Journal of Social Complexity
Vol.2, No.2, 2006, pp. 6-19

The Possible Contribution of Empirical Analysis to the Understanding of Organizational Complexity

Marco Novarese
Centre for Cognitive Economics
Università del Piemonte Orientale
marco@novarese.org

Abstract
This paper aims at studying the effects of learning on team functioning, in an experimental game requiring cooperation and coordination. Results allow confirming previous findings: individuals tend to developed high-routinized paths of behaviour, extending the strategies learned in the past, to new situations faced. Learning processes, yet, are not based on the mechanical repetition of the same choices (participants to this experiment proved, for example, in fact, to be able to imitate and replicate the strategies of their previous partners). A significant heterogeneity in the behaviour, related to the training emerged. The second part of the game allows to understand how significantly such individual differences affect team performance in the same task. The experiment was developed using a mix of real and artificial agents and therefore allows to discuss the possible usefulness of the integration of the two approaches.
Keywords: cognitive economics, emergent behaviour, team, individual learning, experiments and simulations, heterogeneity

1. Introduction

According to a wide series of studies, in the present times, economies are more and more characterized by a strong and diffused interaction of knowledge among all participants to the market process. This is due to the increased number of direct and indirect connections among firms in different countries, to the kind of goods and services produced and to the kind of relations among agents. In the contemporary Economies, besides, human interactions are less constrained by strong bounds and rules imposed by centralized authority. Such economies can, therefore, be seen as complex systems (Foster, 2004) as there are multiple agents creating and using knowledge, pursuing their individual interests and aims, and so shaping macro phenomena. Also globalization and the development of new communication systems contribute to increase complexity, proposing to individuals new examples, new models of life and production and so putting into discussion the old rules. Complexity characterizes directly also the life inside the firms. The old Tayloristic model of organization - in which individual behaviour was strongly determined and constrained by management- is, in fact, no more adapt to deal with a competition based also on creativity, change and flexibility. New models of organizations impose to give workers more and more autonomy and, therefore, to allow them to use their own knowledge and information. But, the absence of rules and strong constraints make firms' functioning more dependent on the individual characteristics of its member. In other words, firm's behaviour and knowledge can be more and more seen as an emergent phenomenon.

Managing a firm in the age of complexity requires to be able to understand such situation: to understand how knowledge, information and expectations rise and develop and influence the behaviour of workers, competitors, consumers. A full comprehension of these phenomenon is still far from being reached, as the capacity to model it. The study of complexity can help to perform this task in a better way, but only if the understanding of the real human behaviour will be seen as a primary part of it.

In the last years, the Economics of Complexity has widely developed, and agent based models as been used as its primary tools (in some way, it was probably the availability of agents based tools to give a push to the rise of the Economic of Complexity). The authors referring to this stream, generally, aim at criticising the mainstream. Therefore they propose bounded rational agents, behaving according rules of thumb. Yet, in the large majority of cases, these rules of thumb aren't at all empirically founded. The resulting models, so, seem sometimes not to exploit in full the power of this tool. A full development of its potentiality, in fact, would allow to deal with complex and complicated model of individual behaviour (usually not taken into account by mainstream economics, also because standard math does not allow to treat them).

This situation is probably due also to the intellectual division of labour. Scholars working on simulations generally do not deal also with empirical analysis and with the study of human behaviour. Besides experimental economics - the main tool potentially available to understand human behaviour - developed in strict relation with the mainstream approach, even when criticising it. For example, the analysis of Kahneman and Tversky (that gave rise to Behavioural Economics and that represent one of the main reference for heterodox economists) propose situations of risk - where the possible results and their probabilities are known - like in the traditional models. So, the analysis of the development of individual and social knowledge, or in other words, the study of routines creation starting from uncertain situations, has been largely neglected.

A different approach could, therefore, be very useful. As shown in Novarese (2004), simulations can be strongly integrated with empirical study of human behaviour, following the example proposed by the studies of Simon, Cyert, March and other scholars. During the fifties and sixties this group proposed and methodologically discussed the potentiality of computer simulations, relating them to a different methodology. They strongly wished to relay on more realistic assumptions, as a condition for a better understanding of the reality. To pursue this end, they relied upon a wide variety of empirical tools. Among these also experiments, whose aims were that of understanding human behaviour and not that of testing (unrealistic) models or behaviour in simple situations like in the traditional experimental models (Novarese, 2003).

