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The impact of group collaboration and performance on interpersonal trust and cooperation

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Can group collaboration and decision-making lead to increased interpersonal trust and cooperation? Prior research suggests that collective problem solving can increase interpersonal trust and cooperation. However, measuring the impact of group collaboration in observational studies is very difficult due to confounding variables. Using an innovative laboratory experiment involving the optimal stopping problem, we test whether collaborative institutions increase trust and cooperation in groups. An especially useful feature of our design is that it allows us to separate the impact of group success and group collaboration. We find no evidence that group collaboration or success in the task affect interpersonal trust and cooperation.

Keywords: groups, performance, trust and cooperation, optimal stopping problem

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Introduction

Trust and cooperation are important outcomes in many social science disciplines. Scholars have argued that trust forms the backbone of many important political activities (Hardin, 2006), underpins the development of social capital (Putnam, 1993; Brehm & Rahn, 1997), and facilitates economic exchange (Arrow, 1972). Social capital, in turn, plays a positive role in government effectiveness and economic development (Putnam, 1993; Knack & Keefer, 1997; Fukuyama, 2001). Likewise, the ability to collaborate with others is an essential element in the development of modern social and political organization (Skyrms, 2003).

Thousands of papers have been published over the past 100 years on group and team dynamics, exploring a wide array of questions.[1] Much of this literature focuses on group efficiency, effectiveness, or performance.[2]

Success or failure in these tasks has been related to a wide variety of factors, including motivation loss, leadership, mediation, decision-procedures, internal cohesion, group type, group efficacy, group motivation losses, and other factors.[3] Besides performance, scholars have studied how group participation is linked to a wide variety of other outcomes, including extremism, interaction, conformity, self-esteem, group-to-individual skill transfers, and stress (Eagly, 1978; Johnson & Glover, 1978; Stern & Schulz-Hardt, 2017). Dynamics have been studied in widely varying settings, including laboratories, classrooms, juries, military organizations, business, sports, and social groups (Kaplan, 1977; Hambrick, 1995; Myers, 2004).

Particularly relevant for this research is the literature examining team or group cohesion and its relationship with trust and performance. Cohesion and performance appear to have a two-way relationship: cohesion increases group performance, and performance increases group cohesion. Of these, there is evidence that performance has a larger impact on cohesion than cohesion does on performance (Mathieu et al., 2015).

Although trust and cohesion are generally thought to develop over time through interaction, there is also research showing that trust can be generated in laboratory environments. Glaeser et al. (2000), for example, find that social connection predicts both trust and trustworthiness, and collaborative projects may provide an opportunity to build such social connection. Berg, Dickhaut, and McCabe (1995) similarly find evidence that learning about others' behavior in a trust game can increase average trustworthiness. Other research shows that conversations among community members increase cooperation (Carpenter, Daniere, & Takahashi, 2004), that conditional cooperators contribute more in a public goods game when they learn they are in a group with other conditional cooperators, and that face-to-face communication increases contributions in a public goods game as well (Chaudhuri, 2011). Finally, using an experimental design, Nielsen (2016) find that electing a leader to make the final decision in a group decision-making process improved trust among group members.

The concepts of trust and cooperation are difficult to test in the field because of many confounding and endogenous variables. Typically, groups that already have high levels of interpersonal trust are those most likely to work together in the first place. In addition, as groups are often more successful than individuals, it can be difficult to identify the impact of collaborative effort from the impact of simply being successful. For example, if individuals work together to complete a small development project in their community and the project is successful, it can reinforce the benefits of collaboration, increase interpersonal trust, and increase the likelihood that individuals will collaborate in the future. Still, identifying the impact of collaborative problem solving on group cohesion is important because across a variety of fields, group problem-solving is recommended as a way to increase social cohesion.

We examine the impact of group versus individual problem solving and the impact of performance on interpersonal trust and cooperation. Our experiment makes two primary contributions to the literature regarding trust and cooperation. First, we examine the impact of group versus individual decision-making on prosocial outcomes, including interpersonal trust and cooperation. While other studies have examined the impact of trust on performance, we test whether merely participating in a group effort creates trust and cooperative tendencies.

Second, we also offer an innovative approach to measuring the causal impact of performance on attitudes. Normally, measuring the impact of performance on prosocial attitudes like trust, cooperation, or cohesion is difficult because the causal effects may flow in either direction. It may be that performance increases prosocial behavior − and also that pre-existing group trust or cohesion increases performance. For this study, we use the optimal stopping problem with randomly chosen numeric sequences (explained below). Performance in this task depends both on skill and on a stochastic element (i.e., the sequences of numbers randomly drawn for the task). In some trials, groups were virtually guaranteed to perform well because of the stochastic element; in others, they were very likely to perform poorly. As a result, we can use this stochastic element as an exogenous instrument for performance, thus identifying the impact of performance on trust.

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1 For a summary, see (Kerr & Tindale, 2004; Zander, 1979; Helmreich, Bakeman, & Scherwitz, 1973)

2 Such studies have examined widely varying performance tasks, including for example, group versus individual true-false examinations, jigsaw puzzles, brainstorming sessions, learning, and spatial perception (Gurnee, 1937; Husband, 1940; Jung & Avolio, 1999; Casey, 2013; Barton, Jr., 1926).

3 For a few examples, see (Liden et al., 2006; Goodman, Ravlin, & Schminke, 1987; Gully et al., 2002; Steiner, 1972; Hill, 1982).

Research Design

We use a laboratory experiment to test whether collaborative problem solving affects trust and cooperation. In our experiment, all subjects are assigned to complete a series of decision-making exercises. The key manipulation is the random assignment of subjects to complete the task individually or in groups. Subjects earn money for making correct choices in the experimental task and do not earn money for incorrect choices. If randomly assigned to the individual treatment, subjects work alone to solve the experimental task and are compensated for their individual success or failure. If randomly assigned to the group treatment, then subjects work with others to solve the experimental task, deliberate over the best choice, decide on a response via democratic procedures, and are then compensated based on whether the group succeeds or fails. The group treatment thus captures three characteristics of collaborative efforts: interactive deliberation, collective decision making, and shared outcomes.

We also test whether performance in the task affects trust and cooperation. The challenge is that group cohesion might affect performance and our measures of trust and cooperation, so we need an exogenous instrument for success. Our solution is to randomize features of the task across trials. These features make success more or less likely, depending on a sequence of randomly drawn values (explained below). In addition, the task allows us to calculate the expected success for each trial. Expected success depends only on randomly drawn values and is thus orthogonal to any pre-existing social capital or group characteristics. Consequently, we use expected success as an instrument for observed success in our analysis, which allows us to identify the impact of success on our dependent variables.

Experimental Procedure

Subjects were undergraduate students from a large public university in the United States, and the experiment was conducted on that university campus. Subjects were recruited from undergraduate departments via email. After completing a short online questionnaire, they were directed to sign up for experimental sessions. Each session was randomly assigned in advance to be either a group or individual treatment, and subjects were not informed prior to participation if they were in the group or individual treatment. After arriving to the experiment location, subjects were seated at a table behind individual study carrels, completed a consent process, and were then read aloud the instructions for the decision-making task (described in the next section). Subjects were also quizzed about the task instructions and were paid for each correct answer. If a subject missed an answer, we corrected it to ensure understanding of the task.[4]

In each session, three subjects participated. Three subjects is a small number (for a group), but balances budget and space constraints with statistical power. Because the treatment is applied at the group level, each session generates only a single experimental observation for analysis. We conducted a total of 102 experimental sessions (51 group, 51 individual), which required recruiting and compensating 306 subjects.

The Decision-Making Task

We use the Optimal Stopping Problem for the decision-making task in this experiment. In this task, the goal is to identify the largest number in a sequence of five randomly drawn numbers without knowing which numbers are in the sequence and only seeing one number at a time. Before the experiments, we drew thousands of random sequences of five integers from all integers from 1 to 100. For each sequence, numbers are sampled without replacement but may be reused across sequences. The experimental subjects know the population from which numbers are drawn but do not know which five have been drawn in a given sequence. Subjects (individually or in groups) are presented with one number at a time from a sequence and must decide whether that number is the largest number of the sequence.

If the subjects decide a number is the largest, then the trial is stopped. If they decide it is not, then we present the next number in the sequence (if they have not reached the end of the sequence). If subjects do not choose one of the first four numbers, then the fifth number is automatically chosen as their answer. If the largest number is correctly chosen, then subjects earn money. In the individual treatment, each individual's earnings depend on their individual performance. In the group treatment, all subjects in a group receive the same compensation depending on their performance. In each session, subjects played three trials of the game with three different sequences of numbers.

The Optimal Stopping Problem has a number of characteristics that make it useful in our experiment. It is a task that can be completed by individuals or groups. It is conceptually simple and builds on skills that subjects already have, ensuring that results are not driven by confusion or an inability to do the task. The task involves uncertain payoffs, as at the time of each decision, subjects do not know whether their choice will lead to earning money. Finally, depending on the numbers randomly drawn for each trial, expected success varies substantially. Some sequences make winning very likely; others make losing very likely. As discussed below, we can calculate the expected success for each sequence of numbers, and use this as an instrument for performance. This feature of the Optimal Stopping Problem will allow us to measure the impact of performance on group trust and cooperation.

