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JEL Classification: C72, C91, D63, D74

Keywords: Experiment, Conditional cooperation, Equilibrium selection

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Beyond Hawks and Doves: can inequality ease coordination?*

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Abstract

It is often argued that inequality may worsen coordination failures as it exacerbates conflicts of interests, making it difficult to achieve an efficient outcome. This paper shows that this needs not to be always the case. In a context in which two populations compete over a scarce resource, we introduce ex-ante inequality, by making one population stronger than the other. This reduces the cost of miscoordination for the weakest population, and at the same time it makes some equilibria more equitable than others, thus more attractive for inequality-averse players. Hence, both social preferences and strategic risk considerations may ease coordination. We provide experimental support for this hypothesis, by considering an extended two-population Hawk-Dove game, where ex-ante inequality, number of pure-strategy equilibria, and cost of coordination vary across treatments. We find that subjects coordinate more often on the efficient outcomes in the treatment with ex-ante inequality.
Keywords: Asymmetric payoff matrix; Conditional cooperation; Equilibrium selection; Experiment; Hawk-Dove game; Inequality aversion.
JEL Classification: C72; C91; D63; D74.

1 Introduction

Coordination failures (between countries, social/interest groups, or individuals) occur everywhere and often lead to conflicts that might be very costly for involved parties.[1] The roots of coordination failures are very diverse and context-specific. This paper studies coordination failures in a context characterized by a conflict over scarce resources, so that a trade-off emerges between equality and efficiency. Such a framework characterizes several economically relevant situations – such as trade wars, military battles, collective bargaining, legal disputes – which the Hawk-Dove game is the prototypical example of.

The recent experimental literature on the Hawk-Dove game focused on the evolutionary dynamics of inter- and intra-group interactions (Oprea et al., 2011; Benndorf et al., 2016, 2021). Typically, this literature focuses on the symmetric version of the game, where the two pure-strategy equilibria are

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[1]Coordination failures may also have positive externalities, for example the difficulty to collude has a positive impact on the competitive level of the market.

ex-ante equally likely to emerge,[2] and on the theoretical and empirical differences in the dynamics of behavior in one- and two-population models.

Our focus here is instead on the impact that ex-ante inequality in opportunities has on coordination. Inequality is a pressing issue in the economic and political sphere. It is often argued that inequality, by being an accelerator of tensions between groups, may worsen a conflictual situation, leading to coordination failures.[3] To explore whether the presence of inequality fosters or hinders coordination, we compare a set-up in which there is no inequality in opportunity (the payoff matrix is symmetric) with one in which the two conflicting players are characterized by ex-ante different strength. This links our paper to the recently expanding literature that explored the impact of inequality on coordination in different game-theoretical setups (Tavoni et al., 2011; Abbink et al., 2018; Camera et al., 2020; Feldhaus et al., 2020; Isoni et al., 2020). While the results from previous papers indicate that inequality either hinders coordination on the efficient equilibrium, or – at best – does not interfere with it, in our set-up inequality actually eases coordination and promotes efficiency.

We consider an extended version of the HD game to account for the fact that people do not always fight to death or fully accommodate; rather, they choose their action between these two extreme options. Subjects can choose from a set of eleven possible values (labeled from 0 to 10). The structure of the payoff matrix is such that an equitable and efficient allocation exists, but it is not sustainable in equilibrium, so there is a trade-off between equality and efficiency. Indeed, all equilibria lead to unequal payoffs between players but the degree of inequality as well as the number of pure-strategy equilibria differ across treatments. In line with the recent literature, we consider a two-population model, which is closer to the real-world environments we would like to mimic, and also allows for coordination on the pure-strategy equilibria to emerge as an evolutionary stable outcome (Oprea et al., 2011).

Our design comprises three treatments. In the Baseline treatment, the game is perfectly symmetric and there are three pure-strategy equilibria where one player receives thrice as much as the other one, and three equilibria where the situation is reversed. In the Asymmetric treatment, players are characterized by different "strengths", and the payoff matrix is modified so that, for each combination of choices, the strongest player earns more than in the Baseline, while the weakest player earns less. Thus, the payoff matrix becomes asymmetric. The number of pure-strategy equilibria is still six, but with a different payoffs distribution. In two of these equilibria, the strong player earns almost seven times as much as the weak one, while in the other four pure-strategy equilibria, the weak player earns almost twice as much as the strong one. The Restricted treatment is similar to Baseline but has only two pure-strategy equilibria, and has a lower cost associated to miscoordination.

The literature on outcome-based inequality aversion (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Charness and Rabin, 2002) would suggest that – in the Asymmetric treatment – subjects coordinate on the least unequal Nash equilibria. Strategic considerations can also promote coordination on this outcome in the Asymmetric treatment: by playing "dove" the strong players ensure a higher payoff than in the other treatments, which may induce them to prefer this option to a more hawkish but riskier strategy. Both arguments lead us to hypothesize that coordination will be easier in the Asymmetric than in the Baseline treatment. In the Restricted treatment, instead, the coordination issue may seem less severe compared to the Baseline since we have only two – instead

[2] The one exception we are aware of is the recent theoretical paper by Bilancini et al. (2021) which also considers the case of asymmetric payoff matrices.

[3] One of the reasons often mentioned is that some individuals have some strong preferences for fairness and may not accept to coordinate on an outcome considered as "unfair" (Bolton and Ockenfels, 2000; Fehr and Schmidt, 1999; Charness and Rabin, 2002).

of six – pure-strategy equilibria. On the other hand, this treatment also reduces the cost of miscoordination, because the Pareto-dominated (but perfectly equitable) outcome where both players play "hawk" here is more profitable than in the BASELINE. Subjects who are averse to outcome-based inequality, thus, might have a stronger incentive to play hawkish strategies in this treatment than in the BASELINE. Strategic risk considerations also push in the same direction: by making the hawkish strategies less risky, and on average more profitable, the RESTRICTED treatment reduces the strategic incentives to coordinate on the efficient, pure-strategy equilibria.

Thus, with our experiment we explore three questions related to coordination failure and inequality: (i) whether coordination on the efficient equilibrium is easier to achieve when the payoff matrix is asymmetric; (ii) whether – in the ASYMMETRIC treatment – players coordinate on the more equitable equilibrium, and (iii) whether coordination on efficient equilibrium outcomes is easier when the cost of miscoordination is higher, or when the number of pure-strategy equilibria is lower.

There are two main results. First, making the game asymmetric seems to simplify coordination: subjects in the ASYMMETRIC treatment are able to coordinate more often on pure-strategy NE, leading to higher efficiency. In particular, they coordinate on the least unequitable among the equilibria. To better understand the determinants of this result, we look at the individual behavior, which differs across treatments. In the BASELINE and RESTRICTED treatments, players tend to be imperfect conditional cooperators (Fischbacher et al., 2001), who play "dove" more often when they expect their opponents to do the same. In the ASYMMETRIC treatment, instead, the players tend to best respond (play "dove" against "hawk" and vice versa), with the weak ones being more aggressive than the strong ones, overall. Thus separation between "hawks" and "doves" emerges prominently only in the ASYMMETRIC treatment, where we observe specialization, but not in the other treatments. Our second result is that restricting the number of (pure strategy) equilibria (in absence of ex-ante inequality) does not seem to facilitate coordination. Comparing BASELINE and RESTRICTED treatments, we found no difference in terms of aggregate efficiency or individual behavior.

Our paper proceeds as follows. Section 2 describes the game and introduces our theoretical hypotheses; Section 3 presents the experimental design and methodology; Section 4 illustrates the results and Section 5 concludes.

2 Set-up and hypotheses

We consider a generalized version of the Hawk-Dove game, which allows for asymmetric payoffs, and for an expansion of the action set. In our setup, there are two players characterized by parameters s_1 and s_2, where $s_1 \geq s_2 > 0$, which we can interpret as their relative "strength." Each player simultaneously and independently chooses his action, $a_i \in [\underline{a}, \bar{a}]$, $i = 1, 2$, where $\underline{a}$ and $\bar{a}$ are exogenously determined and equal for both players. A player i's payoff is defined as:

$$\pi_i(a;\theta,s) = \begin{cases} a_j s_i & \text{if } a_i < a_j \\ a_i \dfrac{s_i}{s_i + s_j}\theta & \text{if } a_i = a_j \\ a_i(\theta - s_j) & \text{otherwise} \end{cases} \tag{1}$$

where $\theta \in [s_1, s_1 + s_2]$ parametrizes the size of the pie to be divided between the two players, and is exogenously determined.[4]

[4]In our experiment, θ does not change across treatments.

For the sake of simplicity, in the experiment we use a discrete choice set C with a given and fixed number n of elements: $C = \{\underline{a},\ \underline{a}+x,\ \underline{a}+2x, \ldots, \bar{a}\}$, where $x = \frac{\bar{a}-\underline{a}}{n-1}$. In what follows, we denote the choice of player i by $c_i \in C$.

2.1 Parameters and treatments

Our first treatment variable is the minimum admissible action $\underline{a}$. By discretizing the choice set, we can manipulate the minimum admissible action without changing the number of choices available to subjects. This element is crucial to maintain the same degree of strategic complexity across treatments. We consider two alternatives:
(i) a *baseline* choice set C, and
(ii) a *restricted* choice set C', where $\underline{a}' > \underline{a}$.
The second treatment variable is the degree of asymmetry between players. We consider two scenarios: in the *symmetric* case, players have the same strength $s_1 = s_2 = s$; in the *asymmetric* one $s_1 > s_2$.

In total, we consider three treatments:

- Baseline: with *baseline* set of actions, and *symmetric* strengths;
- Asymmetric: with *baseline* set of actions, and *asymmetric* strengths;
- Restricted: with *restricted* set of actions, and *symmetric* strengths.

Parameters. In the experiment, we set $\bar{a} = 10$, $\theta = 10$, and $n = 11$, that is: in all treatments players can select their choice from a set C of 11 possible values. In the Baseline and Restricted treatments, $s_1 = s_2 = 7.6$, while in the Asymmetric treatment $s_1 = 8.7$ and $s_2 = 6.5$. In the Baseline and Asymmetric treatments, $\underline{a} = 1$, while in the Restricted treatment $\underline{a}' = 3$. In all treatments, choices $c_i \in C$ are labeled from 0 to 10, and payoffs are rounded to integer numbers. The resulting payoff matrices are reported in Table 1.