These same authors represent also a reference for their theory of organizational behaviour, focused just on the development of social knowledge (in the form of routines). This theory connects individual and organizational behaviour and the link is based on the idea of docility. This analysis represents a good starting point for the present discussion.

2. Individual and Organizational Routines

According to the model of Herbert Simon and of his school, human knowledge is based on routines, i.e. on different types of repetitive behaviours, developed as the results of learning and of satisficing problem solving processes. In such processes satisfaction play a central role. In fact, an individual is likely to take a decision *if it allows reaching a given level of satisfaction.* Later, the person will repeat the same action *if it has proved to be successful* in the past, and to change it if it has not. In this way, when a problem is solved in a satisficing way, behaviour tends to become routinized. Routinization is, in fact, an inborn characteristic of human being, useful to reduce mental effort (Novarese & Rizzello, 2005; Egidi, 2002). Besides, individual tend to apply the rules even to other domains, different from those in which they have been developed. Learning is therefore seen as a key factor in shaping social phenomena. It is defined according to a psychological view as the *human capacity to modify behaviour in a more or less permanent way, whenever new experience is acquired* (Novarese & Rizzello, 2002) and not necessarily as a walk toward optimality as in standard Economics.

Different kinds of repetitive patterns of actions can be individuated. From one side there are "complex, highly automatic … behaviours that function as a unit and typically involves high levels of information processing that is largely repetitive" (Cohen, *et. al.*, 1996: 133). At the opposite side, there are "mental models that are so fundamental to the cognitive activity of the actor that they affect perception as well as problem-solving and other cognitive functions" (Cohen, *et. al.*, 1996: 134).

Human learning cannot, therefore, be reduced to a simple repetition of simple actions, as persons have also the attitudes to build a model of the world: reasoning on what happened, imitating others, comparing their situation with that of their neighbours, and reflecting on the possible choices of the partners involved in strategic situations. (*Cf.* Rizzello & Novarese, 2002; Novarese, 2005a; for experimental evidence on these characteristics).

Also the action of collective actors (like organizations) is based on different kinds of routinized behaviour. Such social patterns emerge because of the individual tendency to repetition but also on the human attitude to imitate others and to learn from their social environment. Simon (1993) defines this aspect as *docility* (also Hayek who individuates a similar mechanism). Docility, as routinization, is a way to reduce mental effort and to deal with bounded rationality. In fact, it allows individual to make use of the knowledge developed by the others and not have to discover everything alone. In this way routines acquire a social dimension, as people living in a same environment develop similar pattern of behaviour, making the environment more predictable (I know what I have to do, and what other persons expect me to do and what I can expect from them). At a social level, in fact, routines represent also a way to coordinate individuals and reduce uncertainty and conflict.

All these ideas suggest that there are multiple links among individual and group behaviour. When different persons are trained in the same environment, they will generally develop similar strategies. When individuals do not share experiences, on the contrary, their knowledge and their perception of the world will, yet, be very different. Hayek (1945) stressed the relevance of these aspects at a market level, Novarese and Rizzello (1999) linked it with his model of learning, and its coherence with the contemporary cognitive approach. The interaction with the other members of the same group contribute also to shape similar levels of aspiration and therefore to make so that the acceptable solution become similar in a group.

Even if it is convincing and partly empirically founded, the picture proposed by this model is still to be completed. Many, relevant, problems are still to be solved and an empirical approach is necessary to go ahead.

For example, as observed by the same Simon (1993), a person has to deal with multiple social groups (for example: firms, political parties, ethnic minorities) and some of them can be, at least partly, contrapposed. In such cases which norms are internalized and why? Even within a given social environment, why some rules are accepted and internalized by the persons, while other are disregarded? Another central question is related to the born, development and change of social rules and to the related roles of individuals. The attention of the stream of research under exam, focused, generally, on how routines shape individual behaviour. The other side of the problem (how individuals give rise to routines) is more neglected, even if it is much important.

In studying such issue, it is necessary to consider that, not all individuals share the same tendency to behave in a routinized manner. Some of them dislike repetition and are prone to innovate. Literature (e.g.: Schumpeter, 1943) has often defined this kind of people has leaders (and entrepreneurs).

Other important differences are related to the tendency to imitate others and to have more or less sociable behaviour, to the need to be predominant. As shown by a wide set of experimental studies, when facing opportunistic behaviours, for example, players can decide to make a rational choice (accepting to gain less than the other) or try to punish the partner, even at the cost of a loss (*Cf.* Novarese, 2005a). The literature on the prisoner's dilemma or on the public goods is another example: some agents free ride, other cooperate.

