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# Learning and the Emergence of Behavioural Rules in a Bargaining Game

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**Abstract**

The study of institutions has been a thriving field of research within many academic disciplines. The reach of that research seems to be constrained by the little sophistication in the description of human agency and by the lack of attempts at establishing a connection between individuals and institutions. Following Hayek (1952) and Bandura (1977) we embrace a richer account of human agency, according to which mental models are the subjective representation that cognitive systems produce in order to interpret the environment; and following Hodgson (2003) and North (1994) we accept that institutions, qua arrangements that bring about order in a complex ecosystem, perform the same function at a collective level.

We present a multi-stage bargaining experiment with both real and artificial agents, that studies the patterns of emergence and the reasons of persistence of institutions. Our results support Hayek's and Bandura's theories and suggest that individual learning is a complex phenomenon that can be accounted for by both subjective factors (like payoff and habit) and collective patterns (group behaviour).

**Keywords:** bargaining game, cognitive economics, coordination, conventions, experiments, institutions, learning

The analysis of institutions has earned in the recent years growing interest from various theoretical standpoints. Social and political sciences at large now consider the study of institutions part of their proper subject matter.[1] Scholars of economics, law, organization studies and political science all direct their efforts towards a set of common research topics like transaction costs, contract theory, and institutional forms; or the role of culture, value systems, and customs. This trend emphasises the strong awareness that formal and informal institutions matter for the development of markets and other social arrangements, and that it is both possible and commendable to approach these themes with interdisciplinary analytical tools.[2] Experimental economists, too, have long taken an interest in the study of institutions. Many experiments aim indeed at uncovering the consequences of different institutional settings on the development of economic systems (e.g. Plott and Smith 1978, Smith 1987).

Nonetheless many compelling questions regarding the emergence and the evolution of social norms, the relationship between different norms, and the interaction of norms and individuals remain to this day unanswered.

Institutional theory has so far addressed individual behaviour only to a limited extent, because it moves from simple assumptions about individuals and their motivation (e.g. Williamson 2000). Bounded rational, forward-looking but myopic, opportunistic agents are thus employed to answer questions at collective and organizational levels, which couldn't be meaningfully addressed within a neoclassical framework. Such limited understanding of institutional individual behaviour, however, does not properly describe the relationship between the singular agent and the collective arrangement. It thus dramatically constrains our capacity to address many complex institutional phenomena.[3]

Following Geoffrey Hodgson (2003) and Douglas North (1994), we take as a starting point the acknowledgement that there exist a bilateral relationship between the mental processes that govern individual choice and institutions. While it is common to consider institutions as exogenous constraints or opportunities, North (1994, Denzau and North 1994) believes the very nature of cognitive processes and institutions to reveal their close interconnection. Mental models are the subjective representation that cognitive systems produce in order to interpret the environment. Institutions, qua arrangements that bring about order in a complex ecosystem, perform the same function at a collective level.

In what follows we present an empirical investigation that rests on the theoretical grounds of Friedrich von Hayek's theory of the emergence of institutions and in Albert Bandura's account of the role of learning in the formation of behavioural norms.

Hayek describes the links between the working of human brain, the mechanisms through which it produces behaviour, and the nature, role, and evolution of social norms. Within social groups, behavioural norms, habits, and routines emerge spontaneously from freely interacting agents. For individuals, they operate as schemes to tackle environmental complexity. The emergence of such norms is a consequence of individual cognitive processes. Mind organizes

[1] The study of institutions and institutional change has a long history in economic thought. Some classical contributions come from Adam Smith, John Stuart Mill, and Karl Marx. The approach to institutional analysis, however, has been varied and it deserves a nuanced treatment that falls beyond the scope of this paper. For a discussion of the different schools of institutional economics and their methodologies, see Rutherford (1994), Vanberg (1994), and Vromen (1995).

[2] On the advantages of interdisciplinary research in institutional analysis, see Rizzello and Turvani (2000, 2002).

[3] It is beyond the reach of the present work to provide a comprehensive account of human agency that tackles all economic activities. We only try to enrich those aspects pertaining to individual and collective learning.

sensorial perceptions through interpretive acts, which transform information into subjectively relevant knowledge. Such interaction is the outcome of brain structures that are both genetically determined and shaped by experience. Each interpretation reinforces the psycho-neurobiological structures that are specific of each individual. This way, even when one imitates the behaviour of other agents, one is producing a wholly subjective action that stems from idiosyncratic knowledge. Therefore there are two conflicting forces at work: one that creates new interpretations and new behavioural rules, and one that uniforms individual behaviour within an emerging social order.

Hayek's theory is substantially confirmed by Bandura's social learning theory. Social order, he suggests, is the result of learning processes that take place every time individuals face and find solutions to new problems. Mind is an active tool, capable of creating knowledge by operating a selection among information and of cumulating knowledge from past experience. Cognitive activity, as a consequence, changes over time. These changes facilitate the acquisition of those representations of phenomena that are shared within a society or a culture and thus reinforce institutional norms of conduct previously acquired. Two processes lead learning: direct interpretation of external stimuli based on individual cognitive structures and past experience, and vicarious experiences where the observation of the behaviour of others reinforces the social dimension of learnt behaviour.

Learning, which we regard from a cognitive standpoint as any change in behaviour that follows from previous experience, is the mechanism through which the behaviour of an atomistic agent may become attuned to that of other agents, and in this process an institution is born. In the context of a game theoretical experiment our use of 'institution' refers to a solution to a game with multiple equilibria (e.g. Bowles 2004). In the experiment below, this institution is a 'convention,' in that every player conforms to it, expects others to conform, and all players have good reasons to conform (e.g. Lewis 1969), but not a 'norm' strictly speaking because there are no (external) sanctions for those who violate it besides a lower in-game payoff for both violators and their co-players. When they emerge, conventions of this kind tend to be self-propagating and self-reinforcing as they have the desirable property of reducing transaction costs (Young 1996). The ways in which conventions emerge have historically been two: a top-down way, via establishment by a central authority and a bottom-up way, with a "gradual accretion of precedent" (ibid.: 106). This latter is by far the most challenging and it is the one our investigation aims at.

