The Impact of Trembling on Behavior in the Trust Game

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This paper reports the results of experiments designed to investigate behavior in games when subjects must make an inference about how they arrived at a decision node. Specifically, we investigate a trust game where a random drawing determines if the first mover's decision is implemented or if instead the first mover trembles and the other action is undertaken. The results indicate that many second movers are willing to give the first mover the benefit of the doubt, but some use the uncertainty to justify more selfish behavior. This pattern is anticipated by first movers who are significantly less likely to trust the other person in this situation than in the typical sequential trust game.

Keywords: Exogenous Trembling, Intentions, Trust Games

JEL Classification: C70, C91, D64, D84

1. Introduction

In an attempt to understand observed behavior, researchers frequently attribute intent to actions. For example, ultimatum game proposers who offer the least possible amount to the second mover are often considered to be selfish or greedy. Previous research has shown that responses to a greedy proposal in ultimatum games can vary depending on the decision context and payoff structure (see for example Hoffman, McCabe, Shachat and Smith 1994). However, such factors do not universally affect behavior (see Cox and Deck 2002a). The behavior of a second mover is a reaction to the first mover's choice and possibly to inferences about the first mover's motivation as well. Another type of game in which motivations have been attributed to actions is the often studied investment game of Berg, Dickhaut, and McCabe (1995). In the investment game and the related trust game, the first mover can forgo a certain payoff in order to allow a second person the opportunity to allocate a larger amount of money. The decision by the first mover to forgo the guaranteed payoff is considered a trusting action and the decision by the second mover to share the additional money with the first mover is frequently considered reciprocal. Some studies have examined motives directly by decomposing a game into a triad of related games, some with and some without the hypothesized motivation (Cox and Deck 2002a,b and Cox 2002a,b). Other researchers have made comparisons by presenting a subject with a collection of similar games and observing how choices vary with the games' payoff structures (Falk, Fehr and Fischbacher, forthcoming; Güth, Huck and Müller, 2000).

It is not too surprising that laboratory experiments have confirmed that the same action can elicit different responses depending on the decision-maker's perception of the choices available to others. But unlike standard laboratory experiments where the chain of events leading up to a decision is completely observable, outside the laboratory people often have to make choices based upon incomplete information about the preceding actions others have taken. For example, agents may not know the set of available actions from which another person can choose or the payoff structure for some or possibly all of the actors. Alternatively, people may tremble when selecting an action. In such situations, inference about the intent and motivation of others is more ambiguous than in standard laboratory experiments. At least in the case of trembling, there is a well-developed theoretical literature. However there is little experimental analysis of this aspect of decision-making. Perhaps the lack of investigation into these more ambiguous situations, is due to the fact that equilibrium concepts such as trembling hand perfection are refinements of the Nash equilibrium concept, which itself has not proven to be an effective behavioral predictor since one cannot assume that utility is solely a positive monotonic transformation of one's own income (see, for example, Deck 2001).

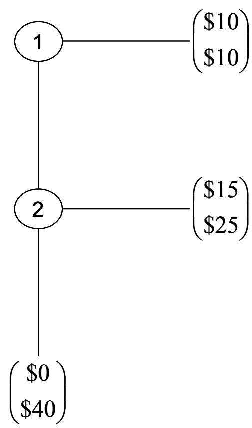
Given the limited direct experimental evidence, it is unclear how people's behavior changes under conditions of incomplete information about other's actions. It is conceivable, that as more noise enters the decision context, people will begin to act in a more materially self interested manner. With less information it would be difficult to ascertain why someone else behaved in a particular manner. Thus non-monetary motivations may become relatively less important to the decision maker. Some experimental evidence supports this hypothesis. McCabe, Rassenti and Smith (1998) conducted a series of experiments in which agents knew only their own payoff for any outcome. With repetition, they observed behavior which closely followed the subgame perfect Nash equilibrium prediction for fully rational self-interested agents. They reported that this behavior differed significantly from that observed when subjects actually had complete monetary payoff information for every outcome.

Our paper is a further exploration of the decision-making process when agents lack a fundamental piece of information. Specifically we investigate behavior when there is a non-trivial probability that a player trembles, which is implemented by the use of a randomization device. Thus, in order to attribute a motivation to another agent one must first consider the likelihood that the action was deliberate. Following sections describe the experimental design and results. The trust game decision task we investigate has been studied extensively and we draw upon this existing body of literature to further interpret our results. A final section contains concluding remarks.

2. Experimental Design

A total of 48 subject pairs played the trust game shown in Figure 1. Subjects were recruited from undergraduate classes at the University of Arkansas and were paid a $5 show up fee in addition to the payment associated with the outcome of the one shot game. Each subject participated in only one session and in one role. Upon entering the Walton Research Laboratory, the 12 students participating in a session were seated at computer terminals with privacy dividers and read the computerized directions.[1] After all subjects had finished the directions, each person was asked to complete a comprehension handout, which was subsequently checked by the experimenter for correctness.[2] Any subject making an incorrect response on this handout was given an oral and written description of the decision task by the experimenter. Throughout the experiment, neutral language was used in describing the task: the extensive form game was called a "decision tree"; players were referred to as "decision makers"; and so on.

Figure 1: Extensive Form Trust Game



Once all of the handouts had been checked, a sheet of additional directions was distributed to each participant. This sheet read as follows.

