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The Disjunction Effect and Reason-Based Choice in Games

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This paper reports an experiment that extends previous findings of the disjunction effect, sometimes described as a violation of Savage's sure-thing principle. Evidence of the disjunction effect is observed using elicited beliefs about others' actions (rather than controlled beliefs) in a prisoners' dilemma studied by Shafir and Tversky (1992) as well as in an asymmetric version of it and in a nondilemma game with a unique equilibrium. Debiasing techniques as well as implications for these extensions are discussed. © 1999 Academic Press

One aspect which makes decision making difficult is evaluating uncertainty about possible outcomes. For example, we can be uncertain about the future state of the economy, about how property values in our neighborhood will move, or about whether our main competitor will start a price war. When we make decisions in these circumstances, we typically consider the possible outcomes under each realization of the uncertainty. Thus the economy could be strong or weak, property values could go up or down, our main competitor could cut prices or raise them.

There are some specific decisions in which a particular action is better *no matter how* the uncertainty is resolved. For example,

> A businessman contemplates buying a certain piece of property. He considers the outcome of the next presidential election relevant to the attractiveness of the purchase. So, to clarify the matter for himself, he asks whether he would buy if he knew that the Republican candidate were going to win, and decides that he would do so. Similarly, he considers whether he would buy if he knew that the Democratic candidate were going to win, and again finds that he

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would do so. Seeing that he would buy in either event, he decides that he should buy, even though he does not know which event obtains. (Savage, 1954, p. 21)

Savage describes the process governing the decision in this passage as the *sure-thing principle*. This principle states that if a person prefers a to b knowing that X obtains and also prefers a to b knowing that X does not obtain, then the person prefers a to b without knowing the outcome of X (p. 22). This reasoning applies equally when X is *exogenous* risk, uncertainty about the state of nature (as in this example), or when X is *strategic* risk, uncertainty about the choice of a strategic opponent (as in the competitor and price cuts example above).

The sure-thing principle is one of the most accepted principles of choice. It relies on *consequential* reasoning; in considering the action to take, one considers the consequences that action generates. These consequences can include economic outcomes (such as payoffs in a game) as well as psychological outcomes (such as regret or disappointment).[1] A recent set of papers, however, suggests that individuals do not typically follow the sure-thing principle in their own decision making (Shafir, 1994; Shafir & Tversky, 1992; Tversky & Shafir, 1992).

For example, Tversky and Shafir (1992) show that significantly more students report they would purchase a nonrefundable Hawaiian vacation if they were to know that they have passed or failed an important exam than report they would purchase if they were not to know the outcome of the exam. Shafir and Tversky call this anomaly in behavior the *disjunction effect* and claim it is caused by the decision process of *reason-based choice*. Participants, instead of considering the consequences of their of their decisions, focus on the *reason* to choose one thing versus another. For example, if the test were passed there would be a good reason to go to Hawaii (to celebrate). If the test were failed, there would also be a good reason to go to Hawaii (to console oneself). However, before knowing the outcome of the test, there is no one reason to go to Hawaii; thus participants choose not to go. This dependence on reasons for choice leads to a violation of the sure-thing principle. A more general discussion of reason-based choice and its applications to different settings can be found in Shafir, Simonson, and Tversky (1993).

This result is related to the tendency of decision-makers to search for and purchase information which does not affect their decisions; in effect they are searching for reasons. For example, when participants did not know the outcome of their exam, a significant number of them were willing to pay to discover it before making their decision about the Hawaiian vacation, even though they would make the same decision regardless. Baron, Beattie, and Hershey (1988) demonstrate this tendency in a hypothetical medical setting where participants choose to order diagnostic tests which would not change their choice of treatment, a claim often levied against the medical profession. Bastardi and Shafir (1998) provide a number of examples of this type of search in different settings.

[1] Recent theoretical work axiomitizing the notion of consequentialism can be found in Hammond (1988), McClennen (1990) (especially chaps. 7 and 8), and Cubitt (1996).

Supraoptimal investment in information stems from the inability to recognize that one's action will be the same regardless of the realization of the uncertainty or the outcome of additional information.

