Group Identity and Strategic Games in the Laboratory *

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Abstract

We study the effects of group identity on cooperation in experimental two-person strategic games. Our results show that in games of strategic complements, group identity only matters initially when a participant interacts with another participant of the same group by delivering more cooperative choices, but this effect disappears in later rounds. The Nash equilibrium with standard preferences describes behavior well regardless of the identity condition. However, in treatments with strategic substitutes, we find that participants are persistently more competitive when playing with another participant of a different group than when there are no identity groups. This is because, in games of strategic substitutes, participants have spiteful preferences toward participants that are members of the another group which leads to choices that are more competitive than the Nash equilibrium.

Keywords: strategic complements, strategic substitutes, Cournot, Bertrand, in-groups, out-groups

JEL codes: C91, D61, D63, L13, L14

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1 Introduction

In this paper, we study how group identity affects choices, cooperation, and competition in different types of strategic games in a laboratory experiment. Group identity categorizes decision-makers into the same group (in-groups) or a different group (out-groups), a terminology introduced by Tajfel *et al.* (1971). Firms competing in marketplaces can be part of the same or different groups depending on the various components of organizational identity (Albert and Whetten, 1985). Likewise, individuals that interact in a variety of contexts can be in-groups or out-groups according to their social identity factors.[1] Akerlof and Kranton (2000) have shown that group identity can have effects on economic outcomes, however, it remains a puzzle how it interacts with the strategic environment. We focus on games of strategic complements (where a player has an incentive to match the strategies of other players) and strategic substitutes (where a player has an incentive to mismatch the strategies of other players). Examples of games of strategic complements include competition à la Bertrand, arms races, the beauty contest, and stag-hunt games; while games of strategic substitutes include competition à la Cournot, the entry game, and the tragedy of the fishers.[2] Our contribution is to provide a systematic analysis of this question, and to show that strategic incentives are the main factor in explaining choices in games of strategic complements, while group identity affects preferences, and hence behavior, in games of strategic substitutes.

We design a 3x2 laboratory experiment with six treatments. In three treatments we vary the nature of group identity. To abstract from the specific characteristics associated with particular identities, we focus on artificial group identity which is induced in the laboratory by the color of a piece of paper in an envelope (Chen and Li, 2009) and reinforced using a neutral task (Chen and Chen, 2011). After that, participants play a strategic game with another in-group, out-group or no-identity participant. The no-identity treatment will be called control hereafter. In two treatments we also vary the nature of the strategic game: strategic substitutes or strategic complements. We use a neutral framing and participants choose an integer number between 0 and 1000 for twenty-five rounds. To keep the spirit of the one-shot interaction, we use random matching between rounds.[3] The payoff function is continuous and quadratic so that each game has a unique Nash equilibrium. We choose games that are as equivalent as possible in the two strategic settings as in Potters and Suetens (2009) and Masiliūnas and Nax (2020): both types of games have the same Nash equilibrium, joint profit maximization and relative profit maximization choices and payoffs. At the end of the strategic game, we also asked participants various questions regarding how they identify with their group and with the other group, their strategies throughout the game, and demographics. There were 288

[1]Examples of organizational identity are brand image, head-quarter's location, publicly vs. privately held, common vs. different owners, strategic alliances, professional associations, or green vs. brown production, while examples of individual identity are gender, race, religion, political views, age, occupation or hobbies.

[2]For additional examples, see Bowles (2004).

[3]See Brandts and Potters (2018) for a review of the random matching versus fixed partners experimental design issues and results in oligopoly experiments.

participants in our experiment equally distributed into the six treatments with 8 participants in each group.

Our main hypothesis investigates how group identity affects choices in a given type of strategic game (Hypothesis H1), and whether for a given identity treatment, choices are the same for each type of strategic game (Hypothesis H2). The predictions of game theory with standard preferences would say that group identity should have no effect in either of the two strategic games, and given our parametrization, that there should be no differences between types of strategic games for a given identity. However, behavioral game theory and previous experiments –such as the evidence provided in the review of Charness and Chen (2020) – have shown that group identity has an effect on social (other-regarding) preferences: individuals have altruistic preferences with in-groups and spiteful ones with out-groups. The implications of these types of preferences in our games imply that choices should be more cooperative with in-groups and less cooperative with out-groups than in the control (Hypothesis H3).

Our findings are as follows. In games of strategic complements, in-groups are initially more cooperative than in the control, but this effect disappears in later rounds. In general, the Nash equilibrium describes well the choices of the second half of the experiment for the group identities and no-group identity conditions. This implies that the strategic incentives are more important than group identification in games of strategic complements. In contrast, in games of strategic substitutes, out-groups are persistently more competitive than the control and in-group treatments. The Nash equilibrium describes well the choices of the control treatment, while out-groups are more competitive than the Nash equilibrium. This suggests that group identification is critical to understanding choices in strategic substitutes environments. When comparing the degree of cooperation of the two types of game for a given identity treatment, we find that choices become less cooperative over rounds in games of strategic substitutes than in games of strategic complements, and that this is driven by the choices of out-groups in games of strategic substitutes. With in-groups and control treatments, there are no differences between choices in games of strategic complements and strategic substitutes.

We then provide two mechanisms that can explain of our findings. We first ask whether beliefs or social preferences can explain our results. With regards to beliefs, we find no statistical differences in initial beliefs about the other participant's choice and own choice within a given treatment. This indicates that participants are likely to believe that other participants have the same other-regarding preferences as themselves (robust beliefs). This implies that beliefs cannot explain our findings. With respect to preferences, we find that standard preferences describe well the choices for all treatments except for out-groups in games of strategic substitutes. In this environment, behavior is consistent with spiteful preferences towards participants of the other group. This means that out-group identification has important effects on preferences in environments characterized by strategic substitutes, and that these are not eliminated by strategic incentives. The second explanation that we provide concerns the adaptation dynamics of choices. We find that best-response dynamics explain well the dynamics of choices in both treatments: it is the major driver of choices in games of strategic complements, while it shares its importance with "imitation of the best" in games of strategic substitutes. This would explain why, in games of strategic substitutes, choices converge to a more competitive outcome than the Nash equilibrium, consistent with the theoretical result of Vega-Redondo (1997) for Cournot markets.

Our results are related to two main strands of the literature. First, there is a large literature about laboratory experiments on strategic games but almost none have studied how group identity interacts with strategic incentives in a comparable way. The literature on experimental industrial organization has analyzed how Bertrand and Cournot competition outcomes compare, such as in Huck *et al.* (2000), Huck *et al.* (2004); Altavilla *et al.* (2006); Potters and Suetens (2009); and for reviews of these issues, see Potters and Suetens (2013), and Brandts and Potters (2018). Using a general framework, Potters and Suetens (2009) compare cooperation in games of strategic complements and substitutes, and find that there is more cooperation under strategic complementarity. Our experiment reconfirms these results, but in addition, we find that after a few rounds of interaction, the effects of group identity disappear in games of strategic complements, while they persist in games of strategic substitutes: out-groups are less cooperative in comparison to no-identity treatment. Masiliūnas and Nax (2020) analyze framing in strategic settings and find that in games of strategic complements there is more competitive behavior under economic framing than under abstract framing, but that this is not found in games of strategic substitutes. In contrast, we find that group-identity effects are persistent in games of strategic substitutes while only temporary in games of strategic complements. This highlights the fact that framing and group identity in strategic games have different effects that can be explained by contrasting mechanisms. Li *et al.* (2011) study an oligopoly market with buyers and sellers and find that group idientity affects who trades with whom and at which price. Their results show trading between in-group sellers and buyers tends to occur more often, and out-group sellers tend to charge lower prices.

Second, our results complement, explain and expand the existing literature on how group identity affects economic decision making in specific games.[4] Following from the seminal work of Akerlof and Kranton (2000), the papers of Eckel and Grossman (2005) and Charness *et al.* (2014) find evidence that sharing the same group identity promotes cooperation amongst individuals when playing a public good game. Charness *et al.* (2007) study group identity in the prisoner's dilemma and the battle of the sexes games. Our results might explain why they find different findings in the two types of games, which have different strategic incentives. Chen and Li (2009) show that participants are more altruistic with an in-group match, and Chen and Chen (2011) find evidence that in-groups lead to more efficient coordination outcomes than out-groups in a game with

[4]For a review of these issues, see Charness and Chen (2020)

multiple equilibria, and that this may be explained by social preferences. The social preference explanation is consistent with ours in the context of strategic games with a unique Nash equilibrium. However, in contrast to these papers, we find that in games of strategic complements, social preferences are not so important because choices very rapidly converge to the Nash equilibrium. Nevertheless, in games of strategic substitutes, out-group social preferences prevail over strategic incentives.

Finally, our results also add to previous evidence analyzing the effects of social cues and friendship on cooperation in games of strategic complements and strategic substitutes. Boone *et al.* (2008) use brief interactions to induce subtle social cues among participants and study its effects on strategic games. The paper finds that social cues are not very important for achieving cooperation in games of strategic complements, while they are essential in games of strategic substitutes. Their results are in line with ours since we also find the strongest effects of group identity in games of strategic substitutes. In a similar spirit, Chierchia *et al.* (2020) study how friendship affects choices in strategic games. They find that friends are more likely to choose actions involving uncertainty in games of strategic complements, but the opposite is true in games of strategic substitutes. In relation to these papers, our identity manipulation is artificial, we use games with a continuous action space (vs. discrete action space in the two other studies) and a random matching (vs. fixed matching) design. In addition, our results highlight the importance of group identity in games of strategic substitutes.

The paper is organized as follows. Section 2 describes the theoretical background. Section 3 outlines the experimental design, procedures, and hypotheses. Section 4 analyzes the results of the paper. Section 5 delves into the mechanisms of cooperation and group identity. Section 6 analyzes the robustness of our identity manipulation, and Section 7 concludes. The instructions of the experiment, the experimental screens, and supplementary results can be found in the Appendices of the paper.

2 Theoretical background

In this paper we consider two main types of strategic games: games of strategic complements and substitutes (Bulow *et al.*, 1985; Vives, 1999). Recall that in games of strategic complements when the other participant increases the action, the marginal benefit of increasing your action increases, i.e., the best-response function is increasing with the action of the other player. In contrast, in games of strategic substitutes, when the other participant increases the number the marginal benefit of increasing your action decreases, i.e., the best response function is decreasing with the action of the other player. We consider two-person games with a quadratic payoff function and with a continuous action space:

$$\pi_i(x_i, x_j) = a + bx_i + cx_j - dx_i^2 + ex_j^2 + fx_ix_j, \tag{1}$$

where $\pi_i(x_i, x_j)$ is player i's payoff when i has chosen action x_i and the other player has chosen x_j. Notice that the game is of strategic complements type if $f > 0$, and of the strategic substitutes type if $f < 0$, as in Bertrand and Cournot markets with product differentiation, respectively. The quadratic payoff function ensures that there is a unique Nash equilibrium.

In order to make the two types of games as comparable as possible for our experimental analysis, we imposed the same standard theoretical benchmarks across both types of games following Potters and Suetens (2009) and Masiliūnas and Nax (2020). Using equation (1), we use the same parametrization as Masiliūnas and Nax (2020), where $a = 1500$, $b = 0.5$, $c = -1.5$ in both games, $d = 2/1500$, $e = 1/1500$, $f = 1/1500$ for games of strategic complements, and $d = 2/2500$, $e = 3/2500$, $f = -1/2500$ for strategic substitutes. The advantage of this parametrization is that the two games have the following properties: the same Nash equilibrium choice (hereafter NE) and payoffs; the same joint payoff maximization choice (hereafter JPM) and payoff; and the same relative profit maximization (hereafter RPM) and payoffs. With this parametrization, the three theoretical benchmarks for the games analyzed are presented in Table 1.

Table 1: Theoretical Benchmarks

	SC		***SS***	
	Choice	Outcome	Choice	Outcome
JPM	0	1,500	0	1,500
NE	250	1,250	250	1,250
RPM	500	1,000	500	1,000

Throughout the paper, we refer to choices that are more cooperative / less competitive than the NE when the chosen number is lower (towards the JPM) while choices are less cooperative / more competitive than the Nash equilibrium when the chosen number is higher (towards the RPM). Notice that the JPM choice is lower than the NE choice since we focus on games with negative externalities.[5]

However, group identity may affect social (other-regarding) preferences. A simplified utility function, inspired by models of other-regarding preferences (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Charness and Rabin, 2002), captures the idea that a participant may give some weight to another participant's profits, and can be written as follows:

$$u_i(\pi_i, \pi_j) = \pi_i + \alpha_i \pi_j, \tag{2}$$

for $i = 1, 2$ and α_i represents the social preference parameter of subject i and can range from $-1 < \alpha_i < 1$. Altruistic preferences are represented by $0 < \alpha_i < 1$, spiteful preferences by $-1 < \alpha_i < 0$, and the standard selfish by $\alpha_i = 0$.[6] The model is not fully specified without making some assumptions about players' beliefs

[5] Potters and Suetens (2009) explain that there may be potentially differences between games of positive and negative externalities. For the sake of simplicity, we focus only on games of negative externalities.