This aspect emerges in a clear way in the studies devoted to link individual behaviour in experiment with their psychological traits measured with appropriate (and different) tests. As an example of this stream, it is useful to remember here the managerial literature (psychological oriented) devoted to the analysis of team works (*Cf.* e.g. van Olffen & Boone, 1998, 2003). Its aim is that of understanding the relation between the strategies performed by a team and many individual characteristics (like tenure, demographic aspects) of its member. Usually the attention is focused on managers. The analysis is generally conducted using data gathered trough surveys. There are, yet, also experimental studies belonging to such approach. They allow, for example, evaluating the role of some of the managers psychological traits, like the locus of control (i.e. the tendency to feel that everyone is the master of his own fates).

The effect of various individual characteristics on firms' performance cannot be generalized as it depends on the task to be accomplished. When the environment is stable, and the capacity to be repetitive is required group composed by less creative persons are more productive (Thesmar & Thoenig, 2000). In some cases team composed by persons with similar characteristics are less productive than team with a mixed composition (van Olffen & Boone, 2003). Magni (2001) shows how in performing an experimental "adaptive tasks" (where group performance results as the sum of individual one) the presence of strong interpersonal links among persons reduces team score (as personal interactions reduce their productivity).

3. The Experiment

The present analysis starts from the recalled literature. It aims at trying to develop an experimental tool allowing studying the link between individual learning and team functioning in a game that represents a metaphor of various strategical situations characterized by the following conditions:

- there are many possible outcomes, more or less efficient for the group as a whole (for example a given good, produced by a group, can be of *first quality* or of *second choice*);
- to reach any of the possible outcomes, it is necessary a certain level of coordination;
- the division of the labour is not centrally planned;
- individuals can contribute in different ways and it is necessary that someone provide a higher level of effort than the others.

Situations of this kind are widespread in the real world at social and organizational level. Team performance, for example, emerges from the choices of more individuals whose behaviour is interrelated. Both coordination and co-operation are involved and there are many possible outcomes. These situations are, nevertheless, usually neglected by the economic analysis (both at a theoretically and empirical level) because of the difficulty to deal with them. Economic theory, in fact, takes into account mainly simple games. Experimental economics uses, generally, the same approach, also because of the need of building environment that can be easily analysed and under the researcher's control. Even the game proposed here is a stylized situation. It is yet more complex than the usual experimental games. and, therefore, it aims at studying, at an empirical level, how to *complicate* Economics. This task requires both a new approach of analysis (new variables to be taken into account, for example), and new statistical and empirical tools (for example, how can we test hypotheses in an emergent situation like this, in which there is no independence among individuals?). After having understood its basic features and how to analyse them, it will be possible to develop different and more realistic versions and to take into account also other aspects. For example, it is possible to study the role of different psychological traits on the behaviour in this game.

From a traditional point of view, yet, this version of "Sum 10" can be seen as too difficult to control as it involves both cooperation and coordination, which are usually studied in separate games. Besides, agents are allowed too many choices compared to typical experiments (like, for example, the classical *prisoner's dilemma*). In fact, one of the aims of this work is testing the possible effects of learning in a context characterized by different levels of cooperation, and the relevance of repetitive behaviour. The complexity arises also by the desire to understand how individual learn to deal with a new environment (developing a new knowledge) and how their choices affect team performance. It is only a first step toward a new kind of cognitive experimental economics (see Novarese, 2003) but very useful, at least, to show a possible direction.

3.1. The Game "Sum 10"

Team of three players are anonymously and randomly built among participants. The game has thirteen rounds. Each of the players has a set of numbers that remains unchanged in every round and is composed by the values from zero to ten (both included). In every round each player has to declare one of the numbers in the set. The numbers of the three people playing together are then summed.

According to the sum, each player receives a payoff, following this rule:

- if $S(i) = 10$, $I(i)=40 - D(i)$

- if $S(i) > 10$, $I(i)=30 - D(i)$
- if $S(i) < 10$, individual payoff=0 - $D(i)$

where:

$S(i) \equiv$ sum of the team *I*, of which player *i* is a member
$I(i) \equiv$ player *i* individual payoff
$D(i) \equiv$ number declared by player *i*

Results are immediately communicated to the players and a new round starts.

The game is divided into two parts. In the first (rounds 1-9) players are coupled with artificial agents. In the second one (four additional repetitions), teams are composed only by the human participants.

