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A Laboratory Investigation of Multiperson Rationality and Presentation Effects*

ANDREW SCHOTTER

Department of Economics, New York University, 269 Mercer Street, New York, New York 10003

KEITH WEIGELT

Department of Management, University of Pennsylvania, The Wharton School, Philadelphia, Pennsylvania 19104

AND

CHARLES WILSON

Department of Economics, New York University, 269 Mercer Street, New York, New York 10003

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This paper reports the results of laboratory experiments in which subjects were presented with different two-person decision problems in both their extensive and normal forms. All games generated the same equilibrium outcomes. Our results indicate that the presentation of the decision problem significantly affects the strategy chosen. Surprisingly, these presentation effects were most prominent in the simplest games where differences in presentation would seem most transparent. It appears that subjects are much more likely to use (and fear) incredible threats when the problem is presented as a one-stage rather than as a multistage game. *Journal of Economic Literature* Classification Numbers: 026,215. © 1994 Academic Press, Inc.

1. INTRODUCTION

Kohlberg and Mertens (1986) identified a number of properties they believe should be satisfied by any solution concept when it is common

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knowledge that all players are perfectly rational. Among others, they argue that the player choices should be undominated, survive iterated deletion of dominated strategies, and satisfy various solution concepts based on backward induction. They also insist that rational decision making implies that the solution of any game should be invariant to its extensive form representation.[1] In contrast, some experimental studies (see, for example, Kahneman and Tversky (1979)) indicate that human behavior may depend, sometimes dramatically, on how a problem is presented.

Our objective in this paper is twofold. First, we investigate the circumstances under which two rationality principles, backward induction and iterated dominance, are likely to govern individual behavior in actual decision problems. Second, we investigate the extent to which the "frame" or presentation form of the game affects subject behavior. These objectives are related since the form of a decision problem may make a particular rationality principle more salient. For example, while iterated dominance can be defined in the normal form of a game, subgame perfection cannot. In contrast, iterated dominance may be less transparent for games presented in extensive form with a sequence of moves.

We performed a series of experiments in which different subject groups were presented with various two-person games, all of which possess the same equilibrium outcomes. The games were related in two ways. First, each had a similar sequential structure and the same set of Nash equilibrium payoffs. They differed in the set of subgame perfect outcomes or in the set of outcomes which survived the deletion of dominated strategies (by pure strategies). Second, each game was presented in two different forms. To some subject groups the game was presented and described in the normal form as a matrix of strategies and payoffs. To other subject groups it was presented and described as an extensive form with an explicit sequential structure. In no case did a subject have more than three strategies from which to choose. In each case, one player could guarantee a secure outcome and the other possessed a self-defeating (incredible) threat.

Our results *strongly* confirm the presence of significant framing or presentation effects. In a simple two-stage game with just two strategies for each player, we observed a dramatic difference in subject behavior depending on whether the game was presented as a matrix with simultaneous moves or as a tree with sequential moves. However, we were unable to substantiate how the presentation form impacted on the saliency of our two rationality principles. In experiments where we expected that our rationality principles would predict behavioral differences across game

[1] This is in contrast to refinements based on the extensive form of a game, such as perfection (Selten, 1975) and sequential rationality (Kreps and Wilson, 1982).

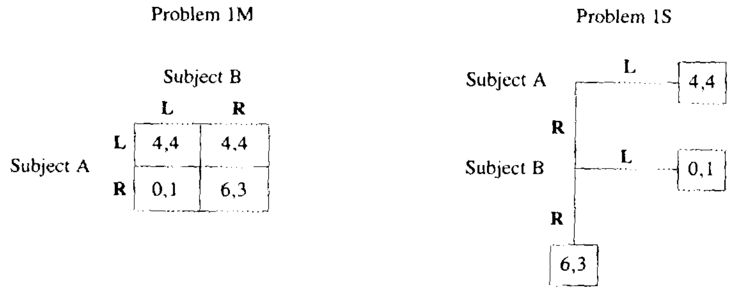


FIGURE 1

forms, either no such differences appeared or they were not what we expected.

The paper is organized as follows. Section 2 presents the experimental decision problem, and Section 3 describes our experimental design. In Section 4 we formulate three predictions to help structure the discussion of the results in Section 5. In Section 6 we discuss issues arising from the analysis of the results and present the results of additional experiments. We discuss related experimental work by others in Section 7 and summarize our conclusions in Section 8.

2. PRESENTATION EFFECTS AND RATIONALITY

A set of six complementary two-person decision problems are represented in Figs. 1 to 3.

2.1. *The Baseline Problem: Backward Induction and Iterated Dominance*

Problems 1M and 1S in Fig. 1 are our baseline problems. They are strategically equivalent since their strategies and payoffs are isomorphic. Subject A has two strategies. If he chooses "L," both subjects receive a payoff of 4, regardless of B's choice. If he chooses "R," the payoff depends on subject B's strategy. If subject B chooses "L," subject A earns 0 and subject B earns 1. If he chooses "R," subject A earns 6 and subject B earns 3.

There are two Nash equilibrium outcomes, (4,4) and (6,3). However, (6,3) is the only outcome which survives the deletion of dominated strategies, and, in Problem 1S, it is the only subgame perfect outcome. Thus, both of these rationality principles lead to the same outcome.

