Studying Collective Choice Influence on Laboratory Participants' Individual Actions

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***Abstract*— The purpose of this study is to assess the degree to which the environment affects the choice of a participant in a laboratory experiment in simple static games and to study the effect of past repetitions of playing with other participants on their current actions. In order to obtain controlled conditions, interaction with other participants in laboratory experiments was replaced by interaction with robots that had predefined automated strategies.**

***Keywords*— experimental economics, game theory, laboratory social games**

I. Introduction

When making a choice person as a social being is guided not only by individual preferences but also by generally accepted norms of society. Therefore, situations in which individual and collective interests diverge are of particular interest and raise the important economic problem of a voluntary contribution to collective welfare. For example, consider the situation of contributing to a public good. If economic agents are rational and selfish, public goods will be insufficiently provided compared to an effective solution [1, 2]. Nevertheless, empirical data from laboratory and field studies show that many people are willing to pursue the public interest voluntarily to some extent. Moreover, those who do this are mostly "conditional cooperators". They cooperate only if they expect the same from other members of the group [3, 4].

It leaves the question about people's motives to be "conditional cooperators" open. One of the psychological motives for conditional cooperation maybe that unconditional cooperation entails the risk of exploitation by free riders, and conditional cooperation protects against this exploitation. Some studies show that there is a connection between conditional cooperation and aversion to betrayal [5]. Another study [6] shows that the genetic characteristics of the participants in the experiments also influence behavior, not only by training, upbringing, and environment.

In this work, we assessed the level of influence of other members' choices on the choice of a participant in a laboratory experiment in simple static games. As well as the effect of past repetitions of a game with other participants on the current choice. In order to obtain controlled conditions, interaction with other participants in laboratory experiments was secretly replaced by interaction with robots that had predetermined automated strategies. Two opposite situations with different generally accepted collective behavior observed by the participants of the experiment:

- cooperative, when the participant of the experiment observes that the other participants maximize the total gain
- aggressive, when the participant of the experiment observes that the other participants maximize the individual gain.

Two social dilemmas were taken as a basis: Trust Game, for which social preferences play an essential role in both trusting and trustworthy behavior [7, 8]. The second dilemma is the Public Goods Game, a long-standing but still urgent problem [9].

II. Experiment design

A. Purpose of experiments

Hypothesis: a friendly environment promotes a change in the participants' behavior to a more cooperative one, and vice versa aggressive environment leads to less cooperative behavior.

For this purpose, there were selected experiments without dependence between other participants' actions and the effect of the participant's actions. Thus, games with the dilemma that pursuing individual goals is beneficial and can increase players' winnings, but it leads to a decrease in the total award.

B. Description of experiments

1) Trust Game (TRUST)

There are two players: A and B. At the beginning of the game, Player A has 10 points, and Player B has nothing. Then, Player A can give any of his 10 points to Player B. Everything that Player B received from Player A will be multiplied by 3. After that, Player B can return any of the received points to Player A or return nothing.

Profit of Player A = 10 - Gave to Player B + Returned to Player B

Profit of Player B = 3 * Received from Player A - Returned to Player A

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2) Public Goods Game (PG)

In this game, three players are involved. In the beginning, each participant has 100 points. After that, players can invest any amount of the available points in a joint project, which will bring profit by doubling the invested points, but all the players will share the benefit from the project equally regardless of their contribution.

Profit of the Player = 100 - Contribution of the player to the project + 2 * Average contribution to the project

3) Modification of the public goods

One of the participants is informed, and after everyone has made a contribution, he learns the other participants' investment and can reconsider his decision [10].

The games were played in two versions with a simple and complex strategy. In a complex variant, the participants set their strategy in advance with all actions for all information states [11]. For example, in Trust Game, the participant set the choice for role A and the choice for role B for each move of player A (i.e., how much to return to A if A transferred X points for each X from 1 to 10).

C. Features of the experiment

In order to obtain controlled conditions, the participants did not play with each other but with pre-written simple algorithmic strategies (bots) of one of two types aggressive or cooperative. These strategies are summarized in Table 1.

As a result, the following experiment was carried out:

- Trust Game with a complex strategy. Players were randomly divided into two groups: one played with an aggressive bot, and the other played with a cooperative.
- The Public Goods Game without additional information, bot type was redetermined randomly.
- A Public Goods Game with an awareness modification and a complex strategy.

D. Technical features

A series of experiments was carried out in May 2021, during the period of self-isolation. Therefore, the interaction with the participants took place through Zoom. The game was written at the Laboratory of Experimental Economics of the Moscow Institute of Physics and Technology using the oTree framework [12].