The goal of our experiment is thus double. Firstly, we want to test whether an interaction among individuals generates behavioural conventions. According to Hayek, institutions, norms, routines emerge spontaneously within a social group. They mirror the cognitive processes of human interpretation of information from the environment and make up for the limited capacity of human mind to interpret and process that information. These institutional norms also make individual perceptions more homogeneous, thereby reinforcing their very institutional strength, and guarantee individual interaction may take place on common ground.

Secondly, we want to uncover the role of learning in the stabilisation of behavioural rules. In the lights of Hayek's theory, indeed, the study of the emergence and stabilisation of institutions appears to be close kin with the study of learning processes.[4] Individual learning processes,

[4] Although economists show growing appreciation of the role of individual learning for institutional evolution, they largely disregard the crucial contributions form psychology and neurobiology. For a review: Dosi, Marengo, and Fagiolo (1996).

while idiosyncratic and highly subjective, play a prominent role in the emergence of shared social behaviour.

Game theoretical research treats learning through different mathematical models based on the idea of reinforcement. These models mostly interpret the probability of a given individual act as the result of a conscious assessment of the payoffs earned in the earlier stages.[5] In the present work, however, we will employ a more sophisticated model of learning. Bandura (1977) maintains, in accordance with Hayek, that the formation of behavioural rules depends on two forms of learning: direct learning, through trial-and-error, and vicarious learning, through observation and imitation. Both processes stage strong self-reinforcing mechanisms, through which individuals internalise the learnt behaviour. Self-reinforcement also means that individuals reproduce what they learnt in an aware and conscious manner, and that they evaluate the behavioural rule not only according to its observed or expected result, but also in the lights of their previous experiences outside and independently of the game, and of moral values at large. Our second goal, therefore, amounts to uncovering which aspects of self-reinforcement affect the consolidation of a behavioural norm.

The experiment we shall describe below is set up around a bargaining game, wherein players have limited information and uncertainty with respect to the conduct of other players. In the first phase, participants will be divided into teams together with a certain number of artificial agents (which play according to a fixed strategy that never changes). We will thus investigate if, through repeated interactions, real players understand the strategy of artificial ones and therefore, by assumption, develop a rule of playing the best response.

In the second stage, when there are only real players, we will see whether the rule learnt in the first phase was maintained and which could be the elements the determine the reinforcement of behavioural rules. Does the rule stabilise because of the payoff? Or because of the number of equilibria reached? Or is it also affected by other factors of moral or psychological nature?

The final step consists in a one shot game ultimatum game. Do behavioural rules emerged during the previous interaction take a normative value? Do they survive in a different context?

## 1. The experiment

The experiment was conducted in Alessandria during the month of November 2005, thanks to the facilities of the AL.EX lab for Experimental Economics, at the University of Eastern Piedmont. Our subjects were 48 law students attending an Economics course that is compulsory for their curriculum. The students were rewarded for their participation: depending on their total score at the end of a series of experiments over the whole course, they were allowed to answer a number of extra questions in their final exam. These additional questions could earn them 0 to 2 points to be added to their exam grade (which in the Italian university system is expressed on a 30 points scale).[6] The experiment was elaborated from the blueprint of a bargaining game,

[5] See, for instance, Fudenberg and Levine (1998) and, for the use of models of learning with reinforcement in experiments with observations between consecutive interactions, see Roth and Erev (1995).
[6] This system of reward might have affected only marginally individual incentive, because the ultimate payoff depends on the results of several experiments.

wherein couples of players (player 1 and player 2) must reach an agreement on how to split a certain amount of points, depending on a payoff matrix.[7]

We first formed a group of 24 students (treatment A). The following day we formed another group of 24 students (Treatment B). For both treatments, the overall experiment time was about one hour, with circa 30 minutes of actual game and some extra time for instructions and other practical matters.

The first phase lasts 15 turns. At the beginning, the software employed for this experiment randomly formed groups of 8 players, which could be of either type: 4 human and 4 artificial players (*50%A*) or 1 human and 7 artificial players (*100%A*). These artificial agents, come in two kinds: those in treatment A always play solution a, those in treatment B always play solution b.

Participants are informed that they were to be assigned to a team of 8 players, wherein there could be anywhere between 0 and 7 artificial agents; that these artificial agents were virtual players managed by the computer according to a defined strategy; and that they were to play with the same group of players for a number of turns.

At each turn, couples change and new couples are anonymously and randomly generated. Also, players may change role. Every turn they were informed whether they were playing as player 1 or 2, which is again randomly determined.

Both players then start the negotiation by choosing, simultaneously with their partners, the division that they deem appropriate – according to the following payoff matrix.

| | | Player 2 | | |
|---|---|---|---|---|
| | | *A* | *B* | *C* |
| **Player 1** | *A* | 8, 6 | 1,1 | 1,1 |
| | *B* | 1,1 | 6, 8 | 1,1 |
| | *C* | 1,1 | 1,1 | 4,4 |

**Matrix 1** Individual payoff per turn, Phase 1 and 2, Treatment A and B

Throughout the game, every turn, players must make their final offer within two minutes. At the end of each turn, the screen displays a summary report with the choice of the player, the choice of the partner, the score obtained in that turn and the overall score.

During this first phase, students should learn to choose the solution proposed by their artificial partners – whether that is a or b – and thus give place to different institutions, one for each treatment. In the second phase of the game, starting in turn 16, the players should then continue to play following the same rule.

At the end of turn 15, the students were asked to state how satisfied they are with the bargaining just concluded and then they received the instructions concerning the second phase of the experiment.

In the second phase the game continues as above. The major change is in the composition of teams: now only human players are involved. The computer now generates three groups of 8 players, two with the students who played in mixed teams in phase one (*50%A*, or half human

[7] Note, however, that the total amount of points may vary. It ranges from 14 for equilibria aa and bb, to 8 for equilibrium cc, to 2 for every other equilibrium.

and half artificial agents), the other with the players who originally played with artificial agents only (*100%A*).

If the first phase indeed functioned as a training session through which players learnt the behavioural rule 'imposed' by artificial agents, we would legitimately hold two expectations. First of all the players should, from the beginning, play according to the strategy they observed in the artificial partners. Secondly, and consequently, they will have a higher satisfaction at the end of phase two. Under the rather intuitive assumption that satisfaction depends on the score, the students should obtain a higher final score if they follow the rule.