2.2 Testable hypotheses

The game described above has multiplicity of pure-strategy asymmetric equilibria, in which player 1 plays as a "dove" and chooses $c_1 = 10$ and player 2 plays more hawkishly, choosing $c_2 < c_1$, or vice-versa, as illustrated in the shaded cells of Table 1. All these equilibria yield the maximum possible social surplus (100).

In the Baseline treatment, we have two sets of three pure-strategy equilibria, which all yield 24 points to the "dove" player and 76 to the "hawk", hence a serious coordination issue emerges. In the Asymmetric treatment, we also have two sets of equilibria. Here, however, one set includes four equilibria in which the strong player, characterized by $s_1 = 8.7$, plays as a dove choosing $c_1 = 10$ and earning 35 while the weak player – with $s_2 = 6.5$ – plays as a hawk and selects a low choice $c_2 \in [0, 3]$, thus earning 65 points. The other set contains two equilibria in which the payoff imbalance is reversed: the strong player chooses $c_1 \in [0, 1]$ and earns 87, while the weak player chooses $c_2 = 10$ and earns 13 points. The two sets of equilibria are equally efficient, but the distribution of the surplus between the two players in the first set of equilibria is much less unequal than in the second set.

Based on the literature on outcome-based inequality aversion (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Charness and Rabin, 2002), we expect that subjects in the Asymmetric treatment coordinate on the least unequal outcome. In other words, we hypothesize that inequality aversion

	0 (hawk)	1	2	3	4	5	6	7	8	9	10 (dove)
0 (hawk)	5; 5	14; 5	21; 7	28; 9	35; 11	42; 13	49; 15	55; 18	62; 20	69; 22	**76; 24**
1	5; 14	10; 10	21; 7	28; 9	35; 11	42; 13	49; 15	55; 18	62; 20	69; 22	**76; 24**
2	7; 21	7; 21	14; 14	28; 9	35; 11	42; 13	49; 15	55; 18	62; 20	69; 22	**76; 24**
3	9; 28	9; 28	9; 28	19; 19	35; 11	42; 13	49; 15	55; 18	62; 20	69; 22	76; 24
4	11; 35	11; 35	11; 35	11; 35	23; 23	42; 13	49; 15	55; 18	62; 20	69; 22	76; 24
5	13; 42	13; 42	13; 42	13; 42	13; 42	28; 28	49; 15	55; 18	62; 20	69; 22	76; 24
6	15; 49	15; 49	15; 49	15; 49	15; 49	15; 49	32; 32	55; 18	62; 20	69; 22	76; 24
7	18; 55	18; 55	18; 55	18; 55	18; 55	18; 55	18; 55	37; 37	62; 20	69; 22	76; 24
8	20; 62	20; 62	20; 62	20; 62	20; 62	20; 62	20; 62	20; 62	41; 41	69; 22	76; 24
9	22; 69	22; 69	22; 69	22; 69	22; 69	22; 69	22; 69	22; 69	22; 69	46; 46	76; 24
10 (dove)	**24; 76**	**24; 76**	**24; 76**	24; 76	24; 76	24; 76	24; 76	24; 76	24; 76	24; 76	50; 50

(a) Baseline

	0 (hawk)	1	2	3	4	5	6	7	8	9	10 (dove)
0 (hawk)	15; 15	28; 9	33; 11	39; 12	44; 14	49; 16	55; 17	60; 19	65; 21	71; 22	**76; 24**
1	9; 28	19; 19	33; 11	39; 12	44; 14	49; 16	55; 17	60; 19	65; 21	71; 22	76; 24
2	11; 33	11; 33	22; 22	39; 12	44; 14	49; 16	55; 17	60; 19	65; 21	71; 22	76; 24
3	12; 39	12; 39	12; 39	26; 26	44; 14	49; 16	55; 17	60; 19	65; 21	71; 22	76; 24
4	14; 44	14; 44	14; 44	14; 44	29; 29	49; 16	55; 17	60; 19	65; 21	71; 22	76; 24
5	16; 49	16; 49	16; 49	16; 49	16; 49	33; 33	55; 17	60; 19	65; 21	71; 22	76; 24
6	17; 55	17; 55	17; 55	17; 55	17; 55	17; 55	36; 36	60; 19	65; 21	71; 22	76; 24
7	19; 60	19; 60	19; 60	19; 60	19; 60	19; 60	19; 60	40; 40	65; 21	71; 22	76; 24
8	21; 65	21; 65	21; 65	21; 65	21; 65	21; 65	21; 65	21; 65	43; 43	71; 22	76; 24
9	22; 71	22; 71	22; 71	22; 71	22; 71	22; 71	22; 71	22; 71	22; 71	47; 47	76; 24
10 (dove)	**24; 76**	24; 76	24; 76	24; 76	24; 76	24; 76	24; 76	24; 76	24; 76	24; 76	50; 50

(b) Restricted

	0 (hawk)	1	2	3	4	5	6	7	8	9	10 (dove)
0 (hawk)	6; 4	17; 2	24; 4	32; 5	40; 6	48; 7	56; 8	64; 9	71; 11	79; 12	**87; 13**
1	7; 12	11; 8	24; 4	32; 5	40; 6	48; 7	56; 8	64; 9	71; 11	79; 12	**87; 13**
2	10; 18	10; 18	16; 12	32; 5	40; 6	48; 7	56; 8	64; 9	71; 11	79; 12	87; 13
3	13; 24	13; 24	13; 24	21; 16	40; 6	48; 7	56; 8	64; 9	71; 11	79; 12	87; 13
4	16; 30	16; 30	16; 30	16; 30	26; 20	48; 7	56; 8	64; 9	71; 11	79; 12	87; 13
5	19; 36	19; 36	19; 36	19; 36	19; 36	31; 24	56; 8	64; 9	71; 11	79; 12	87; 13
6	22; 42	22; 42	22; 42	22; 42	22; 42	22; 42	37; 27	64; 9	71; 11	79; 12	87; 13
7	26; 47	26; 47	26; 47	26; 47	26; 47	26; 47	26; 47	42; 31	71; 11	79; 12	87; 13
8	29; 53	29; 53	29; 53	29; 53	29; 53	29; 53	29; 53	29; 53	47; 35	79; 12	87; 13
9	32; 59	32; 59	32; 59	32; 59	32; 59	32; 59	32; 59	32; 59	32; 59	52; 39	87; 13
10 (dove)	**35; 65**	**35; 65**	**35; 65**	**35; 65**	35; 65	35; 65	35; 65	35; 65	35; 65	35; 65	57; 43

(c) Asymmetric

Table 1: Payoff tables

Notes: The pure-strategy equilibrium outcomes are reported in bold, in the shaded cells. Player 1 is the row player, and Player 2 is the column player.

will work as a coordination device, preventing miscoordination and thus promoting efficiency at the social level. Coordination on the least unequal equilibrium, however, might also be driven by strategic considerations: by choosing 10 (i.e. "dove") the strong players ensure a payoff of at least 35, which may induce them to prefer this option to a more hawkish but riskier strategy.[5]

Hypothesis 1 *(a) Coordination on efficient equilibrium outcomes is more frequent in the* Asymmetric *treatment than in the* Baseline *treatment. (b) In the* Asymmetric *treatment, subjects coordinate on the least unequal pure-strategy equilibrium.*

In the Restricted treatment, the coordination issue may seem less severe compared to the Baseline since we have only two – instead of six – pure-strategy equilibria, which however yield the same outcome as in the Baseline: one player sets $c_i = 0$ and earns 76, and the other chooses $c_j = 10$ and earns 24. On the other hand, by increasing $\underline{a}$ from 1 to 3, we also limit the cost of miscoordination, and we make the Pareto-dominated (but perfectly equitable) outcome where both players play "hawk" more profitable, as compared to the Baseline (both players earn 15, rather than 5). Subjects who are averse to outcome-based inequality, thus, might have a stronger incentive to play hawkish strategies in this treatment than in the Baseline, because they are sure to earn at least 15, if they do so.[6] Strategic risk considerations also push in the same direction: by making the hawkish strategies less risky, and on average more profitable, the Restricted treatment reduces the strategic incentives to coordinate on the efficient, pure-strategy equilibria. Our second hypothesis can thus be summarized as follows:

Hypothesis 2 *Coordination on the pure-strategy equilibria is less frequent in the* Restricted *than in the* Baseline *treatment.*

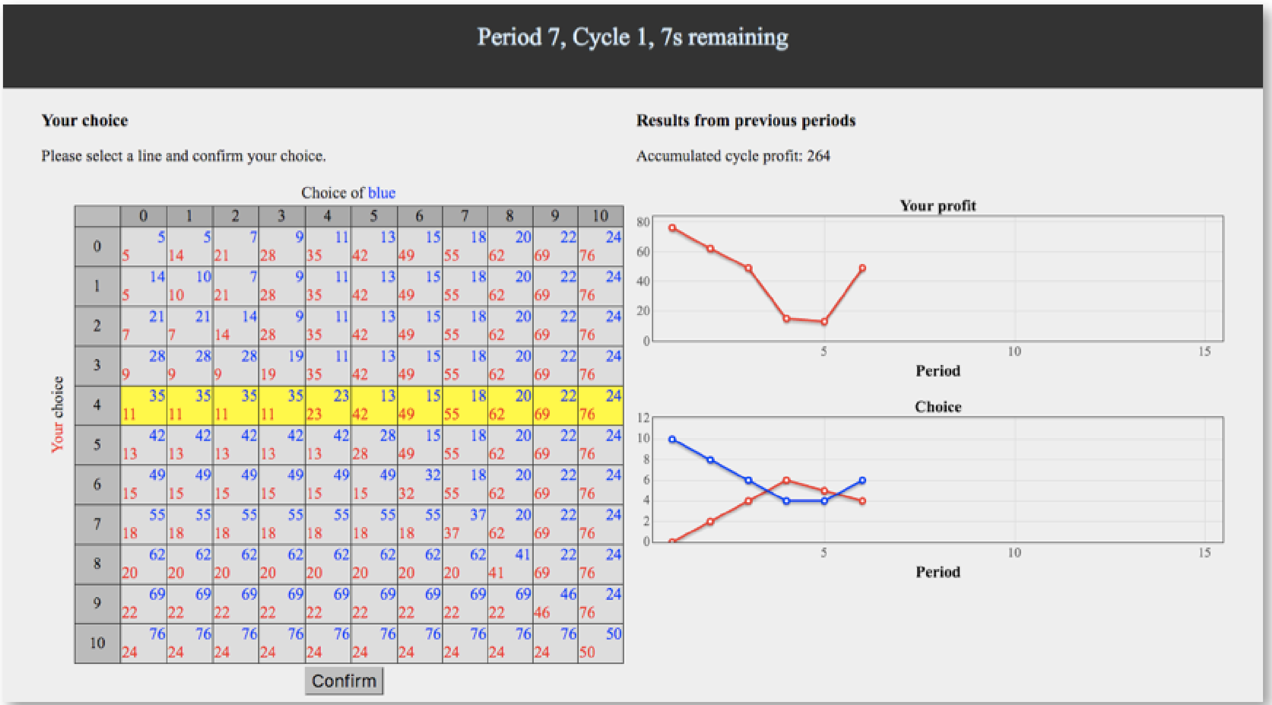
3 Experimental design

Framing. We adopt a neutral framing. Player 1 and player 2 are labeled "Red" and "Blue", respectively. In the Asymmetric treatment, the Red players are the "strong" ones, while the Blue players are the "weak" ones. Subjects have to pick their choice by selecting one of the rows of the payoff matrix, which are displayed on their decision screen (Figure 1).

