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An Experimental Investigation on Learning and Context Effects

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Abstract

This paper revisited Gregory Bateson's theory of hierarchical learning through an experiment testing the existence of context effect and learning spill-over in two following games: a coordination game and a two-step battle-of-the sexes. The first part of the experiment is seen as a kind of training period. The different groups of the coordination game are, in fact, designed so to reinforce different representations of the games, requiring to look at different aspects of a series of images shown in the screen. The second game allows testing if differences in training determine different behaviors in a same situation. Our experiment suggests that the preliminary training influences how the second game is perceived. While the incentive structure of the battle-of-the sexes is not identical to the coordination game, the presence of an image determines a different kind of context similarity with the previous one.

Keywords: hierarchical learning, Bateson, experiment, context effects, coordination

JEL Classification: B5, D03, Z19

1. Introduction

The present paper aims at testing if a reinforced representation of a situation can influence subsequent choices in similar but not identical tasks. The experiment we performed studies the effect of the experience in playing two following games, namely a coordination game and a two steps battle of the sexes.

In previous literature, there are few articles trying to investigate this kind of effect. In some previous articles investigating this kind of effect, different terms to explain how preliminary experiences can affect following behavior are used. In the managerial literature Levinthal and March (1993) use the expression "the myopia of learning", focusing on the negative effect of experience, which in their view can sometimes be a bad teacher. Egidi and Narduzzo (1997) talk about path dependence in a complex organisational task; participants are trained with a specific configuration in a card game, and then play with a different one, requiring a new strategy. Camerer et al. (2000) show the transfer of precedent from two following games. Huck et al. (2007) study "learning spillover" (due to analogy based expectations) from different coordination games with a 3x5 matrix. With many differences, all of these analysis show that a strategy learned in a context can be transferred to a different one, namely to a different game or to a new problem, similar but not identical to a previous one.

This paper proposes additional evidence on this transfer of strategies, starting from a theoretical representation of learning processes based on Bateson (1972). In his view, learning can be represented as a hierarchical process made of different steps. The possibility to use past knowledge is related to the capability to

perceive the similarity between a new context and another experienced in the past. At a first stage, agents adapt to their environment, through a trial-and-error process. The solution defined in such a process and the relation between stimuli and answers affects further learning steps. This strategy allows to take into account different aspects of learning, pointing out to the need of considering the strategies played, but also the representation of the situation. It also allows for reflecting on the relation between individual and environment.

Traditional game theory predicts that equilibrium selection will converge on the unique Nash solution. In case of multiple equilibria, rational players will play a mixed strategy corresponding to a probability equal to 1/n strategies. But, "predicting which of many equilibria will be selected is perhaps the most difficult problem in game theory." (Camerer 2003, p. 336). In fact, the "selection problem is essentially unsolved by analytical theory and will probably be solved only with a healthy dose of observation" (Camerer 2003, p. 336).

For this purpose, in the construction of the experiment we considered learning processes, and in particular Gregory Bateson's learning theory, presented in his book "Step to an ecology of the Mind" (1972), and we used images to create decisional frames.

The problem of equilibrium selection has recently been analysed in coordination games under incomplete information conditions (Cabrales et al. 2007): plausible explanations of results converging on risk-dominant strategies have been the activation of a learning process in iterated games (Cabrales et al. 2007) and social learning mediated by higher status players whose choices tend to be imitated (Eckel et al. 2007).

Batesons learning theory represents a theoretical reference useful for an interdisciplinary dialogue: in his work, he took in account both psychological and

biological insight in order to explain how people perceive a situation. Moreover, his model can be used to understand how a game can be represented by agents, according to their experience. Economists studied learning mainly in stable logical contexts, with given structures of material incentives: for instance, social learning models refer to the frequency of a particular response which tends to be imitated by other social actors in the same population in similar contexts (Bowles 2004; Witt 2003) and cooperative iterated games are characterized by a Pareto-dominant strategy which can be selected for a matter of "precedent" and "collective rationality" (Axerlod 1984), according to an evolutionary game theoretic account.

Notwithstanding, in real-life interactions, contexts are not always stable and people make decisions in different kinds of situations at the same time. What happens in these cases can be understood considering Gregory Bateson's learning theory. In his view, learning can be described as a hierarchical process involving different levels of change. Such levels can be better understood if compared to the laws of motion.

"Zero learning" is the absence of motion, and it can be defined as the absence of change and stasis in decisions taken at different times. In some way, a "zero learning" is the result of already acquired knowledge which leads to a stable situation, in which a given context is responded to with a well-defined strategy or reaction. The subject can also give highly skilled responses for a particular context and he or she can have a set of already available alternatives which result particularly suitable to given situations, but the responses are fixed and, given the context, there is no correction or tendency towards change. In ordinary, non technical parlance, the word "learn" is often applied to what is here called "zero learning," i.e., to the simple receipt of information from an external event, in such