> *Additional Directions:*
> *Once a decision-maker 1 has made a decision by clicking on a branch and pressing send, that decision-maker 1 will be prompted by the computer to pick a number between 1 and 4 including 1 and 4. After all decision-maker 1s have selected a number, the experimenter will randomly draw a ball from a bingo cage. If the number the experimenter draws* ***does not match*** *the number decision-maker 1 selected, then decision-maker 1's* ***decision will remain unchanged****. However, if the number drawn by the experimenter is the same as the number selected by decision-maker 1, then decision-maker 1's choice will be reversed by the computer. Decision-maker 2 will never know the number selected by the decision-maker 1 counterpart.*

After these additional directions were read aloud, subjects were able to ask questions about this procedure. Also, the bingo cage and the numbered balls were shown to the subjects, as was a trial drawing from the bingo cage. Subjects were then prompted by the computer to enter their names. At this point the subjects were shown the game which they were to play one time. Subjects randomly assigned the role of decision-maker 1 selected an action and were then prompted to pick a number between 1 and 4. Next, the drawing was held in the presence of the subjects and then the decision-maker 2's observed the action attributed to their counterparts. Hence a decision-maker 2, who found himself selecting between keeping the entire $40 or keeping $25 and allocating $15 to decision-maker 1, knew that there was a 75% chance that his counterpart had selected the action leading to this decision node and a 25% chance that his counterpart had opted for an equal split of $20.[3] Decision-maker 2s then made their decisions and the outcome was revealed to the decision-maker 1s. Each subject was then paid in private and dismissed from the experiment. On average, the laboratory sessions lasted approximately 40 minutes.

Using the same experimental protocols we employ, previous work has shown that decision-maker 2 behavior is affected by the preceding action of the other person. Data from Cox and Deck (2002a,b) and McCabe and Smith (2000) show the robust finding that approximately two thirds of decision-maker 2s opt for the ($15,$25) outcome under standard sequential play of the trust game. However, data from Cox and Deck (2002a,b) demonstrate that two thirds of subjects in a dictator game prefer receiving $40 and leaving $0 for their counterpart to receiving $25 and leaving $15 for their counterpart. Together, these trust and dictator game data show that more second movers behave generously in response to a trusting action by first movers than they would otherwise. More specifically, the data show that subjects can be divided into three categories: (1) those who are materially selfish; (2) those who are materially generous whether or not a paired first mover has trusted them; and (3) those who are materially generous only if the paired first mover has trusted them. About one-third of the subjects fall into each of these categories. Only the third category of subjects exhibits positive reciprocity (Cox and Deck, 2002a).

When deciding how to react when faced with an observed action that could have arisen from a tremble, it seems unlikely that people who always acted selfishly or generously in the absence of trembles would change their behavior. However, those whose choice is conditional must decide whether or not to give the other player the benefit of the doubt when trembling is introduced. Therefore, if reciprocal behavior is robust in these games, one would expect decision-maker 2 behavior in the tremble treatment to lie somewhere between that observed in trust and dictator game experiments using the same money payoffs and social-distance payoff protocol.

3. Results

Of the seventeen decision maker 2s who had to make a choice, eight acted selfishly. This 53% rate of acting generously is between the 64% rate observed in sequential play of the trust game and 33% rate observed in the dictator game. There is marginally significant evidence that the ($15, $25) outcome was observed more frequently with trembling than in the dictator game (p-value = 0.105 in the one tailed z-test of equal proportions). However, one cannot reject the null hypothesis that decision-maker 2 behavior does not differ when decision maker 1's action may or may not have been intentional, in favor of the one sided alternative that selfish behavior is observed less frequently with trembling than in the sequential trust game (p-value from z-test is 0.232). This suggests that many, but not all, second movers that condition their responses on decision-maker 1 behavior are willing to give the other person the benefit of the doubt.

Given the 25% chance that the computer will reverse a decision-maker 1s choice, it is optimal for a decision-maker 1 to select his or her preferred action (see Appendix 3). Also, decision-maker 1 behavior in the trembling game should not differ from that observed in the standard sequential game unless they believe that decision-maker 2 behavior will change (see Appendix 3). Even though a smaller percentage of decision-maker 2s acting generously is likely to be observed with trembling, previous experimental evidence suggests that decision-maker 1s have difficulty in anticipating decision-maker 2 behavior. Cox and Deck (2002a) found that half of decision maker 1s opted for the equal split of $20 rather than trusting their counterpart under both a single-blind and a double-blind payoff protocol. However, that treatment did significantly alter decision-maker 2 behavior. Instead of two-thirds of the decision-maker 2s acting generously, a reversal occurred: two-thirds of the subjects acted selfishly when their personal action was unknown even to the experimenter.

We observe that decision-maker 1s did anticipate a behavioral shift towards selfishness on the part of decision maker 2s associated with the introduction of trembling. Of the 47 observed decision-maker 1s, 32 chose the ($10,$10) outcome and only 15 trusted the second mover.[4] This 32% trusting rate is in direct contrast to the fairly robust 50% rate found previously. This difference is significant, with a p-value of 0.028, showing that the null hypothesis of equal rates can be rejected in favor of the one-sided alternative using a z-test.

This general pattern of behavior was also observed, at least nominally, by Dufwenberg, Gneezy, Güth, and van Damme (2000). Their experiment included a treatment in which the second mover was told that the multiplier was 3 and another treatment in which the second mover was informed that the multiplier would be 2 or 4, each with probability ½. Second movers in the stochastic-multiplier treatment allocated a lower percentage of the surplus to the first mover even though the expected multiplier was the same in both cases.[5] Correctly anticipating this, first movers in the known-multiplier treatment were less trusting, as measured by the percentage of their endowments sent to the second movers.

4. Conclusion

Often, when people make decisions they have incomplete information and therefore have to make inferences about what they observe. This feature of decision-making has two important consequences for studying economic behavior. First a person has to consider, not how his action will be interpreted, but rather how a noisy signal of his action will be interpreted. Second, a person must decide how to react to an action that may or may not have been intentional. This differs from standard laboratory experiments in which subjects have complete information about the game structure.