Number of repetitions. Each experimental session includes 5 cycles of 15 periods each. In each cycle, subjects interact in "economies" comprising 4 Red and 4 Blue players each, with random matching across periods within an economy. Roles remain fixed within each cycle, but change from cycle to cycle in a predetermined way, so that some participants are Red in three cycles, and Blue in two cycles, and other participants are Red in two cycles and Blue in three cycles. At the beginning of each cycle, new economies are formed, so that no two subjects interact with each other for more than one cycle, along the lines of what was done by Camera and Casari (2014) and Bigoni et al. (2020).

[5]This intuition is supported by a more formal analysis, carried out by Blázquez and Koptyug (2022), who analyze this game through the lenses of the concepts of risk-dominance proposed by Harsanyi and Selten (1992), the robustness to strategic uncertainty proposed by Andersson et al. (2014), and the quantal response equilibrium proposed by McKelvey and Palfrey (1995), to investigate whether these approaches provide a solution to the issue of equilibrium selection. Blázquez and Koptyug (2022)'s results indicate that both the tracing procedure and QRE predict convergence to the least unequal equilibrium outcome.

[6]The difference between our Baseline and Restricted treatments resembles in some sense the difference between the two dynamic games with complete information discussed by Goeree and Holt (2001), who show that a threat is more likely to be implemented when it is less costly.



Note: in the bottom-right panel of the figure, the graph displays the choice made by the two players in the previous periods: it shows that the Blue player started playing "dove" in period 1, while the Red player started with "hawk," but then in the following periods the distance between their choices decreased.

Figure 1: Screenshot of the decision screen of a Red player, for the BASELINE treatment.

Feedback at the end of each period. At the end of each period, subjects received information on the choices made by both players, and their own profit. We do not inform subjects of the other player's profit, which however can be inferred by the payoff matrix. Results from previous periods of the current cycle are always displayed on the subjects' screens by means of two graphs, presenting the choices and the profits, respectively (Figure 2).

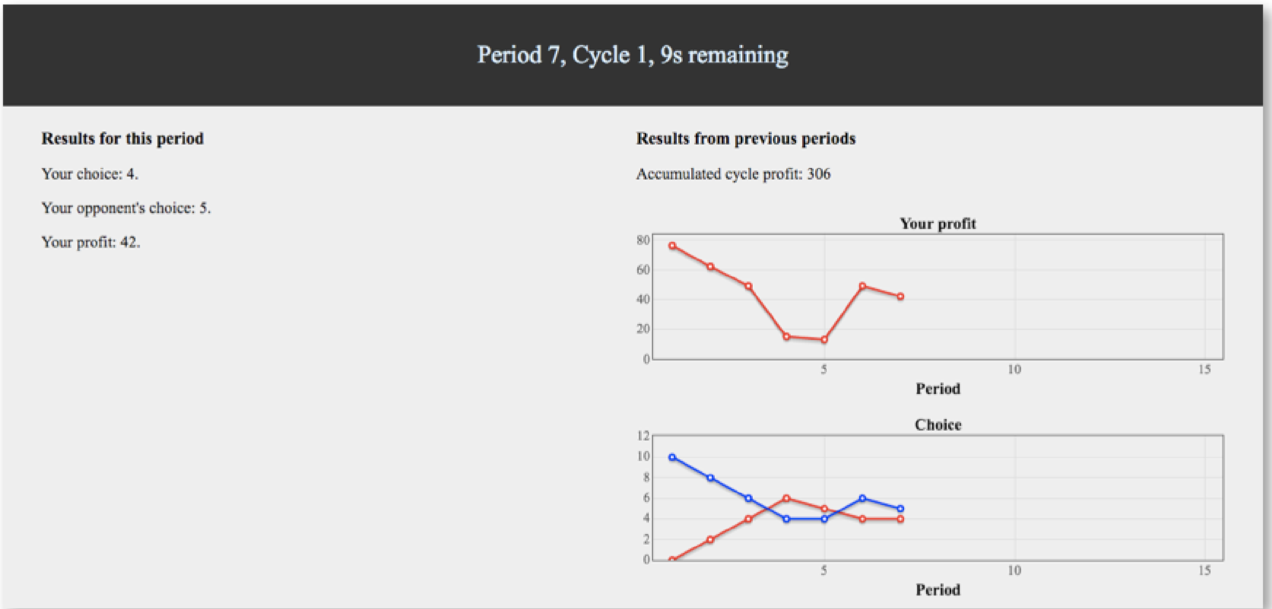


Figure 2: Feedback screen at the end of each period (for a Red player).

Expectations on others' behavior. At the beginning of each cycle we ask subjects to guess the average choice of the other participants who had a role different from their own, in the first period of the cycle which is about to start. The procedure is incentivized by means of a quadratic scoring rule: subjects earn 250 points (€5) for a correct guess, 240 points if their guess differ from the correct answer by at most one unit, 210 if the difference is of at most 2 units, and so forth and so on (see Instructions in Appendix A). To minimize the scope for strategic hedging (Blanco et al., 2010), we ask subjects to guess the choice of subjects who are not part of their economy. Furthermore, we randomly select one of the five cycles for the payment of the guess, and another, different cycle for the payment of the profits realized in the main game.

Procedures. We ran 3 sessions per treatment, with 24 subjects per session, between April 17 and May 3, 2016. Considering all treatments, the experiment involved 216 subjects randomly recruited via Orsee (Greiner, 2015) from a pool of more than 2000 subjects who normally participate in experiments at the BLESS laboratory in Bologna (where all sessions took place). The experiment was programmed and conducted with an ad-hoc web-based platform. Instructions (a copy is in Appendix A) were read aloud at the start of the experiment and left on the subjects' desks. To verify subjects' full understanding of the instructions, we administered two "understanding checks" (one in the middle of the instructions, one at the end), asking subjects to answer a set of computerized control questions. The experimenter did not proceed to the next part of the instructions until all subjects had completed their set of questions. Control questions were incentivized: subjects earned 50 cents for each question they answered correctly. There were 10 questions in total, hence subjects could earn up to €5 for this task.[7] At the end of the session, subjects were asked to fill out a questionnaire meant to collect information on their socio-demographic characteristics, their preferences and their educational background (Appendix B). Experimental points were translated into Euro at a rate of €1 per 50 points. Average earnings were €18.9 per subject ($\min = 7.5, \max = 28.5$). On average, a session lasted about 111 minutes ($\min = 108$ minutes, $\max = 148$ minutes) including instructions and payments.

4 Results

In this section, we first present and discuss aggregate behavior and the main treatment effects. We then zoom in on individual behavior to get a better understanding of the determinants of the observed differences across treatments.

4.1 Aggregate behavior

In all treatments, subjects played the most extreme choices – 0 (i.e. "hawk") and 10 (i.e. "dove") – in the majority of interactions. In Baseline and Restricted the distribution of choices was approximately the same for Red and Blue players, and the modal choice was 0 (Figure 3). In Asymmetric, instead, the modal choice for the Red (i.e. "strong") players was 10, while the modal choice for the Blue ones was still 0: this suggests that coordination on one of the efficient pure-strategy equilibrium outcomes was more frequent in this treatment than in the symmetric ones. This is indeed confirmed by Figure 4, which illustrates the frequency of coordination on pure-strategy Nash-equilibrium outcomes across treatments, by period, averaged across cycles (thick line). The dashed lines represent

[7] Subjects earned on average €4.31 for this task; 92.6% of them made at most 3 mistakes, 63.0% of them made at most 1.