At the end of turn 25, players read the instructions for the third and final phase of our experiment. Now each human agent plays with another a one shot manipulation of the game – that is a ultimatum bargaining game. Player 1 makes an offer and player 2 can either accept, and each subject earns the corresponding points, or reject it. In case of refusal, no points are awarded. Again the computer randomly assembles the couples and assigns the role (player 1 or player 2). In order to make the test for consistency with the rule more severe, another change is introduced in the payoff matrix (below), making the fair solution less damaging for both players and the two other equilibria more advantageous for one of the two players. If learning with self-reinforcement did take place, we can expect players to both propose and accept the strategy they learnt nonetheless.

| | | Player 2 | | |
|---|---|---|---|---|
| | | *A* | *B* | *C* |
| **Player 1** | *A* | 10, 6 | 3,3 | 3,3 |
| | *B* | 3,3 | 6, 10 | 3,3 |
| | *C* | 3,3 | 3,3 | 6,6 |

**Matrix 2** Individual payoff, Phase 3, Treatment A and B

## 2. Hypotheses and results

From the discussion above, we expected our subjects to develop a behavioural routine and thus to converge towards a common answer. Players face a game akin to those referred to as 'battle of the sexes' with multiple symmetrical equilibria; so the emergence of an institution among them amounts to a consistent preference for one of those equilibria. Here, however, we also presented them with a 'fair solution,' where both players would earn an equal, but lower, amount of points. This latter might attract those subjects with a preference for more equitable divisions, at least in the early stages of the experiment. In these early stages, on the other hand, there are artificial agents which follow a fixed strategy – a in treatment A and b in treatment B. It can thus be expected that those players who prefer c, disregarding the fact that it is inefficient, will progressively abandon it and opt for a or b instead.

During the game, indeed, our subjects have the opportunity to witness the superiority of the payoffs afforded by the solution played by artificial agents. This should lead the process of learning by trial and error. At the same time, through the summary presented at the end of each turn, they become aware of the game conduct of their partners and have the opportunity to learn by imitation. It can be expected that this phenomenon is more manifest for the students interacting with 7 artificial agents.

| | | Treatment A | | | | Treatment B | | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | min | max | avg | st dev | min | max | avg | St dev |
| score_1 | 24 | 50 | 100 | 78,125 | 15,644 | 36 | 97 | 65,417 | 16,694 |
| eq a_1 | 24 | 5 | 14 | 9,875 | 2,5076 | 0 | 4 | 1 | 1,3513 |
| eq b_1 | 24 | 0 | 1 | 0,1667 | 0,3807 | 2 | 12 | 7,3333 | 3,1021 |
| resp a_1 | 24 | 6 | 15 | 11,167 | 2,632 | 0 | 11 | 5,5 | 2,8742 |
| resp b_1 | 24 | 0 | 9 | 3,2917 | 2,2742 | 4 | 15 | 8,625 | 2,9015 |
| sat_1 | 24 | 2 | 9 | 7,0833 | 1,8158 | 2 | 10 | 7,125 | 1,5691 |

**Table 1** Statistics, Phase 1, By treatment

**score_1** = score in phase 1; **eq a_1** = number of aa equilibria in phase 1; **eq b_1** = number of bb equilibria in phase 1; **resp a_1** = number of responses a in phase 1; **resp b_1** = number of responses b in phase 1; **sat_1** = expressed satisfaction at the end of phase 1.

| | | Treatment A | | | | Treatment B | | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | min | max | avg | st dev | min | max | avg | St dev |
| score_2 | 24 | 37 | 72 | 55 | 8,1774 | 37 | 73 | 52 | 9,6504 |
| eq a_2 | 24 | 2 | 10 | 7 | 2,043 | 0 | 3 | 0,9167 | 1,1389 |
| eq b_2 | 24 | 0 | 3 | 0,5 | 1,0215 | 3 | 9 | 6,0833 | 1,8396 |
| resp a_2 | 24 | 3 | 13 | 8,375 | 2,143 | 0 | 7 | 2,2917 | 1,8528 |
| resp b_2 | 24 | 0 | 6 | 1,5833 | 1,8631 | 3 | 10 | 7,5833 | 1,8396 |
| sat_2 | 24 | 4 | 10 | 7,125 | 1,454 | 6 | 10 | 7,7083 | 1,0826 |

**Table 2** Statistics, Phase 2, By treatment

**score_2** = score in phase 2; **eq a_2** = number of aa equilibria in phase 2; **eq b_2** = number of bb equilibria in phase 2; **resp a_2** = number of responses a in phase 2; **resp b_2** = number of responses b in phase 2; **sat_2** = expressed satisfaction at the end of phase 2.

Tables 1 and 2 report the statistics of phase one and two respectively.

We observed that in both treatments there is at least one player who follows the strategy of artificial agents through the entire game – that is both in the first and the second phase. On average other subjects, too, converge there over the game. It thus seems that repeated interaction among a small and closed group of agents does indeed favour the emergence of a common behavioural rule that also survives as game conditions change.

We should note, however, that in treatment A during the first phase the average number of answers a (resp a_1) and consequently the average number of points earned (score_1) is higher than corresponding values for answer b in treatment B. In treatment A, players identify solution a as the rule to follow much faster. After turn 4, it is very rare to observe a deviation and only 6 players out of 24 choose an alternative (i.e. b or c) more than 10 times in 15 turns. In treatment B, on the other hand, players stabilize their strategy later and 16 out of 24 participants choose alternatives (a or c) more than 10 times. This is reflected in the higher number of equilibria achieved in treatment A – an average of circa 10 aa – compared with treatment B – an average of circa 7 bb.

Since the length of the game and the number of artificial agents is identical in the two treatments, it may be suspected that solution a is somewhat more straightforward than b, possibly because it is the first answer offered in the game screen (but see our discussion below). Another likely explanation of the faster convergence towards a, and not at all incompatible with the previous, is that game conduct in the early turns matters. Though the strategy of our artificial agents may be very simple, the game is designed in such a way that it is not easy for a player to form an expectation of which answer their partner is going to select. The speed of convergence to the stable pattern of the 'winning' strategy might thus be, at least in part, a matter of chance. By looking at the first answer given by each player, we notice that 31 out of 48 players in total play a, 14 play b, and 5 play c. In treatment A alone, the effect is yet more striking, with no player choosing c, 5 players choosing b, and 19 players choosing a.