Reason-based choice and its resulting anomalous behavior of the disjunction effect can also be observed in strategic situations, in games with dominant strategies. A dominant strategy is an action which yields the best outcome regardless of what the other players in the game do. Reason-based choice suggests that players who have different reasons for playing their dominant strategy will recognize it once the other player has moved and the strategic uncertainty has been resolved, but not beforehand. This nonrecognition will cause them to remain undecided at the initial node of the decision tree.

Shafir and Tversky (1992) test for this implication of reason-based choice in a strategic setting by having participants play three versions of a prisoners' dilemma described in detail below.[2] Their results suggest that participants exhibit significantly more dominated strategy play (i.e., cooperation) when they do not know what their counterpart has done in the game than both when they know their counterpart has defected and when they know their counterpart has cooperated.

The study reported in this paper extends this result of the disjunction effect under strategic uncertainty. First, the manipulation used to demonstrate the effect is weakened from telling a participant what his or her counterpart *has done* in a prisoners' dilemma game to eliciting the participant's belief about what his or her counterpart *will do*. A similar result was found even with this weakened manipulation; participants asked to estimate what their counterparts will do in a prisoners' dilemma game cooperated significantly less than participants who were not so asked. A similar result is found in an asymmetric prisoners' dilemma.

The second extension covered in this paper is to games other than the prisoners' dilemma which also possess dominant strategies. The disjunction effect was also observed in two games solved via iterated dominance. In these games, one player has a dominated strategy while the other does not. When participants guessed what their counterparts would do, they were significantly more likely to both play their own dominant strategy and to play the best response to their counterparts' dominant strategy.

An alternative decision process which could cause the disjunction effect, complexity reduction, is examined in the third extension. A new game involving the same number of choices as the previous games and a similar dominant strategy structure, but without the conflicting reasons for choosing one option rather than another, is played. As predicted by reason-based choice (but not by the complexity hypothesis), the disjunction effect is not observed in this game. Results from this game thus support the claim that reason-based choice is the cause of the disjunction effect, rather than some other cause like complexity.

[2] In the prisoners' dilemma both players have a dominant strategy, and yet a variety of outcomes is recorded in experimental settings. For an extensive discussion see Rapoport and Chammah (1965) and Sally (1995).

PREVIOUS RESULTS

Shafir and Tversky first demonstrated the disjunction effect in a series of papers. The first of these, Tversky and Shafir (1992), used a between- and within-subject questionnaire design to illuminate the effect. The second, Shafir and Tversky (1992), used a within-subject experimental design of the prisoners' dilemma game.

In the first study, students reported their preferences about buying a nonrefundable Hawaiian vacation after a tough examination. One third of 200 participants were told one of the following: (1) they had passed the exam, (2) they had failed the exam, or (3) they did not know if they had passed or failed.

Fifty-four percent of participants in the "pass" group and 57% of participants in the "fail" group purchased the vacation. However, only 32% of participants in the "don't know" group purchased the vacation. Participants who knew they had passed the exam were more likely to buy the vacation than not, participants who knew they had failed the exam were more likely to buy the vacation than not, but participants who did not know the outcome of the exam were less likely to buy the vacation than not. Consequential reasoning suggests that the last proportion should fall between the first two.

In these papers the authors suggested that the source of the anomaly lay in the search for reasons for action. If students had passed their exam, their reason for going to Hawaii would be to celebrate. If students had failed their exam, their reason for going to Hawaii would be to console themselves. Although the action would be the same, since the *reasons* were different in the two situations, no action could be taken before the exam outcome was known.

Tversky and Shafir found a similar result in a within-subjects questionnaire on the outcome of multiple gambles. Students were told that they had played a gamble in which there was a 50–50 chance of winning $200 or losing $100. They were asked whether they would want to play this gamble again, assuming they had won the first time; 69% answered affirmatively. A week later the same participants were asked if they would want to play this gamble again, assuming they had lost the first time; 59% answered affirmatively. Ten days later the same participants were asked if they would want to play this gamble again, given that the coin used in the first gamble had been tossed but they did not yet know the outcome. Only 36% answered affirmatively in this condition. Thus participants exhibited the disjunction effect pattern; a majority of them preferred to take the second gamble both when the first was won and when the first was lost, but did not prefer it when they did not know the outcome of the first. At the individual level, the pattern "accept after a win, accept after a loss, but reject when uncertain" was the most frequent response, exhibited by 27% of the participants. This gamble questionnaire was replicated between participants as well, with similar outcomes.