Experimental Treatments

There were two treatments. The first randomly-assigned treatment was whether the three subjects in a session worked together or individually during the experimental session, which we call the Group Treatment. If assigned to the group treatment, subjects were instructed that they would decide as a group whether to stop at a given number if they thought it was the largest in the sequence or to proceed to the next number. They were told

[4] See appendix for the full experimental protocol.

that they could discuss the group decision and would be given a piece of paper to record each decision and how many of the three members agreed with the decision. After the instructions were read, subjects in the group treatment were instructed to take down the study carrels, and worked together to complete three trials of the task. After completing the three trials, the study carrels were put back up and the total number of correct answers was revealed to each player individually. In the individual treatment, the study carrels were left in place and students completed the Optimal Stopping Problem in isolation.

The second treatment was the set of numeric sequences that were assigned to subjects. We randomly generated sequences for sessions. These randomly-generated sequences also provide a measure of performance in the Optimal Stopping Problem. Typically, it is difficult to estimate how success affects trust and cooperation because pre-existing characteristics of the subjects could also affect the success of collaboration. However, the Optimal Stopping Problem provides a solution to this endogeneity problem.

In the Optimal Stopping Problem, performance depends both on subjects' abilities and choices, and also on the numeric sequences that subjects face. These numeric sequences are randomly assigned.

Thus, we can use an instrumental variables approach. The Optimal Stopping Problem provides some sequences that subjects are likely to win and others that they are likely to lose, even if subjects play optimally. As a result, we can calculate expected performance for any particular sequence of numbers and use this as an instrument for actual earnings. There is an optimal strategy for this game: as each value is drawn, stop if the probability is greater than .50 that the current number is the maximum of the entire sequence, but continue if the probability is less than .50.[5] For every sequence, we calculated the number of games that subjects were expected to win, were they playing optimally. These expected earnings are entirely determined by the random sequences of numbers, and can only be related to post-treatment trust and cooperation through actual success.

Some sequences make success very likely. For example, if drawing from integers between 1 and 100, subjects are likely to succeed with the sequence 1,2,3,4,5, because at each step, the player knows that the next number must be higher; there are no lower numbers left. Consider the following actual sequence from the experiment: 99, 86, 91, 7, 62. Most subjects will understand that if they pick 99, the only way to lose is if the number 100 appears later in the sequence, and this has a relatively low probability of .0404.[6] On the other hand, with some sequences it is unlikely that subjects will stop at the maximum even if playing the optimal strategy. For example, in another sequence drawn in one trial (47, 97, 98, 56, 88), subjects likely would be tempted to choose 97, since the probability of a higher number on the next three draws is only .0899.[7] However in this case, choosing 97 would lead to a loss because there is a higher number later in the sequence.

Most sequences fall between these extremes. Figure 1 shows characteristics of all actual sequences drawn in the experiment.[8] The graph on the left shows characteristics of every value from every sequence used in the experiment. The x-axis is each value's location in the five-number sequence, from first to last. The y-axis shows the ex-ante probability that a value faced by subjects was in fact the maximum. Green and red points show the actual maximum in each sequence. Green maximums identify cases where subjects, if they were playing optimally, would have selected the maximum and won the game. The red maximums show cases where subjects, if playing optimally, would have not chosen the maximum and thus would have lost the game.[9] These maximums would not be chosen when playing optimally because a tempting non-maximum came before them in the sequence, or because their ex-ante probability of being the maximum was less than .50. Note that values are slightly jittered for clarity.

Early in the sequence, the probabilities span the entire probability space from 0 to 1. In cases where the maximum is in the first round, all green points are above .50 and all red points are below .50—the decision-making threshold for stopping or continuing. Note as well that in the first round, there are some tempting non-maximums. For example, the black point at (1,.85) was a tempting candidate for subjects. That point came from the sequence 96, 83, 97, 15, 55. The first value subjects saw was thus 96, which had an ex-ante probability of .85 of being the maximum. However, this was not the maximum—the third value in the sequence, 97, was the true maximum. In this example, subjects playing with an optimal decision rule would in fact lose—they would stop in the first round when they saw the number 96, thus missing the true maximum, 97. In the actual trial, the subjects all chose to stop at 96—and thus lost that game.

In that first round, there are also deceptively low maximums.

5 Subjects should be indifferent between stopping and continuing when the probability is exactly .50. A non-optimal strategy would be to play any other strategy—for example, to only stop if the probability that a number is the maximum is greater than .75.

6 The probability of drawing a 100 on one of the last four draws, after first drawing a 99 is $\frac{\binom{1}{1}\binom{98}{3}}{\binom{99}{4}}$ =.0404.

7 The probability of drawing a 98, 99, or 100 on the last three draws is: $1-\frac{\binom{3}{0}\binom{95}{3}}{\binom{98}{3}} = 0.899$.

8 These graphs examine the ex-ante probabilities associated with the actual sequences faced by subjects in the experiment. By ex-ante probability, we mean the probability before the entire sequence has been revealed. For example, in the sequence 80, 90, 30, 4, 92, the ex-ante probability that the second value, 90, is the maximum is the probability that the subsequent three draws are lower than 90. This can be calculated as $\frac{\binom{10}{0}\binom{88}{3}}{\binom{98}{3}} \approx .72$. Of course, 90 is not the maximum—the last value, 92, is the maximum.

9 The best strategy – in expectation – is as follows. When presented with each number, stop if the probability that the current number is the maximum of the sequence is greater than .50. If the probability that a candidate number is the maximum is less than .50, then do not stop (unless one has reached the end of the sequence). If the probability is exactly .50, then a subject is indifferent between stopping and continuing and either action is optimal

These are cases where the maximum is a relatively small number and is presented in the first round. For example, in one trial, the sequence was 33, 1, 25, 12, 30. In this case, 33 is not a tempting value—indeed, the ex-ante probability that a first value of 33 is the maximum is less than .01! However, in this case 33 was the maximum, and subjects who chose not to stop (all but one of them in this trial) lost.

As the game progresses, the probabilities are gradually distributed with more extreme values, and fewer marginal cases. In the final round, it is obvious whether a candidate value is the maximum or not as subjects have seen the entire sequence, so all probabilities are either 1.0 or 0.0.

The second graph, on the right, compares the expected number of games won when playing optimally, with the actual number of games won. Subjects who played intuitively roughly approximated their expected earnings, but did not play perfectly. In roughly a third of cases, subjects playing optimally should have won all three rounds. In fact, only about one sixth won all three rounds. Similarly, about eight percent of subjects should have lost all three games—but only about 4 percent actually did so. This means that subjects often were not playing optimally, resulting in fewer extreme outcomes.

A key point here is that subject performance, in terms of games won and money received, depends both on subject choices and on luck—the particular sequence of numbers that subjects face. Since the sequences of numbers are randomly assigned, this means that part of outcomes is randomly assigned. We exploit this exogenous variation in performance to identify the impact of performance on trust and cooperation.

Because the expected number of wins depends only on the randomly assigned sequence of numbers, by definition it cannot be correlated with pre-existing group cohesion or trust. But the expected number of wins is also correlated with actual earnings. The only way that sequences might affect trust or cooperation is through actual performance—subject earnings. Thus, expected number of wins is a suitable instrumental variable for performance and allows us to identify the impact of performance on trust and cooperation.

One might worry that since there is a best strategy for playing the Optimal Stopping Problem, subjects might have played the game mechanistically without any deliberation or thought. However, in practice, we did not observe this type of behavior. The group treatment experience ranged from groups that engaged in minimal discussion and generally all agreed on decisions to groups that displayed high levels of interaction, discussing the pros and cons of choosing each number. But even when groups engaged in a high level of discussion, they were not necessarily able to come to a consensus decision, demonstrating that some numbers lead to quite a challenging, rather than a straightforward, decision. In fact, after engaging in a particularly extensive discussion, one group still could not make a decision about a number and so decided instead to use a coin flip to make their final decision.

Although there is an optimal strategy in expectation, participants are unlikely to be aware of or play that strategy except in cases where the best choice is obvious. In almost 60% of our trials, subjects played at least one non-optimal strategy and the correlation between the expected and actual number of correct decisions is .56, a high enough correlation to use this as an instrument, but low enough that we are confident that subjects did not play mechanically.

Performance may affect measured outcomes in several different ways. First, it might create an income effect in which the earnings from success lead subjects to have a greater propensity to use part of those earnings to invest in the possible benefits of social relationships, as measured in our experiment by the Trust Game and Stag Hunt. Second, the earnings from success might also change subjects' risk tolerance, making them more willing to take the potential risks associated with trusting others. Our experiment, however, does not allow us to identify the casual effect of either of these mechanisms and therefore we only estimate treatment effects (Imai, Keele, & Tingley, 2010).

