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José Alberto Molina
J. Ignacio Giménez-Nadal
José A. Cuesta
Carlos Garcia-Lazaro
Yamir Moreno
Angel Sanchez

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Forschungsinstitut
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José Alberto Molina
Universidad de Zaragoza and IZA

Carlos Garcia-Lazaro
BIFI, Universidad de Zaragoza

J. Ignacio Giménez-Nadal
Universidad de Zaragoza

Yamir Moreno
BIFI, Universidad de Zaragoza and Institute for Scientific Interchange

José A. Cuesta
BIFI, Universidad de Zaragoza and GISC, Universidad Carlos III de Madrid

Angel Sanchez
BIFI, Universidad de Zaragoza and GISC, Universidad Carlos III de Madrid

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IZA

P.O. Box 7240
53072 Bonn
Germany

Phone: +49-228-3894-0
Fax: +49-228-3894-180
E-mail: iza@iza.org

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ABSTRACT

Gender Differences in Cooperation: Experimental Evidence on High School Students*

Charles Darwin (1874) stated that "women are less selfish but men are more competitive". Very recent papers (Eckel & Grossman, 1998, 2001 or Andreoni and Vesterlund 2001, among others) have shown the relevance of gender in altruism in both ultimatum and dictator games. In this paper we analyze the role of gender in repeated Prisoners' Dilemma played by Spanish high-school students in both a square lattice and a heterogeneous network. We find that female students have a higher probability of cooperation than male students.

JEL Classification: C72, C73, C93, D03, J16

Keywords: gender differences, cooperation, high school students, prisoners' dilemma

Corresponding author:

Ignacio Gimenez Nadal
Department of Economic Analysis
Universidad de Zaragoza
C/ Gran Via 2, 3rd floor
50005 Zaragoza
Spain
E-mail: ngimenez@unizar.es

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1. Introduction

The question about whether or not cooperation of individuals varies systematically with the sex of the decision maker has generated considerable debate. If such difference is present, it will probably affect the modeling of economic outcomes such as household bargaining or intergenerational transmissions, among others. In the household bargaining framework, Manser and Brown (1980) and McElroy and Horney (1981) model the distribution of resources within couples (e.g., income, consumption) as a solution to a cooperative game, usually a Nash bargaining point, in which the threat point is divorce. More recently, Andaluz et al. (2013) developed a super-game in which the spouses play a non-cooperative Stackelberg game where the leader first decides the contributions to a certain quantity of provision of family good, and thereby sets restrictions for the follower. If women are more cooperative than men, this would affect the modeling of the bargaining process within couples. In the intergenerational transfers setting, if mothers are more cooperative than fathers, this could help explain why mothers devote more time to childcare activities than their male counterparts (Hill and Stafford, 1974; Zick and Bryan, 1996; Bianchi, 2000; Hallberg and Klevmarken, 2003; Gauthier et al., 2004; Sayer et al., 2004; Kimmel and Connelly, 2007; Guryan et al., 2008; Kalenkoski et al., 2009; García et al. 2011; Giménez-Nadal and Molina, 2013). Thus, the study of gender differences in cooperative behavior is important at both the theoretical and empirical level.

Under this framework, we provide empirical evidence on gender differences in cooperation between individuals by developing a repeated prisoner's dilemma experiment. Prior research on the prisoner's dilemma, social dilemmas, and public goods provision has found mixed results from a gender perspective. Psychological studies analyzing gender differences in the prisoner's dilemma setting showed that men cooperate significantly more than women (Rapoport and Chammah, 1965; Kahn, Hottest and Davis, 1971; Mack, Auburn and Knight, 1971); on the contrary, other studies showed that women are more cooperative than men (Sibley, Senn and Epanchin, 1968; Tedeschi, Hiester and Gahagan, 1969), while others found no significant differences in cooperation (Dawes, McTavish and Shaklee, 1977; Dawes and Schwartz-Shea, 1994). From an evolutionary biology perspective, Kümmerli et al. (2007) found that women are more cooperative than men in Prisoner's Dilemma games, but not in the Snowdrift's game. In the field of economic experiments, evidence has been in favor of a gender gap in cooperation favoring women. Frank, Gilovich and Regan (1993) showed that women are significantly more cooperative than men in prisoner's dilemma games, Ortman and Tichy (1999) found the same gender difference in the first round of the game, the difference subsequently disappearing over time. Thus, previous evidence about gender differences in cooperation is mixed, although it seems that evidence in the field of economics points toward women being more cooperative than men from a social dilemma perspective.

We contribute to the literature by analyzing gender differences in cooperation, specifically for high school students, by developing an experiment with 1,229 volunteers from final-year high-school students (17-18 years old) of 42 high schools located in the Region of Aragón. The experiment includes 2 phases of a multiplayer prisoner's dilemma, where in the first phase players' partners are the same for all the 51 rounds while in the second phase of the experiment players' partners change in all the 59 rounds. The fact that we have a large sample of individuals with several observations per individual allows us to disentangle the effect of gender from the effect of other factors that may bias the results, such as that of the unobserved heterogeneity of individuals. Standard econometric techniques used in the field of economics (i.e., Ordinary Least Squares and Random Effects models) are applied to analyze gender differences in the level of cooperation among high school students.

We find that, in all our specifications and phases of the experiment, being male is negatively associated with the level of cooperation, with this association being statistically significant at standard levels. In particular, male students have a probability between 4 and 8 percentage points lower of cooperating compared to male students. We also obtain a gender difference in the level of cooperation when we control for the unobserved heterogeneity of individuals, which indicates that the gender gap in cooperation favoring female students is present after netting out this effect from other socio-demographics factors not controlled for in the experiment, and from gender differences in risk, social and competitive preferences (see Groson and Gneezy (2009) for a review). Thus, our results point toward a gender difference in the level of cooperation that may be attributed to a genetic factor. The fact that we obtain similar results when we use alternative subsamples and econometric techniques indicates that our results are good enough to draw valid conclusions.

The rest of the paper is organized as follows. Section 2 presents the experiment. Section 3 describes the empirical strategy. Section 4 presents our main results, and Section 5 sets out our main conclusions.

2. The Experiment: The Prisoner's Dilemma

The experiment was carried out with 1,229 volunteers selected from final-year high-school students (17-18 years old) of 42 different High Schools located in the Region of Aragón (Spain).[1] 34 High Schools were selected in the province of Zaragoza, 5 in the province of Huesca, and 3 in the province of Teruel. For the recruitment of the students, the coordinators of "Ciencia Viva" ("Living Science"), a program of the regional government that supports the dissemination of Science among public high schools in Aragón, were contacted. Many of the private schools of Zaragoza City were also contacted, offering them the possibility of taking part in the experiment. In all cases, the program was referred to as "a social experiment" and no-one (including the high-school teachers in charge of the coordination) knew in advance what the experiment was about. The final sample of volunteers comprises 541 males and 688 females representing 44.02% and 55.98% of the total number of players, respectively.