Again, the rationale suggested for this behavior is a difference in reasons for the same decision. If the first gamble is won, the second gamble is preferred because the participants are playing with "house money" or are richer and willing to take more risks. If the first gamble is lost, the second gamble is preferred in order to make up the losses or to break even. Although the choice is the same, the reasons for the choice are different; thus before knowing the outcome of the first gamble, the second gamble is not preferred.

All of these results, however, rely on *exogenous* uncertainty; all were games against nature (or against a nonstrategic exam grader). In their second experimental study, Shafir and Tversky (1992) extended the domain of reason-based choice to *strategic* uncertainty, the uncertain effect of another person's strategic decision.

Participants were told they would play a two-person prisoners' dilemma against another participant. Shafir and Tversky predicted (in analogy with their previous paper) that in this game, reason-based choice would produce defection when the other player's move was known, but cooperation when the other player's move was unknown. As in the examples above, there is a reason to defect when your counterpart has defected (retribution) and a different reason to defect when your counterpart has cooperated (profit maximization). But because these two reasons are different, they predicted cooperative play before the strategic uncertainty is resolved.

In a within-subjects design, 80 participants were presented with a series of 40 games, some of which were prisoners' dilemmas. In fact, contrary to what they had been told, participants played against a preprogrammed strategy. All participants were told that they had been randomly assigned to a bonus group, which meant that they would occasionally be given information about the other player's already-chosen move before they had to choose their own. Throughout the experiment, each participant saw three versions of each prisoners' dilemma: one each in which the other player's move was unknown, in which the other player had cooperated, and in which the other player had defected.

When informed that the other player had defected, participants cooperated 3% of the time. When informed that the other player had cooperated, participants cooperated 16% of the time. However, when not informed of the other player's action, participants cooperated 37% of the time. Thus the outcome consistent with the reason-based choice hypothesis was observed.[3]

The study reported in this paper extends these last results of reason-based choice under strategic uncertainty. In a between-subjects design, the manipulation was weakened by eliciting participants' beliefs about what their counterpart in the game would play, rather than controlling these beliefs. The results from previous literature in the prisoners' dilemma and asymmetric prisoners' dilemma game are replicated. The study also extends the domain of the disjunction effect to a non-prisoners'-dilemma game with the same results. Finally, the last game tests and rejects a competing explanation of the disjunction effect, complexity, by constructing a game without conflicting reasons in which

[3] Shafir and Tversky also run an experimental version of Newcomb's problem, suggesting that the reasoning of participants taking only one box is nonconsequential. See Nozick (1969) and Campbell and Sowden (1985) for discussions of Newcomb's problem.

the disjunction effect disappears. The experimental design and predictions of reason-based choice about the outcomes in each game are discussed in the next section.

METHODS

Experimental Design

Two aspects of this experiment's design distinguish it from the Shafir and Tversky experiment. First, participant's beliefs about other player's moves are elicited rather than controlled. Thus instead of telling a participant that his or her counterpart has defected or cooperated (as in Shafir and Tversky), participants are simply asked to report their best guess of what their counterpart will do in the upcoming game.[4] As dictated by this manipulation, the experimental design is a between-subject rather than a within-subject one. Some participants are asked for their guesses and then asked to make their decision; other participants are simply asked for their decisions. What does reason-based choice predict will happen in this case?

Previous research suggests that when a participant knows the outcome of the strategic uncertainty in a prisoners' dilemma (his or her counterpart's move), the participant chooses the dominant move of defection. I suggest that the action of stating one's best belief of the outcome of the uncertainty shares important similarities with knowing the outcome. Thus reason-based choice predicts fewer dominated (cooperation) strategies played in the treatment in which beliefs are elicited than in the treatment in which beliefs are not elicited. When this difference between treatments is present and significant, the disjunction effect exists.