a way that a similar event at a later and appropriate time will convey the same information: "I learn from the factory whistle that it is twelve o'clock". Each time that I will hear the factory whistle I will know that it's twelve o'clock. I acquire this new piece of information, but nothing changed in my decisional strategy. Zero learning, then, can be defined as the absence of trial-and-error experimentation and it is characterized by "the simple acquisition of information" (Novarese, 2012, forthcoming). In particular, what Bateson defined as "zero learning" has been called by behavioral psychologists as conditioned stimulus-response reaction or an operant. This is an habit, that can be defined as a model of repeated behavior resistant to change. Habits are also present in the literature of the "old" institutional economics (Veblen, 1899; Anderson, 1933). The next step, "learning one", is a change in the behavior practiced in zero learning: it is, in fact, a revision of choice in a given set of alternatives. "Learning one happens when a new association is developed" (Novarese, ibidem) The change is, generally, adaptive and is characterized by a process of trial and error and a mechanism of comparison between new choices and previous strategies. Examples of learning one are the cases of instrumental reward and instrumental avoidance, when an agent learns to avoid a specific action in a give situation (in order, for example, to avoid blame). These models are typical of the Western philosophy based on free will, since prizes or punishments are due to the agents' behavior and the same kind of interpretation is applied to economics, in which payoff or utility depends on the agents' choices.

The further step in Bateson' theory is learning two. It determines a different and faster way to develop an action in order to deal with a new situation, based on a previous successful strategy. Learning one determines a specific segmentation, according to which an agent recognizes a context and then reacts to a stimulus by

using a given strategy. The same segmentation, that is a sequence of stimulus recognition and answer, can later be used in a different situation. This process leads to the creation of habits: a same approach is applied to solve an entire class of problems, which are seen as similar. Choices determined by instinct and genetic reactions belong to zero learning, as do pre-programmed responses derived from past learning. The player of a Von Neumannian game, by definition, is capable of all the computations necessary to solve whatever problems a game may present; they are incapable of not performing these computations whenever they are appropriate. Such a player receives information from the events of the game and acts appropriately upon that information. However, their learning is limited to what is here called zero learning (Bateson 1972, p. 284).

A relevant difference between zero learning and learning one is that in the latter, at time t+1, an agent 1 behaves in a different way in respect to time t; because at time t+1 he has undertaken training. Moreover, he behaves differently from an agent 2, who was trained in a different setting or has not been trained.

For this reason, in the definition of learning one, there is an implicit definition of context: the stimulus is somehow the same at time t and t+1, and this notion of *sameness* delimits the notion of context as well, which must be the same in both periods. Without this assumption of repeatable contexts there could just be zero learning. Having a repeatable context is necessary for allowing any kinds of learning, as here defined. If the context changes every time, no learning (one) can occur. Every situations would be different from the others and experience could not be gathered and used. Yet, this fact makes it necessary to define when agents perceive to be in a same given context. There should be some kind of *context marker* informing the agent. In particular, "we may regard context as a collective term for all those events which tell the organism among what set of alternatives he

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must make the next choice" (Bateson 1972, p. 289). Context markers can activate a specific process of segmentation, that is the ability to recognize the stimuli to react to. The process of segmentation is the particular and subjective perception of external reality; it is the way we perceive a situation as punctuated with a particular sequence of stimuli and choices.

Following this interpretation, a context is considered as the set of all possible elements that characterize a situation as a specific one. This is recognizable by all those who share the same perception of the fundamental elements that determine the situation in this specific way. Given the information of the context marker, agents know how to react to a given stimulus. Such stimulus can be seen as an elementary signal. The context marker represents a meta-signal which defines how the stimulus has to be read. An organism could, in fact, respond, to the same stimulus differently in different contexts. When the agent learns to react to the stimulus, they also learn to classify the meta-signal and to define a context and then to make a given choice.

Defining how an agent acts in a given context is easier in a mathematical or logical world where specific structures make the contexts stable, like in standard game theory. Standard economics and game theory do not need this richer representation as they are based on the idea that people react just to the mathematical representation of a situation, based on the material incentive. Contexts do not matter. The problem arises when the analysis is brought into reality or tries to be more realistic, and the logical structure is enriched with data, variables, information: this is exactly what we try to do in our experiment, passing from a pure logical game to a richer representation of the reality.

Bateson's multi-steps concept of learning can also be read in the light of Friedrich Hayek's, between information and knowledge (Hayek, 1937). The first can be described

as the objective data while knowledge is the individual representation of that external signal. In Hayek's view, the process of knowledge development requires a continuous adaptation to the environmental conditions that humans face and is context-dependent. Each rule of behaviour is general because it is abstract and it can be applied in several contexts, but at the same time it is strongly local because, once it has been applied, it depends on the environmental cues triggered by a specific condition and on the individual interpretations given to these cues. So, because of the difference in individual experience, a same information is perceived in a different way. Given a same signal, different reactions will follow. Experimental economics is able to recreate in the laboratory these conditions (Tversky et al. 1981; Smith, 2008), showingthe relevance of a different kind of frames and incentives as agents react to different variables. The model proposed by Bateson helps in understandingg how strategies and decisions need to be related to a specific frame, in order to use the past experience. All situations which are perceived as resolvable with a same kind of strategy can now be defined as similar, as both learning one or two might intervene. Because of learning two, different situations (as different games) can be managed with the same strategy. The use of an image to create a context, is consistent with the "labelling" processes which has been started by Schelling's work on focal points (Schelling 1960): the way in which strategies are described and perceived can influence choices and the expectations players formulate on them. Our image allows to create a kind of frame: so our experiment can be related to the stream of research which investigates how differences in the game's presentation to the players can determine different choices (Hoffman et al.1994; Mehta et al.1994; Sugden 1995; Larrick et al. 1997; Camerer 1998; Warglien et al. 1999; Hoffman et al. 2000, Sugden et al. 2006). However, the originality of the present research

rests on studying the influence of the first game on the second, testing the viability of Bateson's hierarchical learning theory.