Actual performance may also interact with the Group Treatment if subjects associate their success with the group and its members, giving the subject a reason to trust the group and its members again in the future and reinforcing the benefit of working together. In the literature on intergroup relations, for instance, reinforcement theory posits that shared positive outcomes that arise from interpersonal interaction can reinforce positive interpersonal attitudes (Lott & Lott, 1974). An increase in trust and cooperation would seem consistent with the strengthening of positive interpersonal attitudes.

Dependent Variables

After subjects completed the Optimal Stopping Problem, we recorded five measures of trust and cooperative behavior. Three measures came from behavioral games: The Trust Game and the Stag Hunt. These two behavioral games capture key features of social organization and individual trust, and have been widely used to measure these aspects of groups (Avdeenko & Gilligan, 2015; Fearon, Humphreys, & Weinstein, 2009; Skyrms, 2003; Brehm & Rahn, 1997). Two measures came from a questionnaire asking about trust and willingness to work with the same subjects in the future.

Of the three behavioral measures, two came from the Trust game, where we recorded transfers from the Giver and transfers from the Receiver.[10] For the Trust Game, Player 1 (the Giver) was given $3 and could decide to keep or transfer the entire amount to Player 2 (the Receiver). If transferred, the $3 became $6 and was given to the Receiver. The Receiver decided how much, if any, of the $6 to return to the Giver.

Each subject made both decisions but did so with different subjects in their experimental session; they played the role of

10 We chose the binary trust game for two reasons. First, it is a bit simpler than a continuous trust game reducing the possibility of subject confusion. Second, we hoped that the binary game would better differentiate trust behavior because if subjects were uncertain about the trust decision they would send zero and it would therefore be easier to identify a treatment effect. Other researchers have also used the binary trust game to "simplify the game and enhance statistical power." (Eckel & Wilson, 2004) the Giver with one subject in their session and the role of the Receiver with the other subject in their session. Furthermore, they did not know which other subject played each role. In this way, the Trust Game did not test whether subjects would engage in direct reciprocity but rather whether they experienced a more generalized trust of subjects in their session.

Subjects made their decisions as both the Giver and Receiver without any information about others' decisions. For the Giver, we measured whether or not they chose to give their initial $3 to their Receiver; for the Receiver, we measured how much of the $6 they chose to return to their Giver.[11]

The third behavioral measure came from the Stag Hunt Game, which subjects completed after playing the Trust Game. For the Stag Hunt Game, players chose between a cooperative and noncooperative action. If they chose the cooperative action, they would earn $2 if at least one of the other two players in their experimental session also chose the cooperative action and $0 otherwise. If they chose the noncooperative action, they would earn $1 regardless of what others in the session chose to do. The latter choice was a certain payoff that did not depend on the choices of the other players in the session. For the former choice, they were instead choosing an action with an uncertain payoff that was based on the belief that at least one of the other two players would also cooperate. If neither of the other players contributed, then the subject would receive a worse payoff than the certain payoff, whereas if one of the other players cooperated, the subject would receive a better payoff than the certain payoff. Each player's choice was recorded and then players were paid based on their choices and the choices of others in their session. We thus measured cooperative behavior in the Stag Hunt, coding this variable "1" if subjects chose the cooperative action and "0" if they did not.

The final two measures came from a survey which subjects completed after playing the Trust Game and Stag Hunt Game. We asked subjects a generalized trust question (Brehm & Rahn, 1997) and a question asking about willingness to participate with their group again.

Post-Treatment Questionnaire

1. Interpersonal Trust: On the post-Treatment questionnaire, we asked subjects,"Generally speaking, would you say that most people can be trusted or that you cannot be too careful in dealing with people?" Respondents that answered "most people can be trusted" were coded "1"; the alternative was coded "0."
2. Play Again: We ask subjects, if there were another experiment, "Would you be willing to participate with the same people from this group?"

[11] This technique is known as the strategy method in which subjects make hypothetical choices. It is a well-validated approach in experimental economics (Brandts & Charness, 2011)

Power

Identical experiments to ours have not been conducted, however a meta-analysis of economic experiments, including the Stag Hunt and Trust game reported a standardized effect size of 0.279 (Camerer et al., 2016). This effect size suggests we need a minimum total sample size of 90 based on power of 0.8 and an alpha of 0.05. A number of recent papers focused on the trust game have similar sample sizes (Harth & Regner, 2017; Myers & Tingley, 2016). We recruited 306 subjects for a total sample size of 102 trials, with three subjects in each trial. We collect multiple outcome measures for each experimental participant, including both survey and behavioral measures.

Hypotheses

Our hypotheses were developed from the prior literature about trust and cooperation. All hypotheses were preregistered.

1. Group collaboration increases trust and cooperation.

   The group treatment will lead to higher trust and cooperation compared to the individual treatment because the group treatment provides the opportunity for members to interact, deliberate, and make collective decisions with shared outcomes.
2. Expected success is associated with higher trust and cooperation. Success will lead to higher trust and cooperation either through an income effect or an increase in risk tolerance as a result of success. This main effect will occur in both the individual and group treatments.
3. The combination of group treatment and expected success lead to the highest levels of trust and cooperation.

   We expect an interaction between the group treatment and expected success, such that the combination of the group treatment and expected success will have the largest effect on trust and cooperation. Success in the task will reinforce the group interaction because the members learn that collaboration can be beneficial.

Results

We tested each of our three hypotheses on our five dependent variables, leading to fifteen tests.[12] To estimate the impact of the group collaboration treatment, we calculated the difference in the means for each outcome variable between the treatment and control groups. We hypothesized that the mean for the treatment group (collaborative problem solving) would be greater than the mean for the control group (individual problem solving).

Estimating the effect of success on the task on our outcome variables requires a different approach. Since we randomly assign sequences, pre-existing social capital and other pre-treatment covariates should be equivalently distributed across the different

[12] A list of tests conducted is provided in the appendix.

sequences. However, actual performance could be related to pre-treatment characteristics such as cohesion, trust, or other characteristics. Therefore, we use an instrumental variable approach to account for the fact that pre-existing social capital could affect both success in the optimal stopping task and our outcome measures related to trust and cooperation.

To use an instrumental variable approach for actual success we need an instrument that is both correlated with actual success and that is only correlated with the outcome through our measure of actual success (i.e. satisfies the exclusion restriction). In our experiment an appropriate instrument is the expected number of wins (out of 3) if the subject/group played an optimal strategy. Expected earnings vary with the randomly-assigned numeric sequences. Consequently, as they are randomly assigned, they do not correlate with subjects' pre-treatment characteristics, and they satisfy the exclusion restriction for a good instrument. Thus we can use expected earnings as an instrument for actual earnings, allowing us to estimate the causal effect of performance on trust.

For the impact of expected success, we first calculated the expected number of successes (out of three trials) when playing the optimal strategy. Then, we regressed each measure of trust and cooperation against earnings via two-stage least squares, using expected number of wins as an instrument for earnings. We report the estimated impact of performance in our analysis, and again hypothesized that this would be positive.

Finally, for the interaction between collaboration and success, we first calculated the product of the group treatment indicator variable and subject earnings from the optimal stopping game. We then ran a two-stage least squares regression, regressing the dependent variable on the interaction, and using the product of the Group Treatment assignment and the expected earnings as the instrument. Our original hypothesis was that this interaction would be positive without main effects, so we report the coefficient on Group Treatment*Earnings from a simple bivariate model. However, results are similar when main effects are included and are shown in the appendix.

Our unit of analysis is the individual, but our randomization takes place at the session level. All three subjects in each session were assigned either to work in a group or to work as individuals. All subjects in each session faced the same sequence of numbers from the Optimal Stopping Problem, whether or not they worked in a group or not.

This session-level randomization creates potential inference problems when using simple regression or *t*-tests, so we tested our hypotheses using randomization inference (Keele, McConnaughy, & White, 2012). Specifically, we compared the estimated effect of the treatment with a hypothetical distribution of estimated effects calculated by randomly reassigning sessions to group or individual treatments, and to numeric sequences from the experiment, and then reestimating our instrumental variable regression. This is effectively a form of permutation analysis. The randomized inference or permutation analysis is conducted at the paired session level because the treatments were randomized at that level. We conducted 10,000 random permutations of each variable of interest: randomly permuting the Group Treatment variable and the Expected Success variable across experimental trials, calculating the estimated treatment effect for each outcome measure with the permuted treatment variables, saving the results, and repeating. An important virtue of this non-parametric approach is that we do not have to make assumptions about the distribution of the test statistics (i.e., the estimated regression coefficients), because the randomization inference approach allows us to construct a distribution of 10,000 possible test statistics rather than assume a distribution.

Figure 2 shows the distribution of 10,000 random permutations of treatment assignment compared to the estimated treatment effect for each dependent variable. The histogram is effectively the distribution of the test statistic under the sharp null hypothesis that the treatment effect is zero. The vertical line shows the estimate from the experimental trials. When the observed effect is larger than 95% of the permuted values, this is statistically significant evidence that the treatment affected trust and cooperation. When the observed effect is close to the middle of the distribution of permuted values, then our experimental results are typical of what one would observe under the null hypothesis of no treatment effect. Because we pre-registered all our hypotheses, we use one-sided *p*-values and set $\alpha = .05$.