The extension of reason-based choice to this manipulation is an important one. In previous work, the disjunction effect has been compared to the errors exhibited in Wason's task, or to quasimagical thinking (Shafir & Tversky, 1992, p. 463). The manipulation of the disjunction effect in this manner suggests that a simple intervention (like asking people to think about their beliefs before making a decision) is sufficient to reduce the magnitude of the error.

The second extension in this experimental design is the investigation of games other than the prisoners' dilemma with dominant strategies. Consistent with the decision processes of reason-based choice, the disjunction effect is again seen in these games.

Finally an alternative explanation for the disjunction effect, complexity, is tested. The next sections present the results from a game with the same number of moves and choices as the previous games, but in which the *reason* for choosing

[4] This manipulation is similar to one reported by Shafir and Tversky (1992) in which participants in the gamble experiment were asked three questions in rapid succession: what they would do if they had won the first gamble, what they would do if they had lost the first gamble, and what they would do if they did not know the outcome of the first gamble. Only 6% of participants exhibited the disjunction effect in this setting.

the dominant move does not differ based on what the other player chooses. If the disjunction effect is caused by a reduction in the complexity of the decision, a similar difference between treatments should be observed. If instead it is cause by the logic of reason-based choice, there should be no difference between the treatments. Indeed, this no-difference result is observed.

Participants

Eighty participants from the University of Pittsburgh were recruited via posters and phone calls to participate in this experiment. Participants were equally and randomly divided between two treatments. In each, participants entered the room and were randomly assigned to a role. Instructions were displayed on a computer terminal, and a short quiz was administered to ensure participants understood the payoffs in the experiment. Only after each participant had successfully completed the quiz did the experiment begin.

Procedure

In each treatment, participants were randomly assigned an ID number and to the role of "row player" or "column player." Each session involved 10 row and 10 column players. Participants played one game against each of 10 different counterparts; at the top of each game screen participants were informed of the ID number of their respective counterparts. Participants never met the same counterpart twice. At the end of each game, participants were reminded of their move and informed of their counterpart's move; their earnings in that game were then added to their cumulative earnings.

In the first treatment, *no guessing*, participants played 10 games, were paid their earnings in the games, and were dismissed. In the second treatment, *guessing*, participants played the same games but prior to each game were asked for their best guess of what their counterpart in the game would do. The addition of the guessing stage, its accompanying instructions, and the recording of the guesses were the only differences between the treatments.

Experimental sessions lasted less than 1 h. Participants earned a show-up fee of $3 and an average of $10.02 for their play in the session (each point in the game was worth 2 cents to the participants). Earnings were paid in cash at the end of the experiment and served as incentives during the session. Participants were asked not to discuss the experiment with other participants and not to reveal their ID number to anyone, even after the experiment had ended.

As in Shafir and Tversky, the games of interest were interspersed with other games. The games were played in the same order in all treatments. Of the 10 games played, 5 were of interest to this experiment: 2 were dilemmas, 2 were games of iterated dominance, and 1 tested the alternative explanation of complexity. Each game is analyzed separately below.

RESULTS

Results of the first game in the experiment, a replication of one of the prisoners' dilemmas from the Shafir and Tversky study, suggest that previous results are robust to the belief-elicitation methodology of this study. That is, the difference between informed (elicited) and uninformed (not elicited) participants is preserved. An asymmetric version of the prisoners' dilemma demonstrates that symmetry of payoffs is not necessary for the difference to be observed. Further, evidence of the disjunction effect in two games of iterated dominance extends its domain past the realm of the social dilemma to other games with dominant strategies. Finally, an alternative explanation for the disjunction effect, complexity, is examined. Results from an equally complex game without varying reasons to choose the dominant strategy fail to show the disjunction effect, allowing us to reject this alternative explanation.

Shafir and Tversky's Prisoners' Dilemma

One of the prisoners' dilemmas used in the Shafir and Tversky study was run as the first game in the experiment (see Table 1). This game provides a direct test of the robustness of the disjunction effect to the new elicitation mechanism and experimental design. The null hypothesis is significantly more cooperation in the no-guessing treatment than in the guessing treatment. In order to avoid demand effects in the experiment, moves were not labeled Cooperate/Defect. Instead, columns were labeled with Arabic numerals and rows were labeled with letters of the alphabet. For ease of presentation and discussion, I have changed these labels to the more conventional ones where appropriate.