This particular interpretation is a key point in order to understand our laboratory experiment and seems to find a plausible application in field experiments as well, like those run in different small scale societies (Henrich 2000; Henrich et al. 2001). In these experiments it emerged that subjects play experimental "laboratory" games according to rules and models of the world that shape their ordinary social and private life. For instance, people can refuse very high offers in a ultimatum game because they are motivated by a sense of honour and obligation: if they are accepting the offer now, they will have to pay back a higher offer in the future. This example explains how the same game and the same kind of situation can have different meanings and can be subjected to different kind of interpretations, according to the values, cultural practices and habits that a particular member of a population can have. It also shows how the same person can find similarities between different situations, behaving according to the same representation.

2. Methods

2.1 Participants

We enrolled seventy students, attending their first year at the Faculty of Law. They had no prior background in behavioral economics. We divided them in three groups: a total of 24, 18, 28 subjects participated in the first, second and third group respectively. Each subject took part only to the experimental condition corresponding to its group. Each group participate first to a coordination game (turns 1 to 18) and then to a two-steps battle of the sexes game (turn 19-27).

Players were paid according to their payoffs: each point gained was exchanged for 0.07 cents of Euros.

2.2 Procedure

We conducted an experiment of two parts: the first is a coordination game, that was characterized by three different conditions corresponding to three different group of participants; the second is a two-step battle-of-the sexes game, that was the same for all the seventy participants. A computer randomly and anonymously paired up subjects in the lab. These couples remained unchanged throughout the experiment. In each turn, subjects were shown both their own and their partner's choices and payoffs.

2.2.1. The Coordination Game

The first part of the experiment was a coordination game, played by three different groups. In each turn subjects had to pick one word between two possible alternatives. Words in this double-choice option represent written numbers (for example "four; five"). Along with the two words subjects were shown an image. The images appearing next to the decision options represented a set of two numbers in Arabic characters. Each of them was represented in several point of the images either in scattered orders or followed some precise patterns. The images could either present both the numbers in the double-choice option or just one of them and another one that was not presented in the double-choice. One of the two numbers was drawn more frequently. For instance, when subjects had to coordinate in choosing one word out of "five" and "four", an image with "5" and "4" in Arabic characters was presented (see figure 1, used at round seven) and the "5" occurred more frequently in the image. In another round, when subjects needed to coordinate in choosing between "four" and "eight", an image with "8"

and "7" in Arabic characters was presented, and the "8" occurred more frequently (see figure 2, used at round 1). In every round both words and image changed.

Numbers appeared at random on the screen of each player and they might not be visualized in the same order for each of them. So what was seen as the first number for player one, could be the second for player two. The picture appearing next to the words was the same.
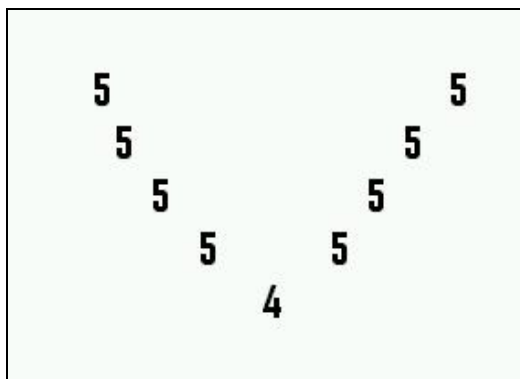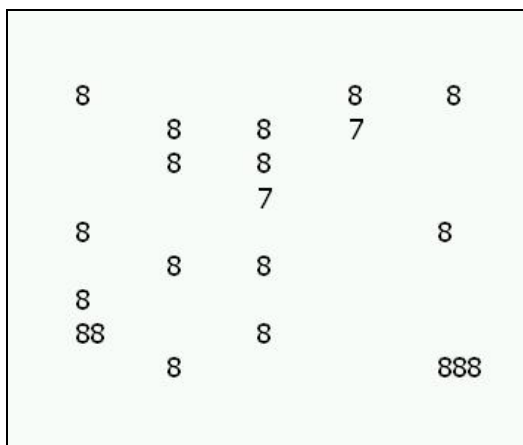
Figure 1

Figure 2

We ran three groups, with different payoff structure of the game.

In the first group, subjects got a higher payoff when picking the same number. In the instructions there was no direct reference to the image as a possible tool for coordinating. Yet, obviously, the picture was supposed to play a fundamental role,

as it seemed to be the easier way to coordinate. Subjects could learn to choose the word of the most frequent number in the picture, or even the opposite one. They could just look at the image and find the most focal number (generally, but not always, the most frequent). Table 1 shows a matrix referring to this treatment. Choosing the same number allowed subjects to score points. The important thing for paired subjects is achieving coordination, regardless on which number. This is the reason why in the following matrix we simply refer to "number A" and "number B".