To begin study of decisions with this realistic component, we make use of the extensive literature on trust games. Authors of previous studies with the same stakes used here, $40 per subject pair, and single-blind payoff procedures, have reported that two-thirds of decision maker 2s typically behave in a generous manner in a sequentially-played trust game. We observe a generosity rate that is somewhat lower, 54%, though this not significantly different from the rate in previous studies. This nominal behavioral shift is in the direction of the 33% generosity rate reported for subjects facing the same allocation decision as dictators, that is without the preceding trusting action of the other person. Hence, we conclude that most of the agents that condition their responses on the trust of the other person are willing to give that person the benefit of the doubt about intentions. However, some decision-makers seem to use the exogenous noise to justify acting selfishly. This finding is consistent with the finding in Cox and Deck (2002a), that reciprocity is not fully internalized, in that two-thirds of decision-maker 2s are selfish when the payoffs are double blind, regardless of whether the decision context is a dictator or trust game. Thus this study offers additional support that conditional generosity is driven by a desire to be viewed by others as being reciprocal, rather than by an internalized social norm for reciprocity. Unlike other factors that have been found to influence decision-maker 2 behavior, decision-maker 1s correctly anticipate how their trembling will affect decision-maker 2s choices. Typically, one-half of decision-maker 1s exhibit trust in the sequential trust game. However, we observed a significantly lower trusting rate, 32%, when trembling was introduced. While the literature is filled with studies that have found that subgame perfect equilibrium, in conjunction with the assumption of material self-interest, lacks good predictive power in complete information fairness games, we observe behavior for both decision-makers that has shifted towards the subgame perfect equilibrium prediction for materially-selfish agents.

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End Notes

[1] A copy of these directions is provided in Appendix 1.

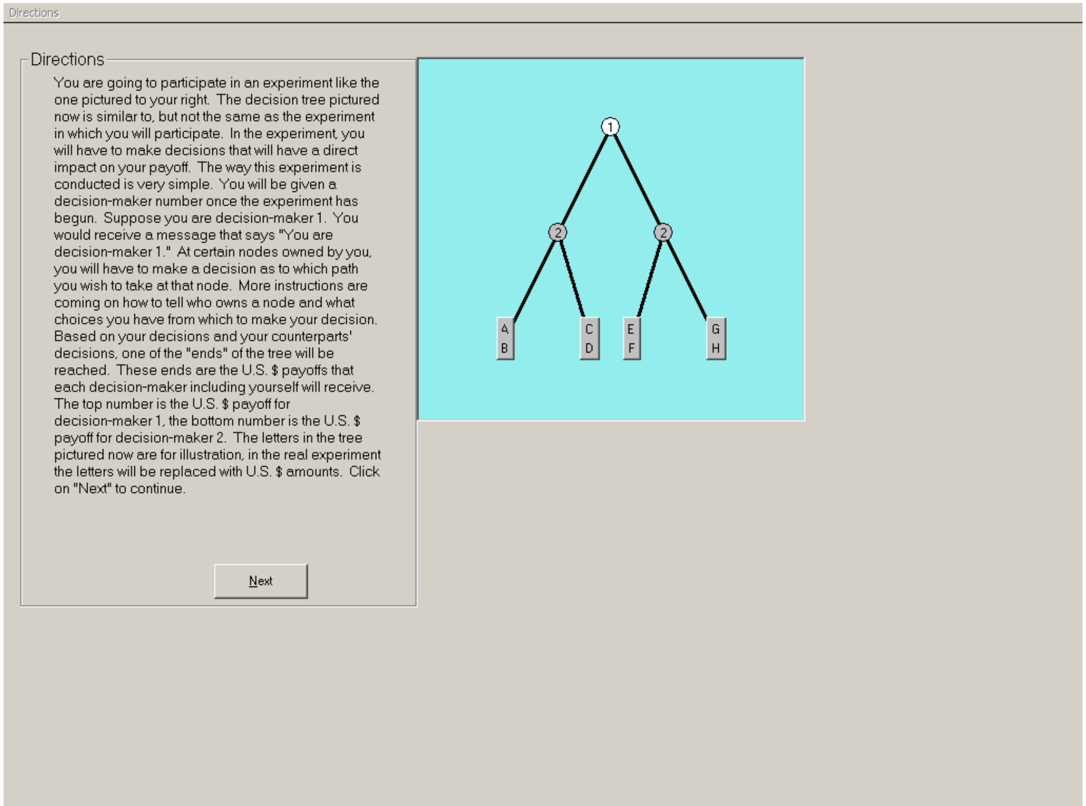
[2] A copy of this handout is provided in Appendix 2.