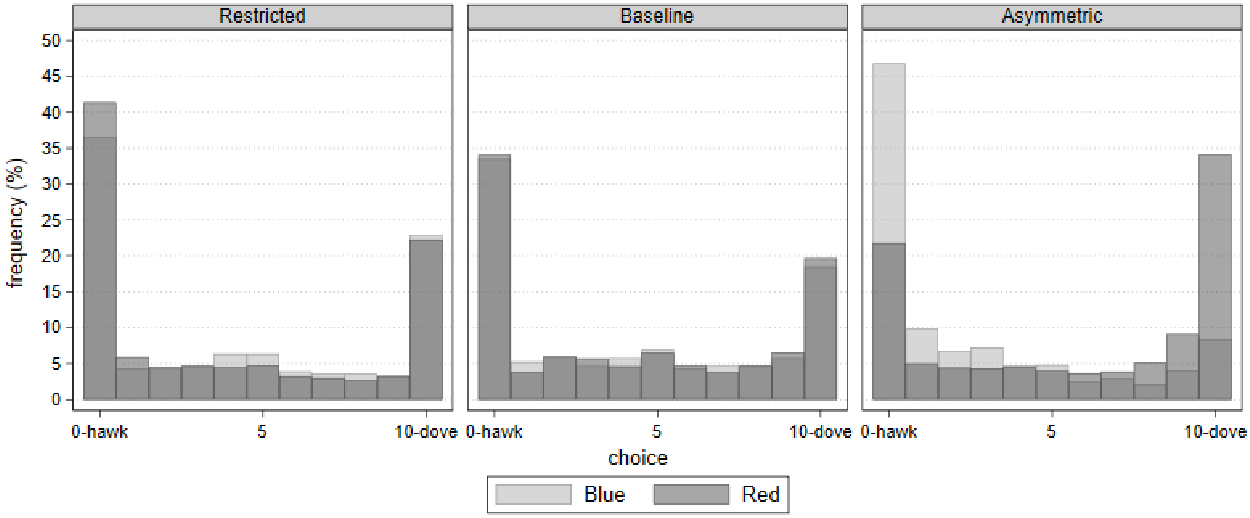


Figure 3: Frequency distribution of choices, by role.

the same frequency for cycle 1 and 5 only, respectively. This frequency increases across cycles in all treatments, but the increase is more pronounced in Asymmetric, where a positive trend within-cycle also emerges.[8]

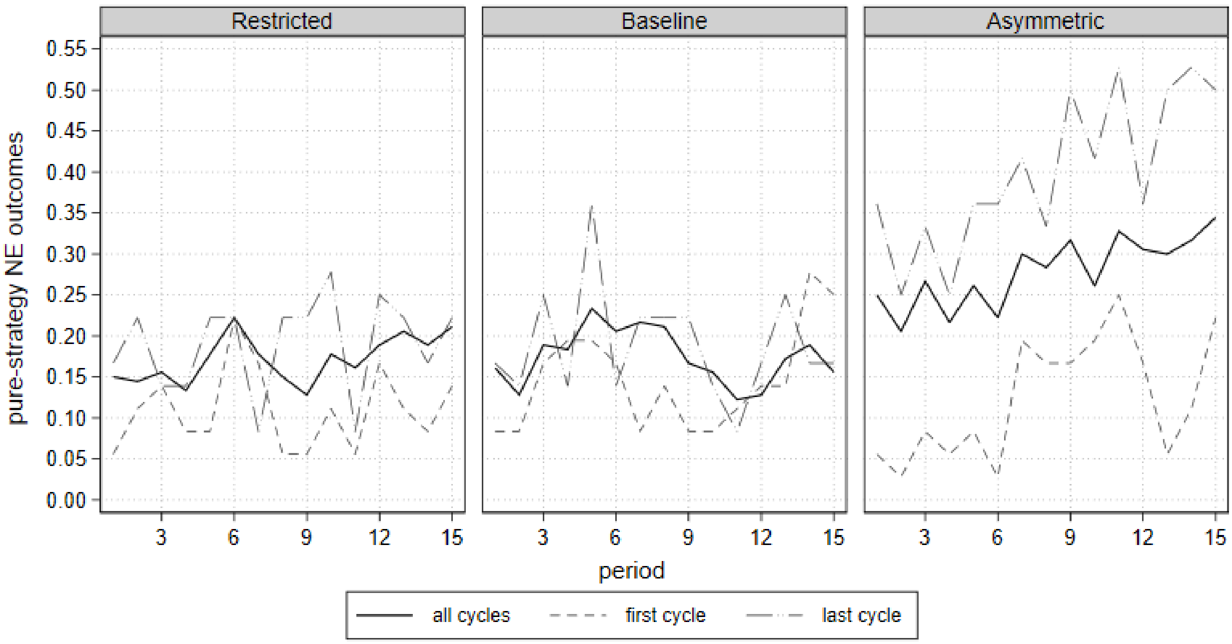


Figure 4: Frequency of coordination on pure-strategy NE outcomes.

To assess the statistical significance of this difference, we run a linear regression where the dependent variable is the frequency ϕ_{tkz} of choices that are part of a pure-strategy Nash equilibrium, in period t of cycle k of session z. Among the regressors, we include two dummies for the Restricted and Asymmetric treatments, and their interactions with the variables *Period* and *Cycle*. Results are presented in Table 2 (model 1). The regression confirms that – despite being initially lower – the

[8]The prevalence of the equitable and efficient 10-10 outcome instead is very low and does not increase with experience.

estimated prevalence of coordination on NE-outcomes in the Asymmetric treatment increases with experience across periods and cycles, and at the end of cycle 5 it reaches 45.4%, which is more than twice as large as in the Baseline (19.6%) and Restricted (22.3%).

	Model 1 **Coordination on NE**	**Model 2** **Efficiency**	**Model 3** **Separation**	**Model 4** **Inequality**
Period	-0.002	-0.007**	-0.006	0.003**
	(0.003)	(0.003)	(0.037)	(0.001)
Cycle	0.017***	-0.010	0.024	0.003
	(0.002)	(0.006)	(0.048)	(0.003)
Restricted	-0.035	-0.060	-0.047	-0.024**
	(0.050)	(0.037)	(0.700)	(0.008)
Restricted × Period	0.005	-0.000	0.020	-0.002*
	(0.003)	(0.003)	(0.039)	(0.001)
Restricted × Cycle	-0.003	0.011	-0.003	-0.006
	(0.007)	(0.015)	(0.080)	(0.004)
Asymmetric	-0.105*	-0.143***	-0.486	0.035
	(0.050)	(0.039)	(0.907)	(0.030)
Asymmetric × Period	0.009**	0.008	0.063	-0.003
	(0.004)	(0.004)	(0.053)	(0.002)
Asymmetric × Cycle	0.045***	0.034**	0.671***	-0.015
	(0.009)	(0.013)	(0.130)	(0.008)
Constant	0.138**	0.729***	1.191*	0.343***
	(0.045)	(0.006)	(0.593)	(0.003)
N	675	675	675	675
R-squared	0.297	0.116	0.356	0.275
Predicted values at t=15 and k=5, and Wald tests on their differences.				
Baseline	0.196	0.577	1.212	0.399
Simple	0.223	0.568	1.445	0.310
Asymmetric	0.455	0.726	5.021	0.318
p-value Base. vs. Simple	0.487	0.893	0.426	0.000
p-value Base. vs. Asym.	0.000	0.005	0.000	0.005

Notes: outcomes averaged at the session/period level. Standard errors clustered at the session level.

Table 2: Linear regressions on treatment effects.

The increased ability to coordinate on pure-strategy Nash Equilibrium outcomes also has an impact on the realized efficiency, which we measure as the sum of the two players' payoffs, normalized by the difference between the maximum and minimum possible joint payoff.[9] Figure 5 shows that efficiency tends to decrease over periods in Baseline and Restricted while it remains stable in Asymmetric, where it also increases over cycles. Results from a linear regression (Model 2 in Table 2) provide additional support to this result, showing that efficiency increases significantly over cycles only in the Asymmetric treatment.

Figure 3 suggests that – in the Asymmetric treatment – subjects specialize on different behaviors depending on their strength: on average, Red (strong) players play "dove" much more often than Blue players, and also than Red players in the other treatments. To investigate this aspect more closely,

[9]Formally, we define efficiency as: $\frac{\sum_i \pi_i - \underline{\Pi}_T}{\bar{\Pi} - \underline{\Pi}_T}$, where π_i denotes the payoff of player i, T identifies the treatment, $\bar{\Pi} = 100$ is the maximum surplus that can be achieved by a pair of players in a period, and $\underline{\Pi}_T$ is the minimum surplus in a pair, which is equal to 10 in treatments Baseline and Asymmetric, and equal to 30 in Restricted. Coordination on pure-strategy Nash-equilibria does not map one-to-one to efficiency, as there are efficient outcomes that are not Nash equilibria, the most prominent being the case where both players play "dove".

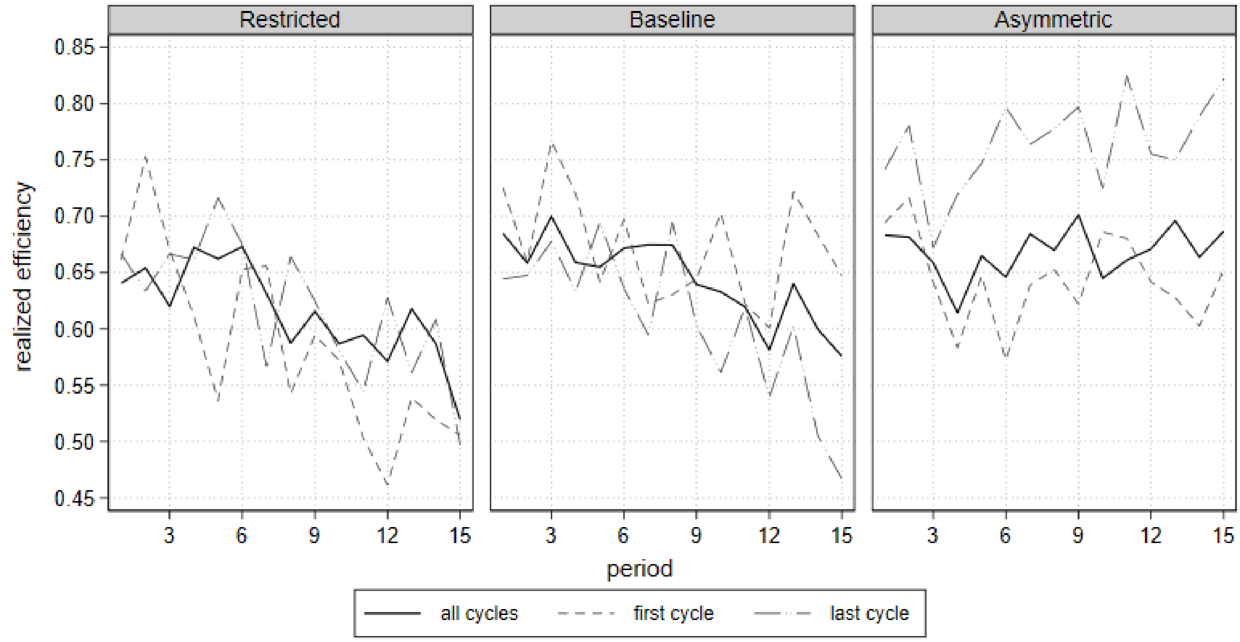


Figure 5: Average realized efficiency.

we follow the approach adopted by Oprea et al. (2011) and study the evolution of the average play of the Red and Blue players across periods and cycles. We identify as "hawks" the group of four (either red or blue) players that adopt the most aggressive behavior, in each economy. We identify as "doves" the other four players. Figure 6 displays the average choice made by the hawks and the doves, in each period. It confirms that in the Asymmetric treatment the separation between hawks and doves is much stronger than in the other two treatments, and increases with experience. Our data also confirm that in the Asymmetric treatment, the Red (strong) players take the role of doves in 97.8% of the supergames, while this percentage drops to 46.7% in the Baseline and 43.5% in the Restricted treatment.

