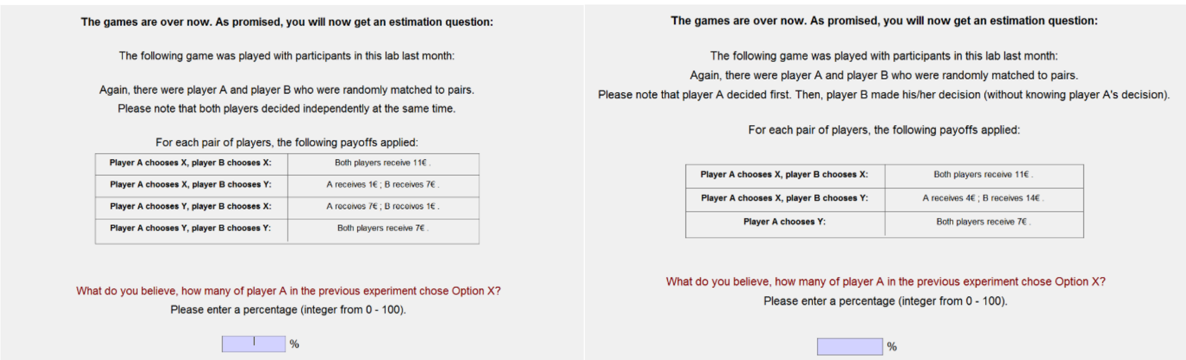


Figure B2: Exemplary screens for the second part of Study 1 (left: treatments SgSb and TgSb, right: treatments TgTb and SgTb).



For Study 2, the zTree-screens looked similar, but the order of the two parts was reversed. In the first part, subjects estimated behavior from the five games played in part I of Study 1. In the second part, subjects made a choice for the games displayed in Figure 1.

Figure B3: Exact payoffs for the games played in the first part of Study 1 and estimated in the first part of Study 2.