Out of the 1,229 students, 625 played the game as nodes on a square lattice (274 males and 351 females, maintaining the male-female ratio), and 604 on a heterogeneous network. In both topologies, players played a prisoner's dilemma with all their neighbors, restricted to choosing the same action for every opponent (see below). In the first topology, every player had k=4 neighbors, while in the second network the connectivity varied between 2 and 16. In the first phase of the experiment, the network was static, i.e., every player interacted with same partners throughout the duration of that part. In a subsequent phase, neighbors were randomly assigned in each round, taking care in the heterogeneous case of keeping the number of partners of every player constant. All the students played via a web interface, specifically created for the experiment, accessible through the computers available in the computer rooms of their respective schools. At least one teacher supervised the experiment in each computer room (which at most had a maximum capacity of 20 students), preventing any

[1] In order to satisfy ethical procedures, all personal data about the participants were anonymized and treated as confidential. The Ethical Committee of the University of Zaragoza approved all procedures.

interaction among the students. To further guarantee that potential interactions among students seated next to each other in the class do not influence the results of the experiment, the assignment of players to the different topologies was completely random. Hence, the odds of having two participants geographically close (i.e., of the same school and seated next to each other) who were also neighbors in the virtual topology was quite small. Additionally, the colors used to code the two available actions of the game were also randomly selected for each player, thus decreasing the likelihood that neighbors would influence each other.

All participants went through a tutorial on the screen, including questions to check their understanding of the game. When every-one had gone through the tutorial, the experiment began, lasting for approximately an hour. At the end of the experiments volunteers were presented a small questionnaire to fill in. Immediately after, all participants received their earnings and their attendance fee, with total earnings ranging from 2.49 to 40.48 €. The experiment started on December 20, 2011 at 10:00 CET. The steps followed during the development of the experiment were:[2]

1. Administrators opened the registration process.
2. Players (students) registered from their computers.
3. Once all students had registered, teachers informed the administrators via their screen.
4. As soon as the required number of participants had registered (this took around 20 minutes), administrators blocked further registrations and initiated the reading of the tutorial.
5. Students and teachers read the tutorial.
6. Teachers informed (also via their screens) administrators that the reading was completed.
7. Phase 1 of the experiment began, which lasted 59 rounds.
8. Students played according to some predefined times (a maximum of 20 seconds per round to choose an action). During these steps, teachers controlled for any potential problem using a chat channel that connected them to the administrators. If one student did not play within the 20 seconds allowed for

[2] See Appendix A for a full description of the tutorial for players.

each action, our software played automatically for her (see below). The administrators were able to identify who was not playing, and to contact the teachers if the situation persisted. However, the experiment went smoothly and no feedback to the teachers for mis-behavior was needed.

9. Phase 1 of the experiment ended and a brief tutorial on the second phase was shown.
10. Once teachers and students had read the tutorial, the administrators were notified.
11. Administrators began phase 2 of the experiment, which lasted 51 rounds.
12. Students played as in the previous phase.
13. Once phase 2 of the experiment ended, players were given a short questionnaire to fill in.
14. All participants collected their earnings and were given their show-up fee.

The experiment ended at 12:30 CET. The experiment did not have a fixed number of rounds for each phase, which explains why the 2 phases have a different number of rounds. We implemented a repeated Prisoner's Dilemma where the game ended at any point between rounds 40 and 60 with equal probability.

The Game: The Repeated Prisoner's Dilemma

In each round, each participant is placed in a node of a virtual network, where participant "i" was linked to "j" (j=2, 3,..., 16) people (whom we shall refer to as neighbors), and where the actual number of neighbors was shown to each participant. Participant "i's" neighbors were connected to other people, not necessarily the same ones as participant "i". Participants did not know who their neighbors were.

About the decision to be made in each round, each of the participants had to choose a color: GREEN or BROWN.[3] To choose a color, participants simply had to click a button appearing on the screen. Each time the participants chose a color, they earned an amount of money that depended on their own and their "j" neighbors' choices. The earnings of each round were given in a monetary unit called ECU. When the experiment

[3] Each participant sees the actual colors chosen for them. For clarity, we henceforth refer to green and brown.

ended, an exchange rate from ECUs to Euros was established as a function of the earnings of the participants and the budget available for the experiment (10 500 €). If participant "i" chose GREEN and her neighbor also chose GREEN, each participant received 7 ECUs. If participant "i" chose GREEN and her neighbor chose BROWN, participant "i" received 0 ECUs, and her neighbor received 10 ECUs. If participant "i" chose BROWN and her neighbor also chose BROWN, each received 0 ECUs. If participant "i" chose BROWN and her neighbor chose GREEN, participant "i" received 10 ECUs and her neighbor received 0 ECUs. These rules were the same for all participants. See Figure 1 for a representation of the game and earnings.

According to the structure of the game, participant "i" and each of her neighbors will globally earn more if both choose GREEN (7 ECUs participant "i"/7 ECUs her neighbors). However, participant "i" will earn more if he/she chooses BROWN and her neighbor chooses GREEN (10 ECUs participant "i"/0 ECUs her neighbor), while if both choose BROWN, participant "i" and her neighbor will each earn less (0 ECUs participant "i"/0 ECUs her neighbor) than if they both chose GREEN. The earnings of each pair of strategies follow the structure of a Prisoner's Dilemma game that represents a situation in which two individuals may defect (e.g., BROWN), even if it appears that it is in their best interests to cooperate (e.g. GREEN): pursuing individual reward logically leads both players to defect, but they would get a better reward if they both cooperated.

Empirical Evidence

Table 1 shows means and standard deviations for our variable of interest (cooperation or defection) and several demographic and game characteristics. We have pooled all the rounds, networks and phases together to obtain average values of our variables of interest.[4] We observe that the variable *Average cooperation* has a mean value of 0.341, indicating that individuals chose to cooperate in 34% of the rounds. Previous literature in experimental economics using prisoner's dilemma situations have found "anomalous" cooperative behavior with 40% to 60% contribution rates in spite that defection in every game is the unique dominant-strategy Nash Equilibrium (Fudenberg

[4] Given that we use information on the previous round in our estimations and thus we will exclude the first round of the game, we show summary statistics excluding information from the first round of each experiment and control phase.

and Tirole, 1991; Dawes and Thaler, 1988), which can be explained by the "sequential equilibrium reputation hypothesis" (Kreps et al., 1982). According to this hypothesis, reputation effects due to informational asymmetries can generate cooperative behavior in repeated versions of the classic prisoner's dilemma as players may believe that there is a small chance that their opponent may be altruistic. Then it could be in each player's best interest to pretend, at least for some time, to be an altruistic player in order to build a reputation for cooperation, until the game eventually unravels to mutual defection.

Figure 2 shows the mean cooperation level of the sample over the rounds of the experiment, and their confidence intervals, in the 2 phases of the experiment. We analyze the 2 phases of the experiment separately because we expect to find differences in the level of cooperation between the 2 phases. The reason is that in phase 1 that was played first, reputation effects may be stronger compared to phase 2 where information on the decisions of neighbors in the previous round are shown for the previous and not the current neighbors. We observe that there is a decreasing trend in the level of cooperation in the phase 1 of the experiment, as the cooperation levels decrease from 50% in the first round to 32% in the last round of phase 1. In particular, the spearman's rank correlation coefficient between our variable of interest and the number of rounds is -0.10, and it is statistically significant at $P < 0.001$ on a two-tailed test. This is consistent with the idea that reputation effects is important during the first phase of the experiment, where players decide without any previous knowledge of the underlying mechanisms of the game, while in the second phase of the experiment reputation effects disappeared as neighbors are different in each round. All this evidence is in favor of the sequential equilibrium reputation hypothesis, consistent with previous studies (Kreps et al. 1982; Andreoni and Miller, 1993).