The players do not know that they are playing with artificial agents. They are told that in the first part they will be coupled with two players, and in the second one to two new ones. They do not know the number of rounds.

In two treatments there are different kinds of artificial agents.

1) Treatment One
   - One agent always plays "3";
   - One agent always plays "3" (first choice) and repeats this number if in the preceding round the human player chooses "4"; if in the previous round the sum was less than seven, it declare "0"; otherwise it chooses the number necessary to get ten according to the sum in the previous round.

Thus, in order to obtain always ten, the human player should choose a number equal or major than "4".

2) Treatment Two
   - One agent always plays "4";
   - One agent plays "3" (first choice) and repeats this number if in the preceding turn the human player chooses "3", otherwise it chooses the necessary number to reach ten (e.g. if the player chooses 2, this agent chooses 10-(2+4)=4; if the player chooses "4", this agent chooses "3").

In the second part, ten teams were built, composed in two different ways:

- teams A: two individuals from the first group and one from the second,
- teams B: one individual from the first and two from the second.

The experiment was organized in the following way. Players have to declare their number using a pre-printed sheet. A team of people managing the experiment collected all the pieces of paper. The data were then inserted in a spreadsheet programmed to perform all necessary operations. The results (sum of the team, number played by the others and score) were then written on the sheets and get to the players. During the session, communication among participants was not allowed and they were carefully monitored so to avoid any interaction. The experiment last about one hour and a half. It was carried out in January 2003 at the University of Torino and was organized by the *Centre for Cognitive Economics*. Thirty students in Communication participated. On the basis of the score obtained they were granted credits for one of the two parts of their exam (they could raise their grade of three points on thirty, according to a rate of conversion that were not specified to stimulate each individuals to get the higher pay-off as possible).

3.2. Some Hypothesis

In a previous work (Novarese, 2005a), I tested the effect of the training in different social contests on the individual behaviour, in the same kind of game under exam here. The present analysis aims at confirming such findings and to widen the understanding of the effect of team composition on its performance. On the basis of the recalled literature and of previous findings, a series of general hypothesis can now be proposed.

1) Individual behaviour in experimental decision-making tasks is heterogeneous. The higher variability should be found when individual face opportunistic partners. In such cases, some of them choose the rational behaviour. Others do not and behave according to a different model (coherent with other experimental findings) that leads to punish their partners.
2) The training (first part of the game) influences how people play the final part. Dissimilar trainings, therefore, lead to different behaviours. As in the first part players in the same treatments could behave in different ways, their conduct in the second period won't, yet, be identical. So the strategies of the second part should be linked to the performance and choices of the training, given the treatment.
3) As many individual manifest a tendency to modify their behaviour according to the situations experienced, in the second part of the game, the composition of the team matters for its performance, as players can tend to repeat behaviour that were satisficing in the old conditions but that are not necessarily efficient in the new ones.

Artificial agents are used as a tool to allow training individual in a given way. So it is possible to test the effect of the interaction with different kinds of partners, or, in other words, the effect of the team on individuals. The second part allows also testing how the eventual effect related to the individual learning influences team behaviours. Even the interaction in the second part, probably, has similar effects, shaping in different manner individual attitudes and strategies. This is the general idea at the basis of this analysis that hypothesises a double and reciprocal influence among team functioning and players behaviour. At this stage it is better to study these aspect separately.

4. Results

The attention is focused on the second part of the experiment, which is more interesting here. The first one is used mainly as a training period. A detailed analysis of the fist part is shown in Novarese (2005a). In short it emerge that there are few significant differences between the two groups. In fact the artificial agents in group 2 can act as those in group 1 (if a player declares "4", both artificial agents will start to play "3" as in the other treatment). The behaviour of the artificial agents in treatment 1 resulted, yet, easier to understand, but for some players, less easy to accept. As in other sessions of this experiment (and in other similar game) some persons do not accept unfair solutions and are prone to punish their opportunistic partners even at their own expenses. Other individual behave according the rational models, preferring a low payoff instead of nothing.

In relation to the second part, as in Novarese (2005a), two aspects will be analysed: the numbers declared, in relation to those of the first one, and the tendency to maintain stable choices.

Table 1 proposes an easy picture of the relation among the numbers most declared in both parts by the individuals in the two groups (the same results could be shown using regressions but this table seems to be more intuitive). Column 1, for group 1, shows the number declared by the seven players of the first treatment who made the same choice at least five times (more than half of the rounds) and (in parenthesis) its frequency. So, for example, the first players declared the number "4" nine times. Column 3 lists the nine participants of the second treatment in the same situation.