To dig deeper into this difference across treatments, we ran a linear regression where the dependent variable is the difference between the average choice taken by the hawks and the doves, in each period, and regressors include the treatment dummies and their interactions with the variables *Cycle* and *Period*. Results are reported in Model 3 of Table 2, and confirm that a net separation between hawks and doves emerges only in the Asymmetric treatment, where at the end of cycle 5 the average difference between the choices of hawks and doves is 5.021, which is significantly higher than in the Baseline (1.21, p-value <0.001).

Our results thus confirm Hypothesis 1:

Result 1 *(a) Coordination occurs more frequently in the* Asymmetric *treatment than in the* Baseline *treatment. (b) In the* Asymmetric *treatment, subjects coordinate on the least unequal pure-strategy equilibrium.*

Hypothesis 2 instead does not find support in our data.

Result 2 *Coordination occurs as frequently in the* Restricted *as in the* Baseline *treatment.*

To check whether the separation of hawks from doves we observe in the Asymmetric treatment results in an increase of the level of realized inequality in payoffs, we measure the Gini coefficient

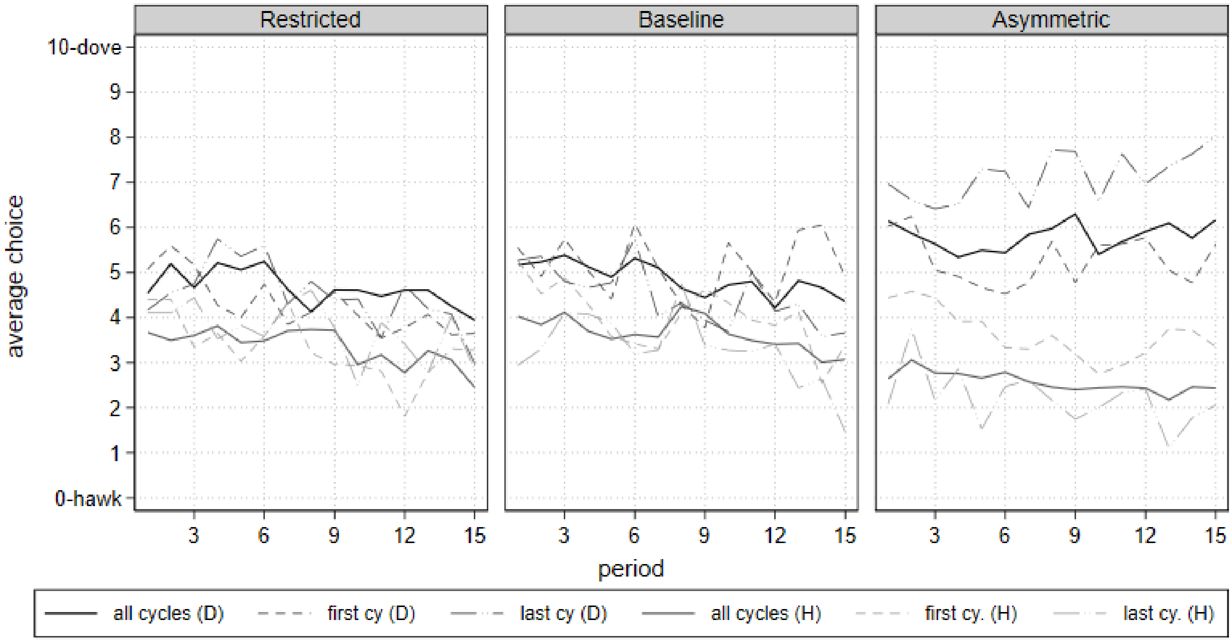


Figure 6: Average choice played by the most ("H") and by the least ("D") hawkish group of each economy.

at the economy-period level. Results are displayed in Figure 7, which shows that, if anything, ex-post inequality seems to be lower in the Asymmetric than in the Baseline. Results from a linear regression (Model 4 in Table 2) suggest that the treatment differences in terms of inequality are small, and a significant decreasing trend emerges only in the Restricted treatment, where inequality in payoffs is lower by design (the minimum attainable payoff is substantially higher than in the Baseline). In the long run, however, the estimated Gini coefficient becomes significantly lower in the Asymmetric (31.8%) than in the Baseline treatment (39.9%).

4.2 Individual behavior

In the previous section we have reported evidence that the Asymmetric treatment induced substantial behavioral differences, as compared to the Baseline. In particular, the asymmetry in the payoff matrix affected the choices taken by subjects assigned the role of Red players, who progressively adopted a more dovish attitude, leading to better coordination and more efficient outcomes. Here, we explore whether this change in behavior is immediately induced by the different setup and appears already in the first period of play, or only emerges with experience. To this aim, we start focusing on the first period of cycle 1. Table 3 presents a summary of the choices taken in Period 1 of Cycle 1, and on the expectations on the opponents' choices elicited before the same period. To test whether the distribution of expectations and of choices differ across treatments – and between roles, within each treatment – we ran a series of Mann-Whitney-Wilcoxon tests.[10] Results indicate that the only statistically significant difference emerges in the Asymmetric treatment, between the expectations of the Red and Blue players (p-value=0.0344). The distribution of choices and expectations in the Baseline is not significantly different from the one observed in the other two treatments, for subjects assigned to either roles.

[10] In all tests, $N_1 = N_2 = 36$.

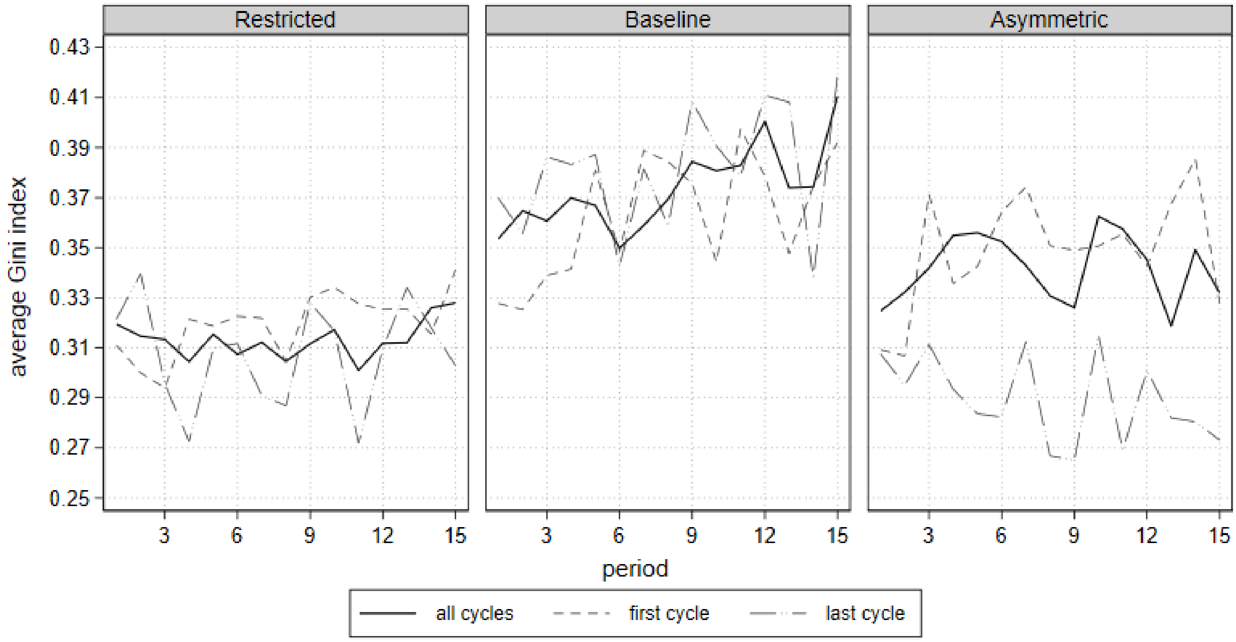


Figure 7: Average Gini coefficient.

	Restricted	Baseline	Asymmetric
Choices			
Red	4.944	5.694	6.028
	[3.807,6.082]	*[4.581,6.808]*	*[4.837,7.219]*
Blue	4.611	5.139	4.444
	[3.499,5.723]	*[4.011,6.267]*	*[3.471,5.418]*
Expectations			
Red	5.167	6.056	4.750
	[4.381,5.952]	*[5.320,6.792]*	*[3.854,5.646]*
Blue	5.833	5.778	5.944
	[4.971,6.696]	*[5.079,6.477]*	*[5.192,6.697]*

Note: Confidence intervals are reported in italics.

Table 3: Average choices and expectations on the opponents' choices in Period 1 of Cycle 1.

Figure 8 illustrates the correlation between individual expectations on the opponents' choices and players' own choices, in Period 1 of Cycle 1, and shows that in the Baseline and Restricted treatment subjects – regardless of their role – seem to adopt a strategy akin to "conditional cooperation" (see Fischbacher et al., 2001), which in this environment is at odds with what best-reply would suggest. This is in contrast with what we observe in the Asymmetric treatment, where the Blue players tend to best reply to their expectations, and play more hawkish, the lower (more dovish) the choices they expect from the Red players; for Red players instead choices and expectations seem to be uncorrelated, which suggests that conditional cooperators and best-responders coexist in this population.