Table 1. Pay-off matrix for the first group

P1/P2	Choose number A	Choose number B
Choose number A	(6,6)	(0,0)
Choose number B	(0,0)	(6,6)

In the second group the numbers to be chosen and the image appearing next to the text were the same as in the previous treatment, but in order to score points, subjects were not just supposed to pick the same number; they both had to choose the lowest one. In other cases each of them obtained zero points. Here the images were the same as for the first group. The game was characterized by imperfect information: players just knew that they would obtain a zero payoff when their choice were different. The instructions just said that if they both picked a same specific number (without specify that has to be the lowest one) they would have obtained a reward. The instructions also said that the winning number could be inferred as it followed a specific rule. Table 2 shows the implicit payoff matrix for this game.

Table 2. Pay-off matrix for the second group

P1/P2	Choose the lowest number	Choose the highest number
Choose the lowest number	(6,6)	(0,0)
Choose the highest number	(0,0)	(0,0)

In the third group each of the player scored six points if both of them choose the lowest number; but each time coordination was achieved by following the wrong rule (i.e, the highest number) both players scored a negative payoff of minus seven. In absence of any coordination, both of them score zero points. Here the image were again the same of the treatment one and two. Players could not infer this from the instructions: the game was characterized by information withholding, so that they had to figure out the payoff structure of the game while playing. In this treatment the instructions said that the score depended on the choices of both players and that they could either win or lose a same amount of money. Table 3 shows the implicit payoff matrix.

Table 3. Pay-off matrix for the third group

P1/P2	Choose the lowest number	Choose the highest number
Choose the lowest number	(6,6)	(0,0)
Choose the highest number	(0,0)	(-7,-7)

Summing up, in the first group, following just the image was the simplest way to obtain coordination; in the second and in the third groups however it was not sufficient, since coordination had to happen on the lowest number and the image did not give information about this. Moreover, while in the second treatment, a

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coordination on the highest numbers gave zero point, in the third one, it gave a loss of seven points. Therefore we considered each of the three different groups as a different kind of possible training before playing the two-steps battle of the sexes. Our aims is to observe the different effects of each of them on the second game. In the fist group looking at the image should be reinforced, while in the others it should not.

2.2.2 The battle-of-the sexes game

The second part of the experiment (turns 19 up to 27) was a two-step battle-of-the sexes game. This part of the experiment was the same for all seventy subjects. It was built up as an ultimatum game, since paired players can be either proposer or receiver. Their roles were randomly selected by the computer at the beginning of the second part (i.e. at turn 19). Differently from an ultimatum game, proposers could not make their own personal offer, because they had to choose between two different possible amounts only. Again, at each round, players were shown an image. The images used in this game were similar to those of the first game. Each turn of the game was, therefore, characterized by a choice among two numbers and by the appearance of an image. The first player had to pick one of the two numbers presented in a double-choice option. The first player's proposal was communicated to the second one who had to accept it or not. Receivers were aware of the possible payoffs and the alternative decisions available and saw the same image as the proposers. If the first number again expressed as a word was selected and the receiver approved it, the proposer got a payoff of seven and the second player a score of five. Otherwise, if the second number (expressed as a word) was selected and approved, the proposer got five points and the second player obtained seven. If the proposal was not accepted both players got zero points.

Table 4. List of all numbers in the double-choice alternative for each group

Turn	1st choice	2nd choice	MFN
1	Four	eight	eight
2	Three	six	three
3	One	two	one
4	Two	four	two
5	Seven	fourteen	seven
6	Four	eight	four
7	Four	five	five
8	Three	seven	three
9	Four	nine	nine
10	One	eight	eight
11	One	two	one
12	Two	seven	two
13	Eight	nine	nine
14	Two	three	three
15	Five	seven	five
16	Four	nine	four
17	Three	nine	nine
18	Five	eight	eight
19	Two	four	four
20	One	two	two
21	Three	seven	seven
22	Four	eight	eight
23	Four	nine	nine
24	Three	six	three
25	Two	five	two
26	Two	seven	two
27	Two	four	two

Table 4 shows the list of choices for each turns in all the experiment: the last
column indicates the most frequent number in the picture of that round. In the
following analysis we will divide the battle-of-the sexes in two periods: from
turns 19 up to 23 (we call this the third period, just to avoid using the adjective
first and second, assigned here to the two games), and from turns 24 up to 27 (i.e.,
the fourth period). While in the third period the lowest number in the two-choices
option and the most frequent number in the image did not coincide, in the fourth
period they did.

2.3. Data Analysis

Both Anova and Krustal- Walliss non parametric test were conducted to test statistical significance of results.

2.4. Results

During the first game, players in group one learnt to play the most frequent number in the image more than the others players. In fact, players had to achieve coordination in order to obtain a positive payoff, regardless on which number. Therefore, they would be motivated to look at the image in order to choose the most (or least) frequent number in the image also in the battle-of-the sexes game more often than players in the other groups. Instead of just looking for the egoistic choice (or for an altruistic one) they would be influenced by the image. Therefore a learning spill-over process happened between the first and the second game.