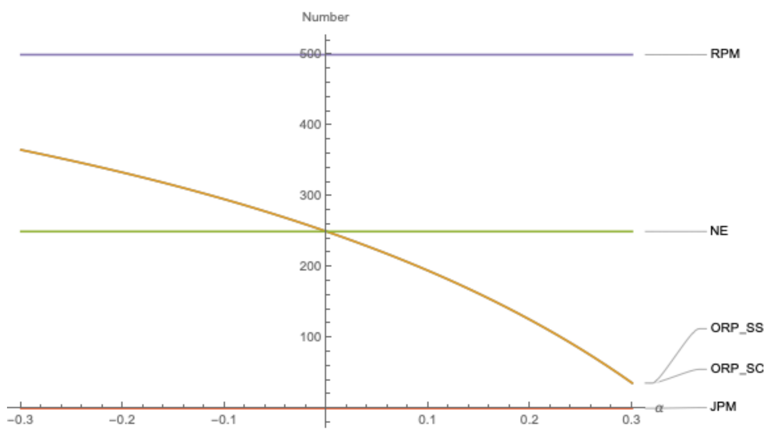
[6] Note that selfish preferences are the ones used to derive the theoretical benchmarks of Table 1.

about the preferences of other players. Following Konrad and Morath (2012) and Cheikbossian (2021), we assume that players have robust beliefs, that is, that their beliefs about the other participants' preferences are identical to their own. This implies that $\alpha_i = \alpha_j = \alpha$ for all i, j. Then, the Nash equilibrium of participants that maximize equation (2) is:

$$x_i^{*,ORP} = 250\left(\frac{1-3\alpha}{1-\alpha}\right), \tag{3}$$

for games of both strategic complements and strategic substitutes. The graph below represents the equilibrium choice with respect to the social preference parameter α.

Figure 1: The equilibrium number with other-regarding preferences and robust beliefs.



Note: The horizontal lines denoted by RPM, NE and JPM are the benchmarks of Table 1 with standard preferences.

Notice that $\frac{\partial x_i^{*,ORP}}{\partial \alpha} < 0$. For both types of strategic games, this implies that with altruistic preferences the equilibrium number is more cooperative than the NE, while with spiteful preferences the equilibrium number is more competitive than the NE.

3 Experimental design, procedures and hypotheses

3.1 Experimental design and procedures

We have designed a laboratory experiment that allows us to study the interaction between group identity and the type of strategic game.[7] For this reason, we use a 3x2 between subject experimental design with six treatments. Three conditions vary the artificial group identity (no-identity, in-groups and out-groups) and the two other conditions vary the type of strategic game (strategic complements and strategic substitutes). The no-identity treatments are referred as control treatments throughout the paper. The experiment was structured as follows: the first part was an individual task related to group identity; the second part

[7] We have pre-registered the experiment at AsPredicted with registration number 68877 on 06/20/2021.

consisted of participants playing a strategic game; the third part had a short post-experimental individual questionnaire, and background questions. Full instructions can be found in Appendix A and screenshots of the participant's screens in Appendix B.

The first part of the experiment began by inducing participants with an artificial group identity as in Chen and Li (2009). Before playing the strategic game, participants in the in-group and out-group treatments were induced with an artificial group identity based on the colour of the piece of paper inside an envelope that they randomly chose when entering the laboratory. Half of the envelopes in each session contained a green piece of paper, while the other half contained a blue one (envelopes in the control treatments were empty and were simply used to determine which computer terminal participants were allocated during the experimental session).

Participants were also asked to conduct a neutral individual task aimed at reinforcing their group identity, which consisted on identifying paintings by two prominent artists – Klee and Kandinsky – as in Chen and Chen (2011). Participants were shown, for one minute each, five pairs of paintings by the two mentioned artists, and participants were informed about which painting was painted by each artist. After that, participants were separately shown two additional paintings (one by each artist) and had five minutes to guess which artist painted each of them. In the in-group and out-groups treatments, participants could communicate through a chat with other participants assigned to the same group identity before guessing who painted the painting shown in the screen. In the control treatment, participants could not communicate with each other during the individual task. At the end of the entire experiment, participants were informed about their performance in the individual task and they were paid for each correct guess about the authorship of the two paintings. Importantly, participants payoffs were not interdependent in this task, that is, participants were paid based only on their own decisions. This feature of the task guarantees that participants need not coordinate their guesses in order to increase their payoffs.

In the second part of the experiment, participants played the two-person strategic game that was described in Section 2. The instructions for the treatments with strategic complements and substitutes were identical except for the payoff tables. Participants played the strategic game for 25 rounds and were randomly rematched between rounds to keep the one-shot spirit of the game, as has been previously done in other market experiments (Cox and Walker, 1998; Bosch-Domènech and Vriend, 2003; Apesteguia *et al.*, 2007; Dufwenberg *et al.*, 2007; Bruttel, 2009; Masiliūnas and Nax, 2020).[8] In the in-group treatments, participants played the strategic game with other participants assigned to the same colour, whereas in the out-group treatment participants played the game with participants of a different colour. In each round, participants chose an integer number in the range of 0-1000. According to the game type, we provided participants with a payoff

[8]The following papers compare random matching across rounds and fixed groups: Davis *et al.* (2003) and Altavilla *et al.* (2006). See Brandts and Potters (2018) for a broader literature review of these findings.

table, where they could find their own payoff depending on their own choice and that of the other participant (see Figures 7 and 8 in Appendix A for the payoff tables). In addition, before taking a decision, in each round participants had the possibility to use a simulator by entering the hypothetical chosen number and the chosen number of the other participant. The results of the simulator showed a participant's hypothetical payoff and the payoff of the other participant. After each round, participants received the following feedback: their own chosen number; the other participant's chosen number; their own earnings; the earnings of the other participant.

In the last part of the experiment, we asked participants to fill in a post-experimental questionnaire which included the strength of their identity identification and some questions regarding the strategies that they chose during the game. In addition, we then asked participants background questions, such as age, gender and degree studied.

We ran the experiment with 288 participants equally distributed into the six treatments with experimental sessions of 16 participants divided in two group of eight participants. The experiment was programmed using z-Tree (Fischbacher, 2007) and conducted at the BESLab of Universitat Pompeu Fabra and at ESADE Business School in Barcelona (Spain). The participants' incentives involved a 5 Euro show-up fee plus a payment for performance for Parts I and II of the experiment (in the second part, we paid for 3 randomly chosen rounds). On average, participants obtained 17.2 Euros and the experiment lasted 75 minutes.

3.2 Hypotheses

The first hypothesis concerns the effects of group identity on cooperation. In each type of strategic game, standard preferences and game theory predict that group identity should not affect choices and outcomes since the structure of the game is the same, and players have access to the same payoff-related information.

H1 [The effect of identity on cooperation]: In both games of strategic substitutes and complements, choices are the same in each of the identity treatments.

The second hypothesis covers the comparison of choices in each of the strategic games for a given identity. By construction, the chosen parametrization predicts the same NE, JPM and RPM choices for both types of strategic games. As a result, using the predictions of game theory, we formulate the following.

H2 [The effect of the strategic game type on cooperation]: For a given identity treatment, choices are the same for each type of strategic game.

Both previous hypotheses use standard preferences. However, the findings of the literature of behavioral game theory and group-identity in other types of games (for a survey, see Charness and Chen (2020)) show that there is generally in-group favoritism and out-group spite. Following from the analysis of these types of preferences and robust beliefs described in Section 2, we can formulate the following hypothesis.

H3 [The effect of other-regarding preferences on cooperation]: In each type of strategic game: (i) with in-groups choices are more cooperative than with no group identity or out-groups; (ii) with out-groups choices are less cooperative than with no group identity or in-groups.

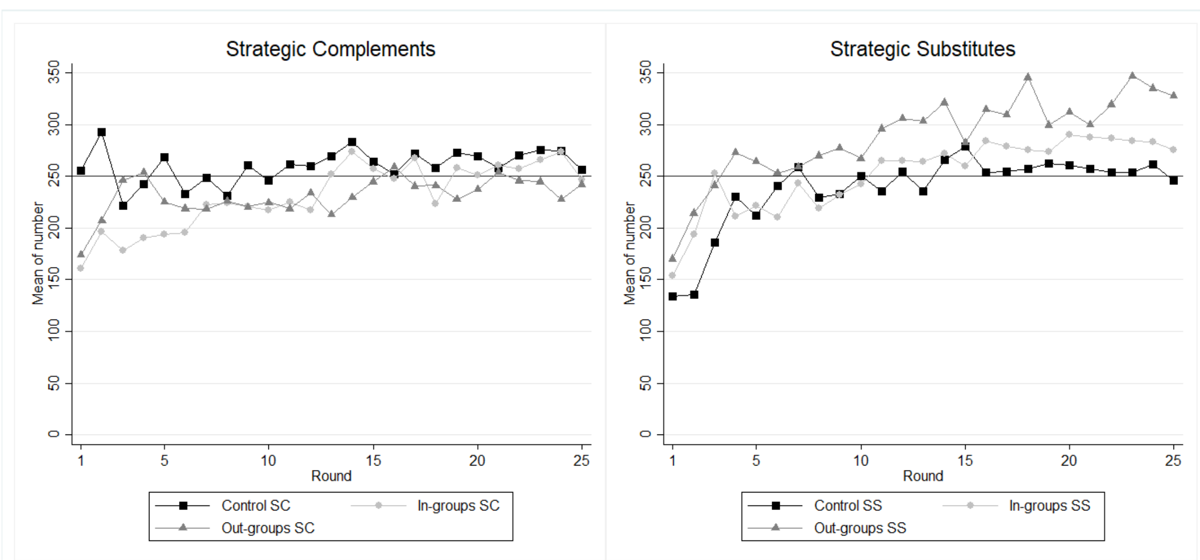
4 Results

We first examine whether and how the type of group identity affects cooperation in each type of strategic game. We then evaluate how choices relate to the various theoretical benchmarks. Throughout the tables of the paper, we often use SC to denote games of strategic complements and SS to denote games of strategic substitutes.

4.1 Cooperation and group identity in strategic games

In Figure 2 we show the evolution of the average choice in each treatment separately for games of strategic complements (left) and strategic substitutes (right), while in Table 2 we compute the summary statistics of choices in each treatment for various rounds. Furthermore, in Table 3 we report the *p-values* obtained from two sided Mann-Whitney tests for various rounds and comparisons: for group identity in a given strategic game, and for each strategic game for a given group identity.

Figure 2: Evolution of the average chosen number over rounds in each strategic setting.



Note: The NE is at 250 and is denoted with a black solid line.

Table 2: Summary statistics of the chosen number

	All rounds		***Rounds 1-5***		***Rounds 13-25***		***Rounds 21-25***	
Treatments	Mean	SD	Mean	SD	Mean	SD	Mean	SD
SC:								
All treatments	240.69	38.22	220.49	40.76	254.35	47.24	256.89	48.54
Control	259.97	42.83	256.11	37.04	267.44	50.11	266.87	53.48
In-groups	231.04	35.07	183.91	29.23	256.52	47.55	260.90	50.91
Out-groups	231.07	35.12	221.46	17.19	239.11	48.23	242.91	46.75
SS:								
All treatments	259.71	38.97	206.30	50.46	283.95	41.84	287.85	49.61
Control	237.67	15.11	179.49	39.20	257.00	20.52	254.27	25.22
In-groups	253.06	47.14	206.78	63.34	278.09	39.68	283.41	45.16
Out-groups	288.41	33.01	232.64	37.61	316.76	41.87	325.90	50.79

Note: The mean and the standard deviation of the chosen number are reported for various period splits.

We find that the type of group identity matters differently in each of the two strategic games as can be seen in Figure 2, Table 2 and the statistical tests reported in Table 3. Our main finding is that, in games of strategic substitutes, out-groups are persistently more competitive than in the control since the average choice is 21% higher (*p-value*=0.01). This effect is significant in all of the considered experimental round splits. However, there is no significant difference between in-groups and the control in games of strategic substitutes (*p-value*=0.52). In games of strategic complements, there are some initial effects whereby in-groups are more cooperative than the control since the average action is 28% lower (*p-value*=0.00), and also more cooperative than out-groups (*p-value*=0.03). However, this effect disappears in later rounds. Out-groups choices in games of strategic complements are not significantly different from the control when considering all rounds, the second half of rounds and the last 5 rounds.[9] This suggests that the experience of interacting gradually overrides group identity effects in games of strategic complements. These effects are also found when considering the outcomes (see Table 8 in Appendix C).