This result is confirmed by the linear regressions reported in Model 1 of Tables 4 and 5, in which the dependent variable is the choice c_i of subject i in Period 1 of Cycle 1, and the regressors include the treatment dummies and their interaction with subject's i expectations $e_{i,1}$ elicited before cycle 1. In Model 2 of the same Tables, we ran two panel regressions to explore whether initial expectations continue to shape subjects' choices in the following periods and cycles. The dependent variable is the choice $c_{i,t,k}$ of subject i in Period t of Cycle k, and the regressors include the treatment dummies and

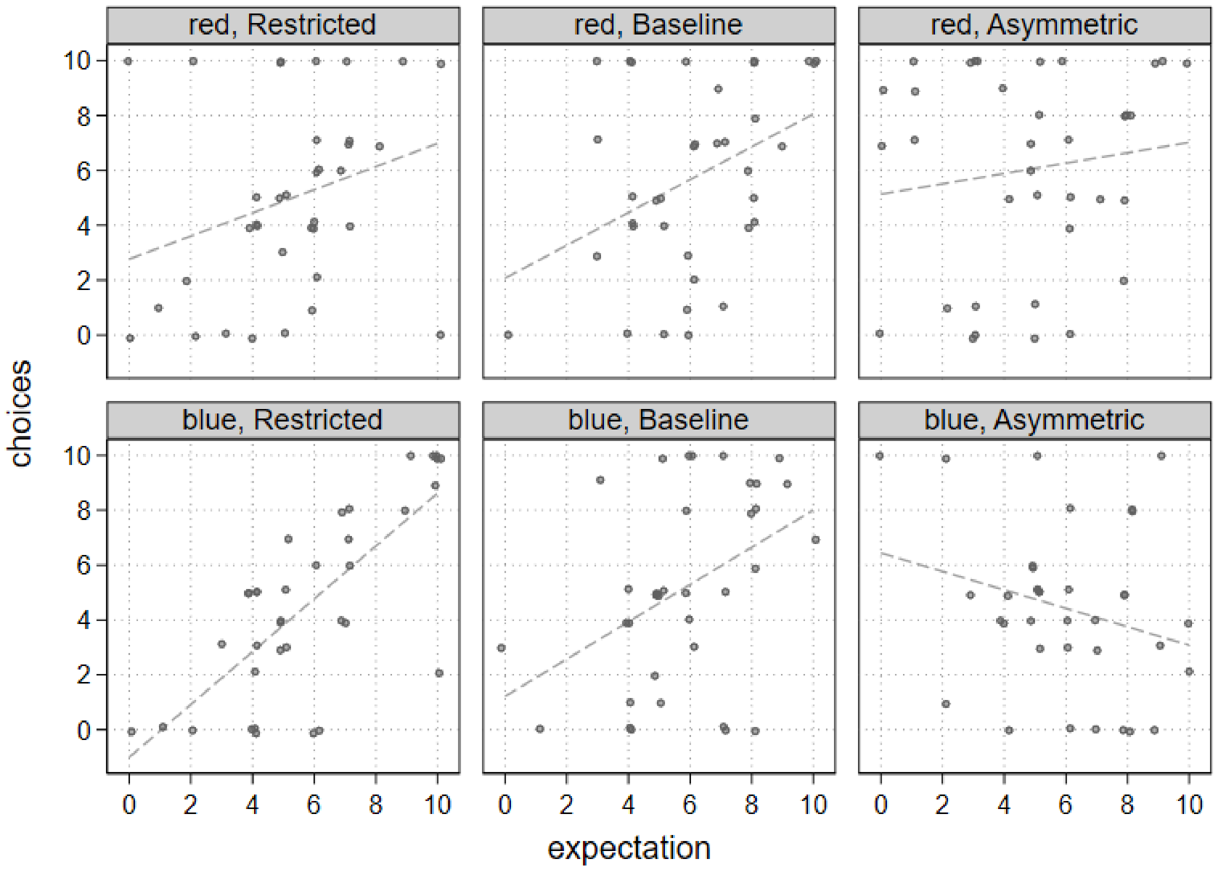


Figure 8: Correlation between expectations on the opponents' choices and players' own choices in the first period of cycle 1.

their interaction with subject's i expectations $e_{i,k}$ elicited before cycle k. The results suggest that the correlation between expectations and choices here becomes much weaker, in all treatments.

In Model 3 we explore the correlation between a subject's current choice $c_{i,t,k}$ and the one adopted in the previous period $c_{i,t-1,k}$, to see if subjects tend to alternate between hawkish and dovish choices, or tend to stick to a consistent play. The estimated coefficients are positive and significant in all treatments, indicating that subjects' behavior tends to remain substantially stable over periods. In Model 4, we look at the relation between a subject's choice in period t and the choice $c_{j,t-1,k}$ taken by his opponent in the previous period. The estimated coefficients confirm a mild tendency towards conditional cooperation in the two symmetric treatments, which disappears in the Asymmetric one. These results are confirmed by Model 5, where we include all regressors together.

To sum up, results in Tables 3-5 and in Figure 8 indicate that, even before having any experience with the game, the Blue players in the Asymmetric treatment adopt a more aggressive behavior, as compared to the other two treatments: while in Baseline and Restricted players display a conditionally cooperative attitude – that is, they play more dovishly when they expect the opponent to do the same – in the Asymmetric treatment the weak (Blue) players tend to best respond, and become more aggressive, the less aggressive the Red players are.

5 Conclusions

This paper presents an experiment on a two-population Hawk-Dove game, in which we vary the degree of inequality in opportunities, the number of pure-strategy equilibria, and the cost of miscoordination.

Our study contributes to two main strands of literature: first, we relate to the literature on inequality and coordination in experimental games, which so far has never explored this issue within the context of the Hawk-Dove game. This is a framework in which agents face a conflict over scarce resources, and captures the strategic incentives characterizing many economically relevant relations. As such, it is quite different from other frameworks already analyzed within this line of research, such as the threshold public good game, the minimum effort game and the indefinitely repeated helping game, which all allow for efficient and equitable cooperative equilibrium outcomes. Second, we expand the literature on the Hawk-Dove game, as – to our knowledge – we are the first to experimentally study the impact on coordination of introducing asymmetry in the payoff matrix. We also consider an expanded payoff matrix, which clearly complicates the game-theoretical analysis, but also makes the game more realistic, as in many situations people do not simply face a binary choice between fighting to death and accommodating completely, but also have more nuanced options. This expansion also allows us to study whether coordination becomes more difficult to achieve when we vary the number of pure-strategy equilibria, and the cost of miscoordination.

Our results indicate that making the game asymmetric seems to simplify coordination: populations characterized by ex-ante unequal strengths coordinate more often on the least inequitable pure-strategy Nash equilibria, leading to higher efficiency. Instead, with a symmetric payoff matrix, we observe no differences in terms of efficiency or individual strategies when we vary the number of pure-strategy equilibria and the cost of miscoordination.

Our main result on inequality and coordination suggests that, if one of the two conflicting populations is ex-ante disadvantaged to the point that for them the cost of miscoordination is much lower relative to the other population, members of this population can afford to be more aggressive forcing the others to accommodate. This eventually drives society to coordinate on the least unequal

	Per.1, cy.1	All periods - all cycles			
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Restricted	0.319	-0.720	-0.536*	-0.473	-1.095**
	(2.236)	(0.902)	(0.299)	(0.459)	(0.472)
Asymmetric	2.179	1.957***	0.521*	1.748***	1.039***
	(2.062)	(0.547)	(0.308)	(0.328)	(0.396)
Baseline × $e_{i,k}$	0.483*	0.120			0.013
	(0.266)	(0.074)			(0.044)
Restricted × $e_{i,k}$	0.424*	0.216**			0.109***
	(0.252)	(0.084)			(0.036)
Asymmetric × $e_{i,k}$	0.317	-0.020			0.001
	(0.224)	(0.046)			(0.028)
Baseline × $c_{i,t-1,k}$			0.403***		0.403***
			(0.075)		(0.077)
Restricted × $c_{i,t-1,k}$			0.463***		0.448***
			(0.020)		(0.012)
Asymmetric × $c_{i,t-1,k}$			0.466***		0.465***
			(0.056)		(0.056)
Baseline × $c_{j,t-1,k}$				0.107***	0.087**
				(0.030)	(0.043)
Restricted × $c_{j,t-1,k}$				0.139***	0.128***
				(0.016)	(0.015)
Asymmetric × $c_{j,t-1,k}$				-0.022	-0.031**
				(0.020)	(0.015)
Constant	-3.164	1.328	1.340***	1.737*	0.948**
	(3.209)	(1.062)	(0.407)	(0.921)	(0.478)
Individual characteristics	Yes	Yes	Yes	Yes	Yes
cycle f.e.	No	Yes	Yes	Yes	Yes
N	108	8100	7560	7560	7560
R-squared	0.188				
R-squared within		0.006	0.070	0.015	0.080
R-squared between		0.169	0.835	0.145	0.827
R-squared overall		0.063	0.244	0.065	0.253

Notes: Models 2-5 present regressions with random effects at the subject level and standard errors robust for clustering at the session level. The number of observations drops from 8100 to 7560 from Model 2 to Model 3-5 as in the latter we cannot include period 1 of each cycle. Symbols $***$, $**$, and $*$ indicate significance at the 1%, 5% and 10% level, respectively. Individual characteristics are obtained through the post-experimental questionnaire (Appendix B), and include: gender, age, education, three dummies indicating whether the participant had a background knowledge of economics, statistics and game theory, a variable counting the number of correct answers (0-3) in the cognitive reflection test (questions 15-17), and the answers to questionnaire measures of risk attitudes (question 11) and prosociality (question 12).

Table 4: Determinants of the individual choices of Red players.