A significant difference between the two treatments was observed in this game with elicited rather than controlled beliefs. As payoffs are symmetric and there were no significant differences between choices by row and by column players, the data are pooled over 40 participants in each treatment.

The rate of cooperation in the no-guessing treatment is 77.5% (a very cooperative group compared with Shafir and Tversky's cooperation rate of 37% when the participant was not informed of the counterpart's move). The rate of cooperation in the guessing treatment, however, dropped significantly to 55%.[5] A one-tailed t test of proportions shows this difference to be significant at the 5% level.[6]

It is also interesting to look at the relationship in the guessing treatment between participant's guesses and their actions. As in other social dilemma

[5] In the no-guessing treatment 13 row players and 18 column players chose cooperation. In the guessing treatment 12 row players and 10 column players chose cooperation.

[6] The t test of proportions tests for the statistical differences in the underlying likelihood of a discrete process in two samples. If the proportions of success in the sample is p_i and the number of observations n_i, then

$$t = \frac{p_1 - p_2}{\sqrt{\frac{p_1(1-p_1)}{n_1} + \frac{p_2(1-p_2)}{n_2}}}.$$

TABLE 1

Shafir and Tversky's Prisoners' Dilemma

	Cooperate	Defect
Cooperate	75,75	25,85
Defect	85,25	30,30

experiments, participants in this game reciprocated their counterpart's expected action (see, for example, Dawes, McTavish, & Shacklee, 1977). When participants guessed their counterpart would cooperate, 83% of them cooperated themselves. When participants guessed their counterpart would defect, only 32% of them cooperated; this difference is significant at the 1% level. The contingency correlation coefficient between guesses and actions is .461, significantly different from zero at the 1% level.[7]

Although participants were more cooperative in this setting than in the Shafir and Tversky experiment, the disjunction effect as seen in the difference between treatments appears robust to the elicitation manipulation. Significantly fewer participants play the dominated strategy of cooperation when asked to guess what their counterpart would do than when not asked to guess.

Asymmetric Prisoners' Dilemma

Until this study, the disjunction effect in games had been investigated only in symmetric prisoners' dilemma games. It would be natural, however, to wonder whether the symmetry of payoffs affects the underlying reasoning process.

To examine this factor, an asymmetric version of the previous game was tested (see Table 2). Ten points were added to all of the column player's payoffs and subtracted from the row player's payoffs. This transformation does not change the structure of the game, the dominant strategies, or the equilibrium.

There were no significant differences between decisions of row and column players in this game; thus the data is pooled over 40 participants in each treatment. Utility theory suggests that choices between row and column players should not differ, as payoffs are simply an affine transformation. Indeed, empirically they do not. The disjunction effect was evidenced in this game, although

TABLE 2

Asymmetric Prisoners' Dilemma

	Cooperate	Defect
Cooperate	85,65	35,75
Defect	95,15	40,20

[7] For a description of the contingency correlation coefficient, see Seigel (1956, pp. 196–202).

TABLE 3A

Iterated Dominance 1

	1	2
A	85,75	25,90
B	50,25	60,40

TABLE 3B

Iterated Dominance 2

	1	2
A	75,85	25,50
B	90,25	40,60

cooperation rates are slightly lower than in the first game. In the no-guessing treatment the rate of cooperative play was 62.5%, while in the guessing treatment it was 42.5%.[8] Using the same test as above, this difference is significant at the 5% level.

Evidence of the link between beliefs and choices is somewhat weaker in this asymmetric version of the prisoners' dilemma. Of the participants who claimed they expected their counterpart to cooperate, 53% of them cooperated themselves; of those who claimed they expected their counterpart to defect, 35% cooperated, a difference significant only at the 10% level. The contingency correlation coefficient between guesses and choices is .295, which is significantly different than zero at the 10% level. This weaker evidence suggests that the perceived similarity between the players was indeed broken in this asymmetric game.[9]

However, the disjunction effect appears to be robust to this breakage in games with dilemma structures. The next set of games tests for the disjunction effect in games with dominant strategies but without the dilemma structure.