For a given group identity, we can also compare cooperation and competition in games of strategic complements and strategic substitutes. When considering all group identities and all rounds pooled together, we find no statistical differences between games of strategic complements and strategic substitutes (*p-value*=0.20). However, in the second half of the experiment and in the last five rounds, we find that choices in games of strategic substitutes are more competitive than in games of strategic complements (*p-value*=0.07 and *p-value*=0.07, respectively). As described earlier, this is driven by the fact that out-groups are significantly more competitive in games of strategic substitutes. Differences between choices for in-groups and the control are no statistically significant for both types of strategic games after the first five rounds.[10] Refer to Figure

[9]We also find that in the first five rounds out-groups are more cooperative than the control (*p-value*=0.03) but this effect is not found in the regressions of Table 4 and therefore is not robust.

[10]In the first five rounds, choices in the control are significantly more cooperative in games of strategic substitutes than in

9 in Appendix C for a graphical evolution of these comparisons across rounds.

Table 3: Mann-Whitney statistical tests

Treatments	***All rounds*** *p-values*	***Rounds 1-5*** *p-values*	***Rounds 13-25*** *p-values*	***Rounds 21-25*** *p-values*
SC:				
Control vs In-groups	0.26	0.00	0.63	0.63
Control vs Out-groups	0.20	0.03	0.42	0.42
In-groups vs Out-groups	1.00	0.03	0.33	0.42
SS:				
Control vs In-groups	0.52	0.20	0.26	0.14
Control vs Out-groups	0.01	0.02	0.01	0.01
In-groups vs Out-groups	0.26	0.87	0.10	0.14
SC vs SS:				
All treatments	0.20	0.54	0.07	0.07
Control	0.10	0.01	0.33	0.52
In-groups	0.52	0.26	0.42	0.33
Out-groups	0.03	0.52	0.01	0.01

Note: The p-values are obtained from two-sided Mann-Whitney tests with 6 observations (groups) in each treatment.

To further analyze and quantify the effects of group identity on cooperation, we conduct random-effects panel regressions using the individual choice in each round as the dependent variable. Table 4 shows the estimated coefficients when both types of strategic games are pooled together in columns (1) and (2); for games of strategic complements in columns (3) and (4); and for games of strategic substitutes in columns (5) and (6).

When both types of games are pooled together (columns (1) and (2) in Table 4), we find that out-groups choose significantly higher numbers in games of strategic substitutes. This means that their choices are more competitive, thus corroborating the main result of this paper. When augmenting the regression with round effects, we show that in general choices become more competitive over time, and that in-groups choose lower numbers in the first 5 rounds in games of strategic complements. These effects are also found when splitting the data for games of strategic complements (columns 3 and 4) and of strategic substitutes (columns 5 and 6). In addition, our results are also robust when including additional controls for end-of-game effects, for variables related to the first part of the experiment, and for demographics (see Table 9 of Appendix C).

games of strategic complements ((*p-value*=0.01) but this effect vanishes in later rounds.

Table 4: Random-Effects Panel Regressions

VARIABLES	(1) Overall	(2) Overall	(3) SC	(4) SC	(5) SS	(6) SS
In-groups	-28.927	-23.771	-28.927	-21.074	15.391	17.849
	(20.932)	(21.798)	(21.239)	(23.011)	(18.991)	(18.264)
Out-groups	-28.894	-27.241	-28.894	-30.420	50.746***	55.578***
	(20.943)	(22.070)	(21.250)	(23.369)	(13.927)	(14.581)
Round		2.608***	1.977***	1.572***	4.112***	3.645***
		(0.451)	(0.592)	(0.502)	(0.575)	(0.650)
Round 5 x In-groups		-25.777***		-39.263**		-12.290
		(9.844)		(16.072)		(10.726)
Round 5 x Out-groups		-8.266		7.628		-24.161
		(13.707)		(16.077)		(16.677)
SS	-22.297	-22.297				
	(17.173)	(17.177)				
SS x In-groups	44.317	44.317				
	(28.079)	(28.085)				
SS x Out-groups	79.640***	79.640***				
	(25.040)	(25.045)				
Constant	259.966***	226.059***	234.262***	239.535***	184.211***	190.286***
	(16.195)	(16.113)	(16.656)	(15.375)	(10.399)	(11.520)
Observations	7,200	7,200	3,600	3,600	3,600	3,600
Number of participants	288	288	144	144	144	144

Note: The dependent variable is the individually chosen number in each round. In-groups and Out-groups variables are dummy variables taking value 1 for observations from in-groups and out-groups treatments, respectively, and 0 otherwise. The Round variable takes the value of each round. The variable Round 5 is a dummy variable that takes value 1 for observations from round one to five, and 0 otherwise. The variable SS is a dummy variable that takes value 1 for strategic substitutes treatments and 0 otherwise. Robust standard errors, clustered at the group level, are reported in parenthesis. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

We can summarize these findings into the following result.

Result 1 [Cooperation and group identity in strategic games]:

a) In games of strategic complements, in-groups are initially more cooperative but this effect disappears over time. By contrast, in games of strategic substitutes, out-groups are persistently more competitive than the control.

b) After the first five rounds, choices are more competitive in games of strategic substitutes than strategic complements. This is driven by the choices of out-groups in games of strategic substitutes.

This result allows us to evaluate Hypotheses $H1$ and $H2$. It implies that we cannot reject $H1$ for games of strategic complements in all group identity treatments. In addition, we cannot reject $H1$ for games of strategic substitutes with the control and in-groups treatments. However, we can reject $H1$ for the out-group treatment in games of strategic substitutes.

With respect to $H2$, we can reject it when we consider all identities pooled together after the first five rounds. Splitting the sample for various identities, we note that we cannot reject $H2$ for in-groups and control treatments. However, we can reject it for out-groups and this drives the overall effect.

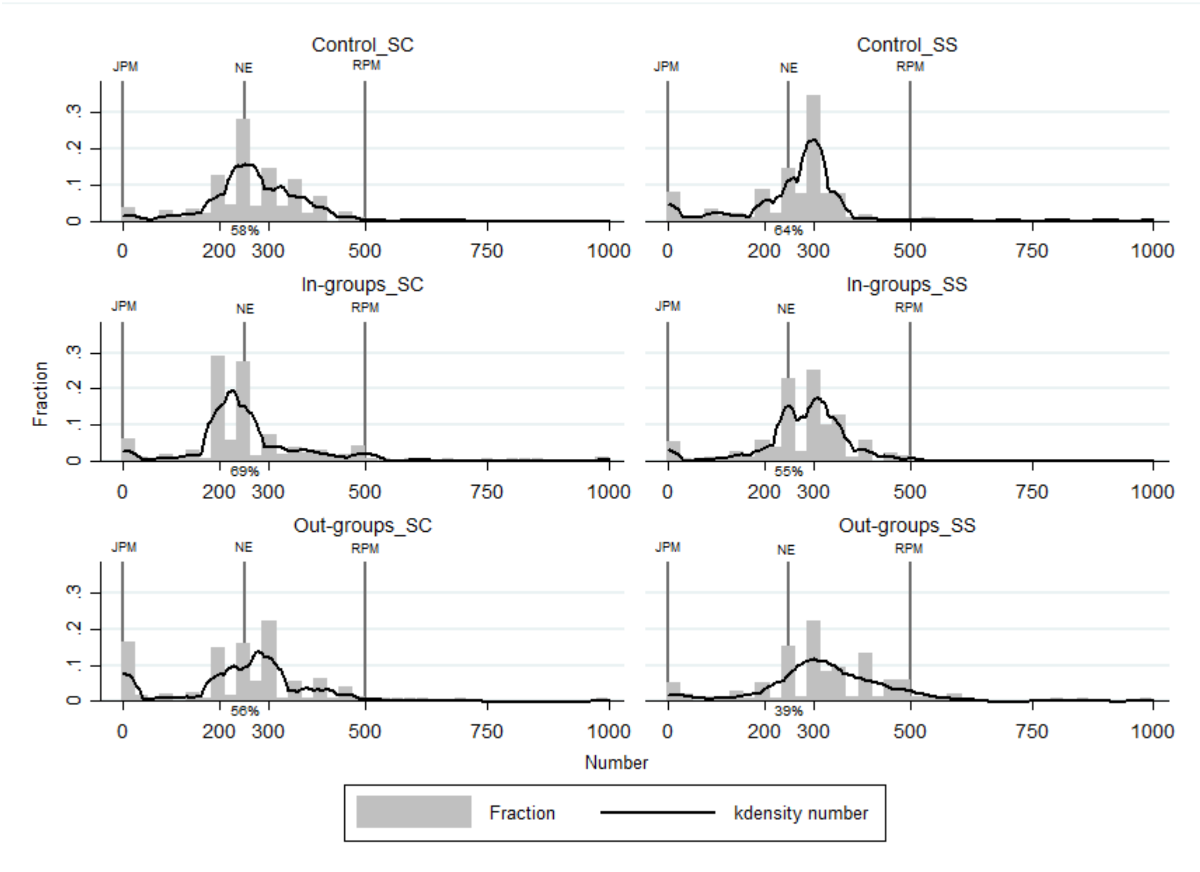
4.2 Empirical evaluation of the theoretical benchmarks

In this section we analyze choices at individual, pair and group levels in relation to the theoretical benchmarks. We study the degree of convergence and coordination at the NE in each treatment.[11] Since we do not expect either coordination or convergence at the NE equilibrium to appear immediately (Holt, 1985; Dufwenberg and Gneezy, 2000), we analyze choices during the second half of rounds of the experiment. We define the neighbourhood of the NE as the 10% percentage of the range between the JPM and RPM benchmarks, that is, decisions in the range [200-300].

Figure 3 shows the histogram and kernel densities of individual choices in the second half of the rounds providing a visual representation of their distribution in each treatment. Moreover, Figure 3 also displays the percentage of individual decisions in the neighbourhood of the NE in the horizontal axis. As it can be observed, out-group choices in both strategic games are much more dispersed than in the control and in-group treatments. In both strategic settings, the distribution of choices in the control is uni-modal with the NE being the mode of the distribution in games of strategic complements, while for games of strategic substitutes, the mode is less cooperative than the NE. Interestingly, in in-group treatments, the distribution is bi-modal with one of the modes coinciding with the NE. In all identity settings, choices are generally more competitive than the NE in games of strategic substitutes, and vice versa for games of strategic complements. Overall, these graphs indicate that group-identity has an important effect on the distribution of choices irrespective of the strategic setting.

[11] As Masiliūnas and Nax (2020) we use the percentage of individual decisions at the neighborhood of the NE to measure convergence to the NE.

Figure 3: Histograms and Kernel densities of individual choices for rounds 13-25 in each treatment.

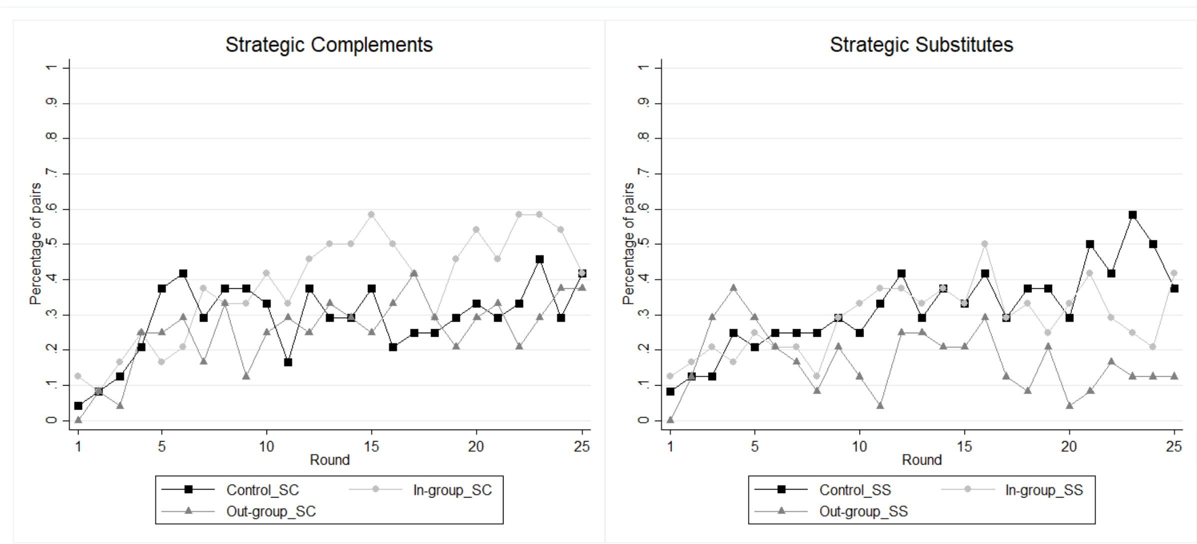


Note: The vertical lines are the theoretical benchmarks corresponding to JPM, NE and RPM. The percentage number displayed in the horizontal axis corresponds to the % of choices at the 10% neighbourhood of the NE.