The variable MAX measures the attitude to maintain a stable choice (the number at its end indicates if the index is computed on the first or second part). See Novarese (2005b) for a discussion of the different indexes that allow measuring such tendency. For example, MAX2 is computed as the frequency of the most declared numbers in the given part (so, for example, a player choose one time "0", and three times "3", MAX2 will be equal to three).

Table 1 **Numbers most played in the first and second part for each participant to the game**

	treatment 1			treatment 2		
	player	column 1	column 2	player	column 3	column 4
group 1	1	4 (9)	3 (4)	16	4 (9)	4 (4)
	2	4 (9)	3 (3)	17	3 (9)	3 (4)
	3	4 (9)	4 (4)	18	4 (8)	3 (4)
	4	4 (8)	3 (3)	19	5 (7)	4/6 (2)
	5	4 (8)	2 (3)	20	4 (7)	2 (4)
	6	4 (7)	3 (4)	21	3 (6)	2 (3)
	7	4 (7)	3 (4)	22	4 (6)	3 (4)
				23	0 (5)	0 (4)
				24	3 (5)	7 (3)
	player	column 1	column 2	player	column 3	column 4
group 2	8	8 (4)	2/5/6/7 (1)	25	6 (4)	5 (2)
	9	4/7 (4)	3 (3)	26	4 (3)	1 (3)
	10	10 (3)	4 (3)	27	5 (3)	3 (2)
	11	4/5 (3)	4 (4)	28	3 (3)	5 (2)
	12	4 (3)	4 (2)	29	-	-
	13	5 (3)	5/7 (2)	30	-	-
	14	6 (2)	4 (2)			
	15	2/3 (2)	0 (4)			

Columns 2 and 4 of table 3 show the number most declared by each of the same players in the second part (and, in parenthesis, its frequency). MAX1 is the frequency in parenthesis in columns 1 and 2 and MAX2 that in columns 3 and 4. The mean value of MAX2 in columns 1 and 2 are respectively 3.2 and 2.6. The part labelled "group 2" proposes the same data for the other players. The mean value of MAX2 in column 1 and 2 are respectively 2.6 and 1.8.

Between the first and second part, for group 1, two kinds of links can be found, in relation to the number declared and to MAX2. In some cases the number declared many times in the fist part is also the most proposed in the second (player 2, 16, 17, 23). In many situations, yet, players imitate the artificial agents they trained with, playing "3", after having chosen a lot of times "4". As seen, the mean values of MAX2 are high than those of the second group, where the links between the two parts are weaker or absent. This result is particularly important to demonstrate that, a part from simple games, persons cannot be modelled as automata, as in the reinforcement learning model: they are able to imitate and build model of the world, and do not only to repeat choices.

Tables 2 shows a series of estimations performed to explain the value of MAX2, in relation to two variables expressing the behaviour and the performance of the individuals in the first part: the number of sum equal to ten (SUM10_1) and MAX1.

The observations of the individuals joined in the same teams are not independent. To overcome the problem estimations include a variable that account for the correlation in the value of MAX2 among the team: the number of sums equal to ten in the second part (NUM10_2). If a team gets a sum equal to ten for a given period, for that set of rounds, all of its members will have the same value of MAX2. In the estimation, this relation is kept by the control variable, so eliminating the problem. Similarly, if a group is not able to coordinate, and players change always their choice, MAX2 will be low, as their number of sum equal to ten. The control variable will again account for this mutual relation (see Novarese, 2005a for a longer analysis of this procedure to eliminate the dependence among observations and Novarese 2005b for estimations with independent samples on this same data).

Estimations are performed for the two treatments separately, so to find eventual differences. In Novarese (2005a), in fact, the training in dissimilar environments had significant effects. Here, yet, in

Table 2 **Estimation with MAX2 as dependent variable, all observations, by treatment**

variable	tr1	tr 2	tr1	tr 2
Number of sum=10 in the second part	0.48 (0.00)	013 (0.47)	0.48 (0.03)	0.14 (0.47)
Number of sum=10 in the first part	0.10 (0.04)	0.36 (0.00)	-	-
MAX1	-	-	0.10 (0.12)	0.33 (0.04
P value F test	0.00	0.00	0.05	0.03
R^2	0.65	0.67	0.59	0.63

the first part there is more homogeneity between the treatments, so few differences should emerge also in the second, as, in fact, shown by tables 4 and 5.