We failed to reject the null hypothesis of no treatment effect in all but two of the fifteen analyses even using a one-sided *p*-value of 0.05. The observed effects are consistently close to zero and well within the permuted distribution of treatment effects. The estimated effect of the Group Treatment is greater than zero for all five dependent variables, but is never significant at the .05 level. In fact, we only observed a significant result for two tests. One was the effect of expected successes on the transfer by Player A to Player B in the Trust Game (Effect size: .171, *p*-value: .045). The other was the effect of the interaction of expected success and group collaboration (Effect size: .11, *p*-value .049). However, these are just two of fifteen results, and they could easily represent Type I error and not be reflective of an actual treatment effect.

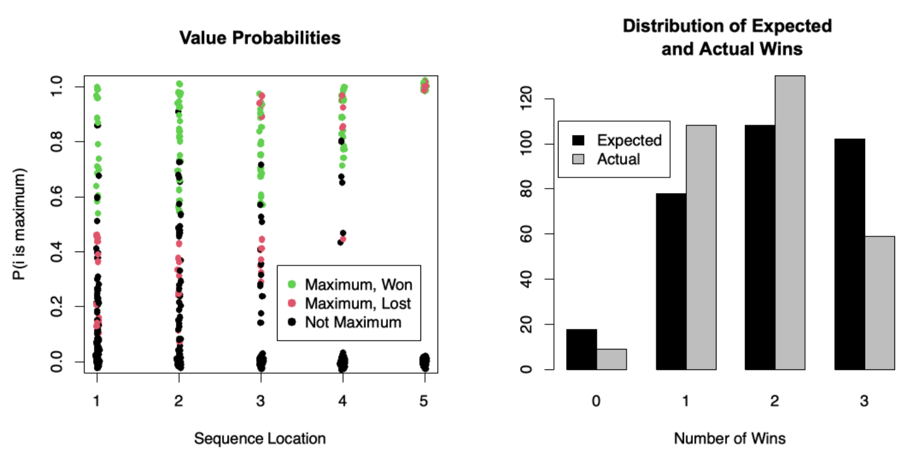

Figure 1. Characteristics of Numeric Sequences Drawn in Experiment

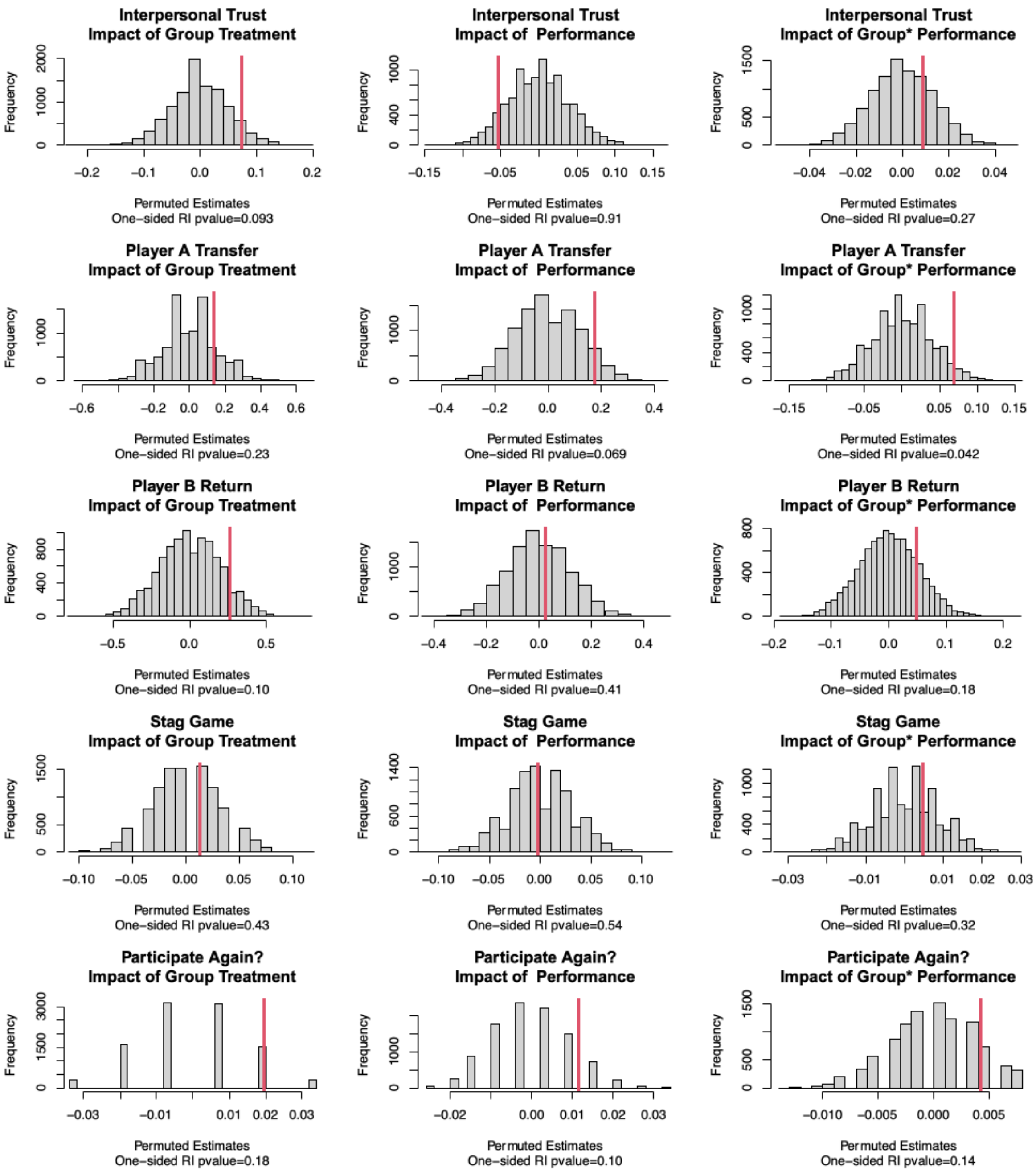

Figure 2. Impact of Treatment (Randomization Inference)
Histograms show permuted difference of means for treated and control groups. Red vertical lines show observed values in experimental trials. One-sided *p*-values reported below each graph. All hypotheses were that effects would be greater than zero.

Conclusion

We used a laboratory experiment to test whether group problem solving and group performance increase trust and cooperation compared to individual problem solving. These outcomes are important to politics, and they are also considered to be relevant for the development of social capital. Across a number of different measures, we fail to reject the null hypotheses. Our experiment did not provide evidence that group collaboration increased trust or cooperation, that successful outcomes increased trust or cooperation, or that a combination of collaborative efforts with positive outcomes increased trust or cooperation.

We found no evidence that group collaboration or group success have any impact on cooperation or interpersonal trust. There are, however, several limitations of our laboratory experiment that might limit the generalizability of our results. First, it may simply be that the brief, low stakes laboratory experience was insufficient to increase trust between subjects. More generally, if building trust and cooperation requires interaction over long periods of time, then a brief lab (or field) experiment will fail to generate trust or cooperation.

Another possibility is that our measures (i.e., the Trust Game, the Stag Hunt, or our survey questions) might not effectively capture variance in the social outcomes we are trying to measure because even relatively low levels of trust lead to "trusting" behavior in these outcome variables. If this is the case, then the subjects who are in the individual treatment or who received a "difficult" task might simply have enough baseline trust to score high on these measures even if they have less trust than subjects in the group or "easy" treatment, in which case our measures might be incapable of picking up this difference.

A final possibility is that the effect may not be apparent in our sample of undergraduates. Collaborative activity could be life-changing in poor and isolated communities, but less effective on an urban US college campus. College students, for instance, might begin with high levels of mutual trust, due to shared norms, experiences and identity. If this is the case, there might be smaller treatment effects from an experiment like this one.

In this sense, our experiment is a step toward exploring the scope conditions of group collaboration's impact on trust and cooperation. Further research should consider whether a longer and more laborious task, a higher stakes game, or variation in the subject populations would yield different results than ours.

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Appendix

List of Analyses Presented in Figure 2

- Group collaboration increases trust and collaboration

  We tested this hypothesis by calculating the difference of means for subjects in the Group Treatment and the subjects in the individual treatment. We used randomized inference to calculate empirical *p*-values. We used this approach on each of the five dependent variables.