Importantly, group identity has a different effect on convergence to the NE in games of strategic complements and strategic substitutes. As in the graphs, we report the percentage of individual choices at the neighbourhood of the NE and test differences across treatments with Mann-Whitney tests using 6 observations (groups) in each treatment. In games of strategic complements, for in-groups the percentage of individual choices at the neighbourhood of the NE (69% of the choices) is significantly higher than in the control and out-groups treatments (58% and 56% of the choices, respectively) with *p-value*=0.05 (in-groups vs. control) and *p-value*=0.05 (in-groups vs. out-groups). In contrast, in games of strategic substitutes, for out-groups, the percentage of individual choices at the neighbourhood of the NE (39% of the choices) is significantly lower than in the control and in-groups treatments (64% and 55% of the choices, respectively) with *p-value*=0.01 (out-groups vs. control) and *p-value*=0.10 (out-groups vs. in-groups).

Beyond convergence to NE, it is also interesting to examine how group identity affects coordination at the NE. Figure 4 shows the percentage of pairs that coordinate at the neighbourhood of NE over rounds in each treatment. We consider that a pair of participants are coordinating at the neighbourhood of the NE when both individual decisions in a matching pair are in the range of [200-300]. Figure 4 shows that in games of strategic complements, for in-groups, coordination at the NE in the second half of rounds is significantly higher than in the control and out-groups treatments with *p-value*=0.05 (in-groups vs. control) and *p-value*=0.05 (in-groups vs. out-groups). In contrast, in games of strategic substitutes, for out-groups, coordination at the neighbourhood of the NE is significantly lower than in the control treatment with *p-value*=0.05, although not significantly different than in the in-groups treatment with *p-value*=0.19.

Figure 4: Coordination at the 10% neighbourhood of the Nash Equilibrium

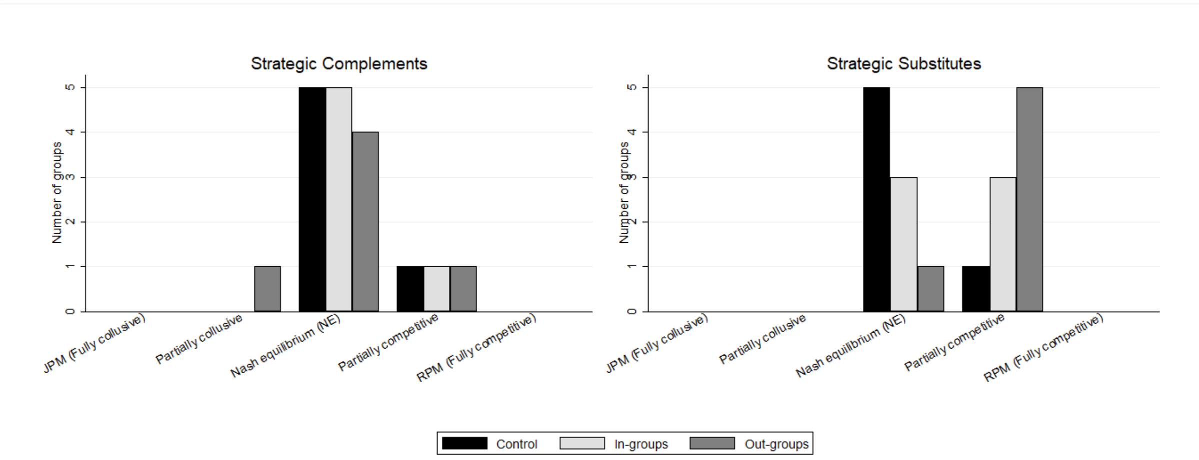


Note: We consider a matching pair coordinates at the neighbourhood of the Nash Equilibrium when both individual choices are in the range [200-300].

We now shift our focus to the group level to further understand how the theoretical benchmarks can explain choices in each treatment in the second half of the experiment. In Figure 5, we classify each group to one of the following five categories: JPM (fully collusive), partially collusive, NE, partially competitive, and RPM (fully competitive). We first categorize individual choices in each round either as JPM if the choice is in the range [0-50]; NE if in the range [200-300]; and RPM if in the range [450-550]. In each round of the second half of the experiment, we then check whether the majority of choices of the group member (at least 5 out of 8) fall in one of these three mentioned categories, and classify each round accordingly. For rounds that remain unclassified, we categorize them as partially collusive when the majority of choices are below the

NE, and as partially competitive when the majority of choices are above the NE. For a given group, we then count the number of rounds in each of the benchmarks, and classify it into the category that corresponds to the highest number of rounds.

Figure 5: Classification of groups during the second half of the experiment into theoretical benchmarks.



In games of strategic complements, Figure 5 shows that the NE benchmark describes the majority of choices in the second half of the experiment for all the identities considered. However, in games of strategic substitutes, the NE only explains choices well in the control treatment. In the treatment with out-groups, the partially competitive benchmark explains the choices of most groups, while in-groups are split between the NE and the partially competitive categories.

Result 2 [Choices and theoretical benchmarks]:

a) In games of strategic complements, the NE describes well the choices of all identities during the second half of the experiment. Furthermore, in-groups coordinate and converge more to the NE.

b) In games of strategic substitutes, the NE is a good descriptor for the majority of choices in the control treatment, and it partially explains choices in the in-group treatment. Most out-group choices are more competitive than the NE and lie between the NE and the RPM benchmarks. Furthermore, out-groups coordinate and converge less to the NE.

This results are broadly consistent with previous evidence reported in Suetens and Potters (2007) and Potters and Suetens (2013) that find behavior is generally more competitive than the NE in games of strategic substitutes (Cournot markets) as compared to games of strategic complements (Bertrand markets).

5 Mechanisms of group identity and cooperation

In this section we analyze the mechanisms that explain the results of the previous section, focusing on the effects of beliefs, social preferences and adaptation dynamics.

5.1 Beliefs and social preferences

We first focus on beliefs, that is, how group identity influences a participant's belief on which number the other player chooses. For this purpose, we use the data of the simulator in which participants' had access to before making each decision (see Appendix B - Simulator and decision screen). Notice that the main purpose of the simulator was not to directly elicit participants' beliefs but to provide participants with an additional tool to understand the payoffs of the game. However, by using the simulator participants reveal their beliefs about other's choices. We focus on the first round since the simulator was used by 86% of the participants of the experiment, and beliefs are not yet influenced by the experience of playing the game. Table 5 shows the average hypothetical own choice and the average hypothetical choice of the other participant in each treatment.[12]

Table 5: Summary statistics of the simulator data for round 1.

	Own number		***Other number***		***Other-Own Diff.***			
Treatments	Mean	SD	Mean	SD	Mean	SD	*p-values*	Obs.
SC:								
All treatments	250.36	229.10	274.35	272.29	23.98	229.11	0.24	126
Control	301.23	255.64	339.27	322.47	38.04	316.03	0.43	42
In-groups	234.18	223.98	238.05	259.78	3.87	152.38	0.86	44
Out-groups	214.75	199.61	246.12	216.97	31.37	192.17	0.30	40
SS:								
All treatments	164.68	196.46	202.75	253.78	38.06	256.39	0.10	122
Control	148.17	153.18	204.78	255.43	56.62	232.65	0.11	43
In-groups	142.66	176.05	145.01	234.93	2.36	294.73	0.96	40
Out-groups	205.49	250.28	259.74	263.60	54.24	241.55	0.16	39

Note: Obs. is the number of observations and refers to the number of participants that used the simulator in the first round in each treatment. SD is standard deviation. The p-values are obtained from two-sided t-tests testing if Other-Own Diff. is equal to 0.

Within a treatment, we find that group identity does not generate an initial difference between other participants' hypothetical choice and the participants' own hypothetical choice. Table 5 shows the p-values of t-tests tests (two-sided) of the null hypothesis that this difference is equal to zero for those participants that

[12] For participants that used the simulator more than once in the first round, we took the average of their hypothetical number and the hypothetical number of the other participant. Figure 10 in Appendix C shows the decrease in usage of the simulator across rounds.

used the calculator in each treatment as an independent observation. In all the treatments, we find that we cannot reject the hypothesis that this difference is equal to zero. This indicates that observed behavior cannot be explained by differences in initial beliefs between treatments.

In addition, in the post-experimental questionnaire we asked about the importance of beliefs in driving decisions throughout the experiment. We find that in both strategic settings no statistically significant difference between the self-reported importance of beliefs in the identity conditions and the control, and also between in-groups and out-groups (see Table 10 and Table 11 in Appendix C). The overall evidence seems to indicate that, within a treatment, it is unlikely that group identity causes a change in beliefs about the choice of the other participant, hence beliefs cannot explain our findings.

Result 3 [Beliefs]:

Within a given treatment, we find no statistical difference in beliefs about the other participants' number and the participants' own number in all types of games and group identities.

This result indicates that the assumption of robust beliefs in Section 2 seems a reasonable approximation of how participants formed beliefs about others in the experiment.

We now ask whether a model of social preferences can explain our results. As in standard economic theory, we assume that individual preferences are stable throughout the experiment. We use a non-linear regression to estimate equation (3) in Section 2 for each treatment using the participants' average choice. The results are presented in Table 6 for all rounds and for the rounds of the second half of the experiment.

We find that for all treatments, except for out-groups in games of strategic substitutes, the social preference parameter α is not significantly different from zero, indicating that standard preferences explain the data well.[13] However, out-groups in games of strategic substitutes have spiteful preferences against other participants (and this is statistically significant at the 5% level), with an estimated $\alpha = -0.083$ when considering all rounds, and $\alpha = -0.154$ when considering the last half rounds of the experiment.[14]

[13]Notice that in the control treatment of the strategic substitutes game, preferences are weakly altruistic when considering all rounds (significant at 10% level), but they are standard when considering the last few rounds of the experiment.

[14]We obtain very similar results when we only consider the last 5 rounds of the experiment.

Table 6: The social preference parameter in each treatment.

	All rounds	***Rounds 13-25***
	α	α
Control SC	-0.020	-0.036
	(0.036)	(0.043)
In-groups SC	0.036	-0.013
	(0.026)	(0.039)
Out-groups SC	0.026	0.021
	(0.036)	(0.037)
Control SS	0.024*	-0.014
	(0.011)	(0.017)
In-groups SS	-0.006	-0.059
	(0.038)	(0.036)
Out-groups SS	-0.083**	-0.154**
	(0.031)	(0.045)

Note: For each treatment, these are the results of using a non-linear least squares estimation of equation (3) with standard errors clustered at the group level reported in parenthesis below the estimated coefficient. The dependent variable is the average chosen number. There are 48 observations (participants) in each treatment. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Result 4 [Social preferences]:

Standard preferences describe choices well for all treatments except for out-groups in games of strategic substitutes, which have spiteful preferences with regards to participants of the other group.

This result points towards a preference-based explanation of the observed behavior in this experiment. That is, the experience of playing the game eliminates both in-group altruistic preferences in both strategic game types, and spiteful preferences for out-groups in games of strategic complements. Thus, in these contexts, we can reject Hypothesis $H3$ since strategic incentives dominate social preferences. However, in games of strategic substitutes, strategic incentives do not eliminate spiteful preferences for out-groups, and we cannot reject Hypothesis $H3$.

5.2 Adaptation dynamics

We next conduct a dynamic analysis of choices taken and ask whether group identity could potentially affect the adaptation dynamics of the choices in our experiment. We follow Huck *et al.* (2000) and Masiliūnas and Nax (2020) to study whether two adaptation rules can explain the adaptation dynamics: (a) best responding to the number chosen by the other participant in the previous round; (b) "imitation of the best", which is equal to the choice of the other participant in the previous round if the other participant's payoff was higher than the own payoff; or equal to the own chosen number in the last round if the own payoff was higher or equal than the other participant's. Notice that, after each round, we provided participants with sufficient feedback about own choice and profit, and other participant's choice and profit so that they could have calculated these two dynamics. Importantly, the theoretical and experimental literature has shown that these adaptation dynamics converge to different benchmarks (for a review, see Potters and Suetens (2013)). Vega-Redondo (1997) showed that "imitation of the best" converges to the Walrasian (fully competitive) equilibrium in games of strategic substitutes (Cournot). However, best-response dynamics converge to the NE in games of strategic complements.