TABLE I. BOT STRATEGIES

Bot type	Trust Game		Public goods
	Role A - how much to transfer to player B	***Role B – how much to return to player A***	***Contribution to the project***
Aggressive	from 0 to 3	from 0 to half of the transferred amount	from 0 to 30
Cooperative	from 7 to 10	from transferred amount + 1 to amount equalizing winnings of both players	from 70 to 100

E. Participants

The experiment involved mainly students of the Moscow Institute of Physics and Technology, 21 people. Also, a pilot experiment was previously conducted for 21 participants. Students enrolled in the “Experimental Economics” lectures who had previously attended a course on game theory participated in this experiment. As a reward, they received points for credit in the subject, not money. The results of both experiments were similar, so they were combined for analysis and hypothesis formation.

III. APPROACH TO THE ANALYSIS OF RESULTS

In Trust Game, there is a single Nash equilibrium (NE) in which Player A does not give anything back to Player B, and Player B never returns anything back. According to the following reasoning, it is easy to come to NE: having received something from Player A, Player B will worsen his result if he gives something in gratitude. And Player A, knowing that he will not receive anything in return, will not give anything back. As various reasons, including the rationale, may explain the player's choice in role A. Therefore, we have focused on the refund amount in role B, which is always irrational.

If there is trust between the players, they can achieve a social optimum, which reduces to the fact that Player A needs to give all his capital, equal to 10 points. If only his winnings exceed the current winnings of player A, Player B will return him such a number of points that their winnings are equal. For example, if Player B received 10, he gives 15 out of 30 points in gratitude. Thus, the social player's plan for the game in a specific round is (10; 0, 0, 1, 3, 5, 7, 9, 11, 13, 15).

There is also only one Nash equilibrium in the Public Goods Game in which no one contributes anything to the project (for both game modifications, it doesn't matter whether the player is informed or not). Thus, it could be explained by the fact that each unit of investment in the project linearly reduces player profit, no matter how much other players invest.

The social optimum is achieved when all players invest all funds in the project, thereby receiving a win of 200 instead of 100, obtained in the NE.

In our experiment, the strategies followed by the players coincided with the indicated ones or were an intermediate version.

IV. RESULTS OF LABORATORY EXPERIMENTS

For complex games in which it was necessary to introduce the entire strategy, there was no strong dependence of players' behavior on the bot type (the opponent's goodwill).

In Trust Game, the change in the gratitude function as a whole weakly depended on the type of bot, and for about 40% of the participants, the strategy did not change at all, and for 70%, it changed temporarily for one or two periods no more than 1-2 points. For clarity, we only compared the strategy of player B, how many points he would return if player A gave him 10 points. It can be seen in Fig. 1. Although at the beginning of the experiment, players in the group with aggressive bots were more cooperative and ready to return on average more points than players with cooperative bots. This difference in the groups most likely was caused by the random distribution of players and the small total number of participants in the experiments (we will not dwell on this fact further). At the end of 5 periods, all players approached the same average value.

Furthermore, although the cooperativity of players who faced aggressive bots declined, especially after the first round, and the cooperativeness of players who faced cooperative bots gradually increased, this data is not reliable enough, especially considering that 70% of participants almost did not change their strategy during the whole game.

In Public Goods Game, the informed participants’ strategies hardly changed from period to period: 50% did not change strategy at all, and 70% did not change or change it insignificantly.

For clarity, consider only the investments of the informed participant when others invest from 80 to 100 points (Fig. 2). Thus, although the average investment in the group with cooperative bots increased from the beginning to the end of the experiment, all this growth is explained by the change in strategies of 1-2 players.

At the same time, the influence of bots on players' behavior for simple strategies is observed. Cooperative bots slightly increase contributions to the overall project, while aggressive ones significantly reduce the average contribution (Fig. 3-4). Only 30% of players do not change their strategy, and only 40% do not alter or hardly change.

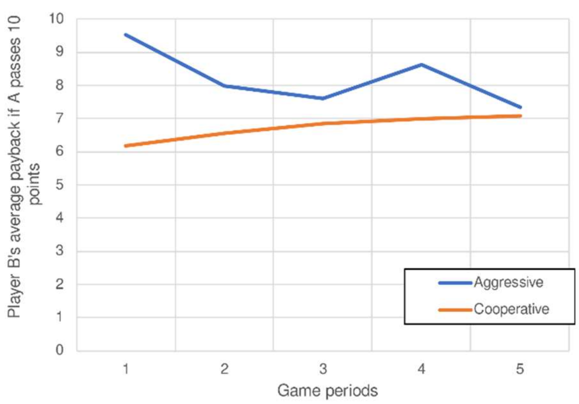

Fig. 1. Trust Game. The average amount that player B planned to return to player A if he passes 10 points