In the second phase, when the bargaining occurs among human agents only, we want to verify whether players enacted self-reinforcement mechanisms of their strategy, either because they observe a correspondence between expected and actual results or because of other psychological phenomena that consolidate the use of the learnt strategy in a new bargaining context. Our results, however, reveal a slight reduction in the number of times players stick to the strategy previously adopted by artificial agents.

This effect can be due to the fact that some participants, now aware that they are interacting with other humans only, might want to try different strategies – and possibly those that afford higher payoffs to themselves. The old strategy thus seems too simple, while the new strategy might look like the standard neoclassical prediction – play a as player 1 and b as player 2 – or it may move towards the fair solution. This way, two patterns emerge: one of rule followers and one of participants who want to establish new conventions or at least explore the stability of the existing one. It seems indeed that rule-complying answers become more polarised. In treatment A, the worst performing subjects obtained 5 aa equilibria in phase one (with 15 repetitions), but only 2 aa equilibria in phase two (with 10 repetitions). The average number of aa equilibria goes up by about 6%. In treatment B, conversely, the worst performing subjects achieved 2 bb equilibria in phase one (15 turns) and 3 in phase two (10 turns) with an average increase of 24%.

It is an observed fact that, though artificial agents might bring about collective phenomena that are very similar to those of real agents, real agents do not treat them as equals. In ultimatum games, for one instance, human players both propose and accept smaller offers to/from computers than to/from other humans. There might be a presumption, which incidentally in the case at hand would be justified, that artificial agents do not care for whatever answer humans propose, but simply enforce their programmed strategy. Real players, therefore, may feel they simply have to face it, understand it, and make the most out of it. This can be seen as a manifestation of the impossibility of establishing some sort of sympathetic link among players, which might help achieving Pareto-superior equilibria.[8] The interaction mediated by a computer screen together with a crucial uncertainty as to whether a specific co-player is human or not (more on this shortly), on the other hand, might make the distinction between human and artificial agents less relevant.

[8] In Ambrosino, Lanteri, and Novarese (forthcoming) we observe that a cheap talk session preliminary to a bargaining game might stimulate a phenomenon of this kind, therefore leading players to higher satisfaction and more efficient results.

In the lights of the numerous repetitions, the random and ever-changing attribution of role, and the small gap between payoffs (8 and 6), therefore, this experiment becomes in an important sense a coordination game where players have a strong incentive to simply achieve a stable equilibrium – either aa or bb. The main difficulty subjects face in pursuing this goal is their lack of contextual cues from outside the game. Thomas Schelling (1960) calls these cues 'focal points.' Focal points cannot be defined *a priori* and can be recognized by observation. They do not emerge by necessity or because of their intrinsic superiority – and indeed focal points may change over time – but are often triggered by precedents in a self-reinforcing fashion. It is largely by chance that one out of several possible patterns of behaviour or equilibria becomes dominant as more and more players choose it, therefore making it a convention. Focal points do not require agents to be especially rational or well informed and it is remarkable how easily people conform to them. When these focal points do not exist and the opportunity to rely on information external from the game is barred, players are at loss and cannot form sensible expectations about the conduct of their partners.

Students might thus believe that the main task of phase one was to simply understand the strategy of artificial agents and play accordingly. This belief should be weakened by the fact that participants did not know in a given turn whether they were interacting with an artificial or a real player nor did they know how many artificial agents were in their group (remember: they were told there could be anywhere between 0 and 7). They also ignored which was the strategy of artificial agents, though they probably suspected that discovering it was a sensible way to go about the bargaining game and indeed one of their most urgent tasks.

The probability that in a given turn a human agent was playing with an artificial one was 100% in the *100%A* variant and 57% in the *50%A* variant. From the perspective of any individual subject, however, such probability ranges from 0% to 12,5%, assuming she even attempted to make such inference – which we doubt.

In the second phase, players know that they always play with other humans and might believe they have a chance to establish a different game routine or that others might attempt to do so. We observe that very few players keep up the learnt strategy when the alternative would be more advantageous to them. In treatment A 5 out of 24 subjects play a when they are player 2, and in treatment B 7 out of 24 play b when they are player 1.

In both treatments, we also notice that the results of phase two were on average deemed more satisfactory by players. It's worth noting that, regardless of an increased score, this does not seem to be the explanation for treatment A. The change in satisfaction, in this case, is remarkably small. We observe that, from phase one to phase two, the average score per turn in treatment A increased by 5% and average final satisfaction increased by a mere 0.5%. The tiny increase in satisfaction might suggest that, in this treatment where subjects easily recognized the behavioural rule, satisfaction levels are affected by other concerns besides the score, possibly the very fact that they were fast and successful in identifying the 'right solution.' In treatment B, conversely, the figures are +20% in average score per turn and +8% increase in average satisfaction.

In the third phase, there is a new bargaining session lasting a single turn and based on a different payoff matrix. Our goal was to verify whether the strategy learnt in the early phases appeared as the natural solution in a yet different context. If this were the case, players would have offered and accepted either a or b depending on the treatment, even in a one shot ultimatum game and regardless of whether this made them relatively better or worse off.

Treatment A does confirm this intuition. Of 12 proposers, only one deviates from the predicted behaviour – by offering the fair solution c. All of these are "accepted," by which we mean that the co-player responds with the same solution she is offered (i.e. responds a to a offers, b to b, and c to c). This conduct, which we regard as corroborating evidence for successful learning, might nonetheless be overrated. We should not forget that proposers in the ultimatum game always take the role of player 1, which gives them a further incentive to propose a. It does seem, however, that the existence of the rule makes participants more confident in offering a, though this might be considered a selfish action by responders.