Specifically, we estimate the following regression for each type of game:

$$\Delta x_{it} = \beta_0 + \beta_{0IG}IG + \beta_{0OG}OG + \beta_{br}(r_{it-1} - x_{it-1}) + \beta_{brIG}(r_{it-1} - x_{it-1})IG + \beta_{brOG}(r_{it-1} - x_{it-1})OG + \beta_{imbest}(xib_{it-1} - x_{it-1}) + \beta_{imbestIG}(xib_{it-1} - x_{it-1})IG + \beta_{imbestOG}(xib_{it-1} - x_{it-1})OG + u_{it}, \tag{4}$$

where $\Delta x_{it} = x_{it} - x_{it-1}$ is the change in the number chosen by subject i from round $t-1$ to round t; IG is a dummy which is 1 for in-group treatments and 0 otherwise; OG is a dummy which is 1 for out-group treatments and 0 otherwise; r_{it-1} is subject i's best response the number chosen by the opponent in round $t-1$; xib_{it-1} is the number chosen by the participant that obtained higher payoffs in round $t-1$; and u_{it} is a random error term. We also estimate a simpler regression based on equation (4) which excludes the interaction variables between the adaptation dynamics and group identities. The estimations can be found in Table 7 with the simpler regressions in columns (1), (3) and (5), and full regression with interaction terms or both games in column (2), games of strategic complements in column (4) and substitutes in column (6).

The regression results from columns (1) and (3) show that best response adaptation dynamics are significant in both types of strategic games, while imitation is only significant in games of strategic substitutes. We also test the importance of these dynamics by conducting Wald tests with the null hypothesis that $\beta_{br} - \beta_{imbest} = 0$. In games of strategic complements, the coefficient of best-response dynamics is larger than the coefficient of imitation ($p-value = 0.00$), while in games of strategic substitutes, the coefficient of imitation is larger than the best-response coefficient ($p-value = 0.00$). Notice that in games of strategic substitutes, the out-groups dummy variable is statistically significant and positive, indicating a treatment effect in adaptation dynamics since out-groups significantly increase the number chosen from round to round.

We then augment the regressions to include the interaction terms between identity and adaptation dynamics, we present the results in columns (2) and (4) of Table 7, and conduct Wald tests for various hypothesis concerning the size of the coefficients. In games of strategic complements, best-responding continues to be the most important factor in explaining adaptation dynamics ($p-value = 0.00$ for testing $\beta_{br} - \beta_{imbest} = 0$), however in-groups also imitate and have a lower coefficient for best-response than out-groups and the control. In games of strategic substitutes, we corroborate the results of the simpler regression of column (3).

Table 7: Regression results on adaptation dynamics

VARIABLES	(1) Overall	(2) Overall	(3) SC	(4) SC	(5) SS	(6) SS
Best response	0.369***	0.433***	0.453***	0.601***	0.341***	0.355***
	(0.024)	(0.046)	(0.040)	(0.067)	(0.030)	(0.037)
Imitation	0.258***	0.226***	0.097***	-0.014	0.374***	0.350***
	(0.035)	(0.072)	(0.032)	(0.046)	(0.037)	(0.057)
In-groups	1.983	-0.152	-6.299	-16.674**	7.765	5.623
	(5.850)	(6.694)	(7.136)	(6.545)	(9.789)	(8.520)
Out-groups	7.875	5.647	-7.690	-14.595**	19.554***	19.058**
	(6.296)	(6.827)	(8.536)	(7.432)	(6.883)	(9.241)
Best response x In-groups		-0.126**		-0.258***		-0.065
		(0.061)		(0.083)		(0.075)
Best response x Out-groups		-0.060		-0.145		0.013
		(0.058)		(0.088)		(0.054)
Imitation x In-groups		0.049		0.194***		0.040
		(0.090)		(0.065)		(0.090)
Imitation x Out-groups		0.043		0.101*		0.033
		(0.094)		(0.056)		(0.087)
Constant	-13.938***	-12.366**	-2.089	5.379	-22.185***	-21.048***
	(3.783)	(5.506)	(5.237)	(5.392)	(5.019)	(6.376)
Observations	6,912	6,912	3,456	3,456	3,456	3,456
Number of participants	288	288	144	144	144	144

Note: This table estimates the full equation (4) in columns (2), (4), and (6), and a simpler version in columns (1), (3), and (5), for both types of games of strategic complements and substitutes, respectively. Robust standard errors, clustered at the group level, are reported in parenthesis. Statistical significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The following result summarises our findings.[15]

Result 5: [Adaptation dynamics]:

a) In games of strategic complements, best-response dynamics is the major driver of the adaptation dynamics. However, in in-group treatments, imitation also explains the dynamics of choices, while best response has a lower coefficient than in the control and out-group treatments.

b) In games of strategic substitutes, both best response and imitation explain the dynamics of choices.

[15]We note that in these regression results players' choices (and beliefs) could be dynamically correlated (since there is a chance that players are matched once again with the same player). For this reason, in Table 12 in Appendix C, we focus on the adaptation dynamics of the first five rounds, where the likelihood of playing with the same other participant is low. The results presented in Table 12 confirm the findings of Result 5 below.

This can explain Result 2. In games of strategic complements, best response dynamics explains most of the adaptation dynamics, and choices converge to the NE. However, in games of strategic substitutes, imitation dynamics are also important and choices converge to an outcome which is more competitive than the NE. This is consistent with the experimental findings of Davis (2011) that Bertrand markets converge faster and closer to the NE than Cournot markets. As explained in Potters and Suetens (2013), this is mainly due to the differences in the strategic settings rather than to differences in the rationality of participants in the two types of games. Our findings, in addition, show that in games of strategic complements, in-groups imitate more and best-respond less compared to control and out-group identities.

6 Robustness: Behavior and Group Identification

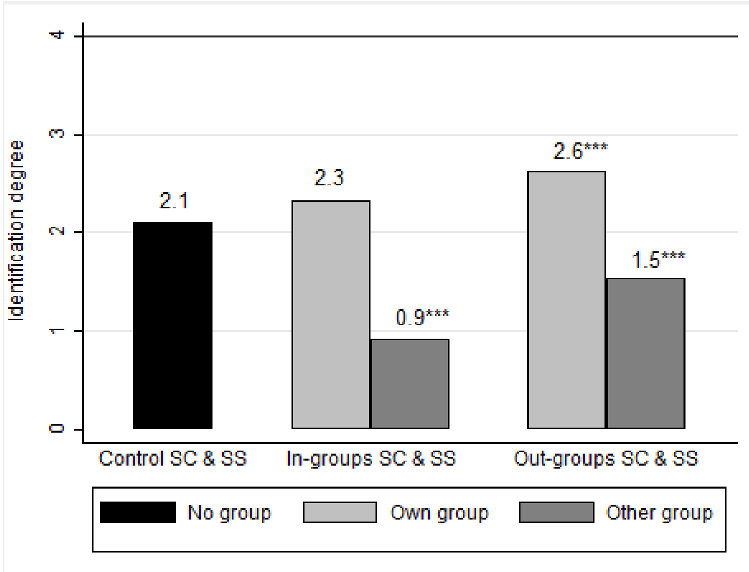
Before we conclude, we want to check that the group identity manipulation of the first part of the experiment still worked after playing the strategic game for 25 rounds.

We analyze the post-experimental questionnaire which asks participants to self-report the strength of their group identity. In the control treatments, the question was: *'I have felt identified with the other participants during the experiment'*. For the identity treatments, we asked two questions: *'I have felt identified with the other blue participants during the experiment'* and *'I have felt identified with the other green participants during the experiment'*. We coded the possible answers to these questions in a scale of five as follows: Strongly disagree (0); Disagree (1); Undecided (2); Agree (3); Strongly Agree (4).[16] Figure 6 shows how strongly participants identified in each of the identity treatments.

The figure shows that, as expected, other group identification is lower than own group identification in both in-groups and out-group treatments. This is statistically significant (p-value=0.00 for in-groups, and p-value=0.00 for out-groups) using Mann-Whitney tests with 12 observations in each condition. In addition, we find that other group identification in the in-group and out-group treatments is lower than in the control treatments, and that the difference is statistically significant (p-value=0.00 for in-groups, and p-value=0.00 for out-groups). With respect to own group identification, we find that in the in-groups treatment, identification is not statistically different from the control (p-value=0.16). However, out-groups have a greater identification to participants assigned to the same colour than in the control (p-value=0.00), and in the in-groups treatments (p-value=0.08). These results are generally robust for both games of strategic complements and substitutes as can be seen in Figure 11 in Appendix C. Overall, our identity manipulation worked even after playing the strategic game for 25 rounds.

[16] For more details of the questions, refer to Post-Experimental Questionnaire part of Appendix A.

Figure 6: Group identification in the identity treatments



Note: No group refers to the identification degree among participants in the control treatments. For in-groups and out-groups treatments, "own group" and "other group" refers to the identification score towards the other participants in the same and different colour group to the ones assigned, respectively. Significant levels, * $p < 0.1$*,* ** $p < 0.05$*,* *** $p < 0.01$*, are obtained from pairwise comparisons between scores in control and identity treatments using two-sided Mann-Whitney tests with 12 observations in each condition (6 observations (groups) from each strategic game type).*

7 Conclusion

In this paper we have explored how group identity affects competition and cooperation in strategic games. We find that when a player has an incentive to match the actions of other players (games of strategic complements), group identity does not generally matter except in the first few rounds in which in-groups cooperate more. The Nash equilibrium with standard preferences provides a good benchmark since there is fast convergence to the Nash equilibrium. Best response dynamics is an important determinant of the adaptation of choices. However, when a player has an incentive to mismatch the actions of other players (games of strategic substitutes), we find that out-groups make more competitive choices than the control, and this is due to their spiteful preferences with respect to the other player. In general, choices are more competitive in games of strategic substitutes than in games of strategic complements partly because both best-response and "imitation of the best" explain the adaptation of choices from round to round.

Our results have several implications for game theory and industrial organization. For behavioral game theory, our results show that one cannot neglect modelling other-regarding preferences in contexts of strategic substitutes, while this is not so important in games of strategic complements. Future work could explore how other-regarding preferences, learning and rationality interact.[17] For industrial organization, we can think of group identity as an investment by an incumbent to gain an advantage at the competition stage (Fudenberg and Tirole, 1984). Depending on whether the game is of strategic substitutes or complements type, and whether the investment makes the incumbent tough or soft, the incumbent has a strategic incentive to over-invest or under-invest. Our experiment has shown that this depends on the type of group identity. Future work could provide a theoretical link between group identity and investments.

Furthermore, team production and organizational design are crucial factors in determining the productivity of many organizations. Some production processes might require work teams with complementary or substitute skills among members, and either team objectives of cooperation or competition (see, for example Gould and Winter (2009) and McGinty (2014)). Our results show that team managers could highlight a particular dimension of identity inducing group members to categorize each other as in-groups or a dimension that will induce work group members to categorize each other as out-groups. For instance, according to our results, team members required to align their decisions would make more cooperative decisions, especially in their first interactions, when they categorize each other as in-groups. For organizational design, it is crucial to understand the type of market competition, whether à la Cournot or à la Bertrand (Vroom, 2006), and how to define a firm's organizational identity. Our results show that market interactions with an in-group competitor might be more beneficial in a Cournot setting than in a Bertrand setting, where the identity of the competitor is not as relevant.

Finally, our results highlight that higher degrees of cooperation can be achieved in strategic complements settings with in-group identities during the initial interactions, while higher degrees of competitiveness can be found in strategic substitutes settings with out-group identities. This has policy implications and future work could delve into analyzing what elements of group identity explain these effects, and relate them to other analogous concepts such as social cues as in Boone *et al.* (2008) or friendship as in Chierchia *et al.* (2020).

[17] For a paper on how strategic incentives and rationality interact, see Camerer and Fehr (2006)

References

Akerlof, G. A. and Kranton, R. E. (2000). Economics and identity. *The Quarterly Journal of Economics*, **115** (3), 715–753.

Albert, S. and Whetten, D. A. (1985). Organizational identity. In L. Cummings and B. M. Staw (eds.), *Research in Organizational Behavior*, vol. 7, JAI Press, Greenwich, CT, pp. 265–195.

Altavilla, C., Luini, L. and Sbriglia, P. (2006). Social learning in market games. *Journal of Economic Behavior and Organization*, **61** (4), 632–652.

Apesteguia, J., Huck, S. and Oechssler, J. (2007). Imitation—theory and experimental evidence. *Journal of Economic Theory*, **136** (1), 217–235.

Bolton, G. E. and Ockenfels, A. (2000). Erc: A theory of equity, reciprocity, and competition. *American Economic Review*, **90** (1), 166–193.

Boone, C., Declerck, C. H. and Suetens, S. (2008). Subtle social cues, explicit incentives and cooperation in social dilemmas. *Evolution and Human Behavior*, **29** (3), 179–188.

Bosch-Domènech, A. and Vriend, N. J. (2003). Imitation of successful behaviour in cournot markets. *The Economic Journal*, **113** (487), 495–524.

Bowles, S. (2004). *Microeconomics: Behavior, Institutions, and Evolution.* Princeton, New Jersey: Princeton University Press.

Brandts, J. and Potters, J. (2018). Experimental industrial organization. In L. C. Corchón and M. A. Marini (eds.), *Handbook of Game Theory and Industrial Organization*, vol. II, Edward Elgar Publishing, pp. 453–474.