	Per.1, cy.1	All periods - all cycles			
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Restricted	-2.451	-0.860**	-0.195	-0.312	-0.622**
	(1.889)	(0.436)	(0.367)	(0.205)	(0.275)
Asymmetric	5.587***	-1.456***	-1.060***	-1.615***	-0.473***
	(2.001)	(0.242)	(0.336)	(0.151)	(0.154)
Baseline × $e_{i,k}$	0.675***	0.074			0.003
	(0.232)	(0.057)			(0.057)
Restricted × $e_{i,k}$	0.978***	0.194***			0.105***
	(0.188)	(0.042)			(0.022)
Asymmetric × $e_{i,k}$	-0.436*	-0.002			-0.049***
	(0.221)	(0.020)			(0.011)
Baseline × $c_{i,t-1,k}$			0.409***		0.409***
			(0.061)		(0.063)
Restricted × $c_{i,t-1,k}$			0.442***		0.428***
			(0.028)		(0.025)
Asymmetric × $c_{i,t-1,k}$			0.443***		0.442***
			(0.021)		(0.021)
Baseline × $c_{j,t-1,k}$				0.082***	0.078***
				(0.018)	(0.021)
Restricted × $c_{j,t-1,k}$				0.101***	0.080***
				(0.023)	(0.019)
Asymmetric × $c_{j,t-1,k}$				0.028***	0.008*
				(0.010)	(0.005)
Constant	-0.979	1.295	1.636**	1.546	1.251**
	(2.557)	(1.179)	(0.734)	(1.111)	(0.633)
Individual characteristics	Yes	Yes	Yes	Yes	Yes
cycle f.e.	No	Yes	Yes	Yes	Yes
N	108	8100	7560	7560	7560
R-squared	0.365				
R-squared within		0.009	0.063	0.012	0.069
R-squared between		0.213	0.854	0.199	0.845
R-squared overall		0.062	0.230	0.060	0.236

Notes: Models 2-5 present regressions with random effects at the subject level and standard errors robust for clustering at the session level. Symbols $***$, $**$, and $*$ indicate significance at the 1%, 5% and 10% level, respectively. Individual characteristics are obtained through the post-experimental questionnaire (Appendix B), and include: gender, age, education, three dummies indicating whether the participant had a background knowledge of economics, statistics and game theory, a variable counting the number of correct answers (0-3) in the cognitive reflection test (questions 15-17), and the answers to questionnaire measures of risk attitudes (question 11) and prosociality (question 12).

Table 5: Determinants of the individual choices of Blue players.

equilibrium outcome, which increases overall efficiency. While of course our result is limited to the artificially simple set-up implemented in our experiment, it would be interesting to study whether the same dynamics would emerge in other, more realistic, frameworks. We leave this for future research.

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Appendix A Experimental Instructions

Note: this section reports the instructions for the BASELINE treatment. Instructions for the other treatments only differ in terms of the payoff matrix and the numbers reported in the examples.

Instructions

Welcome to this study on economic decision-making.

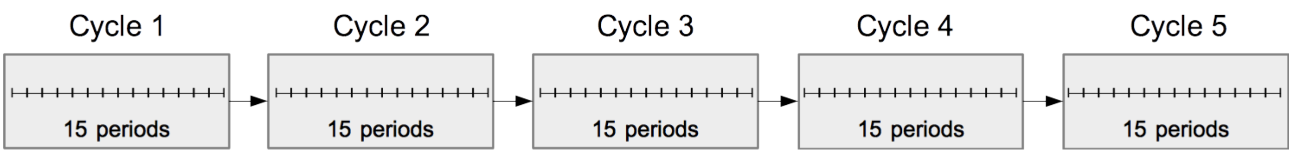
These instructions are a detailed description of the procedures we will follow. In this study, you will earn an amount of money, which depends on how well you understand these instructions, and on the choices you and the other participants will take.

During the experiment you are not allowed to communicate with the other participants. We also ask you to switch off your mobile phone now. If you have a question at any time, please raise your hand and remain seated: someone will come to your desk to answer it.

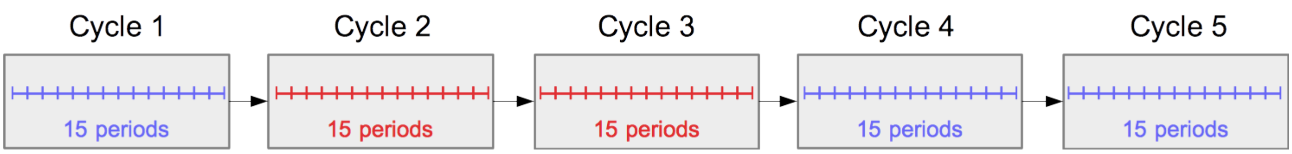
As we proceed with the instructions, you will be asked to answer ten questions designed to verify your understanding of the instructions. You will receive €0.50 for each question you answer correctly. So you can earn up to €5 if you answer all questions correctly.

Overview of the experiment

The study is divided into **5 cycles**. Each cycle will last exactly for **15 periods**.

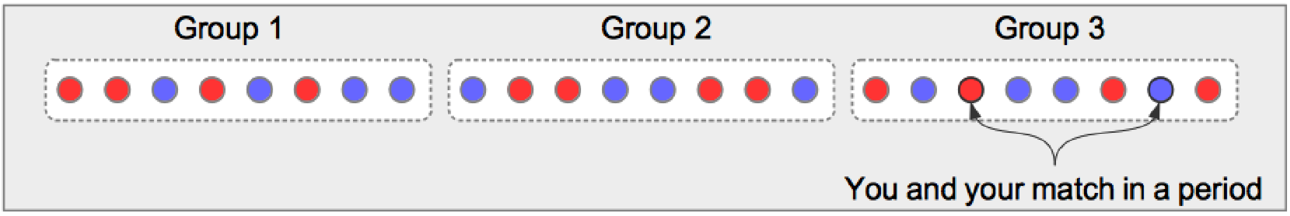


There are 24 participants. At the start of each **cycle**, a computer program will form **groups of 8** participants. In each group, 4 participants will be red, and 4 will be blue. In the first period of cycle 1 you will be randomly assigned a color, either red or blue. Then your color remains the **same for the whole cycle**. Afterwards, your color may change from cycle to cycle, but will always remain the same within a cycle. If in period 1 of Cycle 1 you are blue, then you will be blue in all periods of Cycle 1. At the beginning of Cycle 2, you will be assigned a new color, which may be either blue or red; then you will keep the same color in all periods of Cycle 2. And so forth and so on. So, for example, you could be blue in all periods of Cycle 1, red in all periods of Cycles 2 and 3, and blue again in all periods of Cycles 4 and 5.



In each period of the cycle you will be paired with someone **in your group** to interact with him or her. We will call this person your **"match"**. Your match is a **random person** from your group.

In each pair, one person will be red and the other blue. If you are red, your match will be blue and vice versa. Your match will always remain anonymous. Hence, you will not know if you repeatedly interact with the same participant.



Groups change in each cycle so that you cannot interact with anyone for more than one cycle.

Understanding check 1

Before we proceed, please answer the questions that will appear now on your screen. Remember that you earn €0.50 for each question you answer correctly.

How you earn points in a period

You will earn points that depend on your choices and the choices of your match. Points will be converted into euros at the end of the session in a manner that we explain later. Both you and your match will have to choose an integer number between 0 and 10. These choices determine your **profit** and the profit of your match, as displayed in the following table.

Choice of blue

Your choice	0	1	2	3	4	5	6	7	8	9	10
0	5 / 5	5 / 14	7 / 21	9 / 28	11 / 35	13 / 42	15 / 49	18 / 55	20 / 62	22 / 69	24 / 76
1	14 / 5	10 / 10	7 / 21	9 / 28	11 / 35	13 / 42	15 / 49	18 / 55	20 / 62	22 / 69	24 / 76
2	21 / 7	21 / 7	14 / 14	9 / 28	11 / 35	13 / 42	15 / 49	18 / 55	20 / 62	22 / 69	24 / 76
3	28 / 9	28 / 9	28 / 9	19 / 19	11 / 35	13 / 42	15 / 49	18 / 55	20 / 62	22 / 69	24 / 76
4	35 / 11	35 / 11	35 / 11	35 / 11	23 / 23	13 / 42	15 / 49	18 / 55	20 / 62	22 / 69	24 / 76
5	42 / 13	42 / 13	42 / 13	42 / 13	42 / 13	28 / 28	15 / 49	18 / 55	20 / 62	22 / 69	24 / 76
6	49 / 15	49 / 15	49 / 15	49 / 15	49 / 15	49 / 15	32 / 32	18 / 55	20 / 62	22 / 69	24 / 76
7	55 / 18	55 / 18	55 / 18	55 / 18	55 / 18	55 / 18	55 / 18	37 / 37	20 / 62	22 / 69	24 / 76
8	62 / 20	62 / 20	62 / 20	62 / 20	62 / 20	62 / 20	62 / 20	62 / 20	41 / 41	22 / 69	24 / 76
9	69 / 22	69 / 22	69 / 22	69 / 22	69 / 22	69 / 22	69 / 22	69 / 22	69 / 22	46 / 46	24 / 76
10	76 / 24	76 / 24	76 / 24	76 / 24	76 / 24	76 / 24	76 / 24	76 / 24	76 / 24	76 / 24	50 / 50

In the table, the numbers in red represent the profits of the red person, and the numbers in blue represent the profits of the blue person. To read the profits corresponding to a specific pair of choices, you should

- find the row in the table that corresponds to the choice of the red person;
- move to the right until you find the cell where this row crosses the column corresponding to the choice of the blue person.

Consider the following **examples**. If you are red and you choose 6, while your blue match chooses 3

- your profit is 15;
- the profit of your blue match is 49.

If instead you are blue and you choose 8, while your red match chooses 4

- the profit of your red match is 62;
- your profit is 20.

Understanding check 2

Before we proceed, please answer the questions that will appear now on your screen. Remember that you earn €0.50 for each question you answer correctly.

Timeline of a period

Each period has the following timeline:

Step 1: You are **randomly paired** with another participant in your group.

In each period, half of the members of your group are red and the others blue.