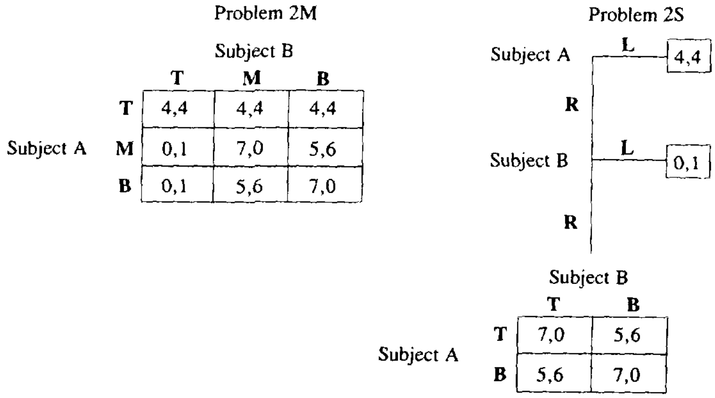


FIGURE 2

The next two pairs of games are variations on the baseline problem. They are designed to isolate the role of iterated dominance and backward induction as the guiding principle of subject behavior.

2.2. *Backward Induction without Iterated Dominance*

Problems 2M and 2S are strategically equivalent games with the same set of equilibrium payoffs as the baseline problem (Fig. 2). They differ from Problem 1 only in that the (6,3) outcome is replaced by a subgame with the same (mixed strategy) equilibrium payoff. In Problem 2S, the extensive form of the game, subgame perfection again requires both players to choose "R" to obtain an expected outcome of (6,3). However, unlike Problem 1, both the (4,4) and (6,3) outcomes survive the deletion of dominated strategies (with respect to pure strategies[2]).

2.3. *Iterated Dominance Without Backward Induction*

Problems 3M and 3S represent another pair of strategically equivalent variations on the baseline problem (Fig. 3). Again the (6,3) payoff has been replaced with a simple bimatrix game. Unlike Problem 2, however,

[2] The (4,4) outcome does not satisfy the deletion of strategies dominated by mixtures of strategies. For instance, a convex combination of M and B dominates T for player B. To construct a game in which (4,4) survives iterated dominance by mixed strategies requires at least four strategies for each player with a complicated set of payoffs. We did not study such a game because we did not want to introduce such complexity into the subgame. Nevertheless, the current design is certainly flawed as a test of subgame perfection in the absence of iterated dominance.

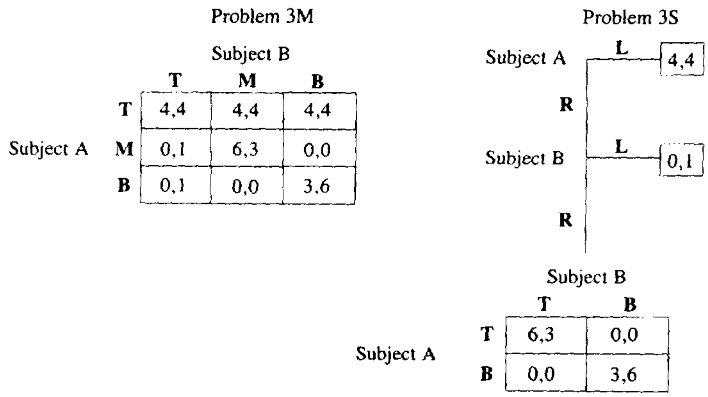


FIGURE 3

the subgame has two equilibria, (6,3) and (3,6). Consequently, both (4,4) and (6,3) are subgame perfect. However, since "T" dominates "B" for Player A in Problem 3M (equivalently, "L" dominates "TB" in Problem 3S), it follows that only the (6,3) outcome survives the iterated deletion of (weakly) dominated strategies, as was the case in Problem 1.

2.4. *A Summary of the Equilibrium Outcomes*

Table 1 summarizes the outcomes of the different games in relation to the predictions we formulate in Section 5. All games possess the same pair of Nash equilibrium outcomes. In the matrix games, subgame perfection adds no restrictions. However, in the sequential versions, it restricts the outcome to (6,3) in Games 1S and 2S, but leaves both the (4,4) and

TABLE 1

SUMMARY OF DECISION PROBLEMS

		Outcomes		
Experiment	Structure	NE	Iterated dominance	Subgame perfection
1M	Matrix	(6,3), (4,4)	(6,3)	—
1S	Sequential	(6,3), (4,4)	—	(6,3)
2M	Matrix	(6,3), (4,4)	(6,3), (4,4)	—
2S	Sequential	(6,3), (4,4)	—	(6,3)
3M	Matrix	(6,3), (4,4)	(6,3)	—
3S	Sequential	(6,3), (4,4)	—	(6,3), (4,4)

(6,3) outcome in Game 3S. In Section 5, we suggest that iterated dominance may be more transparent in the matrix version of the games. The deletion of strategies weakly dominated by pure strategies results in the (6,3) outcome in Games 1M and 2M, but leaves both the (4,4) and (6,3) outcomes in Game 2M.

3. Experimental Design

The instructions for Problems 1M and 1S are included in Appendix A. (The instructions for the other problems are available on request.) Subjects were New York University undergraduate students, drawn primarily from first-year economics courses. Each subject participated in only one experimental session and only one decision problem.

Typically, there were 10 subjects in any given experimental session. Each subject sat at a randomly assigned PC terminal and was given a copy of the instructions. Half of the subjects were randomly assigned to be type A and half assigned to be type B. Each subject was informed of only his own type. The experiment administrator read the instructions aloud and publicly answered any questions. Subjects then played six practice rounds with a partner chosen at random in each round. To avoid biasing the choices in the actual experiments to follow, letters rather than numbers were used to represent payoffs during the practice rounds.[3] Upon completion of the practice rounds, subjects were randomly assigned a different partner in each of the successive rounds. Consequently, the number of rounds played by any subject group depended on the number of subjects in the group. The subjects were explicitly told that no two subjects were ever paired against each other in more than one round.