In treatment B it is clear that solution b is no longer an accepted norm. On the contrary most players offer a, while 4 offer c. Though the difference in the number of c proposals among treatments is not statistically significant, we speculate that having played b so often in the previous turns makes it suspicious to suddenly offer a. Some proposers might thus anticipate rejection and steer away from it, finding it more sensible to offer the fair solution. This effect is nonetheless rather small because the fair solution is inefficient in that it damages one player only (remind: the payoffs are 10/6 and 6/10 respectively for aa and bb, while cc is 6/6 and every other solution is 3/3). The absence of 'rejections' can be explained: it is never rational to turn down an offer in a one shot ultimatum game, and thought rejections do occur, they are typically observed only in the presence of very unfair offers. Such offers were not possible with our payoff matrix.

The scores earned by our subjects thus ranged between 6 and 10 with an average of 7,83 in treatment A and 7,33 in treatment B. Our subjects reported their satisfaction as ranging between 4 and 10 (average: 8,21) in treatment A, and between 0 and 10 (average 7,4) in treatment B

The analysis of the results of the ultimatum game offers some additional insights. We observe that the majority of those who offered c are the players in treatment B. Interestingly they even achieved 3 cc equilibria in phase two. Furthermore those players who offer c in this final stage are those who played the most a answers in the previous stages. This corroborates our earlier intuition that those players who play the least a solutions – and thus seem to prefer different equilibria – also make the least a offers in the ultimatum game. Here, the same is true for b. It may be that b appears to them less desirable than alternatives. In the third phase therefore they don't play it, nor do they play b, because it would penalise them, and eventually opt for the less efficient fair solution.

## 3. Discussion

In order to explore the main determinants of the consolidation of behaviour, we test the impact of different independent variables observed during phase one on the number of answers in accordance with the rule played in the second phase (resp a_2 and resp b_2 in treatment A and treatment B respectively).

The aspects of learning on which Bandura's theory suggests that we focus are the actual outcomes (progressively refined through trial-and-error procedures), the conduct of the group of each player (which triggers vicarious learning), and other psychological and moral characteristics of the individual and of her social and cultural milieu. We thus tried to explain the variables according to:

- the total number of rule-complying answers in phase two, which represents the overall game conduct of the group (a team_2 and b team_2 for treatment A and B respectively). This variable represents the sharedness of the rule and the possibility for further vicarious learning in phase 2.
- the individual payoff earned during the first phase (score_1). Score is a considered a powerful reinforcing mechanism in that it measures the success of game conduct.
- the individual number of responses a/b given during the first phase (resp a_1 in treatment A and resp b_1 in treatment B). This variable represents consistency of behaviour across the two phases.
- the individual number of equilibria achieved in the first phase (eq a_1 in treatment A and eq b_1 in treatment B). This variable indicates another mechanism of reinforcement, measured as the number of successful results to the bargaining.

Since the role affects the payoff and individual incentives to pick solution a or b, we later introduced another variable:

- the individual number of times a participant was player 1 in phase 2 (player 1_2). This variable accounts for individual incentives in game conduct.

| | **Treat A** | | | | | |
|---|---|---|---|---|---|---|
| **ind var** | *Est 1* | *Est 2* | *Est 3* | *Est 4* | *Est 5* | *Est 6* |
| ateam_2 | .120 (.009) | .110 (.012) | .121 (.008) | .116 (.007) | .111 (.010) | .117 (.006) |
| score_1 | .022 (.381) | - | - | .020 (.391) | - | - |
| resp a_1 | - | .241 (.107) | - | - | .170 (.255) | - |
| eq a_1 | - | - | .131 (.405) | - | - | .111 (.453) |
| player 1_2 | - | - | - | .431 (.058) | .359 (.121) | .427 (.062) |
| | | | | | | |
| p-value F test | .016 | .006 | .016 | .008 | .006 | .009 |
| R-sq | .326 | .384 | .324 | .439 | .455 | .434 |

**Table 3a** Estimation with resp a_2 as dependent variable, Treatment A
'-' indicates a variable not included in the estimation; the value in parentheses is the p-value of the t-test.

| | **Treat B** | | | | | |
|---|---|---|---|---|---|---|
| **ind var** | *Est 7* | *Est 8* | *Est 9* | *Est 10* | *Est 11* | *Est 12* |
| ateam_2 | .110 (.423) | .062 (.608) | .100 (.405) | .118 (.394) | .066 (.595) | .102 (.409) |
| score_1 | -.008 (.764) | - | - | -.003 (.895) | - | - |
| resp a_1 | - | .264 (.056) | - | - | .248 (.089) | - |
| eq a_1 | - | - | .471 (.102) | - | - | .437 (.173) |
| player 1_2 | - | - | - | -.153 (.409) | -.073 (.675) | -.051 (.789) |
| | | | | | | |
| p-value F test | .586 | .095 | .157 | .624 | .188 | .297 |
| R-sq | .223 | .201 | .162 | .082 | .208 | .165 |

**Table 3b** Estimation with resp a_2 as dependent variable, Treatment B

| | Treat A | | | | | |
|---|---|---|---|---|---|---|
| **ind var** | *Est 13* | *Est 14* | *Est 15* | *Est 16* | *Est 17* | *Est 18* |
| bteam_2 | .118 (.003) | .107 (.006) | .126 (.002) | .116 (.003) | .107 (.006) | .125 (.003) |
| score_1 | -.030 (.149) | - | - | -.029 (.161) | - | - |
| resp b_1 | - | .276 (.054) | - | - | .255 (.094) | - |
| eq b_1 | - | - | .415 (.632) | - | - | .442 (.610) |
| player 1_2 | - | - | - | -.185 (.330) | -.094 (.626) | -.199 (.316) |
| | | | | | | |
| p-value F test | .003 | .001 | .008 | .007 | .005 | .016 |
| R-sq | .420 | .464 | .365 | .447 | .471 | .397 |

**Table 4a** Estimation with resp b_2 as dependent variable, Treatment A

| | Treat B | | | | | |
|---|---|---|---|---|---|---|
| **ind var** | *Est 19* | *Est 20* | *Est 21* | *Est 22* | *Est 23* | *Est 24* |
| bteam_2 | .113 (.291) | .060 (.555) | .110 (.295) | .120 (.269) | .066 (.526) | .120 (.261) |
| score_1 | .008 (.750) | - | - | .004 (.889) | - | - |
| resp b_1 | - | .234 (.097) | - | - | .211 (.163) | - |
| eq b_1 | - | - | .063 (.634) | - | - | .021 (.884) |
| player 1_2 | - | - | - | .162 (.372) | .081 (.648) | .157 (.410) |
| | | | | | | |
| p-value F test | .434 | .112 | .408 | .482 | .213 | .482 |
| R-sq | .076 | .188 | .082 | .113 | .197 | .113 |

**Table 4b** Estimation with resp b_2 as dependent variable, Treatment B

The main difficulty with running regressions that test the impact of different independent variables is that items such as the number of equilibria achieved and the total score, or the number of individual and overall responses of a certain kind are highly correlated. We thus have multicollinearity problems that force us to account for the variables separately. A first look at the regressions, however, confirms that it is possible to construct models that capture the phenomenon we are trying to investigate. In the tables above we report the summary of our estimations (with resp a_2 as dependent variable in tables 3a and 3b for treatments A and B respectively, and resp b_2 in tables 4a and 4b).