The training effects on the battle of the sexes for the second and third groups was different. While in the first group it is plausible that players learnt to choose the most frequent number in the image, in the other two treatments this behavior was not rewarded and the image did not gave good hints. Even if players did not understand the correct rule (pick the lowest number), the rule "pick the most frequent number" was not reinforced. For this reason the image did not became a focal point. In Bateson's word, the segmentation "look at the image, and then chose the word" was not reinforced in the first game and could not be applied to the second. Players from the first group were more influenced by the image and, consequently, selected different equilibria in part three and four of the battle of the sexes: the word "equilibria" is used when first players' proposals was accepted by the receivers, while "proposals" indicates offers which can be either accepted or

not accepted In fact, in part three, the second choice (the less profitable for the proposer) was the one referring to the most frequent number. In part four, there was an opposite situation as the first word referred now to the most frequent number. Since players are influenced by the first game of the experiment, and so they followed the image, in part three, proposers obtained lower scores than receivers. For the same reason, in part four, proposers obtained higher rewards. Instead, for groups two and three, the differences in the result of the third and fourth parts of the battle of the sexes were less accentuated. In fact, in these groupsts, players did not learn to look at the most frequent number in the image with the same intensity as in the first group.

Since in the first treatment there was a clearly reinforced strategy of the kind "pick the word of the most frequent number", this same strategy was applied also in the second game, with an higher frequency than in the other treatments. So first group agents spontaneously looked at the second game as if it were a natural extension of the first. Therefore in the first group there were more proposals and equilibria on the word corresponding to the most frequent number. This happened even if in the part three of the game the proposer won less than the receiver, selecting the most frequent number in the image, and in the part four, receiver won less than proposer accepting the choice of the most frequent number. This effect at the individual level was less pronounced in the other two groups.

3. Discussion

The goal of our experiment is to find out if and how the experience acquired in the first game influences the choices made in the second one. For this purpose, the

first and the second games of the experiment have been made up with some similarities. A first analogy between the two games is that both of them can be considered and perceived as coordination game. In fact, the battle-of-the sexes has been classified by Camerer (2003) as a coordination game even if it is characterized by divergent rather than common interests. The second analogy is the presence of an image in both game, and more in general, the presence of similar visualizations and tasks in the two games. These analogies could make possible that the coordination game of the experiment works as a training which possibly affects choices in the two-step battle-of-the sexes game.

Our game is then linked to the vast literature on learning, signal detection and stimulus discrimination and differential responding .

The first part of the experiment, namely the coordination game, according with Bateson's theory of learning one, developed a situation in which the same type of behavior has been either reinforced (in group one) or punished (in group two). Given the complexity of the images, participants had to figure out a focal point (i.e. the most frequent number) from other distraction elements, which may suggest to achieve coordination with the partner (and then the equilibrium) following a different strategy. The experiment allowed then to test how the focal point selected in the first game (i.e. the coordination game) has been detected and used again in the second part of the game, i.e. the two-steps battle of the sexes

In particular, we identified at least three possible ways to perceive the game and the influences between the coordination and the battle of the sexes game:

- rational choice; player one chooses the most convenient number for herself counting up on the acceptance of the player two. In this case, player one won more than player two;

- fair choice; players one and two split up the points, alternating the choice of the first number with the one of the second. In this case, both players won the same amount;

- path dependent choice; the choices depended on the image, since the players learned to follow the image in the first game of the experiment[1]. In this case, players did not follow a personal reward. They rather choose following the images.

By applying the model proposed by Bateson (1972), given the similarities in the problems to be solved, we could expect some kind of inertia between behaviors in the two games, but only if players developed a reinforced strategy in the first one. This is, in fact, a key point.

Both Bateson's learning one and two are relevant. Learning one suggests that in a given context, signaled by a context marker, agent should learn to perform a same choice. The problem consists in fixing a context. As in the real world there are no two identical situations, in our experiment the first game and the second one are not identical. Learning two shows that agents can apply classed of solutions in different problems, and in this way reduce the need for a precise definition of the context, that can be seen as a situation where a same action can be performed and eventually reinforced. Contexts need also to be shared and recognized, so there should be some signal able to trigger a specific strategy. A strategy reinforced in the first game, could then also be applied in the second one.

In the second game, the most profitable option for the first player is to choose the first number (rational choice). In this way, he obtains seven point, if the second

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[1]Accordingly with an idea of the acquisition of knowledge as a path-dependence process (Rizzello, 2004)

player accepts: according to the rational choice, the second player should accept, and win five instead of refusing and win zero. Notwithstanding, the second player could be willing to refuse this offer if it was perceived as unfair. The proposer could, therefore, react to this threat by accepting to win five point, or to alternate offers. A similar behavior could be expected by assuming the hypothesis of fairness. We did not neglect any of these possible effects. Yet our contention was that the decision would be related also to the group in which the first game was played and to the relevant experience acquired by the subjects.
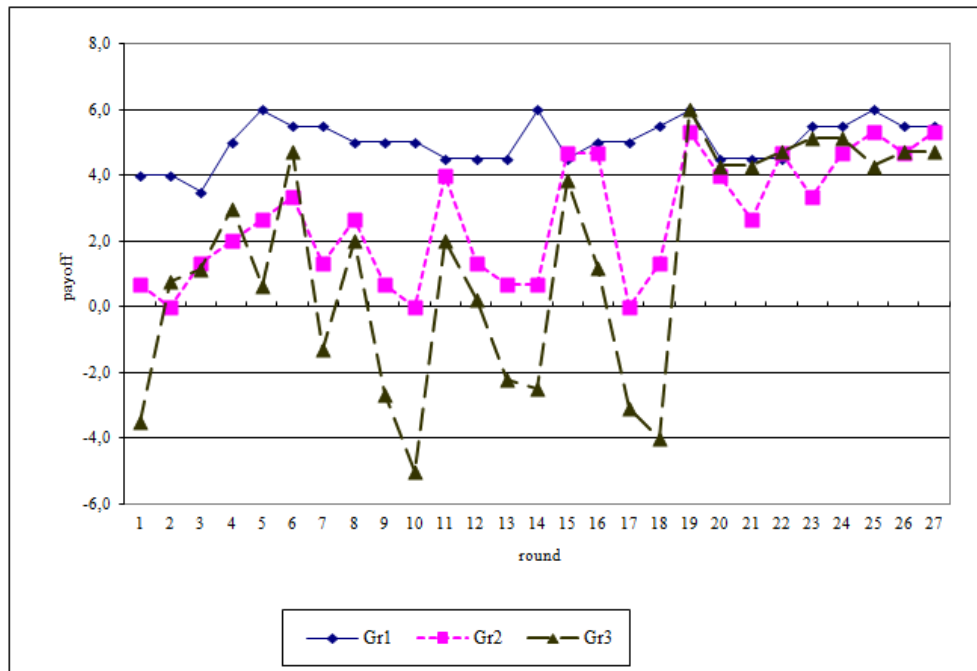
Figure 3 gives a first idea of the mean payoff for the first player[2] for each group during the whole experiment (the first game ends at round 18).