- Hypothesis: Performance increases trust and collaboration

  We tested this hypothesis by running an instrumental variable regression for each dependent variable on subject earnings in the optimal stopping game, using expected number of games won (W) as an instrument for actual earnings (P). We used two-stage least-squares. We then test whether the estimated coefficient $\hat{\beta}$ is greater than zero or not. Again, we used randomized inference to calculate empirical *p*-values. We used this approach on each of the following dependent variables:

  Interpersonal trust $= \alpha + \beta * \hat{P}$

  Stag Hunt Participation $= \alpha + \beta * \hat{P}$

  Trust Game: Amount Sent $= \alpha + \beta * \hat{P}$

  Trust Game: Amount Returned $= \alpha + \beta * \hat{P}$

  Play Again $= \alpha + \beta * \hat{P}$

  where $\hat{P}$ is predicted using the following least-squares model:

  $\mathrm{P} = \psi + \gamma * \mathrm{W}$

- The interaction of Performance and Group Collaboration increases trust and collaboration

  We tested this hypothesis by running an instrumental variable regression. We first create a new variable, C, which is the product of an indicator variable for Group Treatment, I_{Group}, and actual performance measured in earnings, P, where $C = P * I_{Group}$. We then used a two-stage regression, predicting $\hat{C}$ from a regression of C on the interaction of W and I_{Group}. Again, we used randomized inference to calculate empirical *p*-values. We used this approach on each of the following dependent variables:

  Interpersonal trust $= \alpha + \beta * \hat{C}$

  Stag Hunt Participation $= \alpha + \beta * \hat{C}$

  Trust Game: Amount Sent $= \alpha + \beta * \hat{C}$

  Trust Game: Amount Returned $= \alpha + \beta * \hat{C}$

  Play Again $= \alpha + \beta * \hat{C}$

  where $\hat{C}$ is predicted using the following least-squares model:

  $\mathrm{C} = \psi + \gamma * \mathrm{W} * I_{Grou}$

Full Regression Results

The following tables show full estimates of empirical values for the models estimated above. In addition, we include an additional model where the main effects Group Treatment and Performance are both included. The first model which corresponds to Hypothesis 1 is a simple OLS regression of each dependent variable on an indicator variable for Group Treatment. The coefficient here is equivalent to the difference of means when subtracting the mean for subjects in the Group Treatment from the mean for subjects in the Individual Treatment. Models 2-4 are two-stage least squares models. Model 2 shows results for Hypothesis 2, testing the impact of Performance on each of the dependent variables, when using Expected Wins as an instrument for Performance. Model 3 shows results for Hypothesis 3, testing the impact of Performance*Group Treatment on each of the dependent variables, without main effects. Again, this is the second stage of a two-stage least squares model, with Group Treatment * Expected Wins as an instrument for Performance * Group Treatment. Finally, Model 4 is included for comparison although it does not correspond to any of the hypotheses. This model shows the impact of Group Treatment, Performance, and Group Treatment * Performance on each of the dependent variables. Thus, model 4 includes the main effects as well as the interactive effects. Model 4 is also the second stage of a two-stage least squares regression where Expected Wins and Expected Wins * Group Treatment are used as instruments in the first stage.

Deviations from Pre-Analysis Plan and Results according to Pre-Analysis Plans

In our original pre-analysis plan, we proposed to ask whether subjects intended to vote in the upcoming election. Delays with funding and IRB approval meant that both the relevant election passed before we began trials so we did not ask those questions.

In the original analysis, we proposed to conduct simple difference of means and difference of proportions tests. However, this approach would have ignored the fact that the randomization was conducted at the session, not individual level. These tests would have erroneously increased the probability of false positives. Consequently, we used randomized inference, with permutations calculated at the group level. In addition, we originally only planned on a single round of the Optimal Stopping Game, with a subset of possible sequences chosen to make all sequences relatively easy or difficult. This approach would have involved a slight deception as it would have implied sampling from a subset of all possible sequences of five numbers. However, we eventually chose not to use that mild deception and to be completely transparent with subjects, sampling from the full set of possible sequences. As a result, instead of using a binary variable for “difficult” or “easy” sequences, we used a continuous variable counting the numbers of game that would be won if one maximized expected earnings at each stage.

For completeness, however, we show below the results obtained when using the methods proposed in our pre-analysis plan: difference of means tests for the behavioral games, and difference of proportion tests for the survey measures (Interpersonal Trust and Play Again). For the construction of the Difficult binary variable, note that as our population of sequences differed from that original proposed, we had to operationalize “Difficult” differently than proposed in the pre-analysis plan.

In the original plan, we proposed to only give subjects sequences that they were very likely to win, or sequences that they were very likely to lose. As implemented, however, we sampled from all possible sequences. Thus, to construct the “Difficult” binary variable, we examined the number of games that subjects would win when using any of five different decision rules[13]. We counted the total number of games subjects would have won playing each of these strategies. If Subjects would have won no more than one game across all strategies, we called this sequence “Difficult.” If Subjects would have lost at most one game across all three Sequences and across all five strategies, we called this strategy “Not Difficult.” We discarded in-between situations where subjects would have won more than one or lost more than one.[14] Of the 102 sessions, 30 sessions (90 subjects) played the Optimal Stopping Game with sessions they were either likely to win regardless of strategy or lose regardless of strategy.

In the three tables below, we show below difference of proportions and means tests for Hypothesis 1, Hypothesis 2, and Hypothesis 3. In every case, following our original pre-analysis plan also produced results in support of the null hypothesis.

PreAnalysis H1: Estimated Effect of Group Treatment

Dep Var	Y=1	Y=0	Diff	P-Value	*n*
Stag Hunt	0.869	0.856	0.013	0.741	306
Trust Game - Sent	1.902	1.765	0.137	0.413	306
Trust Game - Returned	2.216	1.954	0.261	0.170	306
Interpersonal Trust	0.549	0.477	0.072	0.252	304
Play Again?	0.993	0.974	0.020	0.367	306

13 The strategies varied the decision rule for choosing a number as the maximum of the sequence. The optimal strategy was to stop if the probability that i is the maximum of the five numbers was .50 ($P(x_i = Max(x_1, x_2, x_3, x_4, x_5)) \leq .5$). We compared this strategy with decision probabilities of .40, .45, .55, and .60—considering cases where subjects were too cautious or too optimistic about future values in the sequence.

14 Subjects played the game three times, considering three sequences of numbers. We counted how many games they would have won when playing each of five strategies, specifically, stopping rules of .40, .45, .50, .55, and .60. If they would have won every game, regardless of strategy, this implies 15 wins (3 sequences * 5 decision rules). If they would have lost every game regardless of strategy this implies 15 losses and zero wins. In 22 sessions, the subjects would have won all three games playing any of the strategies we examined. In another 6 sessions, subjects would have won all games with 4 of the five strategies, and lost one game with one of the strategies. In no case with the subjects have lost all three games when playing the strategies we examined. However, in 4 sessions, subjects would have lost all games with 4 of the 5 strategies, and won 1 game with one strategy.

Table shows results from difference of means (first three rows) and difference of proportions (last two rows), comparing subjects assigned to Group or Individual conditions. These tests ignore the grouped sessions and grouped randomization, and are biased toward rejecting the null hypothesis. These tests were proposed in our original pre-analysis plan, before our measurement instruments and experimental design were modified. Even so, conclusions match those reported in the text of the paper: we fail to reject the null hypothesis.

PreAnalysisH2: Estimated Effect of Difficult

Dep Var	Y=1	Y=0	Diff	P-Value	n
Stag Hunt	0.75	0.87	-0.12	0.40	96
Trust Game - Sent	1.25	1.89	-0.64	0.20	96
Trust Game - Returned	1.50	2.01	-0.51	0.31	96
Interpersonal Trust	0.67	0.48	0.18	0.37	95
Play Again?	1.00	1.00	0.00	1.00	96

Table shows results from difference of means (first three rows) and difference of proportions (last two rows), comparing subjects assigned to Difficult or Easy conditions. These tests ignore the grouped sessions and grouped randomization, and are biased toward rejecting the null hypothesis. These tests were proposed in our original pre-analysis plan, before our measurement instruments and experimental design were modified. Even so, conclusions match those reported in the text of the paper: we fail to reject the null hypothesis.

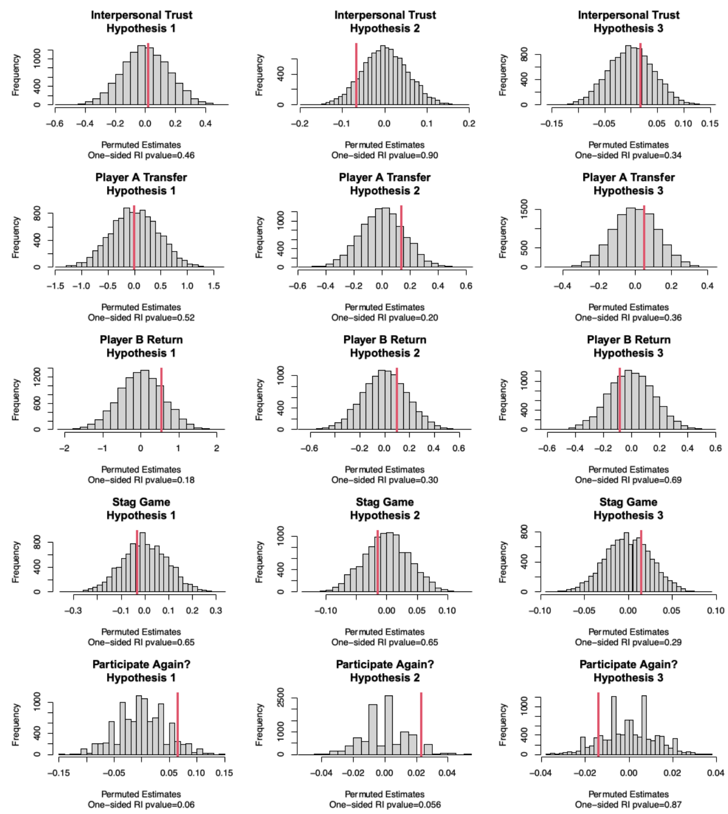
*PreAnalysisH3z: Estimated Effect of Group Treatment * Difficult*