Additionally, we analyze to what extent the design of the experiment affected the behavior of players. The experiment was carried out in two phases, where in the first phase players were randomly assigned to play in a heterogeneous or lattice square network with all players having the same neighbors during this phase. For instance, for an individual playing in a heterogeneous network, this individual had the same number of neighbors, and neighbors were always the same (e.g., same identities) during all the rounds of this phase of the experiment (e.g., static network). Later, in the second phase of the experiment, the same individuals played in the same type of network (e.g., heterogeneous or square lattice) but now neighbors were different in each round (e.g., dynamic network). If we find substantial differences in the level of cooperation between the two phases, such differences may be attributed to differences in the behavior of individuals due to the type of network (e.g., static versus dynamic), given that the same individuals were assigned to the same network (e.g., heterogeneous or square lattice) in the two phases.[5] Such differences may be due to the fact that individuals may have learned how to play during the first phase, approaching the Nash-Equilibrium solution in the second phase.

Comparing the level of cooperation between the two phases, the mean cooperation level in phase 1 is 0.386 with a standard deviation of 0.487 (n=62679), while the mean cooperation level in the control phase is 0.307 with a standard deviation of 0.461 (n=71282). A t-type test of means of the variable for the two subsamples indicates that the difference is statistically significant at the 99% level ($p<0.0001$), and thus a raw comparison of the data indicates that the cooperation level is slightly lower in the second phase compared to the first one. Nevertheless, such a difference in cooperation could be explained by the "reputation hypothesis" and disappears over time as the reputation effect disappears. Thus, we next analyze how differences in the level of cooperation by phase evolved during the experiment. Figure 2 shows the mean level of cooperation over the experiment, by phase, and the confidence intervals of the mean level of cooperation. We first observe that the overall cooperation in phase 1 is larger than the overall cooperation in phase 2 in all the rounds of the experiment. However, looking at the confidence intervals for each phase, the negative confidence interval for the observations of phase 1 ($\overline{X}_1 - 1.96SE_1$) does not overlap with the positive confidence interval for observations of phase 2 ($\overline{X}_2 - 1.96SE_2$) in the first 20 rounds, but afterwards level of cooperation is similar in the two phases of the experiment.[6] Thus, we find evidence that the gap in cooperation decreases over time, reaching similar levels of cooperation later in the game. This may indicate that the reputation hypothesis played a role in shaping individuals' behavior in the first phase of the experiment, disappearing

[5] We do not consider differences in the behavior of individuals between the heterogeneous and the square lattice network, as previous evidence has found no evidence of behavior depending of the type of network (e.g., Gracia-Lazaro et al, 2012a; 2012b).

[6] $\overline{X}_1$ and SE_1 measures the average cooperation and the standard error in cooperation in each round of phase 1 of the experiment. $\overline{X}_2$ and SE_2 measures the average cooperation and the standard error in cooperation in each round of phase 2 the experiment.

at later stages. Also, this evidence suggests that the two phases of the experiment must be analyzed separately.

Considering the overall earnings obtained by students, in each round the mean earning is 10.536, and the mean number of neighbors is 3.574. We also consider the earnings obtained in previous rounds for both participants and the participant's neighbors. Since this information is shown to players in each round, we use this information as a proxy to study the effect of previous actions on the behavior of individuals. In particular, we compute the earnings obtained by the participant in the previous round, and the overall earnings obtained by the participant's neighbors in the previous round.

For the payoffs obtained by respondent's neighbors in the previous round, here we must take into account that while the number of neighbors is fixed in the square lattice network (e.g., four), it varies between 2 and 16 in the heterogeneous network, and thus we need to summarize neighbors' earnings in a single variable to avoid losing observations.[7] In particular, for neighbors' earnings in the previous round we have done the sum of the variable of earnings for all the neighbors in the previous round (e.g., what current neighbor played in the previous round) and then divided the sum by the number of neighbors, which yields an average value of the neighbors' earnings in the previous round. Table 1 shows the average values of the earnings obtained by participants and the mean earnings of neighbors in previous rounds, and we observe that overall earnings obtained in the previous round and mean overall earnings of neighbors are 10.65 and 12.75 ECUs.

Considering the raw gender difference in cooperation, the average cooperation level of female players during the experiment is 0.375 with an standard deviation of 0.484 (n=74992), while the average cooperation level for male players is 0.304 with an standard deviation of 0.460, and a t-type test of means of the variable for the 2 subsamples indicates that the difference is statistically significant at the 99% level ($p<0.0001$). Thus, a raw comparison of the data indicates that female students have a

[7] Consider students who have 16 neighbors, compared to students who have less than 16 neighbors. If we want to introduce variables for the earnings of each neighbor, we will need 16 variables for students who have 16 neighbors. For students who have less than 16 neighbors, some of these 16 variables would contain no values, and thus these students would be dropped out from estimations as they would include missing values in the neighbors' variables. We cannot compute the information of the previous round in round 1, as it is the beginning of each phase and there is no previous round, so we will exclude round 1 of each phase during the empirical analysis.

higher probability of cooperation compared to male students in the experiment. However, previous evidence has shown that gender differences in cooperation are present during the first rounds of a repeated experiment, but that gender differences disappear over time (Ortmann and Tichy, 1999). Thus, we next analyze how differences in the level of cooperation by gender evolved during the experiment. Figure 3 shows the mean level of cooperation over the experiment, by gender, and the confidence intervals of the mean level of cooperation. We first observe that the overall cooperation for female players is larger than the overall cooperation for male players in all the rounds of the experiment. Additionally, looking at the confidence intervals for each gender, in most cases the negative confidence interval for female players ($\bar{X}_f - 1.96 SE_f$) does not overlap with the positive confidence interval for male players ($\bar{X}_m - 1.96 SE_m$), indicating that there is a statistically significant gender gap in cooperation throughout the different rounds of the experiment.[8] Thus, we find evidence that the gender gap in cooperation favoring female students does not disappear over time.

3. Empirical Strategy

As a first specification, we estimate Ordinary Least Squares (OLS) regressions on the decision to cooperate or to defect. We estimate the following equation:

$$C_{ijt} = \alpha + \beta X_i + \delta Game_{ijt} + \varepsilon_{ijt} \quad (1)$$

where C_{ijt} represents the decision (cooperation/defection) by participant "i" in network "j" at round "t". The dependent variable is a dummy variable that takes value 1 if individual "i" in network "j" at round "t" decided to cooperate, and takes value 0 if he/she decided to defect. The vector X_i includes participant's "i" demographic characteristics such as gender (1= male, 0=female), number of siblings, the field of the bachelor (1=humanities, 0=science), whether the student attended a private (1=yes, o=no) or semi-private (1=yes, 0=no), and whether the high school is located in an urban area (1=yes, 0=no) or not. $Game_{ijt}$ includes game variables. ε_{ijt} is a random variable (e..g., standard errors) that represents unmeasured factors, capturing all the factors that

[8] $\bar{X}_f$ and SE_f measures the average cooperation and the standard error in cooperation for female students in each round of the experiment. $\bar{X}_m$ and SE_m measures the average cooperation and the standard error in cooperation for male students in each round of the experiment.

may affect participant's decisions and for what we do not have information, and we assume that $\varepsilon_{ijt} \sim N(0,\sigma^2)$. We cluster observations by individual to allow for differences in the standard errors due to arbitrary intra-individual correlation.