As seen in table 2, players trained in the second group who reached a sum equal to ten many times in the first part, in the second one have rigid strategies and repeat more times the same number. In fact, MAX2 is strongly affected by the performance in the first part. A similar tendency can also be found for the other treatment, but it is weaker: MAX2 is more influenced by the interaction with the partners. This result, so, confirms the findings of Novarese (2005a) on the effects of the training in different contests and on the individual tendency to maintain successful behaviour learned in the past.

The strong effect for the second group could be just a statistical problem as the link between MAX2 and NUM101 can be hide by NUM102. In other words, a player could be repetitive but the effect does not emerge because of the team effect. Therefore the result under analysis would be a reflection of an eventual major efficiency of the teams where the persons from group one play (or of the team where most of them play), but in such case, there would an effect related to the training. Next paragraph analyses this aspect in detail.

Team behaviour and individual learning

Two kinds of groups played the second part, teams A composed by two individuals from treatment one and one from the other, and teams B made with one individuals from treatment one and two from the second.

Table 3 shows a series of indicators of performance for the two kinds of teams.

Two significant aspects emerge. At the end of the game, all teams of type A get a sum equal to ten, while only one of the team B reach this goal (two other teams in this set have reached a sum equal to ten, but have not been able to maintain it; all equilibria get by the team A are confirmed till the end). It's not possible to say what should have happened in eventual following rounds. This result seems yet to suggest that teams A could be more flexible and players more prone to adapt to each others. The difference in the mean value of MAX2 between teams A and B confirms this hypothesis.

Table3 **Mean value of many indicators in the second part of the experiment by team type**

	team A	team B	p value t test	p-value Kruskal-Wallis Test
mean of total score	82	104	0.29	0.46
mean of rounds in which sum =10	1.2	2.2	0.22	0.18
mean of rounds in which sum >10	1	1.6	0.45	0.52
mean of rounds in which sum < 10	1.2	0.8	0.47	0.51
sum=10 in the last round	0.2	1	0.00	0.01
mean MAX2	2.6	3.2	0.17	0.08

"-" indicates a variable not included in the estimation; the value in parenthesis under the parameter estimates is the p-value of the t-test, the number of observation for all estimations is 15

Such effect is related to the compositions of the teams, as individual from treatments two proved to be more rigid in their choices and therefore less able to adapt to the others.

Table 4 proposes a series of regressions that use the number of sums equal to ten of each team in the second part as the dependent variable. In this way they explain team performance using as regressors a series of means and standard deviations, reckoned on the individual values of the members of each group. The idea is that team performance depends on the individual learning, because of the reinforcement effect on the numbers declared and of the tendency to maintain or not a given choice[1]. A team can get a sum equal to ten in many ways. For example, if two individuals maintain a stable choice and the other adapt to them, it will be easier to reach a sum equal to ten. If all of them try to adapt to the previous choices of the partners and change continuously their number, it will be more difficult to find equilibria as in the case in which all maintain the same numbers (not summing to ten). When equilibrium has been reached, players should maintain the same choices. A good team will probably have a mix of stable and adaptive players. In term of the previous analysis, therefore, efficient teams will be composed by two (or one) individuals who realized a good performance in the first part (and so developed a stable strategy) and another (or two others) less rigid. So this hypothetical good team would probably have a high standard deviation in the indicators of individual performance in the first part.

Table 4 **Estimation on team performance in the second part as dependent variable**

	sp1	sp2	sp3	sp4	sp5	sp6	sp7	sp8	sp9
mean value of the dummy on the number of sum=10 in the first part*	3.2 (0.05)	-	2.7 (0.02)	-	4.3 (0.01)	5.3 (0.04)	-	3.4 (0.02)	
mean value of number of sum=10 in the first part	-	-	-	0.67 (0.07)	-	-	0.39 (0.27)	-	
standard deviation RMAX	-	-	-	-	4.3 (0.02)	-	-	2.3 (0.21)	
standard deviation of the dummy on the number of sum=10 in the first part	-	-	-	-	-	-3.3 (0.25)	-	-	
standard deviation of the number of sum=10 in the first part	-	-	-	-	-	-	1.1 (0.15)	-	1.5 (0.03)
mean value DISP1	-	-	-	-	-	-	-	-	
standard deviation of the score in the first part	-	0.03 (0.02)	0.03 (0.01)	-	-	-	-	0.01 (0.10)	
P value F test	0.05	0.02	0.01	0.07	0.01	0.08	0.06	0.01	0.03
R^2	0.41	0.51	0.78	0.38	0.73	0.52	0.55	0.83	0.45