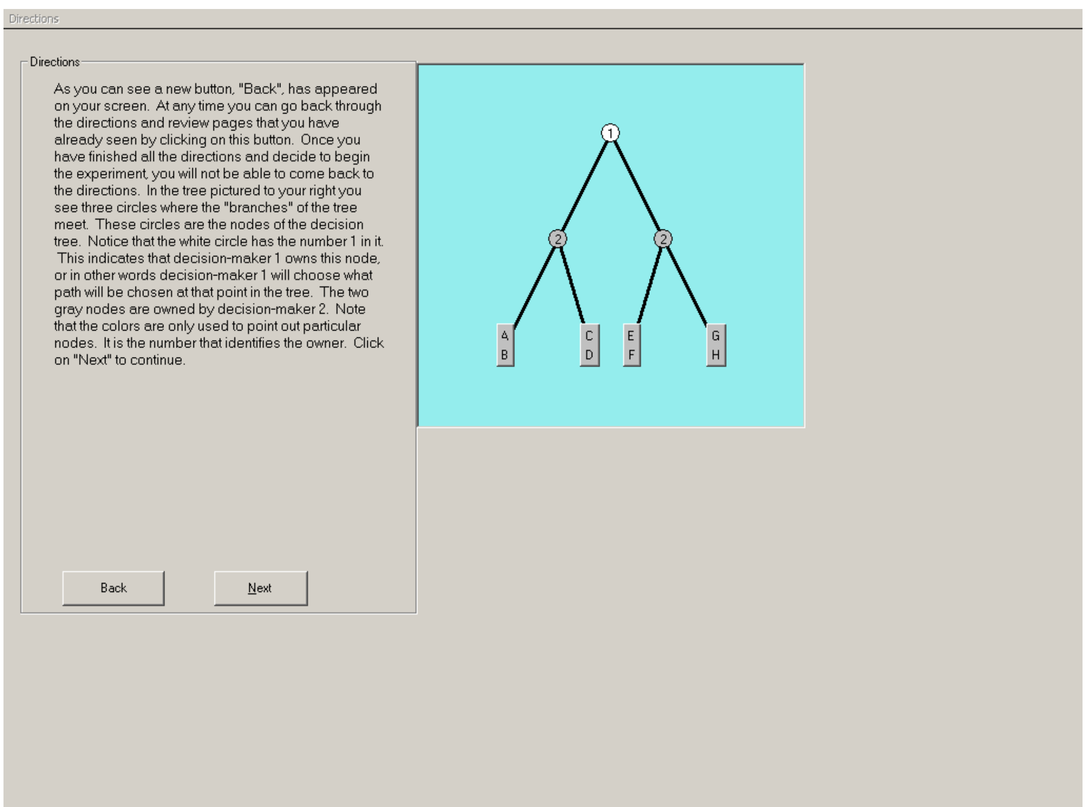
[3] This experimental design is similar to that employed by Dufwenberg, Gneezy, Güth, and van Damme (2000) for the investment game. In that study the first mover knew the multiplier that would be used to increase the surplus as a function of his or her action while the second mover who would decide how to allocate the surplus only knew the distribution from which the multiplier would be drawn.

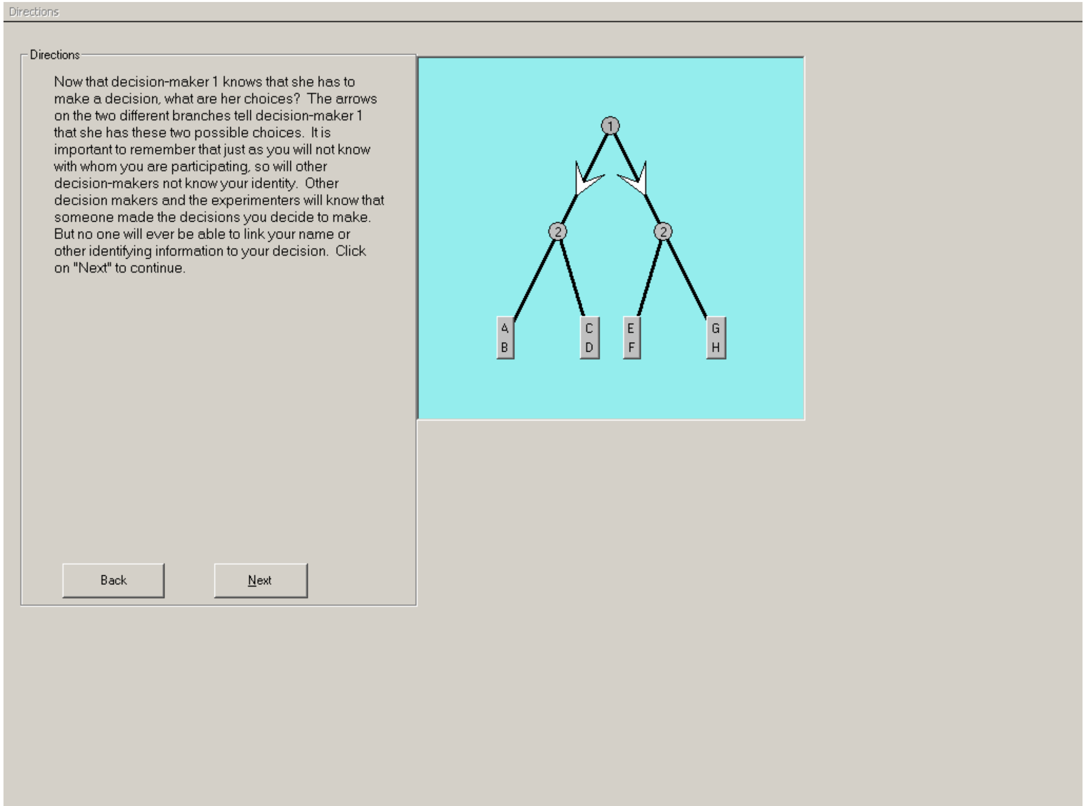
[4] One subject was inadvertently allowed to participate after having been a subject in a related study. The data for this experienced subject was excluded from the analysis.