After both a subject and his partner made their choices, the subject's choice and payoff were listed on the computer screen along with his choices and payoffs in any previous rounds. (In the practice rounds the payoff letter was used.) Subjects were not explicitly informed of the action taken by their partners. This guaranteed that a subject obtained the same information about his partner's behavior in all versions of the problem. The subjects were told that for each payoff point they earned they would receive \$.70. Experiments lasted approximately 45 minutes and typical earnings ranged from \$12 to \$18.

One of our major concerns in designing the experiment was that the subjects perceive the problem as a one-shot game and not try to establish a norm for future play through their own actions. In a pilot experiment we let the subjects play against opponents selected at random for 30

[3] Letters were randomly chosen to avoid suggesting any ranking of the outcomes.

rounds with much lower payoffs in each round. In a post-experiment questionnaire, a significant proportion of the subjects indicated they were trying to build a reputation across rounds, even though the identity of their partner was unknown and there was only a small probability that they would meet in any given round. After the design change, responses to a similar questionnaire indicated that such considerations were not a significant factor.

4. PREDICTIONS

Our experimental design allows us to investigate a number of avenues through which the presentation of a game affects its outcome. First, there is a simple test of the "invariance" principle which requires the play of the game to be identical for all strategically equivalent representations. Second, if subject behavior does depend upon the presentation, then we may investigate the relation between the saliency of specific rationality principles and the form in which a game is represented and described.

4.1. *Invariance*

Kohlberg and Mertens (1986) argue that the set of outcomes of a game which constitutes a self-enforcing agreement should depend only on its strategic form. Consequently, if the solution is unique, we should observe the same behavior regardless of presentation. This implication leads to the following prediction.

Prediction I (invariance). We should observe the same proportion of strategically equivalent choices in both versions of each game.[4]

4.2. *The Saliency of Subgame Perfection and Iterated Dominance*

Contrary to the invariance principle is empirical evidence showing that the presentation or "frame" of a problem may substantially influence subject choice (Kahneman and Tversky, 1979; Tversky and Kahneman, 1986; Thaler, 1980). In multiperson decision problems, the presentation may influence player beliefs that all players respect a given rationality principle. We wished to test two conjectures. First, backward induction is more salient when the sequential nature of the game is emphasized.

[4] Note that we are implicitly assuming that choices are uncorrelated between players. The independence assumption is required because when subject A chooses "L" in the sequential form of a game, subject B is not given an opportunity to respond. Consequently, in the sequential form, we observe only the action of subject B when player A chooses "R," while we always observe his action in the matrix version.

Second, solutions consistent with the iterated deletion of dominated strategies are more likely when the game is represented in strategic form (because the dominance relations are more apparent). The following predictions are designed to operationalize these conjectures.

Since Problem 2 contains no strategies which are dominated by pure strategies, but does contain a unique subgame perfect equilibrium in the sequential version of the game, our first conjecture suggests the following prediction.

Prediction II (backward induction). The frequency of subject play consistent with an expected return of (6,3) when playing game 2S is greater than when playing game 2M.

Similarly, in Problem 3, both the (4,4) outcome and the (6,3) outcome are subgame perfect in both the matrix and sequential form, while only the (6,3) outcome survives the iterated deletion of dominated strategies. Since we conjectured that subjects are more likely to believe that both players are aware of the dominance relations when the game is represented as a matrix, we were led to the following prediction.

Prediction III (iterated dominance). The proportion of times in which subjects achieve the (6,3) outcome when playing game 3M is greater than when playing game 3S.

5. The Results

In this section, we summarize the results of our experiments and discuss the implications for the three stated predictions. For all experiments, the total number of responses of each choice are reported in parentheses of the figure representing the corresponding game. A complete history of each subject is available from the authors upon request. Given the preliminary nature of the investigation, we did not perform any formal statistical tests.

5.1. *Problem* 1

Figure 4 summarizes the results for the baseline experiment, Problem 1. A total of 20 subjects of each type played at least three rounds of the matrix version 1M and 16 subjects played at least five rounds of the sequential version 1S. For Game 1M, 57% of the type-A responses were to play the secure strategy "L" and 20% of the type-B responses were to play the dominated strategy "L." For Game 1S, both types of subjects almost always chose "R." (Of the seven "L" responses by type-A sub-

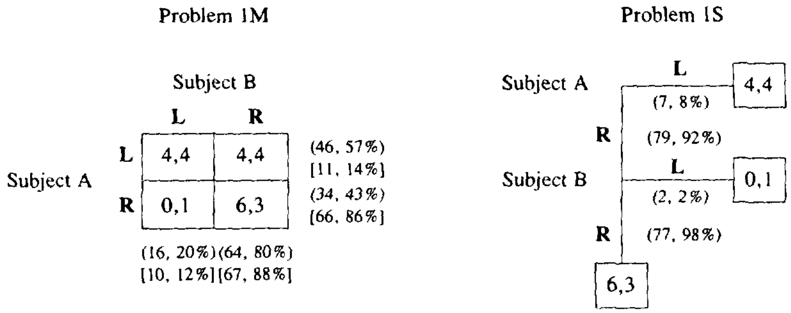


FIG. 4. For each game,the first number in the parentheses corresponding to each action is the total number of responses, and the second is the percentage of responses for players of that type. The corresponding numbers in the brackets refer to the responses for the hybrid problem (1H) discussed in Section 6.1.

jects in Problem 1M, six were by the same subject who later indicated that he had misunderstood the payoffs.)

The results suggest a clear rejection of invariance, prediction 1. The presentation of the game appears to have significantly affected subject behavior.