The most striking outcome of our estimates is the non-significance of score_1. The choice to play the convention-abiding solution is not explained by the number of points earned in the previous stage. This may be disappointing from a neoclassical standpoint. But also from our perspective, the self-reinforcement of learnt behaviour depends on its reward. The variable score_1, however, encompasses the overall payoff of the first phase; it is an aggregate value whose origin depends on the game conduct of two players (at a time when both are still developing a strategy) and whose influence on the responses given in a later stage of the game – which are also affected by the change in the composition of the groups of subjects – might be difficult to capture.

It is worth reminding that, because of the characteristics of the payoff matrix, we can regard our bargaining as a coordination game. Here the goal of players is not to maximise their individual score against that of their partner, but to achieve a viable and stable long-term equilibrium. On this possibility, we must remain cautious, because the number of equilibria in phase one is also non-significant across treatments. This problem can be due to the fact that, as with score, we are again treating a complex variable. Both the participants who immediately understood the rule and those who figured it out late in phase one, whether or not they were often coupled with partners who also followed it, should be expected to follow it in phase two. On these aspects we expect further investigation to shed light and earn us additional insights.

Being player 1 is a component of rule following in treatment A where responses a are consistent with self-interested conduct as well. The significance of this variable, therefore, may be somewhat biased. In treatment B the same significance doesn't hold. Here, as remarked above, we observed that those players who didn't follow the rule when they were player 1 tended to play c instead of a.

It is also worth reminding that a is the default response so that, whenever a player fails (or decides not) to answer within 2 minutes, the computer records his answer as a (see appendix).[9] One might thus suggest that the actual task for our subjects was to make two decisions in sequence: first, 'keep a' vs. 'make a deliberate choice'; and second, in the latter case, choose among a, b, and c. We have no means to verify the actual procedures employed by our students (e.g. how many times did they change their response before submitting it to signify that they actually made a decision when they gave the default answer), so we must refer to response time to draw some inferences.

The discussion about response time concerns different response strategies. Ariel Rubinstein (e.g. 2006: 6) considers them to be of three kinds:

- 'cognitive' when they involve aware reasoning;
- 'intuitive' when they involve an instinct;
- 'reasonless' when they are likely to be the result of a process involving little or no reasoning (e.g. in our example, offering b in the ultimatum game in Treatment A).[10]

Generally speaking, it might be expected that intuitive responses take shorter time than cognitive ones. In two experiments quite similar to ours with respect to the effort required to understand the payoff structure, Rubinstein (ibid.: 7, 9) shows that in a game with a 2-by-2 payoff matrix, the median response time is 37 seconds for the intuitive solution, and 50 seconds for the cognitive one; with a 4-by-4 payoff matrix, the median response time was 76 and 83 seconds for the intuitive solutions, 64 seconds for the reasonless one, and 161 seconds for the cognitive solution.[11]

[9] We imposed a time limit for pragmatic reasons, that is to avoid keeping some students waiting, when their partners were taking a long time giving an answer.

[10] Because even experimenters do not have perfect information about their subjects, also responses that stem from a mistaken reasoning fall within the 'reasonless' category. Concerning response time, conversely, one may predict that random guesses are faster than cognitive responses, but mistaken reasoning will probably take the same time, or more if the subject is having troubles finding an answer.

[11] Rubinstein (ibid.: 5) gathered his data through an internet site, and calculates response time as the number of seconds elapsed between the moment that the server receives the request and the moment that an answer is returned to the server. Therefore differences in the speed of the internet connection might have produced some distortions. Because all our subjects were in the same computer room, our observations of response time were more easily comparable (and suffer less from the typical variation encountered in observations of this kind).

A time limit, if it is very strict, might therefore force a subject to give an instinctive response or one without careful deliberation – i.e. somehow reasonless. This does not seem to be the case. Our students responded well ahead of the deadline and did not seem to be under time pressure throughout the experiment. In Treatment A (N=576), only 4 responses took 2 minutes: three of these were a, and one was b. In Treatment B (N=600), there are 8 observations which took the full time, of these one was a, one was c, and six were b answers.[12] Because of the small number of observations, and because they roughly reflect the general responses obtained in the experiment at large, we do not believe that the time limit was problematic for our subjects.

On the other hand, it is also possible that a player willing to accept the default answer submits it right away without thinking about it, instead of waiting until the end. In this case, her response time should be significantly shorter. (We indeed believe this happened in one case: an answer a given in 2 seconds, which we believe was a mistake.) Once again the data do not suggest such effect to have much impact. In Treatment A, there are 5 observations faster than 20 seconds (4 answers a and 1 answers b). In Treatment B, there are 7 such observations (3 answers a and 4 answers b). If we expand the criterion of ‘excessive speed’ to include all the answers below 30 seconds, there are 16 in Treatment A (11 answers a and 5 answers b) and 20 in Treatment B (8 answers a and 12 answers b).[13] Furthermore, if a student didn’t take any interest in the experiment and decided to respond right away or to let the time go by without answering, we should see a series of very fast/very slow answers, which we didn’t. Both fast and slow answers are isolated and no player gave them repeatedly.[14] It is, again, comforting to note that there were very few observations of this kind, and that they reflect the general game conduct for the experiment at large. We can therefore confidently rule out any major influence of the default response on our data.