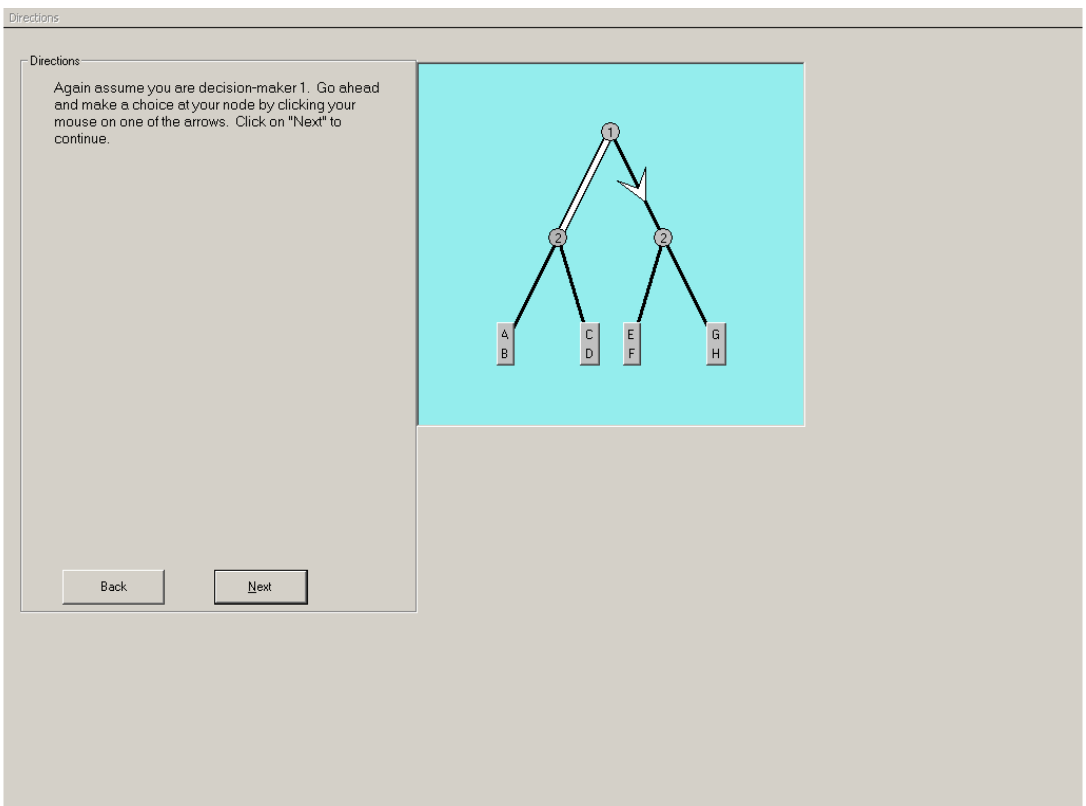
[5] In the investment game, the first mover decides how much of his or her endowment to pass to a second mover. Any amount passed is multiplied at some rate and then the second mover decides how to allocate this money plus his or her own endowment.