We have estimated Equation (1) using 6 different samples: 1) individuals playing in the heterogeneous network in phase 1, 2) individuals playing in the square lattice network in phase 1, 3) individuals playing in the heterogeneous and the square lattice networks during in phase 1, 4) individuals playing in the heterogeneous network in phase 2, 5) individuals playing in the square lattice network in phase 2, and 6) individuals playing in the heterogeneous and the square lattice networks during the phase The reason to estimate with different samples is to see if results are consistent to sample selection and network selection issues. If we obtain different results in different subsamples, it could be that networks may have effects on the decisions process of individuals, or because individuals selected into the different networks are different.

$Game_{ijt}$ includes the following variables: the round number (j=1,2...51), the number of neighbors participant "i" is playing with, participant's earning in the previous round, and the mean earning of neighbors in the previous round. Given that we have an iterative game, and students are shown in each round the earnings and the decision their current neighbors played in the previous round (see Appendix A for an example of the screen students are shown during the game), we include these variables to see whether or not participant and neighbors' decisions in previous rounds affect the behavior of players.

We also estimate models that take into account the unobserved heterogeneity of individuals, since there may be some unobserved factors at the individual level that may be correlated with the cooperation decision, and thus results based on Equation (1) may be biased. For instance, past personal experiences, mood in the day of the experiment, or personal attitudes towards justice, equity and confidence may condition the decisions of individuals of our experiment, and if we do not take into account such differences the coefficient β in Equation (1) would be capturing the effects of such unobserved differences and not the real of factors such as gender. Thus, we estimate a random-effects linear probability model to control for unobserved heterogeneity of individuals, where we use the following equation:[9]

$$C_{ijt} = \alpha_i + \beta X_i + \delta Game_{ijt} + \varepsilon_{ijt} \quad (2)$$

Here C_{ijt} represents the decision (cooperation/defection) by individual "i" in network "j" at round "t", and α_i represent the individual effect. The time variation needed to estimate a panel data model is given by the fact that respondents played more than one round during each phase.

The fact that the data allows to control for the unobserved heterogeneity of individuals makes the linear probability model particularly attractive with respect to other models such as the Probit model.[10] Although the linear probability model may not provide a very good estimate of the partial effects at extreme values of the independent variables, it still produces a consistent and even unbiased estimator of the partial effects on the response probability averaged across the distribution of the independent variable.

4. Results

Columns (1) to (6) in Table 2 show the results of estimating Equation (1) for the six subsamples mentioned above. Considering the effect of gender on the level of cooperation of individuals, we observe negative and statistically significant associations between being male and the probability of cooperation in all the analyzed samples, with these associations being statistically significant at standard levels. In particular, we find that being male is associated with a decrease of between 4 (Column (1)) and 8 (Column (4)) percentage points in the probability of cooperation. Considering that the mean level of cooperation during the experiment is 0.341, we find that female players have a higher probability of between 11 and 23 percentage points to cooperate, compared to male players. This negative association between being male and cooperation is present when we analyze alternative samples and networks (e.g., phase 1 versus phase 2), and is net out of the effects of other demographic characteristics. For instance, it could be that the

[9] Since we are interested on how the level of cooperation depends on gender and the number of neighbors, among others, we cannot use a fixed-effects estimator since these variables would be eliminated from estimates. Thus, the random-effect estimator is preferable for our purpose.

[10] We have also estimated Probit models on the same subsamples, and results are consistent to the OLS results. See Appendix B for a description of the Probit model and the estimation results.

number of siblings of the respondent conditions his/her cooperative behavior, fostering the level of cooperation of the individuals as he/she is more used to intra-household bargaining. Also, it could be that children who attend a private school observe a higher household income, which may make those children to give a relative lower value to the payoffs offered during the game, affecting their behavior. These and more factors may be driving our results, and thus we need to control for these characteristics in our estimations to net out the effect of gender from other effects.

Other factors affecting the level of cooperation of individuals are the round number, the respondent's payoff in the previous round, and the mean payoff of neighbors in the previous round. In the case of the round number, we observe a negative and statistically significant association between the round number and the level of cooperation in both phase 1 (Columns (1) to (3)) and phase 2 of the experiment (Columns (4) to (6)). In particular, we find that an additional round in the experiment decreases the probability of cooperation by 0.3 and 0.1 percentage points in phase 1 and 2 of the experiment. These results are consistent with the "sequential equilibrium reputation hypothesis" since the cooperation level decreases as the game unravels to mutual defection. However, we observe that the effect of the round in the level of cooperation is lower in the phase 2 of the experiment, which may indicate that the reputation hypothesis has a smaller effect in phase 2 of the experiment where players may have learned that reputation is not an underlying mechanism operating during the game, or they may have realized that as their neighbors change in every round the idea of reputation does not apply.

Respondent's payoff in the previous round has a negative and statistically significant association with the probability of cooperation. In particular, each additional ECU obtained in the previous round is related with decreases in the probability of cooperation of around 0.4 percentage points in phase 1 of the experiment, and of around 0.07 percentage points in phase 2 of the experiment. One explanation for this reported association is that if respondent has defected in the previous round, and he/she has obtained a high payoff in the previous round, the respondent is in a "defection mood" to try to obtain a high payoff in the current round. The opposite applies for the mean payoffs obtained by neighbors in the previous round, as it has a positive and statistically significant association with the level of cooperation. Furthermore, this positive association is not present in the phase 2 of the experiment, where neighbors are different in each round. Our experimental findings suggest that the behavior of the players depends on the previous actions of their neighbors (conditional cooperation), but may also depend on the previous action of the players themselves (moody conditional cooperation), indicating that players seem to react to the context in a way influenced by their own previous action (Grujic et al., 2010;2012). However, it is only for static networks where the "moody conditional cooperation" is present, indicating that in networks where neighbors change during the process the behavior of players does not depend on their neighbors. This, in fact, reinforces our interpretation that players realize the difference between the two treatments and act accordingly.

Previous research on gender differences in economic experiments has shown that there are gender differences in risk, social and competitive preferences (see Croson and Gneezy (2009) for a review). Additionally, there can be other socio-demographic factors not controlled for in the experiment, such as the respondent's household income, that can be correlated with the higher level cooperation of women. Thus, the previously observed gender difference in cooperation could be attributed to gender differences in preferences, or to non-controlled socio-demographic factors. For this reason, we need to apply an econometric technique that nets out the effect of gender from other observed (although not controlled for) and unobserved factors (e.g., preferences). If we now consider that our dataset has a panel data structure (e.g., same individuals observed during several periods of time), we can apply the Random Effect estimator (Wooldridge, 2002) to estimate the effect of gender on cooperation net out of observed and unobserved heterogeneity.

Columns (1) to (6) in Table 3 show the results of estimating Equation (2) for the six subsamples we are working with. We observe negative and statistically significant associations between being male and the probability of cooperation in all the analyzed samples, with these associations being statistically significant at standard levels. In particular, we find that being male is associated with a decrease of between 4 (Column (1)) and 8 (Column (4)) percentage points in the probability of cooperation. For the rest of factors, our results are consistent compared to the OLS results, and indicate that our observations cannot be attributed to non-controlled factors.