Games of Iterated Dominance

Reason-based choice suggests that participants cooperate less in the prisoners' dilemma when informed of (or asked to guess) their counterpart's decision because they are better able to come up with reasons to justify their decision. This logic is tested in two games of iterated dominance (see Tables 3A and 3B). Games of iterated dominance do not initially possess dominant strategies for both players. For a theoretical treatment of such games, see Fudenberg and Tirole (1991).

[8] In the no-guessing treatment 13 row players and 14 column players chose to cooperate. In the guessing treatment 8 row players and 9 column players chose to cooperate.

[9] No differences were found between the contingency correlations of row and column players in this game.

These games are mirror images of one another; a column player's decision in the first is the same as a row player's decision in the second. Thus it suffices to analyze the first game and apply the analysis to the second.

Unlike the prisoners' dilemmas above, the row player in this game does not have a dominant strategy. If the column player plays column 1, the row player prefers to play row A (earning 85) over row B (earning 50), while if the column player plays column 2, the row player prefers to play row B (earning 60) over row A (earning 25). However, the column player does have a dominant strategy; column 2 dominates column 1. If the row player chooses row A, the column player earns more with column 2 (90) than with column 1 (75). If the row player chooses row B, the column player also earns more with column 2 (40) than with column 1 (25). One measure of interest is whether participants recognize dominant strategies more in the guessing than in the no-guessing treatment as observed in the prisoners' dilemmas above.

The second, and possibly more interesting, question is the extent to which the player *without* the dominant strategy will recognize the dominant strategy of the other player. If so, he or she will recognize that the column player will play column 2 (the dominant strategy) and will then play his or her once-removed best response to this presumed action, row B.

Thus, there are two hypotheses for these games: that the incidence of dominant strategy play (column 2 in the first game, row B in the second game) will be higher in the guessing treatment than in the no-guessing treatment and that the incidence of once-removed best-response play (row B in the first game, column 2 in the second game) will be higher in the guessing treatment than in the no-guessing treatment.

No significant differences were found between column players in the first game and row players in the second game, nor between row players in the first game and column players in the second game. The data were accordingly pooled into the set of participants facing a dominant strategy (40) and the set facing a once-removed best response (40) in each treatment. Each participant appears exactly once in each of these sets.

The disjunction effect was clearly present in these games. The proportion of participants playing their dominated strategy was significantly higher in the no-guessing treatment, 40%, than in the guessing treatment, 20%.[10] In this game of iterated dominance, as in the prisoners' dilemmas above, asking participants to guess what the other player would do significantly decreased their likelihood of playing a dominated strategy.

In addition, asking participants to guess what their counterpart would do

[10] In the no-guessing treatment 16 players chose their dominated strategy. Of these, 8 were column players in the first game and 8 were row players in the second game. In the guessing treatment only 8 players chose their dominated strategy. Of these 5 were column players in the first game and 3 were row players in the second game. In the no-guessing treatment 14 players chose their best response to their partner's dominant strategy. Of these 9 were row players in the first game and 6 were column players in the second game. In the guessing treatment 22 players chose their best response. Of these 9 were row players in the first game and 13 were column players in the second game.

helped them to recognize their counterpart's dominant strategy and to react accordingly. The proportion of participants playing their once-removed best response is significantly higher in the guessing treatment, 55%, than in the no guessing treatment, 35%.

In these four games, a symmetric and an asymmetric prisoners' dilemma and two games of iterated dominance, a significant difference in playing behavior is found between the guessing and no-guessing treatments in a direction consistent with that predicted by reason-based choice. These results extend the domain of the disjunction effect from the traditional prisoners' dilemma to an asymmetric version of it, as well as to a game in which only one player has a dominant strategy.

An Alternative Explanation: Complexity[11]

The disjunction effect can be caused by participants using reasons-based choice to make their decision in games where there are different reasons for choosing the same action, as those above. However, an alternative theory of decision making, complexity, could also be an explanation of the effect.