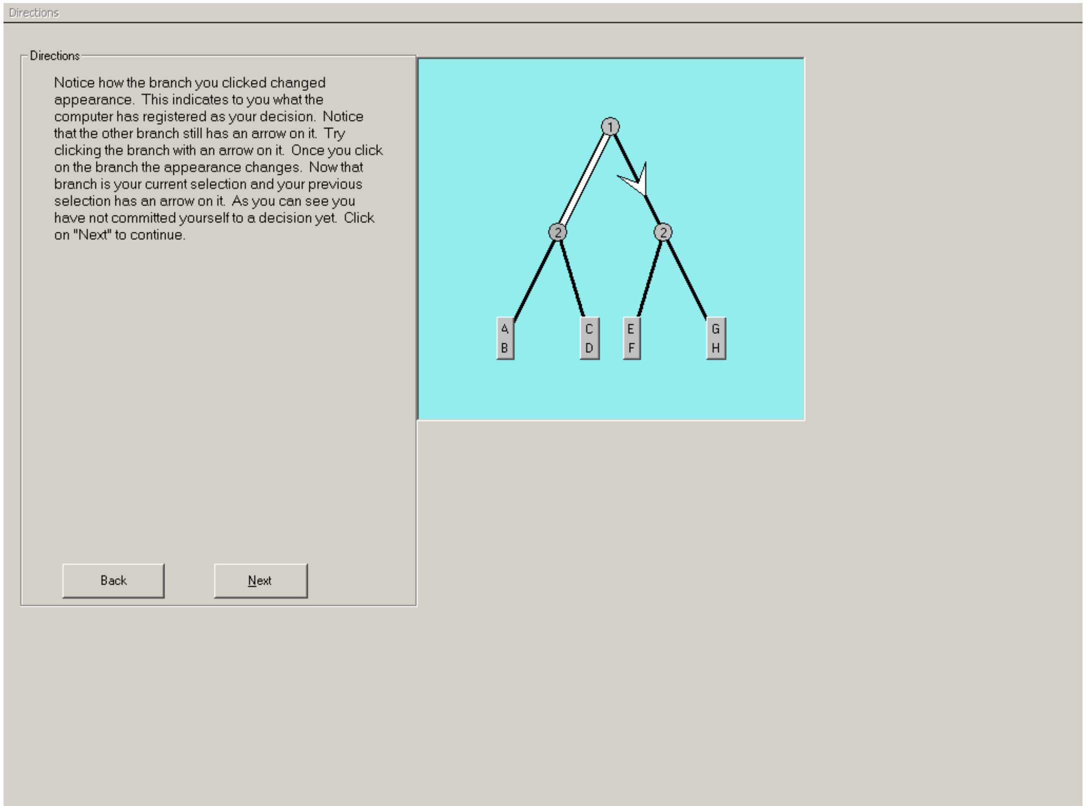
Appendix 1. Subject Directions

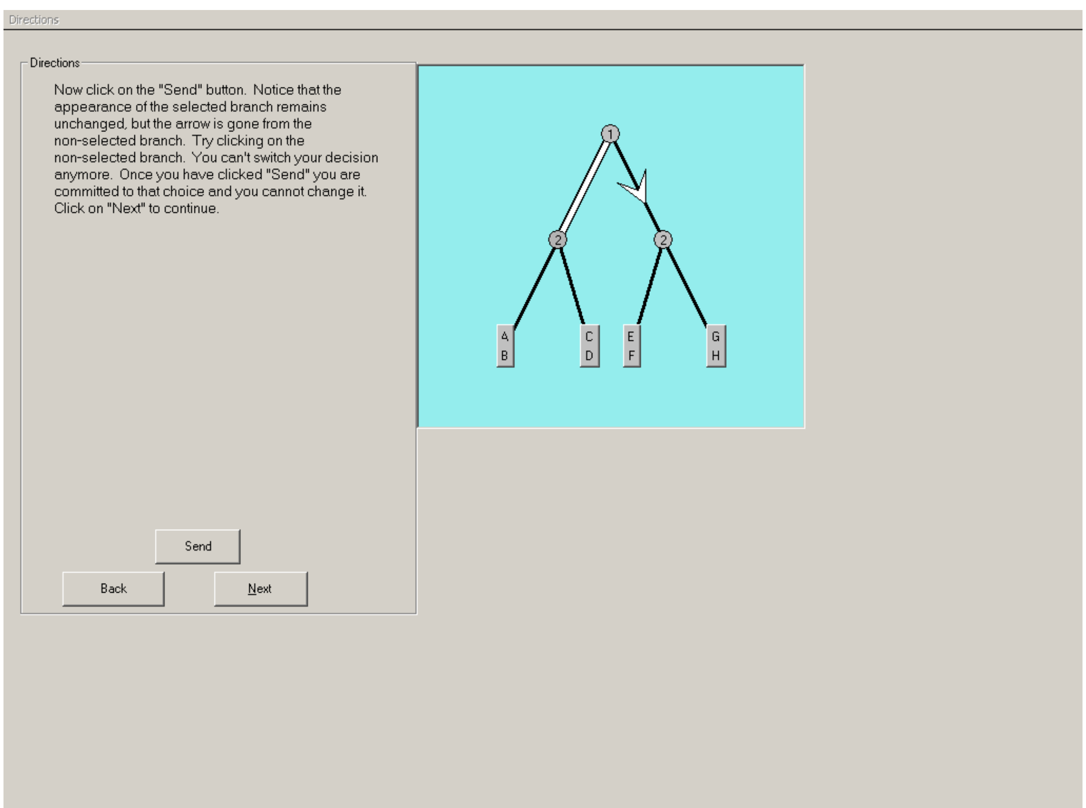


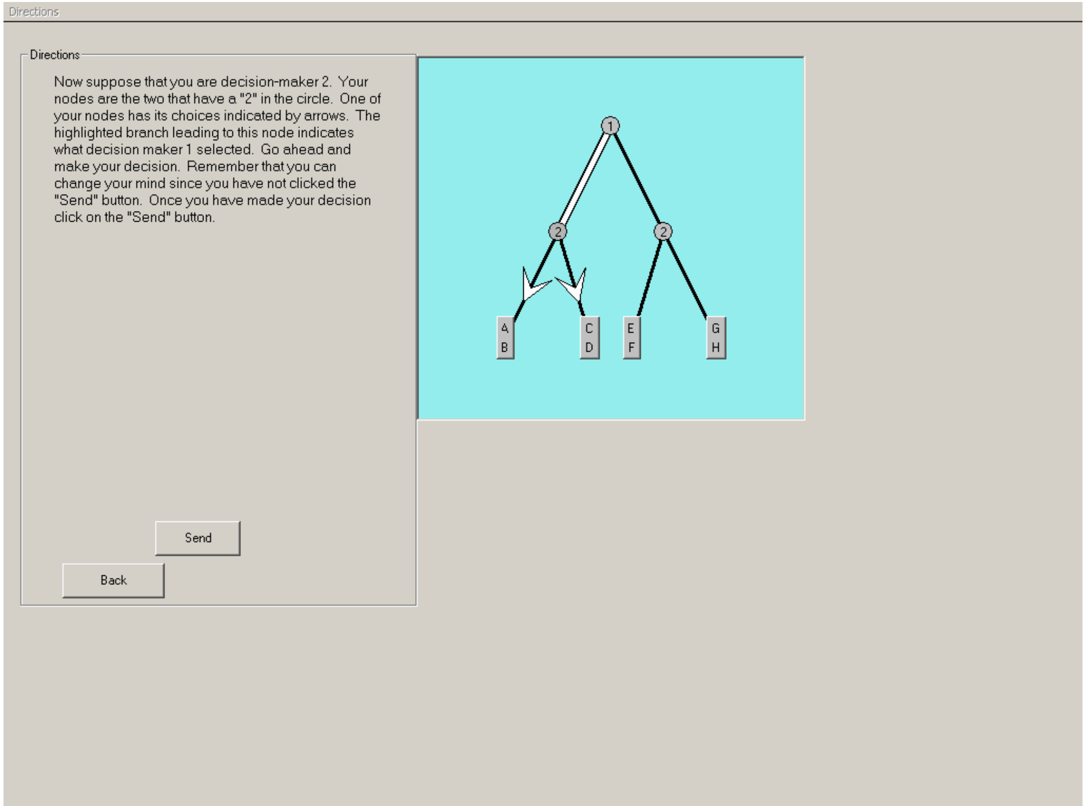


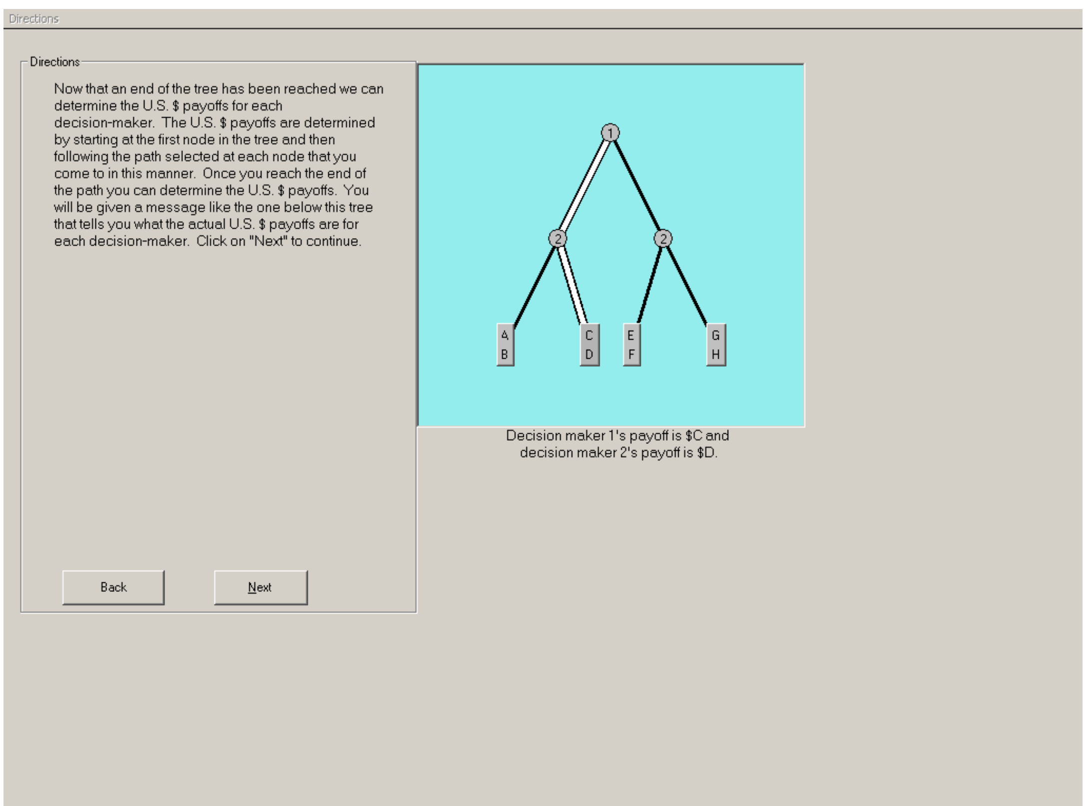

Directions
Directions
Now that decision-maker 1 knows that she has to make a decision, what are her choices? The arrows on the two different branches tell decision-maker 1 that she has these two possible choices. It is important to remember that just as you will not know with whom you are participating, so will other decision-makers not know your identity. Other decision makers and the experimenters will know that someone made the decisions you decide to make. But no one will ever be able to link your name or other identifying information to your decision. Click on "Next" to continue.
1
2
2