We should also remind that there are large variations in individual response times in economic experiments, so their insight is likely to be meaningful only in presence of a large sample (i.e. in the range of thousands of subjects). Although unfortunately this is not the case of our experiment, the response time of our subjects is remarkably homogenous and it affords us the possibility to identify some interesting phenomena. In Treatment A (table 5a) the overall median response time is 53 seconds, and the average response time is 61 seconds; though the prevalence of answers a affects the overall result, this effect is negligible.[15] In Treatment B (table 5b) the overall median response time is 56 seconds, and the average response time is 57 seconds. Once again, the effect of answers b is negligible. This should also rule out the hypothesis that response a was more intuitive than other responses. We find this result comforting because, in order to test learning effects, we did not want any answer to be intuitively superior to any other.

[12] Furthermore, one of these observation occurred during the first turn, and the rest occurred at the beginning of phase 2 (2 in turn 16 and 5 in turn 17) when the change in the composition of players might have induced our subjects to re-evaluate the situation, thereby taking more time.

[13] If these observations mean anything, they seem to suggest that the fastest responses tend to be those in accordance with the rule.

[14] 26 out of 48 subjects produced at least one ‘very fast’ (i.e. <30s) or ‘very slow’ answer (> 2m). One player gave 3 fast and 2 slow answers, but all the others gave only 1 to 3 (over 25 turns). As discussed above, these answers are both a and b (with one ‘slow’ c). This lets us conclude that also at the individual level there are no major effects due to lack of reflection in giving the answers.

[15] Because of a malfunctioning of the software, the system stalled for about 4 minutes during turn 7 in Treatment A. We thus treat the observations from turn 7 as outliers. However, subtracting the ‘stall time’, response time was similar to that of the other turns.

| Resp. | a | b | c | All |
|---|---|---|---|---|
| median | 53s | 63s | 62s | 53s |
| average | 61s | 63s | 62s | 61 |

**Table 5a** Response time by answer, Treatment A

| Resp. | a | b | c | All |
|---|---|---|---|---|
| median | 58s | 56s | 60s | 56s |
| average | 59s | 55s | 69s | 57s |

**Table 5b** Response time by answer, Treatment B

| | Phase 1 | | | | Phase 2 | | | |
|---|---|---|---|---|---|---|---|---|
| Resp. | a | b | c | All | a | b | c | All |
| median | 54s | 65s | 69s | 60s | 48s | 52s | 51s | 49s |
| average | 60s | 65s | 65s | 61s | 60s | 59s | 55s | 60s |

**Table 6a** Response time by answer, by Phase, Treatment A

| | Phase 1 | | | | Phase 2 | | | |
|---|---|---|---|---|---|---|---|---|
| Resp. | a | b | c | All | a | b | c | All |
| median | 61s | 56s | 62s | 58s | 45s | 47s | 43s | 46s |
| average | 63s | 57s | 68s | 60s | 52s | 54s | 73s | 53s |

**Table 6b** Response time by answer, by Phase, Treatment B

Because of the small size of our sample, we cannot draw strong inferences from changes in response time. We can, however, make some general comment. The most common responses (a in Treatment A and b in Treatment B) are operated faster than the others. this observation seems to suggest that learning did in fact occur. One manifestation of learning is the internalization of the rule, which is consequently operated in a more instinctive manner (we believe that rule-following can be faster than a deliberation based on a canonical representation of a choice-situation).

We thus expected our subjects to acquire speed as they become acquainted with the game dynamics. Indeed the median response time in Phase II is about 11/12 seconds lower than in Phase I for both treatments, but the reduction in response time might be to some extent contrasted by the fact that subjects keep changing role, and this might impose extra care in making each decision. Again, the small sample, prevents us from concluding that responses in Phase I are cognitive and they progressively become intuitive in Phase II. Despite the necessary caution, however, we note that there are some indications that this phenomenon might occur.

The variable that seems to best account for game conduct in phase two is the number of responses given during the first stage. Both in treatment A and B, the number of answers a given during the first phase explains the number of answers a given in the second phase. The same is true for answers b in both treatments. This is a strong indication of rule-following behaviour.

We are thus tempted to treat the subjects as belonging to either category: those who recognized the rule and believed it still held its validity in phase two, and those who didn't. The former therefore should behave in accordance with the rule, while the latter don't need to. This conclusion is corroborated by observing the pattern of change in the number of equilibria from phase one to phase two we emphasised above. It is further supported by the remarks we made above regarding the consistency of conduct in the ultimatum game. Furthermore, the decline in response time from Phase I to Phase II, and the faster response time for repeated answers, both point to the suggestion that the rule of each treatment is somehow internalised by many players.

Whether they think the convention should hold and why, however, are questions to which concrete answers we must delay until further investigation is conducted. This result, if weaker than might seem desirable within a traditional approach, is on the other hand perfectly understandable against our theoretical background, which encompasses a larger range of factors that explain individual self-reinforcement of learnt behaviour. The number of times a player makes a choice, indeed, seems to be significantly influenced by the number of times he operated the same choice in the previous phase. This indicates that learnt behaviour is reinforced at individual level also as a consequence of factors like habit or the fact that such behaviour is widely shared, and lack of compliance with it might be a cause of blame. On the other hand, personal moral, psychological, and cultural factors are very important in the determination of the effects of external stimuli on individual responses. In his analysis of individual cognitive processes and learning dynamics, Hayek emphasises that, besides the shared factors deriving from social interaction and cultural context, each individual develops idiosyncratic processes of interpretation that depend on his own personal experiences and on the cytoarchitecture of his brain.

## 4. Concluding Remarks

The experiment we reported is part of a larger research project that investigates the processes through which individuals interacting with other individuals under various institutional settings give place to co-causation dynamics (Hodgson 2003). Our results suggest the presence of complex learning mechanisms which back up the theories of Hayek and Bandura.

The academic convention of producing reports and papers in English, as widely diffused as it is, is not a universal maxim for everyone to follow at all times. There exist thriving markets for French or Japanese books; there exist several academic journals in German and in Italian; and countless conferences and seminars are held daily in languages as varied as Arab, Dutch, and Finnish. This remark, however, doesn't make English less of a convention. In our experiment, in treatment A, we witnessed the emergence of the convention 'play a' and this conclusion remains unaffected by the further observation that one couple of players achieved equilibrium bb.