Complexity might explain the previous results as follows. In the games above when one player does not know what the other will do, there are four alternatives to consider. In contrast, when a player knows exactly what his or her counterpart will do (or has done), there are only two. This reduction in complexity might increase the frequency with which participants recognize their dominant strategy.

While this argument is compelling for the original Shafir and Tversky (1992) data, in which one player knew the counterpart's moves for sure, it is less so for the results of this experiment. While an estimate of the other party's moves can serve the same purpose by accentuating the reasons for one choice over another, it does not entirely rule out the other party's other choice. Estimates can be wrong. Thus the difference in complexity between treatments in the weaker manipulation used in this paper is not as great as the same difference in the Shafir and Tversky paper.

Shafir and Tversky also present some data designed to address this alternative explanation. In one version of the gamble question, they translated the payoffs from the first gamble by $400. In this new treatment participants had either won $600 or won $300 in the first gamble. Participants were then asked if they wanted the same second gamble, a 50–50 chance of winning $200 or losing $100. While the complexity of this problem is the same as the previous one, the reasons participants might have for taking the second gamble are the same regardless of the outcome of the uncertainty of the first gamble. Thus complexity predicts no difference between results in the translated gamble and the old gamble, while reason-based choice predicts little or no disjunction effect in the translated gamble. Shafir and Tversky indeed find no evidence of the disjunction effect in the modified setting.

[11] I am grateful to an anonymous referee for suggesting this alternative explanation for these results.

In order to test the complexity explanation in this context, a new game with the same complexity but without the different reasons to play the dominant strategy is used. This new game is again a 2 × 2 matrix; thus it has the same number of options and moves as the previous games. Like the previous games, it also has a dominant strategy equilibrium. However, unlike in the previous games, the reasons for choosing the dominant strategy are the same independent of the move that a player's counterpart makes.

It is useful to note that this game differs from the prisoners' dilemma game in important ways. The prisoners' dilemma is unique in that it is the only 2 × 2 game with a dominant strategy equilibrium which does not lead to a pareto optimal outcome. In contrast, in this new game the dominant strategy equilibrium is pareto optimal, as it would be for most 2 × 2 games with such an equilibrium.

If the complexity explanation for the disjunction effect is the right one, the effect should be observed in this new game. As in previous games, the reduction in complexity which results from guessing your counterpart's move should enable the player to more reliably find his or her dominant strategy (since there are only two cells to compare rather than four).

If instead reason-based choice is the decision process which causes the disjunction effect, the effect should not be present in this new game, since the reasons for choosing the dominant strategy are the same regardless of the counterpart's move. Results from this game are presented in the next subsection.

Same Reason

This game was run to differentiate between the complexity and reason-based choice explanations for the disjunction effect. Like the symmetric and asymmetric prisoners' dilemma games above, this game involves a 2 × 2 matrix (see Table 4) with a dominant strategy for both parties and thus a dominant-strategy equilibrium. Unlike in the previous games, however, in this game the reason for choosing the dominant strategy is the same regardless of your counterpart's decision.

For both players their second option dominates their first. In addition, the reasons for playing the dominant strategy (2 or B) are the same no matter what your counterpart does. Imagine you are the row player. If your counterpart, the column player, chooses column 1, your choice of row B maximizes your individual earnings (you earn 85 instead of 30), as well as the sum of your earnings and those of your partner (together, you earn 110 instead of 60). If your counterpart

TABLE 4

Same Reason

	1	2
A	30,30	25,85
B	85,25	75,75

chooses column 2, your choice of row B again maximizes your earnings (you earn 75 instead of 25) and the sum of your earnings (together, you earn 150 instead of 110). Thus the reason for choosing row B is the same, no matter how the uncertainty of the other player's move is resolved. If reason-based choice is causing the disjunction effect, then there should be no difference between the two treatments in this game.

In contrast, if complexity is causing the disjunction effect, then the effect should be observed in this game. As in the previous games, in the no-guessing treatment the participant has to compare four cells of payoffs (a complex task) while in the guessing treatment he or she only has to compare two cells (a less complex task). A higher chance of successful identification of the dominant strategy would almost certainly result from the less complex task.