A
B
C
D
E
F
G
H
Back
Next

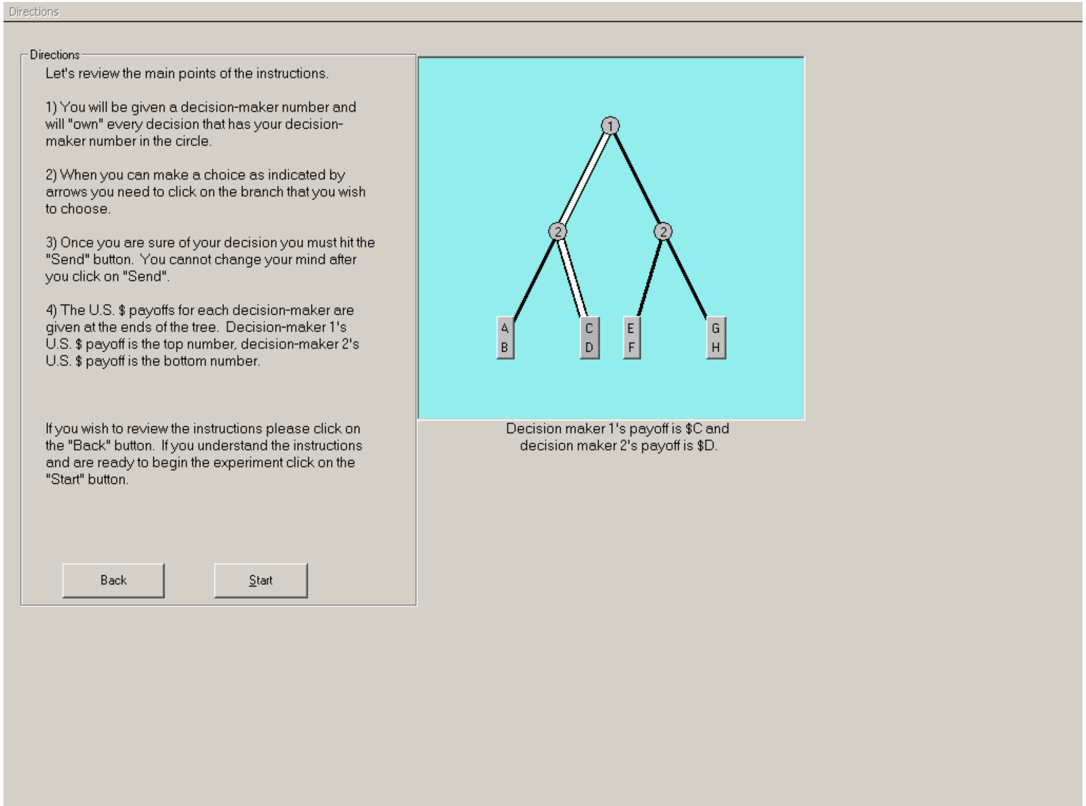

Directions
Directions
Again assume you are decision-maker 1. Go ahead and make a choice at your node by clicking your mouse on one of the arrows. Click on "Next" to continue.
1
2
2
A
B
C
D
E
F
G
H
Back
Next


Directions
Directions
Notice how the branch you clicked changed appearance. This indicates to you what the computer has registered as your decision. Notice that the other branch still has an arrow on it. Try clicking the branch with an arrow on it. Once you click on the branch the appearance changes. Now that branch is your current selection and your previous selection has an arrow on it. As you can see you have not committed yourself to a decision yet. Click on "Next" to continue.
1
2
2
A B
C D
E F
G H
Back
Next