5. Conclusions

The question about whether or not cooperation of individuals varies systematically with the sex of the decision maker is analyzed in this paper. Prior research on the prisoner's dilemma, social dilemmas, and public goods provision has found mixed results from a gender perspective. We contribute to the literature by analyzing gender differences in cooperation for Spanish high school students. To that end, we carried out an experiment with 1,229 volunteers from final-year high-school students (17-18 years old) of 42 high schools located in the Region of Aragón. Standard econometric techniques used in the field of economics (i.e., Ordinary Least Squared, and Random Effects models) are applied to analyze gender differences in the level of cooperation of Aragonians high school students.

We find that being male is negatively associated with the level of cooperation, with this association being statistically significant at standard levels. We also obtain a gender difference in the level of cooperation when we control for the unobserved heterogeneity of individuals, which indicates that the gender gap in cooperation favoring female students is present after netting out this effect from other socio-demographics factors not controlled for in the experiment, and from gender differences in risk, social and competitive preferences (see Groson and Gneezy (2009) for a review). Thus, our results point toward a gender difference in the level of cooperation that may be attributed to a genetic factor.

We hope that this article will serve as a resource for those in the field of economics seeking to understand gender differences in the level of cooperation, and to use it as a starting point to illuminate the debate on genetic differences in behavior. We urge researchers to routinely record the gender of the participants when possible in order to expand our understanding of gender differences. Having established this gender difference, it is appropriate now for research to address the issue of how other parameters of the experimental setting influence the behavior of women and men. Finally, to the extent that our findings support the existence of gender differences in cooperation, the theory used to model some economic outcomes, such as household bargaining, could incorporate this gender asymmetry. We leave all these issues for future research.

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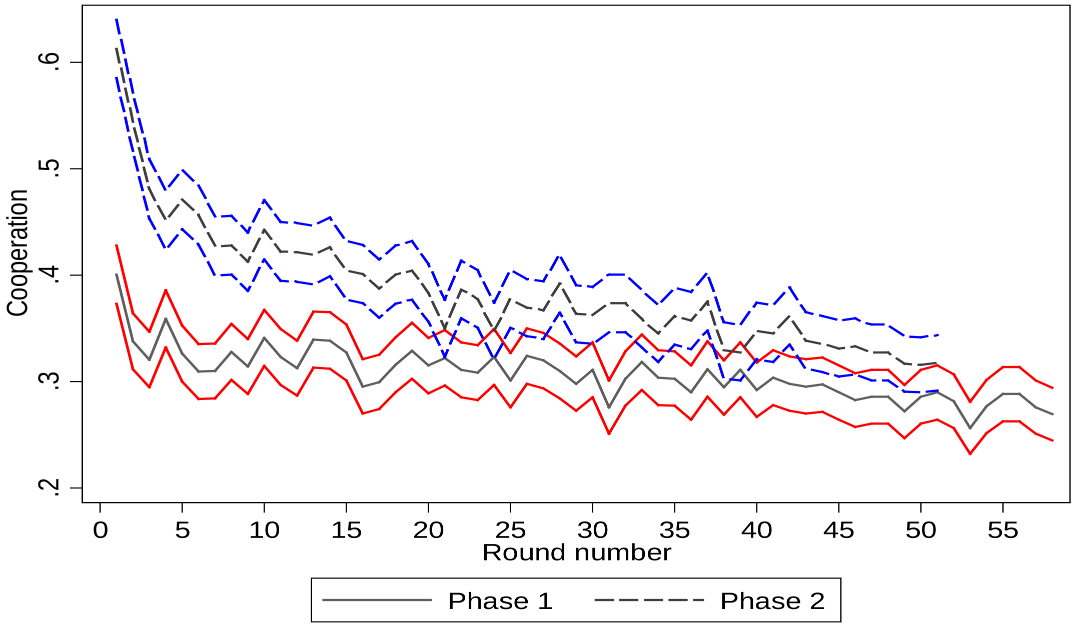
Figure 1. Earning structure of the Game

P1/P2	**GREEN**	**BROWN**
GREEN	(7,7)	(0,10)
BROWN	(10,0)	(0,0)

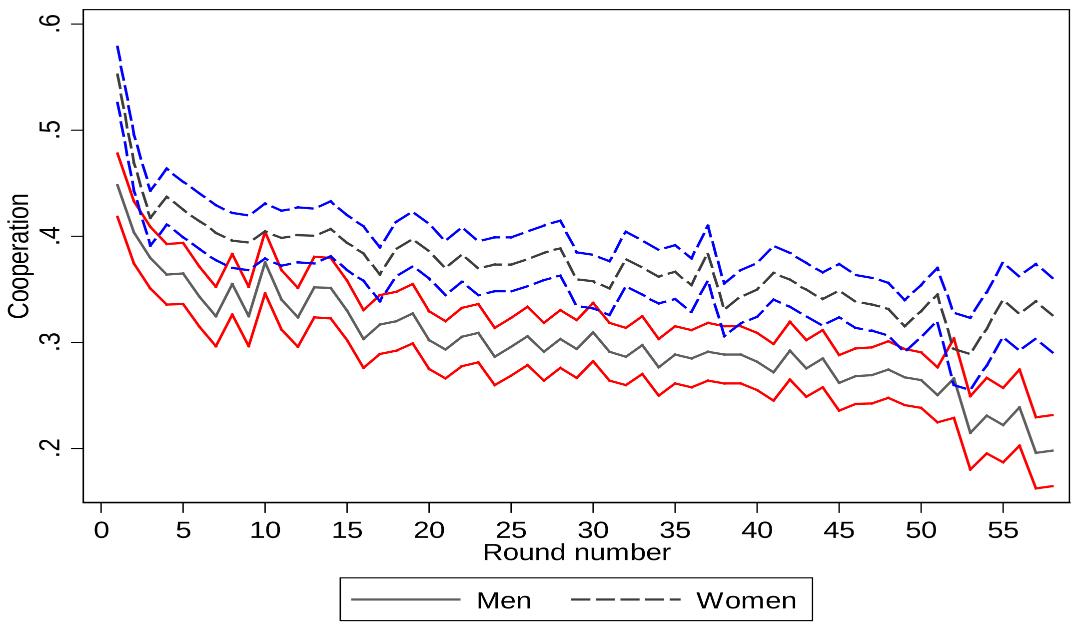
Note: units are ECUs that were later converted to €.

Figure 2. Mean cooperation, by round



Notes: cooperation is defined as the mean value of a dummy variable that takes value "1" if the individual cooperates in the round of reference, and takes value "0· for defection. "Experiment" was played in the first phase of the experiment; "Control" was played in the second phase of the experiment. Round number goes from 1 to 58.

Figure 3. Mean cooperation, by round and gender



Notes: cooperation is defined as the mean value of a dummy variable that takes value "1" if the individual cooperates in the round of reference, and takes value "0· for defection. Round number goes from 1 to 58. Confidence intervals (CI) are defined at the 95% level. Red lines show the CI for men, and blue lines show the CI for women.

Table 1. Sum stats for personal and game characteristics.