5.2. *Problem* 2

Figure 5 summarizes the results for Problem 2. Ten subjects of each type played 5 rounds of both the matrix and sequential versions. In the matrix version 2M, 28% of the type-A responses were to play the secure

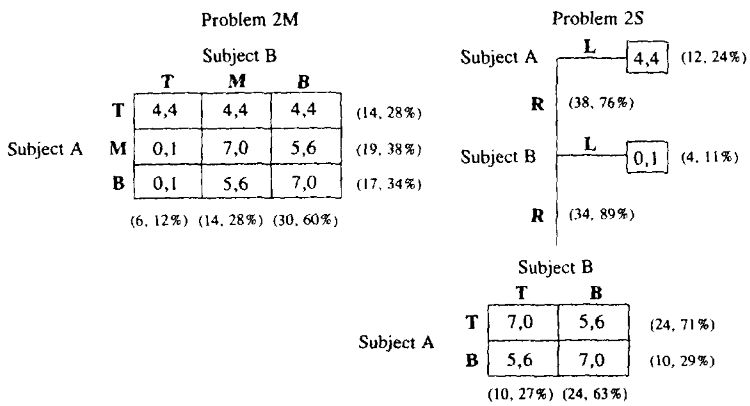


FIG. 5. For each game, the first number in the parentheses corresponding to each action is the total number of responses, and the second number is the percentage of responses for players of that type.

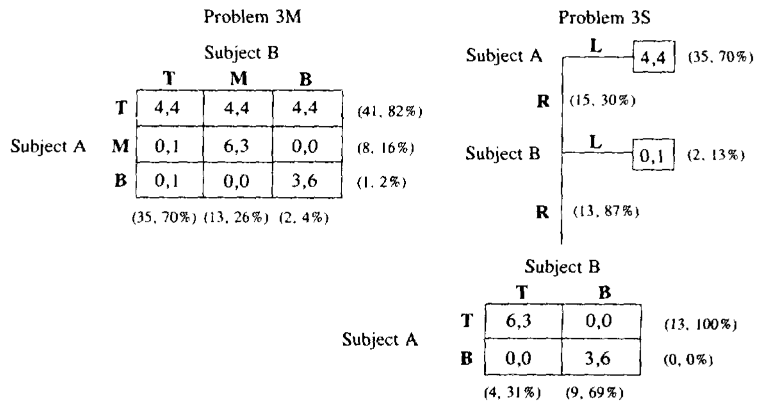


FIG. 6. For each game, the first number in the parentheses corresponding to each action is the total number of responses, and the second number is the percentage of responses for players of that type.

choice "T," while 12% of the type-B responses were to employ the threat "T." For the sequential version 2S, 24% of the type-A responses were to play the secure choice "L," while 11% of the type-B responses were to employ the threat strategy "L."

The results of Problem 2 were surprising in two respects. First, the strong presentation effect which we observed in Problem 1 completely disappeared, even though the problems are quite similar. Second, the behavior of subjects in both versions of the game is not what we would have expected given observed behavior in Problem 1. Recall that in Problem 2, subgame perfection implies restrictions in the sequential representation, whereas iterated dominance (in pure strategies) implies no restrictions in either form. Therefore, consistent with Prediction II, the differences between the subject behavior in the matrix and sequential forms of Problem I should have been accentuated.

5.3. *Problem* 3

Figure 6 summarizes the results for Problem 3. Ten subjects of each type played five rounds of the matrix version of the game and ten subjects of each type played five rounds of the sequential version. The unique iterated dominance equilibrium outcome (6,3) was attained only two times in the matrix version 3M and four times in the sequential version 3S. The low number of (6,3) outcomes reflects the fact that the secure choice "T" was chosen by type-A subjects 82% of the time in matrix version 3M and 70% of the time in the sequential version 3S.

Beyond the fact that the iterated dominance solution was rarely chosen in either version, subject behavior indicates some support for the prediction that iterated dominance is more salient when the game is presented as a simultaneous move game. No type-A subjects played the dominated strategy ("B" in game 3M and "RB" in game 3S) more than once in either version. However, once these dominated strategies are eliminated, player B strategies "B" (in 3M) and "RB" (in 3S) are weakly dominated by "M" and "RT," respectively. Yet type-B players played "M" 13 times and "B" only 2 times in the matrix version, while in the sequential version they played the analogs "RT" 4 times and "RB" 9 times. It appears, therefore, that type-B players are less likely to play the strategies which are weakly dominated after the deletion of the dominated type-A strategies in the matrix version of the game than they are in the sequential version. (In a later test, reported in Section 6.4 below, however, we observed quite different behavior.)

6. New Questions and Further Experiments

Although our results suggest some clear patterns they raise more questions than they answer. In this section we report our initial attempts to address some of these new questions.

6.1. *Framing in Description versus Framing in Structure*

In both Problems 1 and 3, the threat strategy is used much less frequently in the sequential versions of the game than in the matrix version. (In Problem 2, there is no appreciable difference.) In both cases, the threat strategy is dominated (by a mixed strategy in Game 3). Various factors might account for these differences. However, it may be worth noting that in the matrix version the dominance is *weak*, while in the sequential version the dominance is *strict* at the start of the subgame at which subject B makes his choice. One might argue, therefore, that we are testing for more than just a presentation effect. We are testing whether their responses are affected by both a change in the game's description and a corresponding change in the information available to subjects when they make their decisions.

To separate these two effects, we constructed a hybrid version of Problem 1 (1H) in which the game was described sequentially and represented as a tree as in Experiment 1S, but in which Player B was required to make his choice simultaneously with Player A as in Experiment 1M. That is, Subject B was required to commit himself to a course of action in the event that Subject A chose "R" before being told whether or not he would actually be given a choice.