Dep Var	Y=1	Y=0	Diff	P-Value	n
Stag Hunt	0.67	0.87	-0.20	0.39	96
Trust Game - Sent	1.00	1.87	-0.87	0.23	96
Trust Game - Returned	1.50	1.98	-0.48	0.52	96
Interpersonal Trust	0.67	0.49	0.17	0.69	95
Play Again?	1.00	1.00	0.00	1.00	96

Table shows results from difference of means (first three rows) and difference of proportions (last two rows), comparing subjects assigned to Easy and Group conditions, with subjects assigned to all other conditions. These tests ignore the grouped sessions and grouped randomization, and are biased toward rejecting the null hypothesis. These tests were proposed in our original pre-analysis plan, before our measurement instruments and experimental design were modified. Even so, conclusions match those reported in the text of the paper: we fail to reject the null hypothesis.

Alternative Specification of Hypothesis Tests

An alternative to test our hypotheses is in a single interactive model that includes Group Treatment, Earnings, and their interaction (Group Treatment * Earnings). One may view this model as simultaneously testing all three of our hypotheses. For comparison purposes, we include results from this joint estimation of the impact of Group Treatment, Earnings, and their interaction. Note that again, we consistently fail to reject the null hypothesis.



Results from a Joint Test of All Hypotheses in a Single Model

Histograms show permuted coefficient estimates for Group Treatment, Performance, and their Interaction, when estimated in a single model:

$$Y = \beta_0 + \beta_1 \text{Group Treatment} + \beta_2 \text{Performance} + \beta_3 \text{Group Treatment} * \text{Performance}$$

The models used Expected Earnings as an instrument, as per previous models. Red vertical lines show observed values in experimental trials. One-sided p-values reported below each graph.

Experimental Protocol

Recruitment and Individual-Group Randomization

Students from four departments at a large public university received a recruitment email or saw a recruitment blog post, inviting them to take part in a paid experiment and providing them with a link to an initial pretreatment survey that was implemented using

Qualtrics (see survey instructions and questions below). Students were required to be at least 18 years old to be eligible to participate in the experiment. Once students completed the survey, they were then emailed a link to choose a date and time for their session and to indicate their preferred method of communication (email or text) for receiving reminders, which were sent to them twice before the session, including on the day of the session. Sessions were run in an office or conference room on campus.

As explained in the paper, students were assigned to either an individual or group treatment using a randomization procedure. Every two successive sessions (i.e., "a session pair") included one individual treatment and one group treatment. However, the order of these session pairs were randomized. For some pairs, the group treatment was run first and the individual treatment was run second; for other pairs, the order was reversed. Once randomization was complete, we had a list of ordered session treatments for all 102 trials. Students were assigned to a treatment when they arrived at the experiment location, based on whichever treatment had been randomly assigned to the next session in order. Once three students had arrived, that session was full and new arrivals would then be assigned to the next session in order.

Scripts and Materials

Below are the scripts used to instruct subjects in both the individual and group treatments.

Individual Treatment Script

Individual Treatment Script

1. Introduction

Welcome to the Political Science Experimental Lab. Today's experiment is part of a study on decision making. You will be paid for your participation. Today's experiment will last no longer than 1 hour. During the experiment you will earn money based on the decisions you and others make. Please put away and turn off your cell phones during this experiment.

Instructions for the experiment will be given shortly. Along the way, you may have some questions about the experiments. If you do, there will be time at the end of the instructions to ask your questions. It is important that you do not communicate with any other participant unless you are told that it is okay to do so.

Please pay careful attention to the instructions. After explaining the procedures, we will provide a quiz on the instructions, in which you will earn $0.25 for each correct answer.

To expedite the experiment we will keep track of all your earnings during the experiment and we will pay you at the end of the experiment.

During the time you are here today you will take part in many different tasks. I will now describe the decisions and actions you must make in each session during the experiment.

2. Protocol for Optimal Stopping Problem

In this experiment, we use a computer program to select at random 5 whole numbers that fall between 1 and 100. The five numbers will be kept in the order in which they were selected. Each time we select five numbers we will consider it a trial. Each number can only appear once in a trial.

Your task in the experiment is to identify which number is the largest of the five numbers that was selected by the computer. After all five numbers are chosen we will distribute a piece of paper that informs you of the first selected number. You must then decide whether to choose this number as the largest of the five or not.

Once you decide whether or not to select a number as the largest in the sequence, the decision will be recorded on a piece of paper we hand out. On the paper, you will mark whether you have decided to select that number as the largest number or not.

If you decide that the first number is NOT the largest number, then we will distribute the second number. You will again need to decide whether or not to select this number as the largest number of the five. Each decision you make will be recorded on a sheet of paper as described before.

This process will continue until we reach the fifth, and last number. At this point, you will automatically have to accept the fifth number as the largest of the five, but you will not actually be able to observe the fifth number. You will not know after you choose a number whether you correctly identified the largest of the five selected numbers.

Once you decide that a number is not the one you want to choose as the largest, you cannot go back to that number later in the same trial. That is, if you decide the first number is not the largest and that you want to see the 2nd number, then you cannot later choose the first number as the largest. Likewise, if you decide the 1st number IS the largest, you will not see numbers 2 through 5.

The decisions you make during the experiment will all be recorded on pen and paper. Each time we ask you to make a decision about a particular number we will write the number on a piece of paper and hand the paper to you. In addition to the number that we write on the paper, there will be places for you to enter information.

You will circle whether you DO or DO NOT want to select a given number as the largest. If you circle the option to select a number as the largest, then that trial ends.

We will follow the same process for each trial in this part of the experiment.

You will earn money based on the accuracy of your decisions in this part of the experiment. If you correctly identify the largest of the 5 numbers you will earn $2. If the number you choose is not the largest, then you will not earn anything for this trial.

If you have any questions, please raise your hand and we will answer them now.

We will now distribute a quiz to ensure that you understand the experimental task. We will pay you $0.25 for each correct answer.

[Distribute and grade quiz.]

[Distribute earnings for quiz]

We will now select the five numbers for the [first, second, third] trial.

We are now handing out the piece of paper that identifies the first number. After you decide to choose this number as the largest or not, please mark your choice on the piece of paper and give the paper to the experimenter.

[if they DON'T choose the first number]

We are now handing out the piece of paper that identifies the second number only to those who did not choose the first number of this trial as the largest. After you decide to choose this number as the largest or not, please mark your choice on the piece of paper and give the paper to the experimenter.

[if they DON'T choose the 2nd number]

We are now handing out the piece of paper that details the third number only to those who did not choose a previous number in this trial as the largest. After you decide to choose this number as the largest or not, please mark your choice on the piece of paper and give the paper to the experimenter.

[if they DON'T choose the 3rd number]

We are now handing out the piece of paper that details the fourth number only to those who did not choose a previous number in this trial as the largest. After you decide to choose this number as the largest or not, please mark your choice on the piece of paper and give the paper to the experimenter.

[if they DON'T choose the 4th number]

For those who chose NOT to select the 4th number, the 5th number is automatically chosen for you. However, you won't be able to see the actual 5th number that was selected.

This trial is now over. We are now moving on to a new sequence of five numbers.

[REPEAT 3 TIMES]

We have now completed all of the sessions for this experiment, and we will calculate your earnings from this part of the experiment.

[Calculate payoffs for Stopping Problem and write on sheets]

We are now distributing a piece of paper that tells you how much you earned in this part of the experiment.

[Hand out paper with the amount subjects earned from Stopping Problem and collect previous quiz]

3. Protocol for Outcome Measures

We are now handing out a piece of paper that you will use to record your decision in this next part of the experiment. The paper provides a basic description of the task you will be asked to complete.

[Hand out Stag Hunt forms]

[Multi Player Majority Stag Hunt]

We will now describe how you earn money based on your choices in this part of the experiment. In this next task you must choose between two choices: A and B. The amount you will earn depends what you choose and what others in the experiment choose.

If you choose A, you will earn $1 regardless of what others choose.

If you choose B, then you will earn $2 if and only if at least one other person in the experiment also chooses B.

For example, if you are the only person who chooses B, then you will earn $0. However, if you and at least one other person choose B, then each of you will earn $2. People who choose A will earn $1 regardless of what others chose.

If you have any questions, please raise your hand and we will answer them now.

We will now distribute a quiz to ensure you understand this task.

[Distribute QUIZ]

[Grade quiz and distribute earnings for quiz]

Please record your decision for this part of the experiment on the form now. Please remember to put your subject number on the sheet.