In this game very little dominated strategy play was observed: 12.5% in the no-guessing treatment and 5% in the guessing treatment.[12] These treatments were not significantly different. These results, then, are supportive of the reason-based choice story of Shafir and Tversky (1992), by demonstrating a situation where the disjunction effect is not observed.

DISCUSSION

The study reported in this paper extends the domain of the disjunction effect and reason-based choice. First, it demonstrates the effect with a different manipulation: *eliciting* beliefs about the resolution of the strategic uncertainty rather than *controlling* them. Second, it extends the domain of the effect to include asymmetric prisoners' dilemmas and games with dominant strategies but without dominant-strategy equilibria. Third, it demonstrates that the effect is being caused by reason-based choice by removing the conflicting reasons and demonstrating that the effect disappears.

Shafir (1994) characterizes the disjunction effect as an unwillingness on the part of participants to travel down a decision or game tree (p. 26). The results from this experiment suggest that this unwillingness can be overcome by a small intervention: asking decision-makers for an estimate of what will happen. This manipulation is weaker than Shafir and Tversky's manipulation of making the effect transparent by asking participants what they would do in each of the possible branches of the tree before asking what they would do with the uncertainty intact. Both facilitations enable participants to better travel down the tree and choose the dominant action. Tversky and Shafir (1992) conclude that the sure-thing principle "tends to hold when its application is transparent, even though it is sometimes violated when its application is not obvious" (p. 309). One main question this study addresses is the minimum level of intervention needed to make application of the principle transparent. Results suggest that the minimal intervention of eliciting beliefs is sufficient.

[12] In the no-guessing treatment two row players and three column players played their dominated strategy. In the guessing treatment two row players and no column players played their dominated strategy.

Using this minimal intervention, this study demonstrates the existence of the disjunction effect in asymmetric prisoners' dilemma games (where the similarity between the players may be broken) and in games of iterated dominance. In these games, having participants guess the action of their counterpart significantly increased their recognition of their own dominant strategy as in the previous dilemma games. In addition, it increased the frequency of play of the best response to the dominant strategy. These results support the "thinking through the tree" explanation of Shafir (1994).

The weakness of this intervention, however, introduces some new complications. Throughout this paper I have assumed that the beliefs participants have about their counterparts' play of the game cause their own behavior in the game. In the Shafir and Tversky stronger manipulation, this assumption is the natural one, as the beliefs are manipulated and the behavior observed. However, in this weaker manipulation, alternative explanations for the relationship between beliefs and actions are feasible. For example, as suggested by Dawes et al. (1977), participants' actions could be causing their beliefs of what others would do via "false" consensus. That is, participants could be choosing their action in advance, and predicting the action of the other, using their own action either as a signal or even as a rationalization for their own action. Since the results demonstrate that the elicitation of beliefs changes the action that participants choose, they suggest that there is some causal feedback between beliefs and actions, even in this alternative story. Another alternative explanation of the relationship between beliefs and actions is that both are caused by some third (other) process. Since the elicitation of beliefs affects actions, the results suggest under this explanation that beliefs of what others will do influence this third process in some way. While the data presented here cannot differentiate between these alternative processes explaining the relationship between beliefs and actions in social dilemma games, under each explanation the data do suggest that beliefs are causally related to actions in some way. For further work disentangling the relationship between beliefs and actions in games, see Croson and Miller (1999).

Perhaps the strongest test of an explanation for a bias like this one is the ability to make it disappear. This is accomplished in the last game. The reason-based choice explanation for the disjunction effect is that participants have a reason to defect regardless of what their counterparts do, but that the reason differs depending on their counterparts' action. In the final game, the reasons for playing the dominant strategy are the same regardless of the counterpart's action. Consistent with this explanation, the disjunction effect is not observed.

The recognition of dominant strategies is an important part of making good decisions under uncertainty. This study replicates a bias in how people make such decisions (the disjunction effect), extends the set of situations in which the effect is observed past social dilemmas, and identifies a minimal intervention which can aid decision making (estimation of the other's move). Finally, we demonstrate support for the reason-based choice explanation offered for the effect by Shafir and Tversky by demonstrating the lack of a disjunction effect where none is predicted.

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