Bruttel, L. V. (2009). Group dynamics in experimental studies—the bertrand paradox revisited. *Journal of Economic Behavior and Organization*, **69** (1), 51–63.

Bulow, J. I., Geanakoplos, J. D. and Klemperer, P. D. (1985). Multimarket oligopoly: Strategic substitutes and complements. *Journal of Political Economy*, **93** (3), 488–511.

Camerer, C. F. and Fehr, E. (2006). When does "economic man" dominate social behavior? *Science*, **311** (5757), 47–52.

Charness, G. and Chen, Y. (2020). Social identity, group behavior, and teams. *Annual Review of Economics*, pp. 691–713.

—, Cobo-Reyes, R. and Jiménez, N. (2014). Identities, selection, and contributions in a public-goods game. *Games and Economic Behavior*, **87**, 322–338.

— and Rabin, M. (2002). Understanding social preferences with simple tests. *The Quarterly Journal of Economics*, **117** (3), 817–869.

—, Rigotti, L. and Rustichini, A. (2007). Individual behavior and group membership. *American Economic Review*, **97** (4), 1340–1352.

Cheikbossian, G. (2021). Evolutionarily stable in-group altruism in intergroup conflict over (local) public goods. *Games and Economic Behavior*, **127**, 206–226.

Chen, R. and Chen, Y. (2011). The potential of social identity for equilibrium selection. *American Economic Review*, **101** (6), 2562–89.

Chen, Y. and Li, S. X. (2009). Group identity and social preferences. *American Economic Review*, **99** (1), 431–57.

Chierchia, G., Tufano, F. and Coricelli, G. (2020). The differential impact of friendship on cooperative and competitive coordination. *Theory and Decision*, **89** (4), 423–452.

Cox, J. C. and Walker, M. (1998). Learning to play cournot duopoly strategies. *Journal of Economic Behavior and Organization*, **36** (2), 141–161.

Davis, D. (2011). Behavioral convergence properties of cournot and bertrand markets: An experimental analysis. *Journal of Economic Behavior & Organization*, **80** (3), 443–458.

Davis, D. D., Reilly, R. J. and Wilson, B. J. (2003). Cost structures and nash play in repeated cournot games. *Experimental Economics*, **6** (2), 209–226.

Dufwenberg, M. and Gneezy, U. (2000). Price competition and market concentration: an experimental study. *international Journal of industrial Organization*, **18** (1), 7–22.

—, —, Goeree, J. K. and Nagel, R. (2007). Price floors and competition. *Economic Theory*, **33** (1), 211–224.

Eckel, C. C. and Grossman, P. J. (2005). Managing diversity by creating team identity. *Journal of Economic Behavior and Organization*, **58** (3), 371–392.

Fehr, E. and Schmidt, K. M. (1999). A theory of fairness, competition, and cooperation. *The Quarterly Journal of Economics*, **114** (3), 817–868.

Fischbacher, U. (2007). z-tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics*, **10** (2), 171–178.

Fudenberg, D. and Tirole, J. (1984). The fat-cat effect, the puppy-dog ploy, and the lean and hungry look. *The American Economic Review*, **74** (2), 361–366.

Gould, E. D. and Winter, E. (2009). Interactions between workers and the technology of production: Evidence from professional baseball. *The Review of Economics and Statistics*, **91** (1), 188–200.

Holt, C. A. (1985). An experimental test of the consistent-conjectures hypothesis. *The American Economic Review*, **75** (3), 314–325.

Huck, S., Normann, H.-T. and Oechssler, J. (2000). Does information about competitors' actions increase or decrease competition in experimental oligopoly markets? *International Journal of Industrial Organization*, **18** (1), 39–57.

—, — and — (2004). Two are few and four are many: number effects in experimental oligopolies. *Journal of Economic Behavior and Organization*, **53** (4), 435–446.

Konrad, K. A. and Morath, F. (2012). Evolutionarily stable in-group favoritism and out-group spite in intergroup conflict. *Journal of Theoretical Biology*, **306**, 61–67.

Li, S. X., Dogan, K. and Haruvy, E. (2011). Group identity in markets. *International Journal of Industrial Organization*, **29** (1), 104–115.

Masiliūnas, A. and Nax, H. H. (2020). Framing and repeated competition. *Games and Economic Behavior*, **124**, 604–619.

McGinty, M. (2014). Strategic incentives in teams: Implications of returns to scale. *Southern Economic Journal*, **81** (2), 474–488.

Potters, J. and Suetens, S. (2009). Cooperation in Experimental Games of Strategic Complements and Substitutes. *The Review of Economic Studies*, **76** (3), 1125–1147.

— and — (2013). Oligopoly experiments in the current millennium. *Journal of Economic Surveys*, **27** (3), 439–460.

Suetens, S. and Potters, J. (2007). Bertrand colludes more than cournot. *Experimental Economics*, **10** (1), 71–77.

Tajfel, H., Billig, M. G., Bundy, R. P. and Flament, C. (1971). Social categorization and intergroup behaviour. *European Journal of Social Psychology*, **1** (2), 149–178.

Vega-Redondo, F. (1997). The evolution of walrasian behavior. *Econometrica: Journal of the Econometric Society*, pp. 375–384.

Vives, X. (1999). *Oligopoly pricing: old ideas and new tools*. MIT press.

Vroom, G. (2006). Organizational design and the intensity of rivalry. *Management science*, **52** (11), 1689–1702.

Appendix

Appendix A: Experimental instructions

In this appendix we provide the instruction for the In-group Treatments. The instructions for Out-group and Control Treatments were identical except from:

Out-group treatments. The only difference between the instructions for in-group and out-group treatments is regarding the matching protocol used when participants play the strategic game in Part II. Whereas participants in the in-group treatments are told they will be paired with another participant from the "same" group, participants in the out-group treatments are told that they will be paired with another participants from the "other" group.

Control treatments. In Part I, participants in the control treatments are not induced with any group identity, and when guess who are the authors of the two additional paintings they do it so without being able to communicate with any other participant in the experimental session. In Part II, participants in the control treatments are told that they will be paired with another participant "in the experimental session".

For the full instructions of Out-group and Control treatments, please refer to the Online Appendix.

Instructions for the In-group Treatments

Welcome to the experiment in which you will be asked to make decisions. Please read these instructions carefully. The instructions are identical for all the participants with whom you will interact during this experiment. If you have any question, please raise your hand and one of the experimenters will come to you and answer your questions privately. During the experiment, communication between participants will only be allowed under the conditions specified in these instructions. Any other type of communication is not allowed. The use of mobile phones is not allowed. The experiment is anonymous in the sense that you will not receive information about who the other participants are either during the experiment or after the experiment. Likewise, the other participants will not receive information about who you are.

The experiment consists of two parts. First, you will receive the instructions for the first part of the experiment. After you have conducted the first task you will then receive instructions for the second part of the experiment, where you will play a game for several rounds.

In this experiment you can earn money. During the experiment we will use ECU (Experimental Currency Unit) to refer to your earnings. Your final total earnings will be the sum of your earnings in the two parts of the experiment to which a 5 Euros participation fee will be added for your participation. The conversion rate used to convert your ECU into money will be **300 ECU = 1 EUR**. At the end of the experiment, you will be privately paid in cash your total earning in the experiment.

Part I:

At the beginning of the experiment you have been asked to randomly choose an envelope which contains either a green or blue slip. If you have received a green slip, you have been assigned to the green group, while if you have received a blue slip you will belong to the blue group. Your group assignment will remain the same throughout the experiment. That is, if you drew a green slip, you will belong to the green group for the rest of the experiment, and if have received a blue slip, you will belong to the blue group for the rest of the experiment.

Each participant will be shown 5 pairs of paintings by two artists. You will have 5 minutes to individually study these paintings.Each pair of paintings will appear in your screen for 1 minute. The paintings shown to each participant are the same.

After that, you will be asked to answer some questions about two other paintings. Each correct answer will bring you earnings of 450 ECU. You will have 5 additional minutes to answer each question regarding the two paintings. To answer these questions you may get help from or offer help to other participants in your own group through a chat box that you will find at the bottom of your screen. Messages will be shared only among participants from your own group. You will not be able to observe the messages exchanged among participants of the other group. Participants in the other group will not observe the messages from your own group either.

To communicate with the members of your group you must enter your message in the chat at the bottom of your screen and press the ENTER key. You can type whatever you want in the chat box, except for the following restrictions on messages:

1. Please do not identify yourself or send any information that could be used to identify yourself.

2. Please refrain using obscene or offensive language. Be respectful to others.

When you finish the first part of the experiment stay seated and silent until the other participants finish.

You will not know if you have correctly answered the questions until the end of the second part of the experiment.

Once all participants have finished the first part of the experiment, we will give you instructions for the second part of the experiment.

Part II:

The second part of the experiment consists of 25 rounds of the same game. You will be asked to make a decision each round. Each round is independent of the others. In each round, you will be randomly paired with another participant from the same group with whom you have performed the first part of the experiment. You will not know who the other participant in your same group is. In each new round, the computer will match you with another participant from the same group chosen at random. The decisions you make and the other participant you are paired with will determine your earnings in each round.

In each round you will choose a number between 0 and 1000. The other participant will also choose a number between 0 and 1000. Your earnings will depend on the number you choose and the number chosen by the other participant from the same group with whom you are paired. The participants of the same group with whom you will interact will perform the same task as you and will have the same information and payment function. You will not be able to see the other participant's choice of number while making your decision, nor will the other participant be able to see which number you choose. The task and the payoff function will be the same in all rounds. The table attached to the end of these instructions provides information about your payoffs for some combinations of your choice and the choice of the other participant with whom you will be paired. The other participants with whom you will be paired will have the same payoff table.

You will be able to calculate your payment and the payment of the other participant with whom you are paired in more detail using the PAYMENT CALCULATOR that will appear on your screen. By entering a hypothetical value for your own choice of number and a hypothetical value for the other participant's choice of number, you will be able to calculate your hypothetical payoff and the other participant's hypothetical payoff for the entered choice combination. The PAYMENT CALCULATOR is designed to familiarize you during the first rounds with the payoff of the game.

To make your choice in each of the rounds, you must enter your number in the blank field in the "decision" part of the screen and click the "OK" button at the bottom right.

At the end of each round, you will be informed about your own choice and your earnings in ECU as well as the number and earnings in ECU of the other participant with whom you have been paired in the round under consideration. 3 out of the 25 rounds will be randomly selected to determine your payoff for this part of the experiment. All rounds have the same chance of being selected. At the end of the second part of the experiment, you will be informed of your final earnings. Your earnings from the first part of the experiment, as well as the earnings from the three randomly selected rounds in the second part of the experiment will be added together, converted to euros using a conversion rate of **300 ECU = 1 Euro**, and you will be paid in cash and privately once you complete a short questionnaire.

At the end of the experiment, remain seated until we ask you to come and receive your payment. If you have any more questions, raise your hand now. The experiment will begin once everyone has finished reading the instructions.

Figure 7: Strategic Complements.

(The values within the matrix report your payoff for the possible choices of your number and the number chosen by the participant with whom you are paired)

Other participant's number

Your number	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000
0	1500	1427	1357	1290	1227	1167	1110	1057	1007	960	917	877	840	807	777	750	727	707	690	677	667
50	1522	1450	1382	1317	1255	1197	1142	1090	1042	997	955	917	882	850	822	797	775	757	742	730	722
100	1537	1467	1400	1337	1277	1220	1167	1117	1070	1027	987	950	917	887	860	837	817	800	787	777	770
150	1545	1477	1412	1350	1292	1237	1185	1137	1092	1050	1012	977	945	917	892	870	852	837	825	817	812
200	1547	1480	1417	1357	1300	1247	1197	1150	1107	1067	1030	997	967	940	917	897	880	867	857	850	847
250	1542	1477	1415	1357	1302	1250	1202	1157	1115	1077	1042	1010	982	957	935	917	902	890	882	877	875
300	1530	1467	1407	1350	1297	1247	1200	1157	1117	1080	1047	1017	990	967	947	930	917	907	900	897	897
350	1512	1450	1392	1337	1285	1237	1192	1150	1112	1077	1045	1017	992	970	952	937	925	917	912	910	912
400	1487	1427	1370	1317	1267	1220	1177	1137	1100	1067	1037	1010	987	967	950	937	927	920	917	917	920
450	1455	1397	1342	1290	1242	1197	1155	1117	1082	1050	1022	997	975	957	942	930	922	917	915	917	922
500	1417	1360	1307	1257	1210	1167	1127	1090	1057	1027	1000	977	957	940	927	917	910	907	907	910	917
550	1372	1317	1265	1217	1172	1130	1092	1057	1025	997	972	950	932	917	905	897	892	890	892	897	905
600	1320	1267	1217	1170	1127	1087	1050	1017	987	960	937	917	900	887	877	870	867	867	870	877	887
650	1262	1210	1162	1117	1075	1037	1002	970	942	917	895	877	862	850	842	837	835	837	842	850	862
700	1197	1147	1100	1057	1017	980	947	917	890	867	847	830	817	807	800	797	797	800	807	817	830
750	1125	1077	1032	990	952	917	885	857	832	810	792	777	765	757	752	750	752	757	765	777	792
800	1047	1000	957	917	880	847	817	790	767	747	730	717	707	700	697	697	700	707	717	730	747
850	962	917	875	837	802	770	742	717	695	677	662	650	642	637	635	637	642	650	662	677	695
900	870	827	787	750	717	687	660	637	617	600	587	577	570	567	567	570	577	587	600	617	637
950	772	730	692	657	625	597	572	550	532	517	505	497	492	490	492	497	505	517	532	550	572
1000	667	627	590	557	527	500	477	457	440	427	417	410	407	407	410	417	427	440	457	477	500