[Collect Stag Hunt forms and previous quiz]

[Trust Game with Strategy Method (each player plays both P1 and P2)]

We will now move on to the next part of the experiment.

In this part of the experiment you will make two decisions and how much you earn during this task depends on both what you do and the other subjects do. We will describe both tasks in order and then you will have the opportunity to make the two decisions we have described.

For the first part of this task, we will give each subject $3. Each subject will also be randomly matched to another subject in this room, whom we refer to as "the other person," and you will not know who the other person is.

You will first choose whether or not to transfer the $3 to the other person. If you choose to transfer the $3 to the other person, then the $3 will be doubled and the other person will receive $6. If you choose to keep the $3 then it will be credited to your experimental account and added to your earnings from the experiment.

Since everyone is making the same first decision, someone may have transferred money to you. For the second decision, you must make a decision about how much, if any, to return to the person who was randomly matched to you and who may or may not have transferred their $3 to you. You will make this decision without knowing whether the person chose to transfer the money to you. You must decide how much, if any, of the $6 to transfer back to the other person, if they chose to transfer it to you initially.

The amount you choose to transfer back is subtracted from the $6 and you keep the amount that is not transferred. The money that you choose to transfer back to the other person will be given to them at the end of the experiment.

To be clear, each of you will make two choices in this part of the experiment: 1. Whether or not to transfer $3, which will become $6 if transferred, to another person, and 2. How much to transfer back of $6 if the person who was randomly matched to you chose to transfer their money to you. When making this decision you will not yet know if another person has chosen to transfer money to you.

If you have any questions please raise your hand and we will answer them now. We will now hand out a quiz to ensure you understand your decisions in this task.

[Distribute QUIZ]

[Grade quiz and distribute earnings for quiz]

We are now handing out a form for you to mark your decision for both parts of this task.

First, please write your subject number on the form.

Second, mark your decision about transferring the $3 to the other person.

Third, mark you decision about how much, if any of the $6 to transfer back, if the person to whom you were randomly matched transferred their money to you.

[Hand out and then collect this sheet and collect previous quiz]

We will now hand out a questionnaire that you must complete. While you complete the questionnaire we will determine how much you each made during the experiment. Please stay at your seat until you are called up to collect your earnings and sign a receipt.

[Pass out questionnaires, calculate earnings, and fill out receipts]

[Call subjects one at a time, collect questionnaire, and give them their earnings balance and receipt]

Group Treatment Script

1. Introduction

Welcome to the Political Science Experimental Lab. Today's experiment is part of a study on decision making. You will be paid for your participation. Today's experiment will last no longer than 1 hour. During the experiment you will earn money based on the decisions you and others make. Please put away and turn off your cell phones during this experiment.

Each of you has a subject number. We will be referring to you by this number during the experiment. Instructions for the experiment will be given shortly. Along the way, you may have some questions about the experiments. If you do, there will be time at the end of the instructions to ask your questions. It is important that you do not communicate with any other participant unless you are told that it is okay to do so.

Please pay careful attention to the instructions. After explaining the procedures, we will provide a quiz on the instructions, in which you will earn $0.25 for each correct answer.

To expedite the experiment we will keep track of all your earnings during the experiment and we will pay you at the end of the experiment.

During the time you are here today you will take part in many different tasks. I will now describe the decisions and actions you must make in each session during the experiment.

2. Protocol for Optimal Stopping Problem

In this experiment, we use a computer program to select at random 5 whole numbers that fall between 1 and 100. The five numbers will be kept in the order in which they were selected. Each time we select five numbers we will consider it a trial. Each number can only appear once in a trial.

In a moment, I will ask everyone in the room to take down the cardboard study carrels in front of you. During the next task in this experiment you will work as a group. The group's task in the experiment is to identify which number is the largest of the five numbers that was selected by the computer.

After all five numbers are chosen we will distribute a piece of paper that informs the members of the group of the first selected number. The group must then decide whether to choose this number as the largest of the five or not. During this process you can discuss with the members of the group whether to choose a number as the largest or not. If the group wants to choose a number as the largest, then a majority of the members must agree on that decision.

Once the group decides whether or not to select a number as the largest in the sequence, the decision will be recorded on a piece of paper we hand out. On the paper a member of the group will mark whether the group has decided to select that number as the largest number or not and also record how many people agreed with the decision made by the group.

If the group decides that the first number is NOT the largest number, then we will distribute the second number. The group will again need to decide whether or not to select this number as the largest number of the five. Each decision the group makes will be recorded on a sheet of paper as described before.

This process will continue until we reach the fifth, and last number. At this point, the group will automatically have to accept the fifth number as the largest of the five, but you will not actually be able to observe the fifth number. You will not know after you choose a number whether the group correctly identified the largest of the five selected numbers.

Once you decide that a number is not the one you want to choose as the largest, you cannot go back to that number later in the same trial. That is, if you decide the first number is not the largest and that you want to see the 2nd number, then you cannot later choose the first number as the largest. Likewise, if you decide the 1st number IS the largest, you will not see numbers 2 through 5.

The decisions you make during the experiment will all be recorded on pen and paper. Each time we ask you to make a decision about a particular number we will write the number on a piece of paper and hand the paper to the group. In addition to the number that we write on the paper, there will be places for you to enter information.

You will circle whether you DO or DO NOT want to select a given number as the largest. If you circle the option to select a number as the largest, then that trial ends.

The sheet will also have a line for you to record the number of people in the group who agreed with the decision made by the group.

We will follow the same process for each trial in this part of the experiment.

You will earn money based on the accuracy of your decisions in this part of the experiment. If you correctly identify the largest of the 5 numbers each person in the group will earn $2. If the number the group chooses is not the largest, then you will not earn anything for this trial.

If you have any questions, please raise your hand and we will answer them now.

We will now distribute a quiz to ensure that you understand the experimental task. We will pay you $0.25 for each correct answer.

[Distribute and grade quiz]

[Distribute earnings for quiz]

We will now take down the carrels so that you can work together during the first trial, and we will select the five numbers for the first trial.

[Only for 2nd/3rd trials]: We will now select the five numbers for the [second, third] trial.

We are now handing out the piece of paper that identifies the first number. After the group decides to choose this number as the largest or not, please mark the group's choice on the piece of paper and give the paper to the experimenter.

[if they DON'T choose the first number]

We are now handing out the piece of paper that identifies the second number. After the group decides to choose this number as the largest or not, please mark the group's choice on the piece of paper and give the paper to the experimenter.

[if they DON'T choose the 2nd number]

We are now handing out the piece of paper that details the third number. After the group decides to choose this number as the largest or not, please mark the group's choice on the piece of paper and give the paper to the experimenter.

[if they DON'T choose the 3rd number]

We are now handing out the piece of paper that details the fourth number. After the group decides to choose this number as the largest or not, please mark the group's choice on the piece of paper and give the paper to the experimenter.

[if they DON'T choose the 4th number]

As a group you chose NOT to select the 4th number, which means the 5th number is automatically chosen for you. However, you won't be able to see the actual 5th number that was selected.

This trial is now over. We are now moving on to a new sequence of five numbers.

[REPEAT 3 TIMES]

We have now completed all of the sessions for this experiment, and we will calculate your earnings from this part of the experiment.

[Calculate payoffs for Stopping Problem and write on sheets]

We are now distributing a piece of paper that tells you how much you earned in this part of the experiment.

[Hand out paper with the amount subjects earned from Stopping Problem and collect previous quiz]

3. Protocol for Outcome Measures

For the remainder of the experiment you will make decisions individually. Please do not speak with one another for the remainder of the experiment. We will return the cardboard study carrels to their prior location.

We are now handing out a piece of paper that you will use to record your decision in this next part of the experiment. The paper provides a basic description of the task you will be asked to complete.

[Hand out Stag Hunt forms]

[Multi Player Majority Stag Hunt]

We will now describe how you earn money based on your choices in this part of the experiment. In this next task you must choose between two choices: A and B. The amount you will earn depends on what you choose and what others in the experiment choose.

If you choose A, you will earn $1 regardless of what others choose.

If you choose B, then you will earn $2 if and only if at least one other person in the experiment also chooses B.

For example, if you are the only person who chooses B, then you will earn $0. However, if you and at least one other person choose B, then each of you will earn $2. People who chose A will earn $1 regardless of what others chose.

If you have any questions, please raise your hand and we will answer them now.

We will now distribute a quiz to ensure you understand this task.

[Distribute QUIZ]

[Grade quiz and distribute earnings for quiz]

Please record your decision for this part of the experiment on the form now. Please remember to put your subject number on the sheet.

[Collect Stag Hunt forms and previous quiz]

[Trust Game with Strategy Method (each player plays both P1 and P2)]

We will now move on to the next part of the experiment.

In this part of the experiment you will make two decisions and how much you earn during this task depends on both what you do and the other subjects do. We will describe both tasks in order and then you will have the opportunity to make the two decisions we have described.