"-" indicates a variable not included in the estimation; the value in parenthesis under the parameter estimates is the p-value of the t-test, mean values and standard deviations are computed among members of given teams; the dummy on the number of ten assumes value 1 if the number of ten is at least equal to half of the number of rounds (4) in the first part; all estimations used 10 observations

[1] The relation between the number declared in the first part and team performance and equilibria cannot be studied here because of the relatively few observations and of the individual heterogeneity.

Table 4 proposes different specifications of the model. Some of them are based on similar variables. For example the effect of the performance in the first part is analysed using the *mean of the numbers of ten* or the *mean of a dummy on the same numbers of ten*. The reason for using this last value is easy to understand. If *the number of ten* got by the individuals in the first part is relevant (trough the effect on MAX2), its mean value is, yet, not a good indicator. Consider, in fact, a group in which one of the player make *eight times* a sum equal to ten in the first part, another one *three times* and the last just *one time*. Probably only the first person will show the *reinforcement effect* described and the following high value of MAX2. Imagine another group where all players got four times a *sum equal to ten*. These two teams have the same *mean number of individual ten in the first part* (equal to four), but only in the second case there would, probably, be a reinforcement effect on all the members of the team. The standard deviation of this dummy variable is, on the contrary, not much informative, as it can assume just few values and, besides, it is also strictly correlated with the mean value (and with few observations that affect strongly the variance of the estimates). Other indicators of variability are then preferable.

As hypothesized, both the mean performance in the first section and its variance among members affects significantly team performance. Both the variables measuring the mean of the individual performance in the first part are significant (sp1 and sp4). As expected, the dummy on the number of ten[2] increases the fit of the model more than the mean on the number of ten. Also the variance of the performance in the first part is significant, taken alone (sp2 and sp10). Inserting in the model both the variables leads to a higher fit (sp1 and 2 vs. sp3 and sp4 and sp10 vs. sp7).

The relevance for the team of the variability in the individual behaviours is confirmed by the specifications including the standard deviation of RMAX (sp5 and sp811). RMAX is the ratio between MAX2 and MAX1 divided respectively for the number of rounds in the second and first part. It is a way to measure the attitude to maintain fixed choices in both the first and the second part. If a player tends to have MAX1 and MAX2 high (or low) in both the sections, RMAX takes a value of about one. A high (low) value means that in the second part there is a stable (variable) series of choices, while in the first one there were variability (stability). The estimation in table 4 shows that teams in which all players tend to maintain the same strategies of the first part are less efficient[3]. The significance of the standard deviation of RMAX helps to understand why team of type B - composed by more players coming from treatment one, where the variance of the variable under exam is higher (see Novarese, 2005 b)- are more flexible.

5. Conclusion

The results showed in this paper allow supporting the main general idea proposed, on individual and social learning and also on the possible usefulness of a new approach to the analysis. The experiment proposed made it possible to enter in the individual black box and in this way even in the organizational one, finding new results and confirming previous ones on the development of routines,

[2] It's important to note that in this sample the mean of the dummy take tree values: 0, 0.33, 0.67. There are therefore no team entirely composed by individuals with a strong probability of reinforcement.

[3] The standard deviation of RMAX is related to the standard deviation of the score, but it's not the same thing, as a comparison between sp5 and sp8 indicates.

and connecting individual and group functioning. Reinforcement mechanisms proved to be very relevant in shaping individual behaviour, but not always and not in the same ways for all persons. Persons are, yet, also able to imitate and reflect on what happened and to define new strategies. The relation between performance and choices the first and second part proved the relevance of learning mechanisms (experience modifies behaviour, in a conscious and probably even in an unconscious way). The effect of the composition of the team on its performance (and on the variety of possible results) confirms how composition matters (individual are not always able to compensate). A significant heterogeneity among individuals emerged in relation to the tendency to face the same environment and then to develop routinized strategies.

A last note is worth to be said on the mix between experimental analysis and simulations. Here artificial agents served as a tool for training humans in the desired way. Simulations, yet, can also be useful, in a following step, to help in testing hypothesis on team performance in relation to the characteristics of its member, and to model - in a proper way- individual behaviour and heterogeneity.