	(1)	(2)
Variables	**Mean**	**Standard deviation**
Round Characteristics		
Cooperation	0.341	(0.474)
Earnings	10.536	(9.621)
Number of neighbors	3.574	(1.504)
Payoff in previous round	10.647	(9.671)
Mean payoff of neighbors in previous round	12.745	(7.712)
Demographic Characteristics		
Male	0.440	(0.496)
Number of siblings	1.117	(0.869)
Following Humanities	0.265	(0.441)
Attending to a private school	0.071	(0.256)
Attending to a Semi-private school	0.277	(0.448)
Attending to an urban school	0.746	(0.435)
N Observations	131,503	

Note: Sample consists of final-year high school students from Aragon (Spain). *Cooperation* is a dummy variable that takes value 1 if individual "i" in network "j" at round "t" decided to cooperate, and takes value 0 if he/she decided to defect. *Earnings* measures the payoff received by the reference player in each round. *Payoff in previous round* measures the payoff received by the reference player in the previous round. *Mean payoff of neighbors in previous round* measures the average payoff received by the neighbors' player in the previous round. The demographic characteristics includes gender (1= male, 0=female), number of neighbors, number of siblings, the field of the bachelor (1=humanities, 0=science), attending to a private or semi-private school, and attending to an urban school.

Table 2. OLS Regressions for cooperation of individuals playing the Prisoner's Dilemma.

OLS Regressions	(1)	(2)	(3)	(4)	(5)	(6)
	Heterogenous's Experiment	***Sq. Lattice Experiment***	***Het + Sq Lattice Experiment***	***Heterogenous Control***	***Sq. Lattice Control***	***Het + Sq Lattice Control***
Male	-0.038***	-0.061***	-0.050***	-0.081***	-0.068***	-0.073***
	(0.013)	(0.012)	(0.009)	(0.016)	(0.016)	(0.012)
Round number	-0.003***	-0.003***	-0.003***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of neighbors	-0.004	-	-0.004	-0.001	-	-0.002
	(0.004)	-	(0.003)	(0.004)	-	(0.004)
Humanities	0.012	0.037***	0.024**	0.020	0.028	0.025**
	(0.014)	(0.013)	(0.010)	(0.018)	(0.017)	(0.013)
Number of siblings	0.004	0.000	0.002	-0.012	0.009	0.000
	(0.007)	(0.006)	(0.005)	(0.009)	(0.008)	(0.006)
Attending a private school	0.017	-0.040**	-0.017	0.041	-0.027	0.000
	(0.022)	(0.020)	(0.016)	(0.033)	(0.026)	(0.021)
Attending a Semi-private school	-0.010	-0.016	-0.013	0.010	-0.024	-0.008
	(0.014)	(0.014)	(0.010)	(0.019)	(0.019)	(0.013)
Attending an urban school	-0.001	-0.010	-0.006	-0.032*	-0.010	-0.022
	(0.014)	(0.015)	(0.010)	(0.018)	(0.020)	(0.014)
Mean payoff of neighbors in previous round	0.004***	0.009***	0.005***	0.000	0.001	0.000
	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)
Payoff in previous round	-0.003***	-0.004***	-0.004***	-0.007***	-0.008***	-0.007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.475***	0.395***	0.458***	0.480***	0.432***	0.462***
	(0.021)	(0.021)	(0.017)	(0.023)	(0.024)	(0.020)
Observations	30200	31250	61450	34428	35625	70053
Number of id	604	625	1229	625	604	1229
R-squared	0.03	0.04	0.03	0.03	0.03	0.03

Note: Sample consists of final-year high school students from Aragon (Spain). Clustered standard errors in parenthesis. We estimate the following equation: $C_{ijt} = \alpha + \beta X_i + \delta Game_{ijt} + \varepsilon_{ijt}$ where C_{ijt} represents the decision (cooperation/defection) by individual "i" in network "j" at round "t". The dependent variables is a dummy variable that takes value 1 if individual "i" in network "j" at round "t" decided to cooperate, and takes value 0 if he/she decided to defect. The vector *Xi* includes participant's "i" demographic characteristics such as gender (1= male, 0=female), number of siblings, the field of the bachelor (1=humanities, 0=science), while $Game_{ijt}$ includes game variables from the previous round. We cluster observations by individual to allow for differences in the variance/standard errors due to arbitrary intra-individual correlation.

Table 3. Random effects regressions for cooperation of individuals playing the Prisoner's Dilemma.

RE Regressions	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Heterogenous Experiment	***Sq. Lattice Experiment***	***Het + Sq Lattice Experiment***	***Heterogenous Control***	***Sq. Lattice Control***	***Het + Sq Lattice Control***
Male	-0.038***	-0.063***	-0.051***	-0.082***	-0.069***	-0.074***
	(0.012)	(0.010)	(0.009)	(0.014)	(0.013)	(0.010)
Round number	-0.003***	-0.003***	-0.003***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of neighbors	-0.008**	-	-0.007**	-0.005	-	-0.007**
	(0.003)	-	(0.003)	(0.004)	-	(0.003)
Humanities	0.011	0.038***	0.025**	0.020	0.028*	0.026**
	(0.014)	(0.012)	(0.010)	(0.017)	(0.015)	(0.011)
Number of Brothers	0.004	0.001	0.002	-0.012	0.009	0.001
	(0.008)	(0.006)	(0.005)	(0.009)	(0.007)	(0.006)
Attending a private school	0.018	-0.040**	-0.018	0.040	-0.028	-0.001
	(0.027)	(0.019)	(0.017)	(0.032)	(0.024)	(0.020)
Attending a Semi-private school	-0.010	-0.015	-0.012	0.010	-0.024	-0.008
	(0.014)	(0.012)	(0.010)	(0.016)	(0.015)	(0.011)
Attending an urban school	-0.001	-0.010	-0.006	-0.032**	-0.010	-0.022**
	(0.014)	(0.013)	(0.010)	(0.016)	(0.016)	(0.011)
Mean payoff of neighbors in previous round	0.004***	0.005***	0.005***	0.000	0.001**	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
Payoff in previous round	-0.002***	-0.003***	-0.003***	-0.006***	-0.006***	-0.006***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.467***	0.445***	0.472***	0.478***	0.408***	0.461***
	(0.020)	(0.018)	(0.016)	(0.022)	(0.020)	(0.018)
Observations	30200	31250	61450	34428	35625	70053
Number of id	604	625	1229	625	604	1229
R-squared	0.03	0.04	0.03	0.03	0.03	0.03

Note: Sample consists of final-year high school students from Aragon (Spain). Standard errors in parenthesis. We estimate the following equation: $C_{ijt} = \alpha + \beta X_i + \gamma Game_{ijt} + \varepsilon_{ijt}$ where C_{ijt} represents the decision (cooperation/defection) by individual "i" in network "j" at round "t". The dependent variables is a dummy variable that takes value 1 if individual "i" in network "j" at round "t" decided to cooperate, and takes value 0 if he/she decided to defect. The vector *Xi* includes participant's "i" demographic characteristics such as gender (1= male, 0=female), number of siblings and the field of the bachelor (1=humanities, 0=science), while $Game_{ijt}$ includes game variables from the previous round.