Even to the extent that a large majority of scholars does recognize English as the appropriate language of scholarly interaction worldwide, this acknowledgement says nothing about the subjective reasons for conformity. It is easy to imagine that someone does so because they think it would be too costly to establish a new convention for all to speak, say, Portuguese. Someone else might be an English speaker who knows no other language. Insofar as they meet and greet and interact in English, the convention obtains regardless of any individual difference behind that façade. We remarked above that the proposer in the last stage of our experiment is in a position to exploit 'play a' in treatment A. Nonetheless, as long as she plays a, while thinking it is appropriate in the light of previous interactions (and we noticed this phenomenon is somewhat twisted in treatment B), she is conforming to the convention.

Conventions per se do not carry a detailed list of conditions under which they do or do not apply. This information is usually supplemented by external cues. In our lab experiment, as mentioned above, those cues are largely ruled out. The fact that both recognize English as the appropriate language for their academic interaction doesn't make it very likely that two colleagues from Turkey address each other in English rather than Turkish. But, even when they are in Ankara or Istanbul, if foreigner researchers are present, it can be expected that they switch to English. As conditions, setting, partners change, it is understandable that an agent may want – so to speak – to experiment around the applicability of a newly learnt convention. This might be yet more probable when the convention is somehow abstract and externally induced, as in our experiment. The short overall duration of the experimental session (and of each distinct phase in particular) makes us suspicious of the possibility that all our subjects fully internalised the rule. By asking them to express their satisfaction at the end of each phase, we tried to induce the participants to thinking about it and about the alternatives. To fully internalise a behavioural norm through both trial-and-error and vicarious learning mechanisms may require several interactions and take a longer time than was available under our conditions.

It may be added in passing that even someone who knows and recognizes a norm might find it unjust or inappropriate, and refuse to comply with its requirements. Some of our subjects in treatment B probably thought it wasn't fair to ask of them to play against their better judgement in the ultimatum game.

Human learning is a multifaceted phenomenon. Not every lesson learnt is the same, nor is every learning process the same. The most immediate consequence of this complexity is witnessed by the fact that there exist several theoretical approaches to learning.[16] Theories of collective patterns of learning, moreover, need not rest on any account of individual learning, traditionally making this enterprise more of an independent research question than the extension of earlier achievements. Indeed the analysis of the emergence and resilience of institutions broadly defined, but also defined as conventions as in the case at hand, has progressed independently from the psychological underpinning one might expect such analysis to rest upon. We believe the dichotomy between individual and collective levels of analysis to be untenable, and to pose limiting constraints on our capacity to address various relevant institutional phenomena.[17]

We thus approve of and elaborate upon those efforts that aim at bridging the gap. This task is admittedly daunting. Our experiment and the kind of data we asked of it must face the further challenge of giving birth to a shared behaviour in the context of a multi-stage game theoretical bargain with both human and artificial agents. This experiment, as every empirical investigation, captures only some aspects of the complexity of the real world (or of the laboratory, for that matters) and these are the aspects experimenters believe to be the most relevant. In this respect, we have the firm conviction that our experiment reached much farther than statistical significance reveals.

[16] For the state of the art, see the Special Issue on Learning of Daedalus, and in particular Gardner (2004) and Bruner (2004).
[17] For instance institutional change (e.g. Rizzello and Turvani 2002).

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**Appendix**

*Instructions phase I*

You will be assigned to a group of 8 players. Some of them might be artificial agents (virtual players managed by the computer which, nonetheless, act in accordance with a fixed logical strategy). The number of artificial agents in you group may vary: from 0 (none) to 7 (everyone, except you). You will play with the same group for a number of turns.

Each turn you will be told whether in that turn you will take the role of player 1 or player 2.

You will be randomly and anonymously coupled with another member of your group.

Each turn you will have to choose one letter among A, B, or C.

At the same time, without communication of any kind, the player you are coupled with will make the same choice.

If you both choose A, player 1 will win 8 points and player 2 will win 6.

If you both choose B, player 1 will win 6 points and player 2 will win 8.

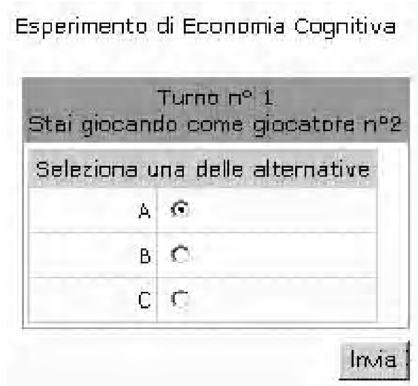
If you both choose C, both players will win 4.

In every other possible solution, you will both win 1 point.

The choice of the player you are coupled with will be revealed to you at the end of each turn.

Each turn you have a maximum of 2 minutes to make your choice. If you do not express your choice within this time, the computer will automatically select solution A.

To start the game, you will be asked to enrol.




First and Last Name: ……………………………………………………………

How satisfied are you of the result obtained during the first phase of the game? Express your satisfaction with a grade between 0 and 10.

Each turn you will be told: which turn it is, if you are player 1 or 2, and the options you can choose among.

First and Last Name: ……………………………………………………………

How satisfied are you of the result obtained during the first phase of the game? Express your satisfaction with a grade between 0 and 10.

*Instructions phase II*

From this moment you will be assigned to another group, entirely composed of real people who are in this room.

The game is the same as before.

First and Last Name: ……………………………………………………………

How satisfied are you of the result obtained during the first phase of the game? Express your satisfaction with a grade between 0 and 10.

Do you consider the division obtained a fair solution?

*Instructions phase III*

Now the game changes.

You will be randomly coupled with another player.
At the beginning of the game you will be told whether you are player 1 or 2.

Player 1 plays first and makes an offer that player 2 may accept or not.
If player 1 offers A and player 2 accepts, the former wins 10 and the latter 6.
If player 1 offers B and player 2 accepts, the former wins 6 and the latter 10.
If player 1 offers C and player 2 accepts, the former wins 6 and the latter 6.
In every other solution, both players will win 3 points.

At the end of the bargaining you will be asked to state how satisfied are you of the result obtained, with a score between 0 and 10.