In the first game the highest mean payoff was almost always achieved by the first group, as expected, since coordination was easier. A fast learning process can be observed here: from the fourth turn the percentage of subjects who coordinated with their partner increased and remained stable. It is evident that the image acquired a real powerful role: even though the players were not told about the need to find out a rule in order to coordinate, they might have related to the image and the most frequent number depicted in it suddenly became their focal point.

Coordination in group two and three was more difficult: players won a lower mean payoff than players in the first treatment. In those treatments, the most frequent number in the image could still be the most focal one from a visual point of view, but this time the game was built upon a very specific rule, that is "coordinate on the lowest number". This rule seemed to be difficult to identify. The image was too strong and captured players' attention.

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[2] Obviously the earnings of the two coupled players in the second game are highly dependent. So we decided to focus our analysis mainly on the first one. The mean payoff in the first game were identical for both players, since they won the same payoff in each turn.

Figure 3.

In order to compare how coordination took place in the different groups, Table 5 shows the percentage of choice of the most frequent number for each group. A number could be either the most or the least frequent; in a single round a player can appear to choose an option just by accident. In other words: the lowest number could be chosen, but this could also be the most frequent. So an external observer might not understand the decision criteria. Looking at the decisions taken in many following rounds, we eliminated this problem as, throughout the game, the lowest number was independent from the most frequent. A slightly different and more reliable indicator of the same attitude is the sequence of turns in which any couple of players chose the word corresponding to the most frequent number (or to the lowest one)[3].

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[3] Let us consider, for instance, the first five rounds. Let us imagine that a couple selects the most frequent number at round three, four and five. It is possible to define a variable called repetition whose value is equal to zero in the first three rounds, while afterwords it takes the values one and

In the first group the percentage of choice of the most frequent number and of the sequences of choices were higher. Groups two and three failed to understand their optimal coordination rule. So their percentage of choice of the lowest number was not higher than that of the first group.

Figure 3 shows also the mean payoff of players one in the second game. If we look at the first treatment, we understand that mean payoffs in the rounds from 24 to 27 were higher than the ones in rounds from 19 to 23. In the last five rounds there was a clear increase in this value. For the other two groups the picture was quite less clear. Especially for the third group, there seemed to be no difference between what we called part three and part four of the second game. Table 5 allows a better analysis of the differences between groups, showing a series of indicators and two significance tests.

In the third period of the first group, players one often offered the less profitable number for themselves (the word proposed corresponding to the most frequent number - i.e. the second one - was higher for this group, even though the difference is not very significant). Notwithstanding, they obtained the highest mean payoff, with respect the other two groups. This can occur because the first group is characterized by the lowest offers' rejection rate, and, then, by the highest number of equilibria.

two. We can compute a mean value for the given period and couple of this variable and divide it by five. In this way we have an indicator of the tendency to repeat a same choice in a given period. If a same choice is repeated by a same couple of players it is less probably a random choice. Using this index, we found the same tendency shown in table 5. Treatment one had the highest mean value (0.29 while treatment two had and index equal to 0.09 and treatment three had a value equal to 0.10).

Table 5. Choice of the most frequent and lowest number in the coordination game: mean values per treatment

	Treatment 1	Treatment 2	Treatment 3	KW p-value	Test t p-value
Percentage of choice on the most frequent number	0.88	0.66	0.68	**0.000****	**0.000****
Percentage of choice on the lowest number	0.55	0.53	0.52	0.490	0.382

Table 6 shows that data about equilibria on the most frequent number, for the first group, are statistically significant both in period three and period four with a parametric and non parametric test. Proposers from the first group choose the most frequent number 72% of the times and the proposals made were accepted 68% of the times. Instead, in groups two and three, the first players were more likely to choose proposals which were the most profitable for themselves but not for the second player, and their proposals were more likely to be rejected as well: proposal for the most frequent number were 56% and 60% respectively in period three of the second and third treatments, while equilibria on the most frequent number decreased with respect the first treatment, being 35% and 42% respectively.

Table 6. Mean Values for some indexes in the battle-of-the sexes, player one.