APPENDIX A: The Experiment

The experiment was run using a web application specifically developed to this purpose, using free software. It was developed in Ruby On Rails, and has a MySQL database, a freely available open source relational database management system based on Structured Query Language (SQL), the most popular language for adding, accessing and managing content in a database.

The application was designed to be used by three different user profiles. First of all, we have all the players. Secondly, there are teachers who were responsible for supervising students through their dedicated web monitors, facilitating the work of the central administrator work and contributing to the success of the experiment. Finally, the administrators were responsible for controlling the game and everything that was happening in real time. There was a last participant, a daemon or process running in the background whose function was to update the results and play instead of players who do not play within the specified time frame for each action (20 seconds). Considering that the experiment required that around 1300 students could play online simultaneously, we used a server with enough power, and many optimizations were performed in terms of connections to the server, access to database, client-server data exchange, lightness of the interface, control logic, etc.

On-line tutorial for players

The following is a translation of the Spanish original on-line tutorial (available upon request). It is worth remarking that each player had a customized pair of colors and a corresponding number of neighbors. We refer in what follows to the latter as X (but X showed its actual value for each participant). As advanced above, to avoid framing effects, the two actions were always referred to in terms of colors (chosen randomly among a predefined set of possible pairs of colors), and the game was never referred to as Prisoner’s Dilemma in the material handed to the volunteers. Subjects were properly informed of the consequences of choosing each action, and some examples were given to them in the introduction. After every round subjects were given the information of the actions taken by their neighbors and their corresponding earnings. In all cases, the earnings were properly normalized to avoid the possibility of guessing the number of connections of their neighbors. The instructions are given here assuming a given pair of colors (green and brown), but again, each participant saw the actual color assigned to him/her. Moreover, we took into consideration the possibility that some of the students were colorblind. In this sense, we provided clear instructions to avoid any possible error in the final results, specifying the order in which each color appeared on the screen and also using a combination of specifically selected colors (5 different pairs) so that the probability of error was reduced to a minimum.

Page 1

This is an experiment designed to study how individuals make decisions.
You are not expected to behave in any particular way.
Whatever you do will determine the amount of money you can earn.
You have a written version of these directions which you can check at any stage of the experiment.
Please keep quiet during the experiment. If you need help, raise your hand and wait to be attended.

Page 2: Directions to participate in the experiment
This experiment consists of TWO (2) parts.
Each part consists of an undetermined number of ROUNDS (approximately between 50 and 70, but there might be more or less).
Each part will last at most 35 minutes, but could finish before.
In each part you will be able to earn different amounts of money, depending on the decisions that you and the rest of participants make in every round.
The earning of each round is given in a monetary unit called ECU. When the experiment finishes, an exchange rate from ECUs to Euros will be established as a function of the number of participants.
Your total earning in this experiment will be the accumulated earnings in all the rounds of the two parts, plus a show-up fee.

Page 3: A Round
In each ROUND you will be placed in a node of a virtual NETWORK.
In this network you will be linked to X (*here the actual number is shown to each participant*) people, whom we shall refer to as “neighbors”.
Your neighbors will also be connected to other people. You will be one of those neighbors, but the rest of them will not necessarily be the same neighbors that you have.
You will never know who your neighbors are, and nobody will know if you are her neighbor either.
The network is virtual. People around you in the room are not necessarily your neighbors.

Page 4: Decision to make in every round
Every round, each of the participants must choose a color: GREEN or BROWN. (*Note: as explained before, each participant sees the actual colors chosen for them. For clarity, we henceforth refer to green and brown*)
To choose a color you just have to click a button appearing in the screen.
Each time you choose a color (either blue or yellow) you will earn an amount of money which will depend on yours and your X neighbors’ choices.
If you choose GREEN and your neighbor also chooses GREEN, each receives 7 ECUs.
If you choose GREEN and your neighbor chooses BROWN, you receive 0 ECUs and your neighbor 10 ECUs.
If you choose BROWN and your neighbor also chooses BROWN, each receives 0 ECUs.
If you choose BROWN and your neighbor chooses GREEN, you receive 10 ECUs and your neighbor 0 ECUs.
These rules are the same for all participants.

Page 5: Possible earnings per neighbor
In the following table each row corresponds to the decision you can make and each column correspond to one of your neighbors’ decision.

Figure A1: Snapshot of the experimental software.

Consider that:

- you and each of your neighbors will globally earn more if you both choose GREEN (7 ECUs you / 7 ECUs your neighbor);
- you will earn more if you choose BROWN and your neighbor chooses GREEN (10 ECUs you / 0 ECUs your neighbor);
- but if both you and your neighbor choose BROWN you both will earn less (0 ECUs you / 0 ECUs your neighbor) than if you both chose GREEN.

Figure A2: Snapshot of the experimental software.

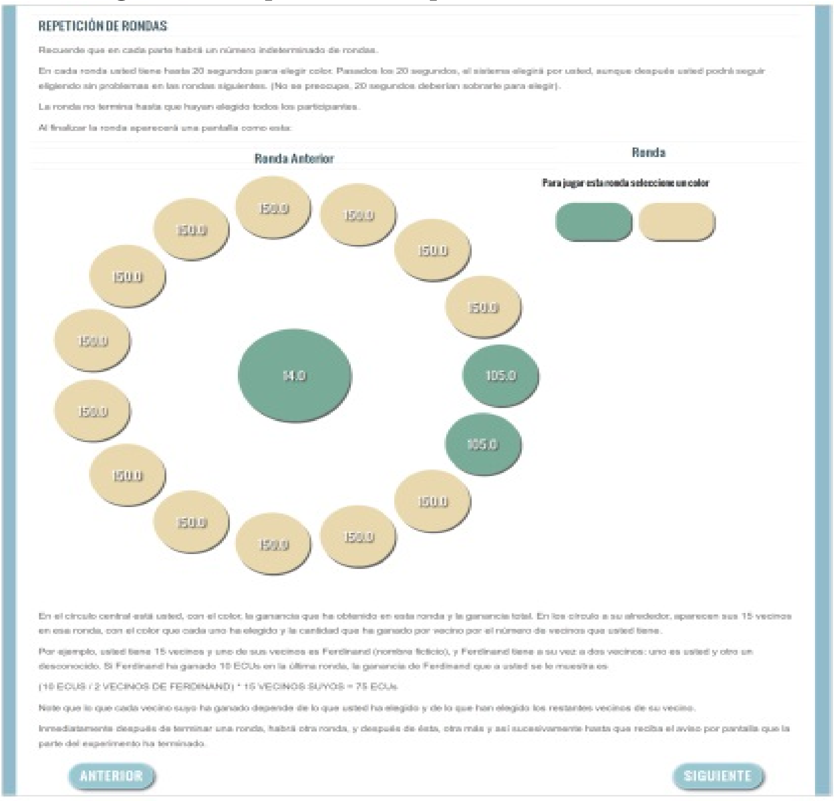
Note: earnings shown do not correspond to any real situation, but simply illustrate how they were seen by the subjects.

This is the screen you will be seeing during the experiment. The central circle represents you, and the surrounding circles represent your virtual neighbors in that round.
On the right of the screen you will see two buttons: GREEN and BROWN.
Each round you must choose one of them clicking the corresponding button.