Acknowledgements

The experiment presented was designed with Salvatore Rizzello and carried out at the University of Torino. I thank also Sandra Aloia, Angela Ambrosino, Maria Teresa Servello, Anna Spada and Alessandra Sterpone who collaborated to its management.

References

Cohen M.D., Burkhart R., Dosi G., Egidi M., Marengo L., Warglien M. & Winter S. (1996). 'Routine and Other Recurring Action Patterns of Organizations: Contemporary Research Issues.' In *Industrial and Corporate Change*, *5(3)*: 653-98.

Cyert, R.M. & J.G. March. (1963). *A Behavioural Theory of the Firm*. Englewood Cliffs, New York: Prentice-Hall.

Egidi, M. (2002), 'Biases in Organizational Behavior.' In M. Augier & J.J. March., (eds.). *The Economics of Choice, Change and Organization: Essays in Memory of Richard M. Cyert*. Aldershot: Edward Elgar.

Foster, J. (2004). 'From Simplistic to Complex Systems in Economics.' *Discussion Paper No 335, School of Economics, The University of Queensland.*

Hayek, F.A. (1945). 'The Use of Knowledge in Society.' *The American Economic Review*, *35(4)*: 519-30.

Knudsen, T. & N.J. Foss. (1999). 'Dispersed Knowledge and Firm Organization: Fragments of an Austro-Evolutionary Approach - Paper Prepared for the workshop on "Austrian Economics and the Theory of the Firm.' *Copenhagen Business School, 16-17 August 1999.*

Novarese, M. & S. Rizzello. (2004). 'Satisfaction and Learning: an experimental game to measure happiness.' In *The Law and Economics of Irrational Behavio*r. F. Parisi & V. Smith., (eds.), Princeton University Press.
http://d.repec.org/n?u=RePEc:wpa:wuwpmi:0306004&r=cbe

Novarese, M. (2002). 'Lealtà, apprendimento e innovazione, tra teoria dell'impresa e organizzazione aziendale: una lettura cognitiva.' *Working papers, Dipartimento di Scienze Giuridiche ed*

Economiche, Università del Piemonte Orientale.

Novarese, M. (2003a), 'Toward a Cognitive Experimental Economics.' In S. Rizzello., (ed.), *Cognitive Paradigms in Economics*. London: Routledge.
http://d.repec.org/n?u=RePEc:wpa:wuwpex:0211002

Novarese, M. (2004). 'Simulations, theory and experiments: Notes from an historical perspective.' In *the Proceedings of the Wild@ace Conference 2003, World Scientific Publishing.*
http://www.novarese.org/sim.htm

Novarese, M. (2005a). 'Learning in different social contests.' *Journal of Socio Economics*, forthcoming.
http://d.repec.org/n?u=RePEc:wpa:wuwpga:0405008&r=cbe

Novarese, M. (2005b). 'Individual learning and team functioning.' *Icfai Journal of Managerial Economics, February 2005.*

Novarese, M. & S. Rizzello. (1999). 'Origin and Recent Developments of Experimental Economics.' *Storia del Pensiero economico, 37.*
http://www.cce.unifi.it/dse/spe/indici/numero37/nova.htm

Novarese, M. & S. Rizzello. (2002). 'A cognitive approach to individual learning: theoretical issues and some experimental results.' *Working papers, Dipartimento di Scienze Giuridiche ed Economiche, Università del Piemonte Orientale.*
http://d.repec.org/n?u=RePEc:wpa:wuwpgt:0301001

Schumpeter, J. (1943). *Capitalism, Socialism, Democracy*, London: Allen & Unwin.

Thesmar, D. & M. Thoenig. (2000). 'Creative destruction and firm organization choice.' *The Quarterly Journal of Economics, November 2000*: 1201-37.

van Olffen, W., & C. Boone. (1998). 'Psychological team composition and strategy making: team level locus of control in relation to planning quality and action consistency.' *NIBOR Research Memorandum.* Maastricht: NIBOR.

van Olffen, W., & C. Boone. (2003). 'Team Composition, Leadership And Information-Processing Behavior. A Simulation Game Study Of The Locus-Of-Control Personality Trait.' *No 35 in Research Memoranda from Maastricht: METEOR, Maastricht Research School of Economics of Technology and Organization.*

Weiss, H.M., & S. Adler. (1984). 'Personality and organizational behaviour.' In B.M. Staw & L.L. Cummings. (eds.), *Research in Organizational Behavior*:1-60. Greenwich: JAI Press.