For the first part of this task, we will give each subject $3. Each subject will also be randomly matched to another subject in this room, whom we refer to as "the other person," and you will not know who the other person is.

You will first choose whether or not to transfer the $3 to the other person. If you choose to transfer the $3 to the other person, then the $3 will be doubled and the other person will receive $6. If you choose to keep the $3 then it will be credited to your experimental account and added to your earnings from the experiment.

Since everyone is making the same first decision, someone may have transferred money to you. For the second decision, you must make a decision about how much, if any, to return to the person who was randomly matched to you and who may or may not have transferred their $3 to you. You will make this decision without knowing whether the person chose to transfer the money to you. You must decide how much, if any, of the $6 to transfer back to the other person, if they chose to transfer it to you initially.

The amount you choose to transfer back is subtracted from the $6 and you keep the amount that is not transferred. The money that you choose to transfer back to the other person will be given to them at the end of the experiment.

To be clear, each of you will make two choices in this part of the experiment:

1. Whether or not to transfer $3, which will become $6 if transferred, to another person, and

2. How much to transfer back of $6 if the person who was randomly matched to you chose to transfer their money to you. When making this decision you will not yet know if another person has chosen to transfer money to you.

If you have any questions please raise your hand and we will answer them now. We will now hand out a quiz to ensure you understand your decisions in this task.

[Distribute QUIZ]

[Grade quiz and distribute earnings for quiz]

We are now handing out a form for you to mark your decision for both parts of this task.

First, please write your subject number on the form.

Second, mark your decision about transferring the $3 to the other person.

Third, mark you decision about how much, if any of the $6 to transfer back, if the person to whom you were randomly matched transferred their money to you.

[Hand out and then collect this sheet and collect previous quiz]

We will now hand out a questionnaire that you must complete. While you complete the questionnaire we will determine how much you each made during the experiment. Please stay at your seat until you are called up to collect your earnings and sign a receipt.

[Pass out questionnaires, calculate earnings, and fill out receipts]

[Call subjects one at a time, collect questionnaire, and give them their earnings balance and receipt]

Surveys

Below are the surveys subjects completed as part of the experiment.

Pretreatment Survey

Welcome and thank you for participating in our research project. Your participation requires two steps. First, you must sign up for the experiment on this website. Second, we will contact you soon with days and times for the in-person part of the experiment. During the in-person component you will earn money based on the decisions you and others make.

Q1: What is your name (first and last)?

Q2: What is your [university name] student ID number? (we may use this to identify you instead of your name for anonymity purposes)

Q3: What is your preferred email address?

Q4: What is your college major?

Q5: What was your SAT math score?

Q6: Sex
o Male
o Female

Q7: Are you at least 18 years old?
o Yes
o No

Q8: Generally speaking, would you say that most people can be trusted, or that you cannot be too careful when dealing with others?
o Most people can be trusted
o You cannot be too careful when dealing with others

Q9: Are you a member of a fraternity or sorority? If so, please write which one below:

Q10: Have you participated in other experiments on campus? If so, please write in which department(s):

Thank you for completing the experiment registration. We will contact you soon to have you sign up for the in-person experiment. During that experiment you will earn money based on the choices you and others make. Please click the link below to complete the survey.

Post-treatment Survey
Q1: GPA: ____________________

Q2: The researchers who conducted this experiment may conduct additional experiments. If they do, would you be willing to participate again?
YES or NO

Q3: If yes, would you be willing to participate with the same people from this group?
YES or NO

Q4: Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people? (circle the one that best applies to you)
A. Most people can be trusted
B. Can't be too careful

Q5: When it comes to politics do you usually think of yourself as extremely liberal, liberal, slightly liberal, moderate or middle of the road, slightly conservative, extremely conservative, or haven't you thought much about this? Circle one below.
o Extremely liberal
o Liberal
o Slightly liberal
o Moderate
o Slightly conservative
o Conservative
o Extremely conservative

Q6: Do you attend church? (circle one)
YES or NO
About how many times per month? ________________
Which church/religion? _____________________

Q7: Are you eligible to vote in the U.S.?
YES or NO

Q8: If so, are you registered to vote?
YES or NO

Q9: Did you vote in the 2016 election?
YES or NO

Q10: Did you vote in the 2014 election?
YES or NO

Experimental Forms

Below are the forms subjects completed during the experiment to report their choices.

Quiz on Optimal Stopping Problem

1. How do you earn money during this part of the experiment?
a. Pick any one of the numbers
b. Correctly identify the largest number
2. How many numbers will we draw?

3. What happens if you correctly identify the largest number?
a. Nothing
b. You earn $2
c. You earn $5

4. What happens if you do not correctly identify the largest number?
a. You neither earn nor lose money
b. You lose $1

5. What happens if you do not choose any of the first 4 numbers?
a. Nothing, there are only 4 numbers
b. The fifth number is automatically chosen as the one you believe is the largest

Optimal Stopping Problem Form for Individual Treatment

Round: ____________________
Number: ____________________

You must decide if you believe the number written above is the largest of the five numbers in the sequence. If you choose this number, then this trial of the experiment will end. If you do not choose this number, then we will show you the next number in the sequence. [Unless this is Round 4 and then the number in Round 5 will automatically be chosen as your decision.]

Please circle your choice:
I have decided TO select this number as the largest of the five.
I have decided NOT TO select this number as the largest of the five.

Optimal Stopping Problem Form for Group Treatment

Round: ____________________
Number: ____________________

The group must decide if they believe the number written above is the largest of the five numbers in the sequence. If the group chooses this number, then this trial of the experiment will end. If the group does not choose this number, then we will show you the next number in the sequence. [Unless this is Round 4 and then the number in Round 5 will automatically be chosen as the group's decision.]

Please circle your choice:
Our group has decided TO select this number as the largest of the five.
Our group has decided NOT TO select this number as the largest of the five.

Of the three members in this group ____________________ agree with this decision.

Optimal Stopping Problem Results Form

During the prior task you could have earned up to $6 and you earned $ ____________________. You will be paid this money at the end of the experiment.

Quiz on Stag Hunt

1. If you choose option A how much do you earn?
a. Depends on what others choose
b. $1 regardless of what others choose
2. If you choose option B how much do you earn?
a. $1 regardless of what others choose
b. $2 but only if you and at least 1 other choose B and $0 if fewer than 1 other also chooses B.

Stag Hunt Form

You will record on this paper whether you choose A or B in this task.

If you choose A, you will earn $1 regardless of what others choose.

If you choose B, then you will earn $2 if at least 1 other person (2 total people) in the experiment also chose B. If no one else chooses B, then you will earn $0.

You now need to make a choice. Circle below whether you wish to choose A or B.

I wish to choose A or B

Quiz on Trust Problem

Questions on first transfer decision:
1. Do you have to transfer money to the other person?
a. Yes
b. No. I can keep the $3.

2. If you choose to transfer your $3, how much will the other person receive from your transfer?
a. $9
b. $6

3. If you choose to transfer money to the other person do they have to transfer money back to you?
a. Yes
b. No

Questions on second transfer decision:
1. If the other person chose to send money to you, how much will you receive?
a. $1
b. $3
c. $6
d. $10

2. Do you have to send money back to the other person?
a. Yes
b. No

3. If you choose to send money back, how much must you send back?
a. Any amount
b. $2
c. All of it
d. $6

Trust Problem Form

You must now decide whether or not to transfer $3 to a person with whom you are randomly matched.

You can decide to keep the $3 for yourself, and you do not have to transfer the $3.

If you choose to transfer $3, then the other person will receive $6 and will decide whether to return any of the $6 to you.

Would you like to transfer $3 to the other person? YES NO

On this paper you will record your decision for this task in the experiment.

A person to whom you were randomly matched chose whether to transfer $3 to you, and if the person chose to pass the money it was doubled and will be $6.

Although you do not know if the person to whom you were randomly matched chose to transfer money to you, you must decide what to do with the $6 if the other person transferred their money.

You can choose to transfer none, some, or all of the money back to the other player. Any money that you do not transfer is yours to keep.

How much, if any, do you choose to transfer back? Circle the amount:

$0 $1 $2 $3 $4 $5 $6

Additional Measurement Explanations

Expected earnings were calculated as the earnings one would receive if playing the game optimally. Optimal play would be deciding to stop or not at each stage based on the probability that the current number will be the highest number in the sequence. For example, consider sequence 25, 57, 56, 72, 5. In the first round, the probability that 25 is the highest is the probability that all subsequent numbers are smaller than 25: (24/99)*(23/98)*(22/97)*(21/96)=.003. If that probability were greater than .50, the optimal strategy would be to stop. If that probability were less than 50, the optimal strategy would be to not stop. With the second number, 57, the probability that this is the largest of the sequence is: (55/98)*(54/97)*(53/96)=.17. With the third number, 56, the probability that this is the largest of the sequence is 0, because there is a larger number already present in the sequence. With the fourth number, the probability that this is the largest in the sequence is: (68/96)=.708. Since this is greater than .50, the optimal strategy is to stop. In this sequence of five numbers, playing the optimal strategy leads the player to stop on the winning number.

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