The results are illustrated in the square brackets of Fig. 4. Fifteen subjects of both types participated in the experiment in at least four rounds each. Fourteen percent of the type-A responses were to play the secure strategy "L" (compared to 57% in Problem 1M). Twelve percent of the type-B responses were to play the dominated threat strategy "L." The results suggest that the change in description of the game may be more important than a change in its structure. Both types of subjects are much more likely to play in a way consistent with (6,3) outcome in the hybrid version than in the matrix version. They also appear to be less likely to reach the (6,3) outcome in the hybrid version than in the sequential version, although given the small of number "L" observations in both Problem 1S and 1H, the evidence is not clear. (Recall that one type-A player accounted for six of the seven "L" responses in Problem 1S and later indicated that he was confused about the payoffs. Two type-A players predominantly chose "L" in Problem 1H.)

6.2. *Modifications of Problem* 3

In Problem 3S, type-B subjects were given an opportunity to respond only 30% of the time. Evidently the risk of not coordinating in the second period was sufficiently great to deter a choice of "R." To induce type-A subjects to choose "R" more often, we also ran a few sessions in which the payoffs in the second stage of the game were modified. In one case, we replaced diagonal payoffs of (0,0) with (2,2). In another case, we replaced the (6,3) and (3,6) payoffs with (8,4) and (4,8). Both matrix and sequential versions of these games were tested.

The representations of the games and the experimental results are reported in Figs. 7 and 8. Our results do not suggest any major revisions in our conclusions. As might be expected, type-A subjects played the secure strategy less often. Also, type-B subjects played strategy "B" more often. Player B also played the threat strategy less often, although not as infrequently as might be expected.

In Fig. 8, player B's threat strategy "T" is strongly dominated. Yet type-B subjects played "T" 11% of the time. This behavior may be limited to a small fraction of the population, however. Only 3 of the 12 subjects ever chose this response and one of the subjects chose it 4 times.

6.3. *Communication and Learning*

In each of the games, the solution implied by one or both of the rationality principles defined above is unique. However, this outcome is consistently attained in only Problem 1S. In all of the other cases, the observed

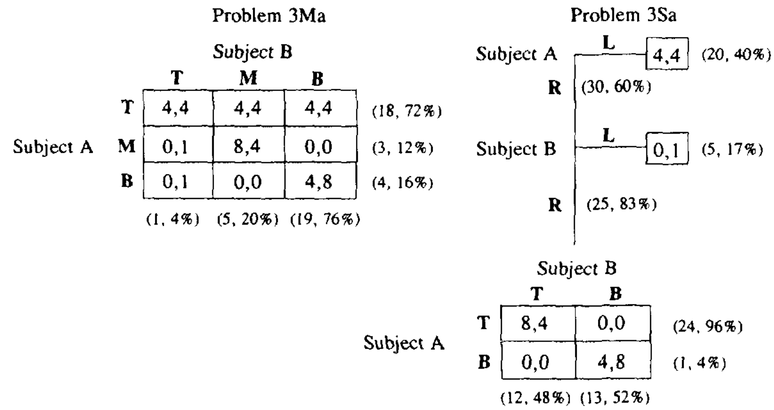


FIG. 7. For each game, the first number in the parentheses corresponding to each action is the total number of responses, and the second number is the percentage of responses for players of that type.

behavior is not consistent with any Nash equilibrium. Furthermore, most of the subjects experimented with different choices in the three to six rounds they played the game. This suggests that the subjects were not very confident about how their opponents would play the game.

A common interpretation of Nash equilibrium and its various refinements is that it is a self-enforcing convention (or at least that any self-

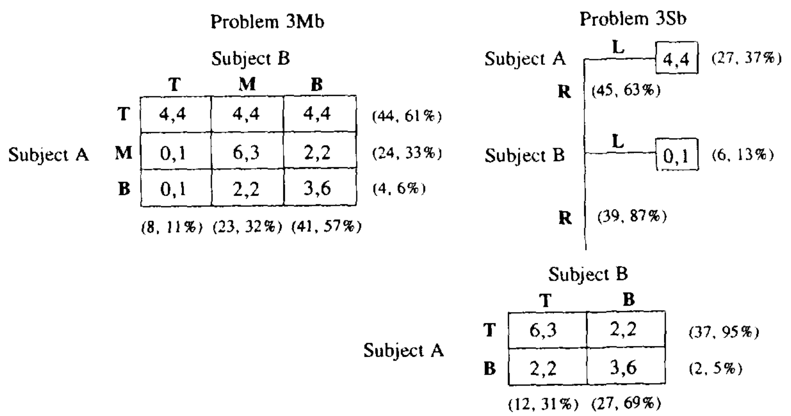


FIG. 8. For each game, the first number in the parentheses corresponding to each action is the total number of responses, and the second number is the percentage of responses for players of that type.

			Subject B		
		T	M	B	
Subject A	T	4,4	4,4	4,4	(26, 74%) [30, 83%]
	M	0,1	6,3	0,0	(8, 23%) [5, 14%]
	B	0,1	0,0	3,6	(1, 3%) [1, 3%]
		(8, 23%) [12, 33%]	(2, 6%) [13, 36%]	(25, 71%) [11, 31%]	

FIG. 9. The numbers in the parentheses corresponding to each action give the total number of responses and the percentage of total responses during the first six rounds for players of that type. The numbers in the brackets provide the corresponding information for the next six rounds where the roles of the players were reversed.

enforcing convention is contained in the set of Nash equilibria). Therefore, the test of the refinement (or its underlying principles) should not be based only on how agents play the game in the first few rounds or even after several rounds. Rather, it should satisfy the following two criteria. First, no convention which is not consistent with that refinement can be sustained. Second, we should be able to demonstrate that there is a method of leading the subjects to consistently play according to a convention which does satisfy that refinement. This suggests that we need to redesign the experiment to give subjects more opportunities to establish a convention.