Figure 8: Strategic Substitutes

(The values within the matrix report your payoff for the possible choices of your number and the number chosen by the participant with whom you are paired)

Other participant's number

Your number	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000
0	1500	1428	1362	1302	1248	1200	1158	1122	1092	1068	1050	1038	1032	1032	1038	1050	1068	1092	1122	1158	1200
50	1523	1450	1383	1322	1267	1218	1175	1138	1107	1082	1063	1050	1043	1042	1047	1058	1075	1098	1127	1162	1203
100	1542	1468	1400	1338	1282	1232	1188	1150	1118	1092	1072	1058	1050	1048	1052	1062	1078	1100	1128	1162	1202
150	1557	1482	1413	1350	1293	1242	1197	1158	1125	1098	1077	1062	1053	1050	1053	1062	1077	1098	1125	1158	1197
200	1568	1492	1422	1358	1300	1248	1202	1162	1128	1100	1078	1062	1052	1048	1050	1058	1072	1092	1118	1150	1188
250	1575	1498	1427	1362	1303	1250	1203	1162	1127	1098	1075	1058	1047	1042	1043	1050	1063	1082	1107	1138	1175
300	1578	1500	1428	1362	1302	1248	1200	1158	1122	1092	1068	1050	1038	1032	1032	1038	1050	1068	1092	1122	1158
350	1577	1498	1425	1358	1297	1242	1193	1150	1113	1082	1057	1038	1025	1018	1017	1022	1033	1050	1073	1102	1137
400	1572	1492	1418	1350	1288	1232	1182	1138	1100	1068	1042	1022	1008	1000	998	1002	1012	1028	1050	1078	1112
450	1563	1482	1407	1338	1275	1218	1167	1122	1083	1050	1023	1002	987	978	975	978	987	1002	1023	1050	1083
500	1550	1468	1392	1322	1258	1200	1148	1102	1062	1028	1000	978	962	952	948	950	958	972	992	1018	1050
550	1533	1450	1373	1302	1237	1178	1125	1078	1037	1002	973	950	933	922	917	918	925	938	957	982	1013
600	1512	1428	1350	1278	1212	1152	1098	1050	1008	972	942	918	900	888	882	882	888	900	918	942	972
650	1487	1402	1323	1250	1183	1122	1067	1018	975	938	907	882	863	850	843	842	847	858	875	898	927
700	1458	1372	1292	1218	1150	1088	1032	982	938	900	868	842	822	808	800	798	802	812	828	850	878
750	1425	1338	1257	1182	1113	1050	993	942	897	858	825	798	777	762	753	750	753	762	777	798	825
800	1388	1300	1218	1142	1072	1008	950	898	852	812	778	750	728	712	702	698	700	708	722	742	768
850	1347	1258	1175	1098	1027	962	903	850	803	762	727	698	675	658	647	642	643	650	663	682	707
900	1302	1212	1128	1050	978	912	852	798	750	708	672	642	618	600	588	582	582	588	600	618	642
950	1253	1162	1077	998	925	858	797	742	693	650	613	582	557	538	525	518	517	522	533	550	573
1000	1200	1108	1022	942	868	800	738	682	632	588	550	518	492	472	458	450	448	452	462	478	500

Post-Experimental Questionnaire

Control Treatments

[General id] I have felt identified with the other participants during the experiment:

Strongly disagree / Disagree / Undecided / Agree / Strongly Agree

Identity Treatments

[Blue id] I have felt identified with the other blue participants during the experiment:

Strongly disagree / Disagree / Undecided / Agree / Strongly Agree

[Green id] I have felt identified with the other green participants during the experiment:

Strongly disagree / Disagree / Undecided / Agree / Strongly Agree

All treatments

[Identity] My group identity has influenced my decisions during the second part of the experiment:

Strongly disagree / Disagree / Undecided / Agree / Strongly Agree

[History] My decisions in the second part of the experiment have been influenced by the decisions of the other participants in the previous rounds:

Strongly disagree / Disagree / Undecided / Agree / Strongly Agree

[Beliefs] My decisions in the second part of the experiment have been influenced by what I thought other participants might choose in future rounds:

Strongly disagree / Disagree / Undecided / Agree / Strongly Agree

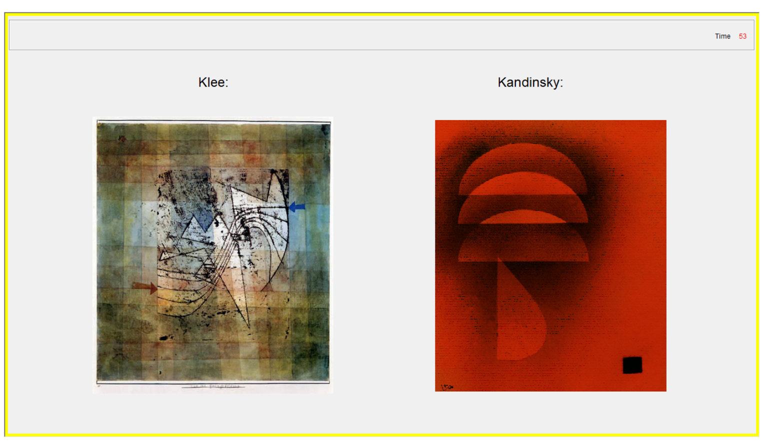
In terms of demographics, we asked participants for their gender, age and degree studied.

Appendix B: Experimental screens

These are the z-tree screens that were shown to participants during the experimental sessions.

Part 1. Pairs of paintings

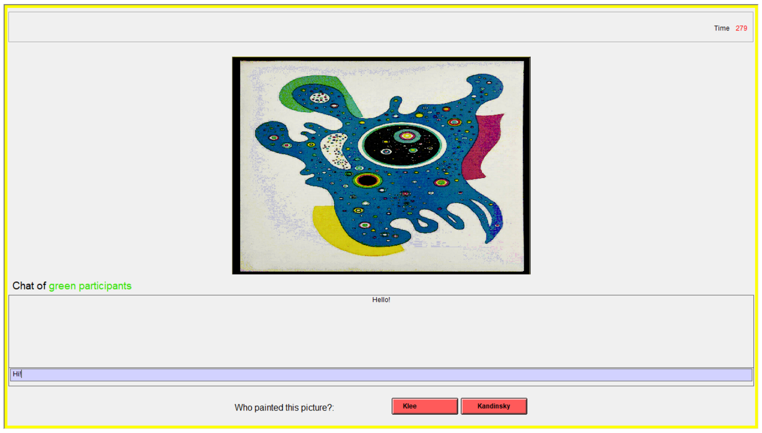
The initial individual task begins by showing participants five pairs of paintings like below.



Participants were given one minute to observe each pair of paintings. The same five pairs of paintings were shown in the same order to all participants in the experiment.

Part 1. Chat and Painting Decision screen

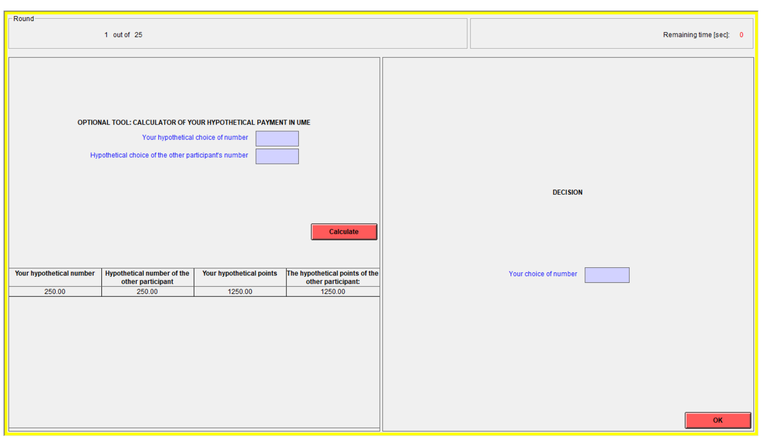
After individually observing the five pairs of paintings by Klee and Kandinsky, participants were shown two additional paintings separately and had to guess which of the two artists painted the painting shown on the screen.



In the in-groups and out-groups treatments, participants had access to a communication device (chat box) where participants could communicate with other participants of the same group to reinforce their group identity. In contrast, participants in the plain-group treatments could not communicate with each other.

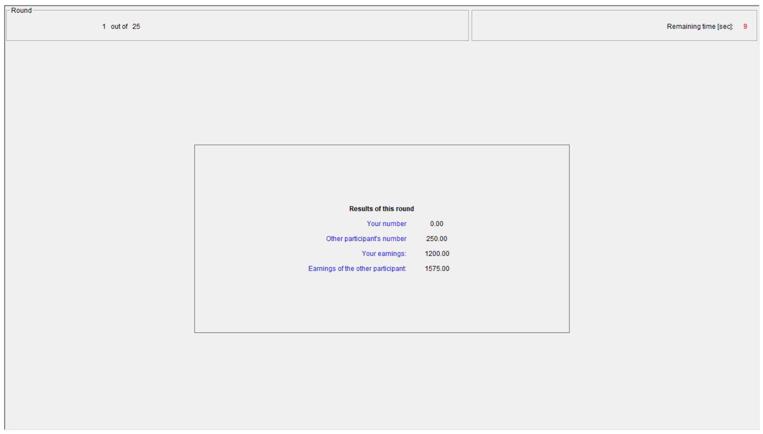
Part 2. Simulator and Decision screen for each round.

On the left hand side of the screen there is a simulator, while on the right hand side is the decision screen. We prime identity in the in-groups and out-group treatments with the group colour assigned at the beginning of the experiment. In the no-identity treatment, the text is displayed in black.



Part 2. Feedback screen.

In this screen we report the feedback after each round with the own number, the other participant's chosen number, the own payoff and the other participant's payoff. We prime identity in the in-groups and out-group treatments with the group colour assigned at the beginning of the experiment. In the no-identity treatment, the text is displayed in black.



Appendix C: Additional Results

Table 8 complements Section 4.1 and summarizes the earnings of participants in Part II of the experiment in each treatment. In addition, we test whether there are statistically significant differences in the identity treatments as compared to the control treatment for the same strategic game.

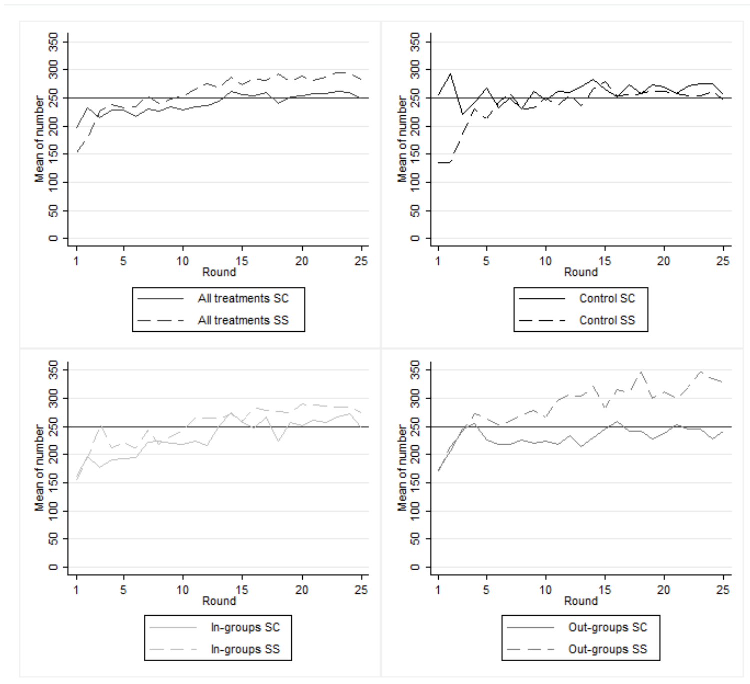
Table 8: Summary statistics of earnings in ECUs for Part II of the experiment.