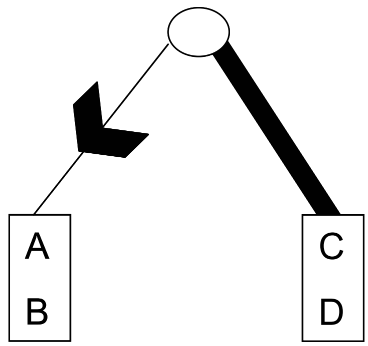

Directions
Directions
Now click on the "Send" button. Notice that the appearance of the selected branch remains unchanged, but the arrow is gone from the non-selected branch. Try clicking on the non-selected branch. You can't switch your decision anymore. Once you have clicked "Send" you are committed to that choice and you cannot change it. Click on "Next" to continue.
1
2
2
A B
C D
E F
G H
Send
Back
Next


Directions
Directions
Now suppose that you are decision-maker 2. Your nodes are the two that have a "2" in the circle. One of your nodes has its choices indicated by arrows. The highlighted branch leading to this node indicates what decision maker 1 selected. Go ahead and make your decision. Remember that you can change your mind since you have not clicked the "Send" button. Once you have made your decision click on the "Send" button.
1
2
2
A B
C D
E F
G H
Send
Back


Directions
Directions
Now that an end of the tree has been reached we can determine the U.S. $ payoffs for each decision-maker. The U.S. $ payoffs are determined by starting at the first node in the tree and then following the path selected at each node that you come to in this manner. Once you reach the end of the path you can determine the U.S. $ payoffs. You will be given a message like the one below this tree that tells you what the actual U.S. $ payoffs are for each decision-maker. Click on "Next" to continue.
1
2
2
A B
C D
E F
G H
Decision maker 1's payoff is $C and decision maker 2's payoff is $D.
Back
Next


Directions
Directions
Let's review the main points of the instructions.
1) You will be given a decision-maker number and will "own" every decision that has your decision-maker number in the circle.
2) When you can make a choice as indicated by arrows you need to click on the branch that you wish to choose.
3) Once you are sure of your decision you must hit the "Send" button. You cannot change your mind after you click on "Send".
4) The U.S. $ payoffs for each decision-maker are given at the ends of the tree. Decision-maker 1's U.S. $ payoff is the top number, decision-maker 2's U.S. $ payoff is the bottom number.
If you wish to review the instructions please click on the "Back" button. If you understand the instructions and are ready to begin the experiment click on the "Start" button.
Back
Start
1
2
2
A
B
C
D
E
F
G
H
Decision maker 1's payoff is $C and decision maker 2's payoff is $D.

Appendix 2. Comprehension Handout



If you press Send when the decision tree looks like the figure above

what is decision maker 1's payoff? ________

what is decision maker 2's payoff? ________

Appendix 3. Theoretical Analysis of Decision-Maker 1 Choices

Let u(x,y) denote decision-maker 1's utility from the outcome where decision-maker 1 receives \$x and the other person receives \$y. We assume that no player is indifferent between his or her two alternative actions. Also, let λ be player 1's subjective probability that player 2 will choose the outcome (15,25) if player 2 observes a trusting action in the tremble game and let α be the probability that player 1 does not tremble.

Proof that Player 1 should reveal truthfully

Suppose that player 1's preferences are such that $u(10,10) > \lambda u(15,25) + (1-\lambda)u(0,40)$. That is, player 1 prefers that the second mover not have an opportunity to make a decision. From selecting the action leading to (10,10), player 1 would receive an expected utility of $\alpha u(10,10) + (1-\alpha)(\lambda u(15,25) + (1-\lambda)u(0,40))$. From selecting the trusting action, player 1's expected utility would be $(1-\alpha)u(10,10) + \alpha(\lambda u(15,25) + (1-\lambda)u(0,40))$. Thus this agent should select the action leading to (10,10) if $\alpha u(10,10) + (1-\alpha)(\lambda u(15,25) + (1-\lambda)u(0,40)) > (1-\alpha)u(10,10) + \alpha(\lambda u(15,25) + (1-\lambda)u(0,40))$. Which can be rewritten as $(2\alpha-1)u(10,10) > (2\alpha-1)(\lambda u(15,25) + (1-\lambda)u(0,40)$. This can be reduced to $u(10,10) > \lambda u(15,25) + (1-\lambda)u(0,40)$ as long as $2\alpha-1>0$ or $\alpha > ½$. Given that $\alpha = ¾$ in the experiments a player 1 who prefers the (10,10) outcome should select that action. As the preference structure in the preceding argument can be replaced by a strict preference for trusting, all player 1s should truthfully reveal. □

Proof that player 1 behavior differs between the trembling game and the standard sequential game only if player 1's belief about player 2's behavior differs between the games

From the preceding proof, player 1 should select the action that truthfully reflects her preferences if $\alpha > ½$, given her beliefs represented by the subjective probability λ. In the trembling game, $\alpha = 3/4$ and in the standard sequential version of the game, $\alpha = 1$. Let γ be player 1's belief that player 2 will choose the outcome (15,25) if player 2 observes a trusting action in the standard sequential game. Consider the case of a person who chooses (10,10) when $\alpha = 3/4$ and trusts when $\alpha = 1$. For this individual it must be that $u(10,10) > \lambda u(15,25) + (1-\lambda)u(0,40)$ from above and that $u(10,10) < \gamma u(15,25) + (1-\gamma)u(0,40)$. The only way these two inequalities can hold simultaneously is if $\lambda \neq \gamma$. By symmetry an individual who trusts when $\alpha = 1$ and chooses (10,10) when $\alpha = 3/4$ must also believe the probability that player 2 will select (15,25) differs between the standard trust game and the tremble treatment. □