We mention here three possible methods of testing to see which if any conventions of play can be adopted and sustained. One is to allow the players to play more rounds of the game, alternating roles, with more time to contemplate their actions between rounds. For instance, they might be asked to explicitly predict the action of their opponent before making their choice, as in Van Huyck *et al.* (1990). Another possibility is to allow for preplay communication which gives agents an opportunity to explain their reasoning and to explicitly agree on a convention. (See Cooper *et al.* (1989) for a nice study of the effect of preplay communication in the battle-of-the-sexes game.) Finally, we might publicly suggest various conventions of play, perhaps with some accompanying explanation, and determine which conventions are sustained. This approach is used by Van Huyck *et al.* (1992) to test various deductive equilibrium selection principles.

To date we have experimented only with the possibility of reversing roles and only in Problem 3M. In one session, we informed the subjects that they were to participate in two experiments. At the end of the first experiment they were given the same game but assigned the opposite role.

The results are summarized in Fig. 9. For the first six rounds of the experiment, most type-A responses were the secure strategy "T," while most type-B choices were strategy "B." In the second six rounds, with the roles of the subjects reversed, the behavior of the new type-A subjects was largely the same as before. If anything, there was an even greater tendency to play the secure strategy. However, there does appear to have been a significant change in the behavior of the type-B subjects (formerly type-A subjects). During these rounds, type-B subjects chose strategy "M" slightly more often than "B."

There was less variation in the responses of individual subjects after the roles were reversed, suggesting that the individual subjects were more convinced of their best responses. However, it is not clear what convention, if any, the subjects would eventually settle upon if the process were continued. We suspect the change in behavior of type-B subjects is indicative of a tendency which would persist even if more rounds were played. We also suspect that the change in behavior after the role reversal is due in part to the fact that subjects had a chance to think about the game while the procedures were explained again.

7. Related Work

Although we are not aware of any work which explicitly focuses on the presentation effects studied here, several authors have investigated the saliency of various solution concepts in games. Future work on studying presentation effects should benefit both from the insights these studies yield and their methodology.

We divide this work into two groups. The first body of work is concerned with testing various principles of equilibrium *selection*. Roughly speaking, a selection principle is designed to complement a theory of multiperson rationality when that theory does not lead to a unique prediction of behavior. Examples of selection principles are symmetry, payoff dominance, and payoff security. Several authors have recently investigated the saliency of these various criteria and their dependence on the structure of the game. Particularly noteworthy is the work of Cooper *et al.* (1989) and the work of Van Huyck *et al.* (1990, 1993). Typically, they consider coordination games in which there are several equilibria satisfying even the strongest refinements but in which various selection principles give different but unique solutions. Their work provides convincing evidence that no single selection principle is always salient. Although we are concerned with testing how the presentation of a game affects the saliency of different refinement principles, the general approach is quite similar. In both cases, the basic question is not *if* a principle is salient, but *when* the principle is salient.

The other line of experimental work is on equilibrium *refinements*. Much of its focuses on the explanatory power of backward induction in multistage games. There are several questions yet to be settled in this literature, particularly with respect to the role of learning. Nevertheless, it does appear that there are severe limitations to the saliency of backward induction in games with many stages or in games in which issues of fairness arise. Our results suggest that the mere presentation (or the interpretation) of the problem may also have a significant effect.

Several investigators have also begun to study the explanatory power of various forward induction refinements in the context of games of incomplete information. Camerer and Weigelt (1988) test a multistage reputation game and find that the behavior of the subjects is better explained by the "intuitive" criterion (Cho and Kreps, 1987) than by any other sequential equilibrium. Similarly, Brandts and Holt (1988) test a version of the Cho–Kreps "beer–quiche" game with two sequential equilibria. They also find that the behavior of subjects is better explained by the unique equilibrium satisfying the intuitive criterion. Banks *et al.* (1993) investigate a broad class of games to try to determine the appropriate forward induction criteria. They conclude that generally the concept of "divinity" (Banks and Sobel, 1987) accords best with the data. Problem 3 above is most closely related to this work.

Finally, we should mention the work of Beard and Bell (1991) which investigates the confidence players have in the rationality of others. They consider a set of games similar to 1S, except that the secure payoff to Player A is generally much closer to the subgame perfect payoff and the threat strategy of Player B does not necessarily yield a payoff which is lower than his payoff when Player A plays the secure strategy. In contrast to our results, they find that a significant fraction (sometimes over 50%) of the type-A players choose the secure strategy. Our results suggest that if the subjects were to play the matrix version of the game, almost none of the subjects would play the secure strategy.

8. Summary and Conclusion

Observed results of the play of Problem 1 strongly reject the prediction that subject behavior is invariant to the game's presentation. Problem 1 is a simple two-stage game with a secure strategy for one player and an incredible threat for the other. Yet the outcome of the game is typically quite different when the game is described and played as a static problem rather than as a sequential problem.

Problem 2, which was designed to isolate the explanatory power of subgame perfection, is probably flawed. First, the subgame perfect outcome requires mixed strategies, which introduces an additional degree of complication and requires stronger assumptions about the preferences of the subjects. Second, once we consider mixed strategies, the (4,4) outcome is again eliminated by the iterated deletion of weakly dominated strategies. Although subgame perfection is distinct from iterated dominance, the two concepts are very closely related when the information structure is relatively simple. It is probably more useful to establish less subtle properties before trying to firmly establish which of the two principles is more salient.