Page 7: These are some examples of what you could earn in a round:
Example 1: Imagine you choose GREEN, 3 of your neighbors choose GREEN and 1 chooses BROWN. In that round you will earn 3X7+1X0=21 ECUs.
Example 2: In another round you choose BROWN, 2 of your neighbors choose GREEN and 2 choose BROWN. In that round you will earn 2X10+2X0=20 ECUs.

Page 8: Round iteration
Remember that each part will consist of an undetermined number of rounds.
Each round you will have up to 20 seconds to choose a color. After these 20 seconds, if you didn't choose, the system will choose for you. Whatever happens it will not affect the behavior of the system in the next rounds: you will be able to make your subsequent choices normally. (Don't worry: 20 seconds are more than enough to make a choice).
The round will not end until all participants have made their choice.
At the end of each round you will see a screen like this one:

Figure A3: Snapshot of the experimental software.



Note: earnings shown do not correspond to any real situation, but simply illustrate how they were seen by the subjects.

Page 9: Part I of the experiment

In this part the system will randomly assign each participant to a given node of the virtual network.

This place will be kept fixed until this part ends.

This means that you will be interacting with **the same X neighbors** during all rounds of this part.

Remember that in each round you must choose a color.

When this part finishes, you will be notified and will see the directions for the next part.

(Part I begins.)

Page 10: Part I of the experiment has finished.

Please, keep quiet.

Part II will start in a few seconds.

Page 11: Part II of the experiment

In this part, **before each round begins,** every participant will be moved to a **new** random node of the virtual network. Therefore, in general **you will likely have X new neighbors every round.**

This means that **the node you are in will be changing along the experiment.**

Thus you will NOT be linked all rounds to the same X neighbors.

Page 12: The rules to make decisions every round are the same as in Part I.

The only thing that is different is that your neighbors will most likely not be the same every round.

Remember:

- Every round you have 20 seconds to make a choice.
- The round finishes only when all participants have made their decisions.
- At the end of each round you will be seeing a screen like in Part I

(Part II begins.)

Page 13: Part II of the experiment has finished.

Please, keep quiet.

The experiment has not finished yet.

You have to answer the following questionnaire.

Please, answer ALL questions in the questionnaire that you will be shown immediately.

(*The questionnaire was shown and afterwards they were notified how much they had earned and were to go to get paid.*)

Synchronous play and automatic actions

The experiment assumes synchronous play, thus we had to make sure that every round ended in a certain amount of time. This playing time was set to 20 seconds, which was checked during the testing phase of the programs to be enough to make a decision, while at the same time not too long to make the experiment boring to fast players. If a player did not choose an action within these 20 seconds, the computer made the decision instead. This automatic decision was randomly chosen to be the player's previous action 90% of the times and the opposite action 10% of the times. Note that we did not inform the volunteers of this procedure, only that the computer would play by them if they did not play in time. We preferred not to let them know the precise intervention to avoid players using this fact to play the same action instead of explicitly choosing an action. In any case, for the reliability of the experiment it is important that a huge majority of actions were actually played by humans, not by the computer. This quantity, when averaged over all rounds, yields that the 90% of the actions were chosen by humans, regardless of the underlying network of contacts.

APPENDIX B: Probit results

We have alternatively estimated Probit models that take into account the dichotomous behavior of our dependent variable, in order to see the consistency of our results to alternative specifications of the econometric model. The Probit model can be estimated as follows:

$$Y^*_{ijt} = \beta X_i + \delta Game_{ijt} + \varepsilon_{ijt} \tag{3}$$

where Y^*_{ijt} is a latent variable, and $\varepsilon_{ijt} \sim N(0,1)$. Then Y_{ijt} can be viewed as an indicator for whether this latent variable is positive:

$$C_{ijt} = \begin{cases} 1 \text{ if } Y^*_{ijt} > 0 \text{ i.e. } -\varepsilon_{ijt} < \beta X_i + \delta Game_{ijt} \\ 0 \text{ otherwise} \end{cases} \tag{4}$$

The use of the standard normal distribution causes no loss of generality compared with using an arbitrary mean and standard deviation because adding a fixed amount to the mean can be compensated by subtracting the same amount from the intercept, and multiplying the standard deviation by a fixed amount can be compensated by multiplying the weights by the same amount. Table B1 shows the results of estimating Probit models on the 6 subsamples used throughout the paper.

Table B1. Probit regressions for cooperation of individuals playing the Prisoner Dilemma.

Probit Regressions	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Heterogeneous Experiment	***Sq. Lattice Experiment***	***Het + Sq Lattice Experiment***	***Heterogeneous Control***	***Sq. Lattice Control***	***Het + Sq Lattice Control***
Male	-0.102***	-0.168***	-0.136***	-0.236***	-0.206***	-0.217***
	(0.033)	(0.034)	(0.024)	(0.048)	(0.051)	(0.035)
Round number	-0.007***	-0.007***	-0.008***	-0.003***	-0.004***	-0.004***
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)
Number of neighbors	-0.013	-	-0.011	-0.006	-	-0.009
	(0.010)	-	(0.009)	(0.015)	-	(0.014)
Humanities	0.030	0.103***	0.065**	0.060	0.083*	0.076**
	(0.037)	(0.035)	(0.026)	(0.052)	(0.050)	(0.036)
Number of Brothers	0.011	0.001	0.006	-0.032	0.027	0.002
	(0.019)	(0.016)	(0.013)	(0.027)	(0.024)	(0.018)
Attending a private school	0.045	-0.113**	-0.046	0.116	-0.085	0.000
	(0.058)	(0.057)	(0.043)	(0.093)	(0.082)	(0.062)
Attending a Semi-private school	-0.026	-0.045	-0.035	0.029	-0.074	-0.024
	(0.037)	(0.040)	(0.028)	(0.054)	(0.058)	(0.039)
Attending an urban school	-0.003	-0.025	-0.014	-0.094*	-0.028	-0.065*
	(0.036)	(0.040)	(0.027)	(0.053)	(0.060)	(0.040)
Mean payoff of neighbors in previous round	0.010***	0.024***	0.014***	-0.001	0.003*	0.000
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
Payoff in previous round	-0.009***	-0.010***	-0.011***	-0.024***	-0.024***	-0.024***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	-0.046	-0.263***	-0.088*	0.009	-0.134*	-0.034
	(0.055)	(0.057)	(0.046)	(0.069)	(0.069)	(0.062)
Observations	30200	31250	61450	34428	35625	70053
Number of id	604	625	1229	625	604	1229
R-squared	0.02	0.03	0.03	0.03	0.03	0.03

Note: Sample consists of final-year high school students from Aragon (Spain). Clustered standard errors in parenthesis. We estimate the following equation: $C^*_{ijt} = \beta X_i + \delta Game_{ijt} + \varepsilon_{ijt}$ where C^*_{ijt} is a latent variable, and $\varepsilon_{ijt} \sim N(0,1)$. Then C_{ijt} can be viewed as an indicator for whether this latent variable is positive, where C_{ijt} represents the decision (cooperation/defection) by individual "i" in network "j" at round "t". The dependent variables is a dummy variable that takes value 1 if individual "i" in network "j" at round "t" decided to cooperate, and takes value 0 if he/she decided to defect. The vector Xi includes participant's "i" demographic characteristics such as gender (1= male, 0=female), number of siblings and the field of the bachelor (1=humanities, 0=science), while $Game_{ijt}$ includes game variables from the previous round.