	All rounds			***Rounds 1-5***			***Rounds 21-25***		
	Mean	SD	*p-value*	Mean	SD	*p-value*	Mean	SD	*p-value*
Control SC	1,230.78	57.03	—	1,220.26	76.74	—	1,227.78	52.36	—
In-groups SC	1,255.63	61.17	0.26	1,293.77	59.22	0.01	1,233.10	53.14	0.52
Out-groups SC	1,256.67	55.58	0.33	1,256.27	60.39	0.07	1,249.80	53.00	0.52
Control SS	1,269.21	54.36	—	1,330.17	64.84	—	1,247.96	35.60	—
In-groups SS	1,252.24	66.53	0.52	1,302.89	76.52	0.20	1,218.46	45.02	0.10
Out-groups SS	1,219.38	66.65	0.01	1,279.15	79.64	0.05	1,181.97	54.99	0.01

Note: Earnings are reported using ECUs. The p-values are obtained from a two-sided MW test comparing each identity treatment with the control treatment in each strategic game with 6 independent observations per treatment.

Figure 9 adds evidence to Section 4.1. and shows the evolution of the chosen number over periods, separately for the strategic complements and substitutes games in each identity condition.

Figure 9: Chosen number in each identity condition



Note: Evolution of the average chosen number over rounds. The NE is at 250 and is denoted with a black solid line.

Table 9 complements section 4.1 and shows a panel regression analysis including additional variables to analyze end game effects (Round 25), the effect of performance in Part I of the experiment (Correct guess, Questions, Coordination, and Conversation length), and the effect of demographics (Age, Gender).

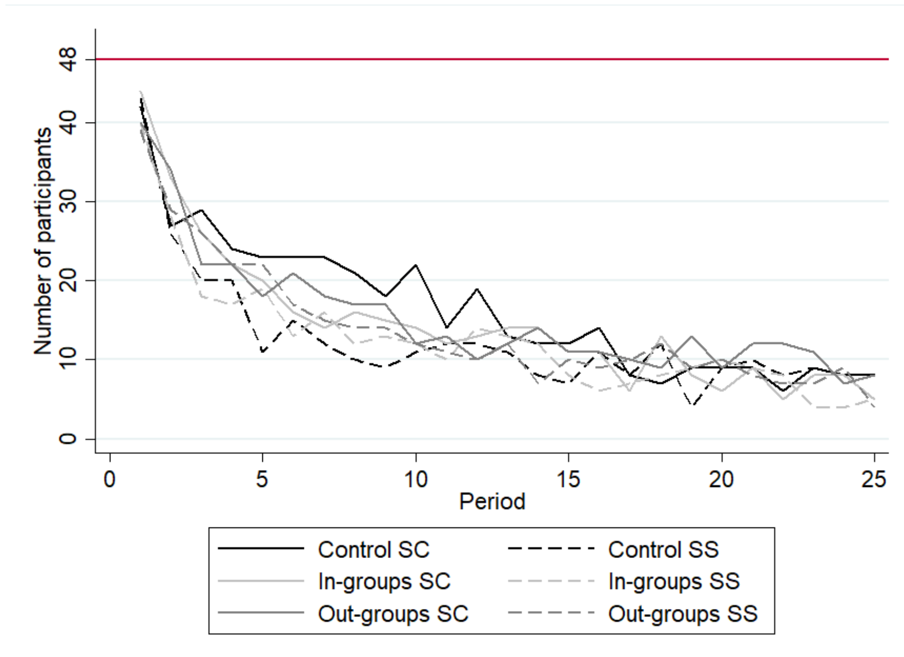
Table 9: Regression with additional controls

VARIABLES	(1) SC	(2) SC	(3) SS	(4) SS
In-groups	-34.846	-29.090	47.718	53.028*
	(28.996)	(29.341)	(31.751)	(31.845)
Out-groups	-18.075	-18.817	76.079**	82.178***
	(31.069)	(31.220)	(30.565)	(30.861)
Round	1.977***	1.468**	4.112***	3.970***
	(0.593)	(0.602)	(0.575)	(0.784)
Round 5 x In-groups		-38.203**		-11.891
		(15.739)		(10.783)
Round 5 x Out-groups		5.808		-22.175
		(16.110)		(17.087)
Round 25 x In-groups		9.427		-14.661
		(7.423)		(13.013)
Round 25 x Out-groups		-2.095		-8.316
		(8.956)		(16.513)
Correct guess	-11.267	-11.267	-1.212	-1.212
	(11.035)	(11.041)	(6.847)	(6.851)
Questions	3.235	3.235	-1.181	-1.181
	(5.314)	(5.317)	(4.118)	(4.121)
Coordination	22.511	22.511	-14.251	-14.251
	(25.422)	(25.436)	(34.917)	(34.937)
Conversation length	-0.646	-0.646	-0.360	-0.360
	(0.424)	(0.424)	(0.490)	(0.491)
Age	-1.548	-1.548	2.475	2.475
	(1.859)	(1.860)	(2.057)	(2.058)
Gender	7.122	7.122	17.711*	17.711*
	(14.268)	(14.276)	(9.468)	(9.473)
Constant	270.310***	276.931***	132.914***	134.762***
	(39.667)	(37.631)	(41.148)	(40.780)
Observations	3,600	3,600	3,600	3,600
Number of participants	144	144	144	144

Note: The dependent variable is the individually chosen number in each of the rounds. In-groups and Out-groups variables are dummy variables taking value 1 for observations from in-groups and out-groups treatments, respectively, and 0 otherwise. The Round variable takes the value of each round. The variables Round 5 and Round 25 are dummy variables that take value 1 for observations from round one to five and rounds twenty-one to twenty-five, respectively, and 0 otherwise. The variable Correct guess is the number of correct answers in Part I of the experiment (equal 0 for participants in the control treatments). The variable Questions is the number of questions formulated by participants in the chat in each group during Part I of the experiment (equal 0 for participants in the control treatments). The variable Coordination captures the number of same answers in Part I of the experiment for each group. It takes values from 0 to 1 being 1 the case in which all group members provide the same answer (equal 0 for participants in the control treatments). The Conversation length variable is the number of sentences introduced in the chat during Part I for each group. Robust standard errors, clustered at the group level, are reported in parenthesis with * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 10 complements Section 5.1 and shows the number of participants that use the payoff simulator in each period for each treatment. As it can be observed, the number of participants using the payoff simulator decreases over rounds.

Figure 10: Number of participants that use the simulator in each round for each treatment.



Note: The red line represents the total number of participants in each treatment.

Table 10 adds to Section 5.1 and shows the self-reported measures collected from participants in the post-experimental questionnaire about how much their identity (Identity), other participants' previous decisions (History), and other participants' future decisions (Belief) affected their choices during the experiment in each treatment. Table 11 reports the p-values of the self-reported measures and shows that we do not find any significant difference in the Beliefs measure.

Table 10: Post-experimental questionnaire: Identity, history and beliefs.

	Identity		***History***		***Beliefs***	
Treatments	Mean	SD	Mean	SD	Mean	SD
SC						
All treatments	1.84	0.72	2.90	0.46	3.13	0.41
Control	2.44	0.42	2.96	0.54	3.08	0.28
In-groups	1.96	0.33	2.88	0.30	2.94	0.42
Out-groups	1.13	0.68	2.90	0.60	3.38	0.46
SS						
All treatments	1.50	0.58	3.04	0.45	3.23	0.40
Control	1.90	0.49	3.06	0.67	3.38	0.60
In-groups	1.46	0.64	3.02	0.37	3.23	0.18
Out-groups	1.17	0.46	3.06	0.34	3.09	0.33

Table 11: Post-experimental questionnaire on identity, history and beliefs: Mann-Whitney statistical tests

Treatments	***Identity*** *p-values*	***History*** *p-values*	***Beliefs*** *p-values*
SC:			
Control vs In-groups	0.07	1.00	0.62
Control vs Out-groups	0.00	0.74	0.16
In-groups vs Out-groups	0.03	0.51	0.17
SS:			
Control vs In-groups	0.33	0.74	0.28
Control vs Out-groups	0.04	0.80	0.19
In-groups vs Out-groups	0.22	0.80	0.21

Note: The p-values are obtained from two-sided Mann-Whitney tests with 6 observations (groups) in each treatment.

Table 12 provides additional evidence to Section 5.2 and restricts the adaptation dynamics analysis to the first five periods and provides support for the results found in Table 7. Table 12 shows that best-response dynamics is the major driver choices in games of strategic complements, whereas in games of strategic substitutes, both best response and imitation explain the dynamics of choices. Interestingly, imitation also explains the dynamics of choices for in-groups in the strategic complements game.

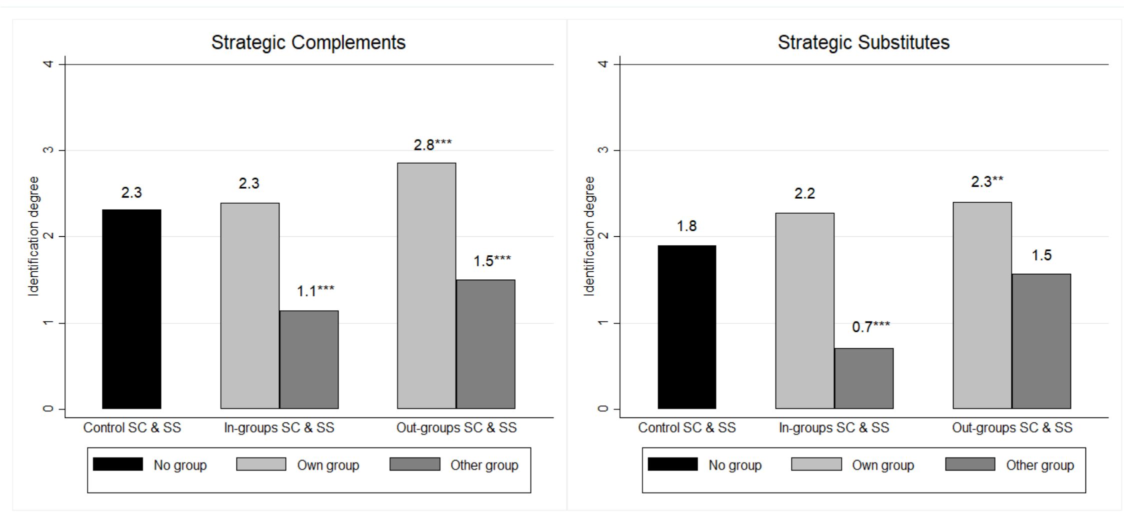
Table 12: Adaptation dynamics periods 1-5

VARIABLES	(1) Overall	(2) Overall	(3) SC	(4) SC	(5) SS	(6) SS
Best response	0.550***	0.493***	0.602***	0.686***	0.548***	0.414***
	(0.044)	(0.072)	(0.069)	(0.092)	(0.059)	(0.083)
Imitation	0.249***	0.298***	0.136*	0.067	0.354***	0.438***
	(0.048)	(0.099)	(0.077)	(0.101)	(0.055)	(0.129)
In-groups	-3.496	-3.789	-27.767***	-40.136***	17.734	13.810
	(13.420)	(12.103)	(7.354)	(8.409)	(25.703)	(18.888)
Out-groups	15.143*	22.699*	-7.006	-2.822	36.114**	28.686*
	(8.898)	(11.589)	(5.339)	(11.926)	(16.030)	(15.067)
Best response x In-groups		-0.014		-0.266**		0.113
		(0.094)		(0.110)		(0.131)
Best response x Out-groups		0.178*		-0.008		0.272**
		(0.104)		(0.168)		(0.111)
Imitation x In-groups		0.017		0.269**		-0.115
		(0.112)		(0.117)		(0.158)
Imitation x Out-groups		-0.164		-0.056		-0.138
		(0.130)		(0.180)		(0.136)
Constant	-33.264***	-34.147***	-6.031	-0.459	-58.568***	-51.116***
	(9.152)	(9.611)	(5.686)	(6.207)	(14.566)	(13.538)
Observations	1,152	1,152	576	576	576	576
Number of participants	288	288	144	144	144	144

Note: This table estimates the full equation (4) in columns (2), (4), and (6), and a simpler version in columns (1), (3), and (5), for both types of games of strategic complements and substitutes, respectively. Robust standard errors, clustered at the group level, are reported in parenthesis. Statistical significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 11 complements Section 6 and shows the identification degrees of participants separately for treatments of strategic complements and strategic substitutes. Overall, we can observe participants in identity treatments felt more identified with other participants with the same group identity (own group) than with participants induced with a different group identity (other group). Furthermore, the identification degree towards in-group used to be higher than in the control and the identification degree towards the out-groups used to be lower than in the control.

Figure 11: Group identification in each treatment



Note: No group refers to the identification degree among participants in the control treatments. For in-groups and out-groups treatments, "own group" and "other group" refers to the identification score towards the other participants in the same and different colour group to the ones assigned, respectively. Significant levels, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$, *are obtained from pairwise comparisons between scores in control and identity treatments using two-sided Mann- Whitney tests with 6 observations (groups) in each treatment.*