In neither the matrix nor the sequential version did we generally obtain the forward induction solution of Problem 3. Evidently it requires more experience in the game than was permitted by our experimental design for players to confidently predict the rational responses of their opponents.

Finally, we did accumulate some evidence that subjects are much less likely to play a strongly dominated strategy than a weakly dominated strategy.

APPENDIX

This appendix contains the instructions for Experiments 1M and 1S.

A.1. *Experiment* 1M

Subject Type __________

INSTRUCTIONS

This is an experiment in decision making. Several research foundations have provided funds for these experiments. If you follow the instructions, and make good decisions, you may earn a sizable amount of money.

The experiment consists of two parts. The first part will be "practice," in the sense that payoffs will be non-monetary letter payoffs. The second part of the experiment is where your dollar earnings will be determined. Here your decisions will earn you monetary payoffs which will be paid to you in cash.

PRACTICE ROUNDS

Half of the subjects in the room have been designated as type-A subjects and half as type-B subjects. Your type is printed in the upper right hand corner of this instruction sheet. Before each round you will be paired with a subject of the opposite type. The experiment will last for 6 rounds. Before each round the subject you are paired with will be randomly selected by the computer.

In each decision round, the two of you will simultaneously choose between two alternatives. The choices made by the two of you will determine how many points you earn in that round.

The payoffs resulting from the decisions that the two of you make in any round are described in the matrix below. That is, this matrix tells you the outcome of the four possible decision choice pairs. The two choices for Subject B are listed along the top of the matrix. The two choices for Subject A are listed along the left side of the matrix. For any pair of choices, the first letter in the corresponding box gives you the payoff to Subject A, and the second letter gives the payoff to Subject B.

		Choices for Subject B	
		L	R
Choices for Subject A	L	M, W	Q, K
	R	A, B	C, P

Some Examples

Suppose Subject A selects Choice L and Subject B selects Choice R. Then the outcome is represented by the letters Q,K.

Suppose Subject A selects Choice R and Subject B selects Choice L. Then the outcome is represented by the letters A,B.

EXPERIMENTAL PROCEDURES

As you set at your computer the monitor screen should look like this:

Round	Your Choice	The Outcome
1		
2		
3		
4		
5		
6		

⟨⟨⟨⟨⟨⟨⟨⟨ Please Wait ⟩⟩⟩⟩⟩⟩⟩⟩⟩⟩

As the experiment proceeds you and your various counterparts will fill in the columns of this screen by making your choices. In round 1 when we tell you to begin, the following prompt will appear at the bottom of your screen:

Please make your choice: L or R

You will then type the letter L or R into the keyboard. The computer will then respond with the following message at the bottom of the screen:

Is _____ your choice? (Y/N)

If this choice is the one you want, type Y. That will enter your choice into the computer. If you type N, the computer will ask you to choose again.

Your counterpart for that round will be asked to do the same thing. After both of you have recorded your choices, the computer will compute your earnings and the following message will appear at the bottom of the screen:

You selected Choice ____ . The outcome is _______ .
⟨⟨ Press any key to Continue ⟩⟩

The computer will then record this information in the table above (on your monitor screen). You will then be asked to wait until all subjects in the experiment have completed the round. Notice that you are not explicitly told what choice your counterpart selected.

After completing round 1 you then proceed to round 2. We will proceed this way for 6 rounds.

YOUR DECISION PROBLEM

This decision situation is very similar to the one you just completed. Half the subjects in the room have been designated as type-A subjects and half as type-B subjects. Your type is printed in the upper right hand corner of the instruction sheet. Before each round you will be paired with a subject of the opposite type. The experiment will last for 5 rounds. In each of the five rounds, *you will play against a different subject of the opposite type. That is, you will never play against the same subject of the opposite type more than once.*

As before, in each decision round the two of you will simultaneously choose between two alternatives. The choices by the two of you will determine how many points you earn in that round.

The payoffs resulting from the decisions that the two of you make in any round are described in the matrix below. That is, this matrix tells you how many points each of the four possible decision choice pairs are worth to you. The two choices for Subject B are listed along the top of the matrix. The two choices for Subject A are listed along the left side of the matrix. For any pair of choices, the first number in the corresponding box gives the point payoff to Subject A, and the second number gives the point payoff to Subject B.

		Choices for Subject B: L	Choices for Subject B: R
Choices for Subject A	L	4, 4	4, 4
	R	0, 1	6, 3

Some Examples

Suppose Subject A selects Choice L and Subject B selects Choice R. Then Subject A earns 4 points and Subject B earns 4 points.

Suppose Subject A selects Choice R and Subject B selects Choice L. Then Subject A earns 0 points and Subject B earns 1 point.

PAYOFFS

Your dollar earnings for the experiment are determined as follows. First, we will sum up your point total over the 5 rounds. Then we will multiply this sum by $.70.

The procedure will be the same one you followed in the practice game. Remember, in each round you will be paired with a new (and different) counterpart. You will never play against the same counterpart more than once.

A.2. *Experiment* 1S

Subject Type __________

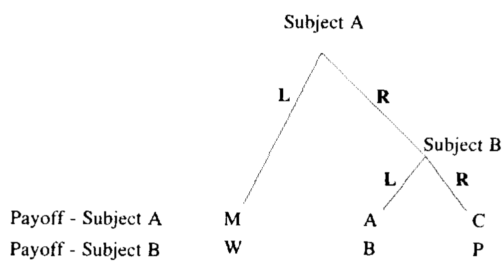
INSTRUCTIONS

This is an experiment in decision making. Several research foundations have provided funds for these experiments. If you follow the instructions, and make good decisions, you may earn a sizable amount of money. The experiment consists of two parts. The first part will be "practice," in the sense that payoffs will be nonmonetary letter payoffs. The second part of the experiment is where your dollar earnings will be determined. Here your decisions will earn you monetary payoffs which will be paid to you in cash.