Index	Treatment 1	Treatment 2	Treatment 3	KW p-value	Test t p-value
Proposals for the word corresponding to the most frequent number, period 3	0.72	0.56	0.60	0.125	0.094
Proposals for the word corresponding to the most frequent number, period 4	0.83	0.67	0.57	**0.023***	**0.019***
Equilibria on the proposals of the word corresponding to the most frequent number, period 3	0.68	0.35	0.42	**0.003****	**0.001****
Equilibria on the proposals of the word corresponding to the most frequent number, period 4	0.79	0.56	0.41	**0.001****	**0.000****
DIFF3	-0.36	-0.15	-0.15	0.231	0.201
DIFF4	0.65	0.28	0.04	**0.003****	**0.001****
DDIFF	1.01	0.43	0.19	**0.010***	**0.003****
Mean payoff for couples, period 3	5.08	3.56	3.40	**0.000****	**0.000****
Mean payoff for couples, period 4	5.63	5.00	4.71	0.119	0.159
Percentage of choices' confirmation for identical images between the coordination and the two steps battle-of-the-sexes (turns 1-22; 4-27; 9-23; 12-26)	0.71	0.50	0.54	**0.034***	**0.022***

The first group was characterized by the highest frequency of choices on the most

frequent number: this datum can be seen by looking at the *mean difference in the payoff among player one and player two in each pairs of subjects*. We call this variable DIFF, which is computed as:

mean value over all t, of: first player's payoff in turn t- pair's of subjects mean payoff in turn t.

If DIFF is negative, this means that the proposer's payoff is lower than receiver's. If, for example, a proposer always picks the first number (winning 7 points, while the receiver gets 5), DIFF is equal to 1. An opposite behaviour would determine a value equal to -1. Data in table 7 shows that in period three, proposers in all treatments won a lower mean payoff than the second player, as they offered many times the second word. The mean value of DIFF 3[4] was lower for the first treatment, but the difference was not significant from the other groups. In period four, all treatments jumped to a positive value of DIFF4, but now the first one had a significantly higher value. In treatment three, DIFF4 is almost equal to 0: there were virtually no differences between the two players. While in the first group in most cases proposers picked the first number and receivers accepted it, in group three players shared the points almost equally and therefore behaved as if they were not relying so much on the most frequent object in the image.

The variable DDIFF measures the differences between DIFF in period four and DIFF in period three. Group one had the highest difference in DDIFF between the two periods. This is consistent with our prediction: players who had been used to look at the most frequent number in the image kept on doing so at a greater extent than

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[4] In Table 6 we defined as DIFF3 and DIFF4 the value corresponding to DIFF in period three and period four respectively.

others.

The inertia between the two games can be tested in another way. Four images had been presented in the coordination game and were then repeated in the second part. Players in the first group showed the greatest consistency, confirming the same choices in the two situations. The first group showed, moreover, the longest sequence of choices on the most frequent number, in both parts of the game, as they showed highest values for the same kind of decision in the first game.

Table 7. An analysis at the individual level: some correlation coefficients between choices in the two games

	tr 1	tr 2	tr 3
Correlation coefficient between the score in the first part of the game and the frequency of seven got in the second part by the first player in the third part of the game	-0.42 (0.09)	0.30 (0.31)	-0.26 (0.23)
Correlation coefficient between the score in the first part of the game and the frequency of seven got in the second part by the first player in the fourth part of the game	0.41 (0.10)	0.59 (0.05)	-0.27 (0.21)

The link between the behavior in the two games can be detected also at an individual level. In the first treatment, a well defined behavior is reinforced. Players who learn to pick the most frequent number got an higher score and developed a stronger tendency to look at the image in the same way also in the second game. This same attitude was only partially reinforced in the second group and is not reinforced at all in the third one.

The correlation coefficient between the score in the first part of the game and the frequency of number seven got in the second part by the first player in the third

part of the game was negative and significant for the first group: first players who understood in a better way the game in the first part got a lower score in part three and an higher one in part four. In the third group this coefficient was not significantly different from zero. So there was no such correlation where picking the highest number was not reinforced. In the second treatment (where picking the highest number where partially reinforced) the correlation was found just when it was convenient for the proposer. The same behavior is maintained in the two games only if it were initially reinforced.

4. Conclusions

This paper aimed at proposing new evidence on learning transfer from different contexts, starting from some insights proposed by Gregory Bateson (1972). This topic is not new in the literature, but it is quite neglected, so further evidence is needed to understand both its importance and field of application. Moreover, there is mainly the need of a general framework for modeling this phenomenon in order to understand when it occurs and which effect it determines. Among other possibilities, the steps based learning idea proposed by Bateson seems to be quite useful. First of all, it is quite general, as it can be applied to study both game theory and other decision settings. It helps, besides, in understanding the adaptive origin of the transfer of learning. It shows both the positive and negative elements of learning. It highlights the link between decisions and the environment and the problem of fixing an environmental context. It shows how the same environment can be perceived in different ways, because of different social reinforcement based on a selection of the information. This model makes it clear how in the real

world agents need first of all to define in which decision context they are, screening all the variables and selecting some of them. Economics usually models human being as just interested to monetary incentives. So all other information can be excluded from analysis. The experimental literature showed that agents react also to other variables, as information. Therefore, studying how information is selected becomes a necessary task. The idea of context and context marker can help in understanding how this selection can occur and how apparently not relevant variables can be used because of learning. Bateson shows that this process can happen because of the same adaptation process (and therefore because of ecological rationality).