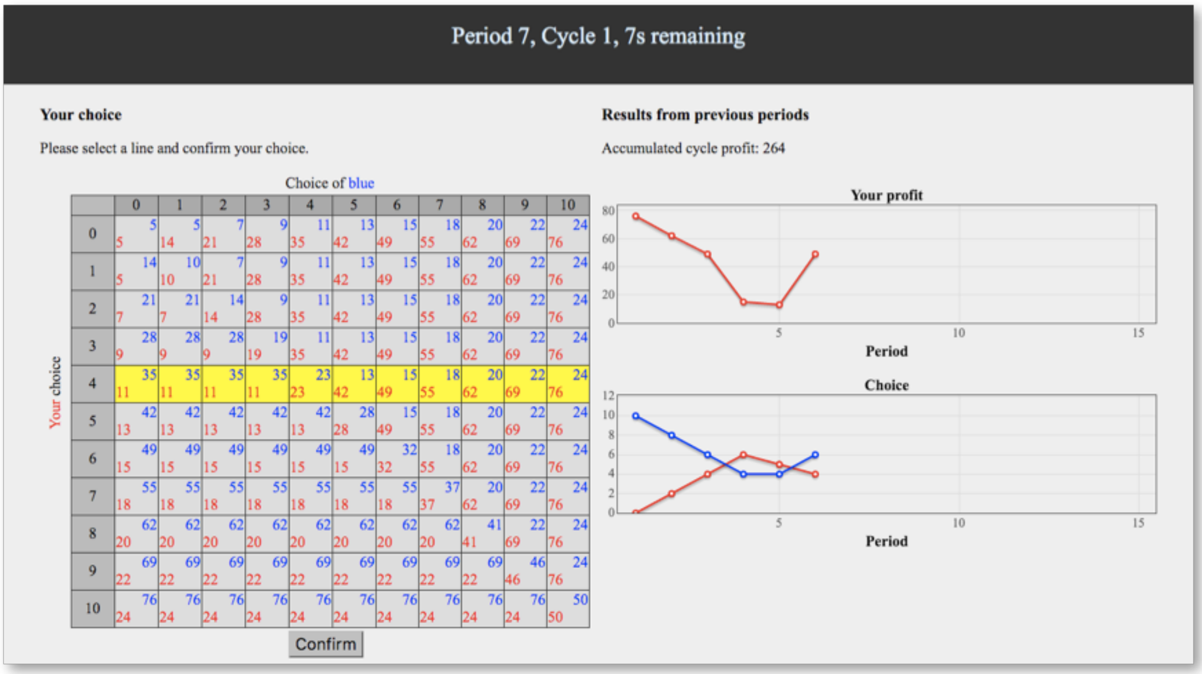
Your match has always a color different than yours. Your match changes from period to period with a probability equal to 3 out of 4 (75%) because your match can be **any of the 4 members** of your group who have a color different than yours. You will never know whom you meet, and your match will not be able to identify you, either.

Step 2: You and your match **choose a number** between 0 and 10.

To make a choice, click on the row corresponding to your preferred option. The line of the table corresponding to your choice will be highlighted in yellow (see the figure below). To submit your choice, click the "Confirm" button.

You cannot observe the number chosen by your match before making your choice. Similarly, your match cannot observe the number you chose, before making his choice.

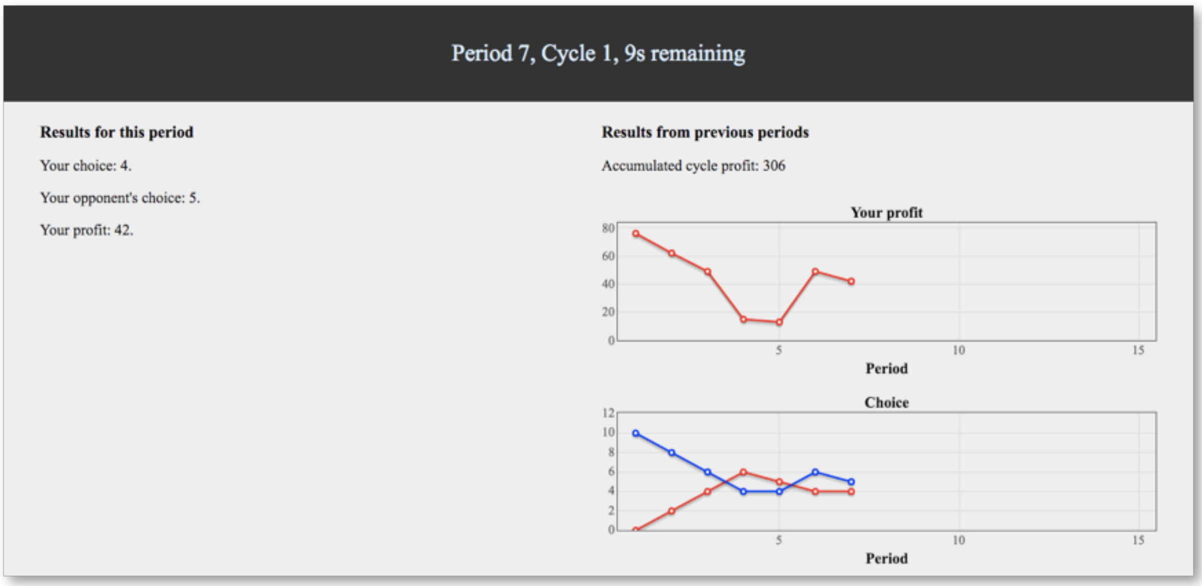
You can review results of **past periods of the cycle** in the two graphs in the right-hand part of the screen. The graph at the top displays your profits in the past periods, while the graph at the bottom represents your choices, and the choices of your match. At the top of the graphs, you can also read your accumulated profit in the current cycle.



Step 3: You observe the outcome.

The outcome in your pair for the period will be displayed after you and your match make a choice. You will see your choice, the choice of your match and your profit in points (see the figure below).

Results from past periods will again be visible on the right of the screen.



<u>End of the cycle and beginning of a new cycle</u>

Each cycle lasts for 15 periods. Then a new cycle begins, until the end of cycle 5.

At the beginning of each cycle:

- **new groups** of eight participants are formed, so that you will never interact with the same participant for more than one cycle;

- you will see your **color**;
- you will be asked to **guess the average number** that the other groups' members, who have a color different than yours, will choose in the **first period** of the cycle which is about to start.
  - If you are red, you will have to guess the average number chosen by the participants who are blue, and who do not belong to your group.
  - If you are blue, you will have to guess the average number chosen by the participants who are red, and who do not belong to your group.

Payments

At the end of today's study, **one** of the five cycles will be randomly selected to determine your payment. The accumulated profit you have earned in that Cycle will be converted into Euros: 1 point is worth 2 cents (€0.02).

A second cycle will be selected, **among the remaining four**, to reward your guess on the others' choices. Your earnings (in points) for this Cycle will depend on the **guess** you made on the other participants' choice, at the beginning of that Cycle. The closer is your guess to the actual value of the average number chosen by the other participants, the higher your earnings, as displayed in the following table.

Difference between your guess and the actual average	**Your earnings in points**
No difference (exact guess)	250
The difference is larger than 0 and at most 1	240
The difference is larger than 1 and at most 2	210
The difference is larger than 2 and at most 3	160
The difference is larger than 3 and at most 4	90
The difference is larger than 4	0

Final reminders

- The session is divided into **5 cycles**; each cycle has **15 periods**.
- In **each period**
  - you meet an anonymous match, who **changes** from period to period with 75
  - you must **choose** an integer number between 0 and 10;
  - you **earn points** depending on your choice and on the choice of your match, as displayed in the **profit table**.
- You **cannot** interact with anyone for more than one cycle.
- At the beginning of each cycle, you will be asked to **guess** the average number that the other groups' members, who have a color different than yours, will choose in the **first period** of the cycle which is about to start.
- At the **end of the study**,
  - one cycle will be randomly selected to determine your payment;
  - another cycle will be randomly selected to reward your guess on the others' choices.

Understanding check 3

Before we start, please answer the questions that will appear now on your screen. Remember that you earn €0.50 for each question you answer correctly.

Appendix B Post-experimental questionnaire

We kindly ask you to complete this questionnaire. The answers you give will not affect in any way your earnings. Some of these questions refer to personal information, which will help us in this study. Your identity will not be revealed under any circumstances in the presentation of the results.
Please answer carefully. Once an answer is given, you can no longer change it. Press OK to begin. Thank you.

1. Were the instructions you have received for today's activities clear?
(1) No, not at all (2) No, not so much (3) Yes, enough (4) Yes, very much

2. Gender (press the corresponding button)
(1) Male (2) Female

3. Age (please, give your answer using the slider below and press ok to confirm)

4. Education background
(1) Middle high school (2) High school (3) Bachelor degree (4) Master degree (5) Ph.D. or postgraduate degree (6) Other

5. Occupation
(1) Student (2) Self-employed worker (3) Employee (4) Retired (5) Jobless (6) Others

5.1 Field of studies (this question is accessed only if the subject gives answer (1) to question 5)
(1) Social sciences (2) Mathematical, Physical and Natural sciences (3) Engineering and Architecture (4) Medicine (5) Literature and Philosophy (6) Others

6. Have you attended courses in Economics?
(1) Yes (2) No

7. Have you attended courses in Statistics?
(1) Yes (2) No

8. Have you attended courses in Game Theory?
(1) Yes (2) No

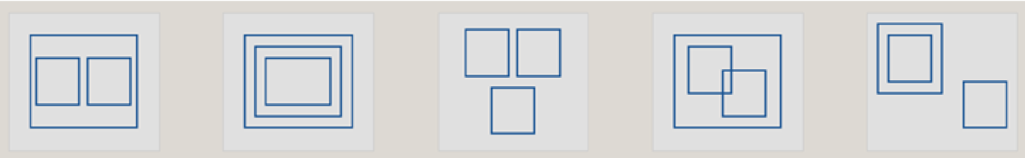
9. Have you previously participated as a volunteer in other researches?
(choose one or more answers)
(1) Yes, in the field of economics
(2) Yes, in the field of psychology
(3) Yes, in the field of medicine or biology
(4) No

10. Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?
(1) Most people can be trusted (2) Can't be too careful (3) No idea

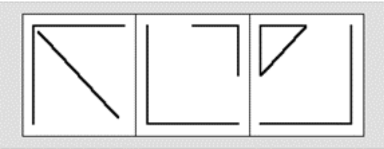
11. Are you generally a person who is fully prepared to take risks or do you try to avoid taking risk? Please tick a box on the scale, where the value 1 means: "unwilling to take risks" and the value 10 means: "fully prepared to take risk"

12. In general, do you think it is important to help others, and take care of their well being? Please tick a box on the scale, where the value 1 means: "not important at all" and the value 10 means: "Maximally important"

13. Which of these diagrams represents the relationship between Orange-Citrus Fruit-Fruit? Please select an answer and click OK to confirm.



14. Select the element that completes the following series. Please select an answer and click OK to confirm.



15. A bat and a ball cost \$ 1.10 in total. The bat costs \$ 1.00 more than the ball. How much does the ball cost?

16. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?

17. In a pond, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire pond, how long would it take for the patch to cover half of the pond?