PRACTICE ROUNDS

Half of the subjects in the room have been designated as type-A subjects and half as type-B subjects. Your type is printed in the upper right-hand corner of this instruction sheet. Before each round you will be paired with a subject of the opposite type with this subject being randomly selected by the computer. The experiment will last for 6 rounds.

In each round, the decision problem faced by you and your counterpart is summarized in the diagram below. The choices made by the two of you will determine how many points you earn in the round. Subject A chooses first. If Subject A selects L, then Subject B has no choice and Subject A receives M and Subject B receives W. If Subject A chooses R, then subject B must make a choice. If Subject B chooses L, then subject A receives A and Subject B receives B. If Subject B chooses R, then Subject A receives C and Subject B receives P.



SCHEME 1

Some Examples

Suppose Subject A selects Choice L. Then the outcome is represented by the letters M,W.

Suppose Subject A selects Choice R and Subject B selects Choice L. Then the outcome is represented by the letters A,B.

EXPERIMENTAL PROCEDURES

As you sit at your computer the monitor screen should look like this:

Round	Your Choice	The Outcome
1		
2		
3		
4		
5		
6		

⟨⟨⟨⟨⟨⟨⟨⟨ Please Wait ⟩⟩⟩⟩⟩⟩⟩⟩⟩⟩⟩

As the experiment proceeds you and your various counterparts will fill in the columns of this screen by making your choices.

If you are Subject A:

In round 1 when we tell you to begin, the following prompt will appear at the bottom of your screen:

Please make your choice: L or R

You will then type the letter L or R into the keyboard. The computer will then respond with the following message at the bottom of the screen:

Is _______ your choice? (Y/N)

If this choice is the one you want, type Y. That will enter your choice into the computer. If you type N, the computer will ask you to choose again.

If you select Choice L, then the following prompt will appear at the bottom of the screen:

You selected Choice L. The round is over. You earned M
⟨⟨ Press any key to continue ⟩⟩

If you select choice R, the following prompt will appear at the bottom of the screen:

You selected Choice R.
⟨⟨ Please wait while Subject B makes his choice ⟩⟩

After Subject B makes his choice, the computer computes the payoffs and the following message appears at the bottom of the screen:

You selected Choice _______ . The outcome is _____ .
⟨⟨ Press any key to Continue ⟩⟩

The computer will then record this information in the table above (on your monitor screen). You will then be asked to wait until all subjects in the experiment have completed the round. Notice that you are not explicitly told what choice your counterpart selected.

If you are Subject B:

In round 1 when we tell you to begin, the following prompt will appear at the bottom of your screen:

⟨⟨ Please wait for Subject A to make a choice ⟩⟩

If Subject A chooses L, the round is over and the following prompt will appear at the bottom of the screen:

⟨⟨ You have no choice to make. You earned W points ⟩⟩

⟨⟨ Press any key to continue ⟩⟩

The computer will then record this information in the table above. An asterisk (*) will indicate you had no choice to make. You will then be asked to wait until all subjects have completed the round.

If Subject A chooses R, the following prompt will appear.

Press make a choice: L or R

You will then type the letter L or R into the keyboard. The computer will then respond with the following message at the bottom of the screen:

Is _____ your choice? (Y/N)

If this choice is the one you want, type Y. That will enter your choice into the computer. If you type N, the computer will ask you to choose again. After you make your choice, the following prompt will appear at the bottom of the screen:

You selected Choice ____ . You earned _____ points.

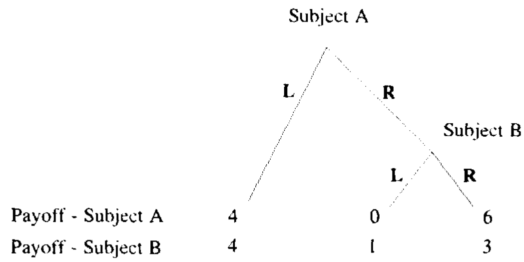
After completing round 1 you then proceed to round 2. We will proceed this way for 6 rounds.

YOUR DECISION PROBLEM

This decision situation is very similar to the one you just completed. Half the subjects in the room have been designated as type-A subjects and half as type-B subjects. Your type is printed in the upper right hand corner of the instruction sheet. Before each round you will be paired with a subject of the opposite type. The experiment will last for 4 to 6 rounds. In each round, *you will play against a different subject of the opposite type. That is, you will never play against the same subject of the opposite type more than once.*

As before, in each decision round the two of you will choose between two alternatives. The choices by the two of you will determine how many points you earn in that round.

The payoffs resulting from the decisions that the two of you make in any round are described in the diagram below. That is, this diagram tells you how many points each of the four possible decision choice pairs are worth to you.



SCHEME 2

Some Examples:

Suppose Subject A selects Choice L. Then Subject A earns 4 points and Subject B earns 4 points.

Suppose Subject A selects Choice R and Subject B selects Choice L. Then Subject A earns 0 points and Subject B earns 1 point.

PAYOFFS

Your dollar earnings for the experiment are determined as follows. First, we will sum up your point total over the 5 rounds. Then we will multiply this sum by $.70.

The procedure will be the same one you followed in the practice game. Remember, in each round you will be paired with a new (and different) counterpart. You will never play against the same counterpart more than once.

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