In our experiment, the firs group generates a reinforcement of the strategy played in the first game. This strategy is maintained in the second game, while a possible perception of similarities seems to be weaker, or at least different, in the other groups.

The strategy based on choosing the word of the most frequent element reinforces also the role of the image. The image is then the context marker, while the most frequent object is the variable used for picking a word. Players learnt to look at the image, searching for specific information. In the other groups there is no shared information able to allow an easy coordination, as shown by the lower capacity to reach equilibrium. The only shared strategy could be a common expectation of the difficulty in getting a positive payoff. Sharing a rule can be, in a social context, good even if such a rule is not direct to increase the payoff of a single agent in a individualist way. The overall better performance in the first group can therefore be explained by a common representation of the game, lacking in the other groups. In this experiment, learning two therefore can be seen as adaptive, because it allows for a common view of the game: in this game,

learning two is the capacity to apply a same strategy to two different games. If we consider the proposer, fit of decision depends on the reply of the second player, and if the second player refuses choices different from the ones used in the first game, the two games can be seen as a unique context. Therefore, the altruistic strategy developed in this game is just the result of the representation of the game itself and even a demonstration of rationality. Given receivers' behavior, picking the less profitable word in period three can be seen as a rational strategy.

Appendix A: Instructions for the first part of the game

The instructions for the three treatments are reported below. In the original version of the experiment they were written in Italian. The English translation reported here is as faithful as possible.

Instructions for the first group:

You are supposed to fill in the next page with your first name and last name. Once you will click on the start button, the game will start with a certain number of turns. Throughout the duration of the experiment, the computer will pair you with another person in the lab, anonymously and randomly chosen. Your partner will be the same throughout the experiment. In each turn, each of you will see the same image and the same list of two words. The words will be the same for each member of the pair, but their order may be different between the partners because is randomly generated by the computer in a different way for each player. Each of you has to choose a word. If you choose the same word, both of you will be awarded with 6 experimental points; if the options chosen are different, you will not score any points for that turn. You are not allowed to communicate in any way. In each turn you have three minutes of time to make your choice. After you have chosen, the computer shows the choices that you both made and the payoff results for both of you.

Instructions for the second group:

You are supposed to fill in the next page with your first name and last name. Once you will click on the start button, the game will start with a certain number of turns. Throughout the duration of the experiment, the computer will pair you with another person in the lab, anonymously and randomly chosen. Your partner will be the same throughout the experiment. In each turn, each of you will see the same image and the same list of two words. The words will be the same for each member of the pair, but their order may be different between the partners because is randomly generated by the computer in a different way for each player. Each of you has to choose a word. If you both make the same choice selecting the word that fulfills a particular criterion, you will both obtain 6 experimental points. If partners make different choices, they will not score points in that turn. You are not allowed to communicate in any way. If you make different choices or you select the wrong word, you will both get zero payoff. The word that makes you win 6 points follows a specific logic that can be inferred while playing.

Instructions for the third group:

You are supposed to fill in the next page with your first name and last name. Once you will click on the start button, the game will start with a certain number of turns. Throughout the duration of the experiment, the computer will pair you with another person in the lab, anonymously and randomly chosen. Your partner will be the same throughout the experiment. In each turn, each of you will see the same image and the same list of two words. The words will be the same for each member of the pair, but their order may be different among the partners because is randomly generated by the computer in a different way for each player. Each of

you has to choose a word. The payoff in each turn depends on the choice you both made. According to your choices, you could win or lose experimental points. The points won or lost are identical for both of you. You are not allowed to communicate in any way.

Appendix B: Instructions for the second part of the game

Instructions in case the computer has randomly determined that you are player one

At this time the game has changed. A player one and two have been determined, randomly, by the computer: you are player one.

You are still paired with the same player as in the first part of the game: pairs will remain unchanged throughout the experiment.

You have to make a choice in the following double-choice options. Your choice will be transmitted at player two, who can see the same image and words as you. Player two can either accept or refuse the proposal made. If you choose the first number in the double-choice options, and player two accepts it, you will win 7 experimental points, and he or she will win 5 experimental points. If player two refuses, you will both win zero payoff. If you choose the second number in the double-choice option, instead, and if player two accepts it, you will win 5 experimental points and he or she will win 7 experimental points. If player two refuses the offer made, you will both get a zero payoff. You have three minutes to make a decision for each trial.

Instructions in case the computer has randomly determined that you are player two

At this time the game has changed. A player one and two have been determined, randomly, by the computer: you are player two.

You are still paired with the same player as in the first part of the game: pairs will remain unchanged throughout the treatments.

Player one has just chosen a word from the double-choice options (he or she can see the same words and numbers as you). You can accept or refuse his or her offer. If player one's proposal corresponds to the first number in the double-choice option, and you accept it, player one will win 7 experimental points, and you will win 5 experimental points. If you refuse it you will both obtain zero payoff. If player one's proposal, instead, corresponds to the second number in the double-choice option, and you accept the offer, you will win 7 experimental points, and player one will win 5 experimental points. If you refuse, you will both obtain zero payoff.

You have three minutes to make a decision for each trial.

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