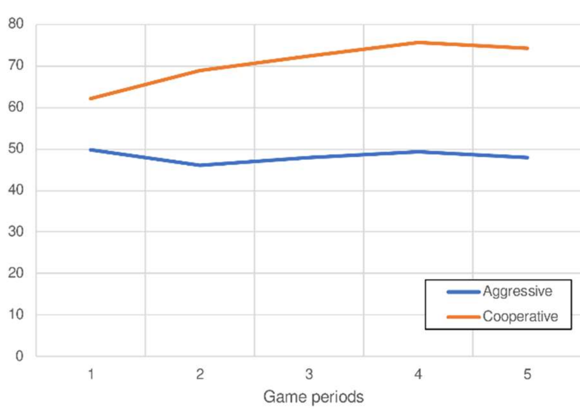

Fig. 2. Public Goods. The average amount that a player decides to invest for an informed participant provided that other participants invest from 80 to 100 points

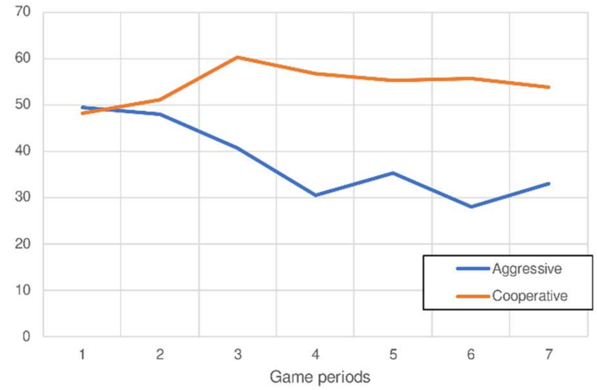

Fig. 3. Public Goods Game without additional information. The average contribution to the project for an uninformed participant.

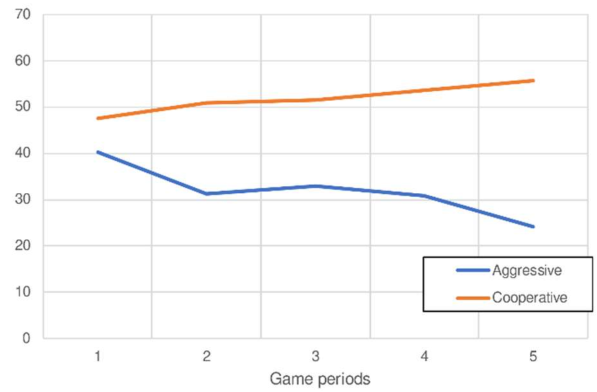

Fig. 4. Public Goods Game with additional information. The average contribution to the project for an uninformed participant.

And although, as noted above, the complex strategies did not change when moving to the next game, and the player had to choose a new strategy, his choice was influenced by the actions of the bot that he previously played with in the last game (Table 2). So, if there was a cooperative bot in Trust Game, then in the Public Goods, the players started with more cooperative moves (average contribution to the project is 63 points). And vice versa (the average contribution to the project is 35 points, which is almost two times less than that of cooperative players).

If there was a cooperative bot in a simple Public Goods Game (Table 3), they started with a more cooperative strategy in the following complex Public Goods Game (the average contribution to the project was 51 points versus 37 points). However, between the two Public Goods Games, there is no such abrupt switch in strategy. On the contrary, the contribution to the general project in the last period of the simple Public Goods Game without information strongly correlated with the contribution in the first period in the complex Public Goods Game with information.

TABLE II. BOT STRATEGIES

Bot strategy	*Last Trust Game period*	*First period Public Goods Game*
Aggressive	5.5	34.6
Cooperative	4.8	62.9

TABLE III. BOT STRATEGIES

	First PG period without information	***The last period PG without information***	***The first period of PG with information***
Aggressive	49.8	35.7	37.4
Cooperative	48.2	53.8	50.5

One of the goals of experiments was to try to achieve that the players' behavior did not shift towards the Nash equilibrium, as it usually happens [12], but towards the social optimum. Thus, we can say that this purpose has been achieved. Nevertheless, of course, not all participants were affected. Most surprisingly, some participants adhering to the cooperative strategy and even aggressive bots could not force them to deviate from the cooperative strategy.

V. CONCLUSIONS

By the example of the Trust Game and the Public Goods Game, we found an effect of environment (pleasant norms of behavior in the game) on the players' strategies. So, the environment significantly affects the players when it comes to simple strategies and actions. While the players' sophisticated strategies alter little, it still has an effect when it is the turn of the formation of a new strategy. These hypotheses require further verification of large experimental data.

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