

**The intermingling between cognitive economics and experimental economics: a few remarks on history, methodology and applications**

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## 1. Introduction

Economics is more and more a science of complexity. In this context, complexity may be defined as the property of a real-world system, revealed by the impossibility to catch all its characteristics by means of a formal approach. The peculiar complexity of economic science consists in the fact that the analysed interaction processes among people are not completely foreseeable and their outcomes are often unexpected. This is mainly due to the cognitive characteristics of economic agents, who act within real constraints arising from the environmental structure and, as a consequence, under structural uncertainty. As regards the comparative analysis between relations, implications and relevance of human cognitive peculiarities in decision-making processes and in economic processes in a broad sense, a recent but rapidly growing literature, deeply rooted in the economic thought, is now effectively illustrating the potentiality of a new approach focusing on these issues. This discipline is cognitive economics, which designs an interdisciplinary approach to the study of problem solving, decision making, choice and change. Though this cannot be a complete list, the major fields of interest of cognitive economics can be summarised as follows:

- dynamic analysis of decision-making processes under uncertainty, linked to the psycho-neurobiological aspects typical of human nature;
- relevance of comprehension in the mental processes (tacit processes included) lying below the process through which knowledge is built and spread;
- in-depth examination of the mechanisms of perception and learning, taking into account the outcomes of cognitive and experimental psychology;
- survey of the subjects' representing capacity and of the use of cognitive and emotional shortcuts and of imagining, which generate biases and heuristics in decision making;
- study of the nature and role of creativity with reference to innovation;
- development of decision-making models of the satisficing type, alternative to the classical models of constrained optimisation;
- a new view on the economic role of organizations, in the light of the studies on organizational learning processes, knowledge sharing, and distribution of competencies;
- a new view on the nature and economic role of institutions, in the light of their connection with the cognitive mechanisms through which knowledge is built.

The literature that has explored environmental constraints is largely interconnected with the above mentioned literature, but – as it has emphasised the evolutionary approach to economic processes – it can be subsumed under a quite broad corpus which for more than two decades now has been defined "evolutionary economics". The reference fields of application of evolutionary economics are wide-ranging indeed, but, as far as cognitive economics is concerned, we specifically refer to that part of literature dealing with the relations between environmental structures, constraints to decision-making, and innovative processes. Therefore the more relevant aspects are the study and the application of:

- evolutionary models that are in all or in part alternative to Darwinian models;
- selective mechanisms and cultural development;
- self-regulation principles for systems and organizations;
- analysis of localised and idiosyncratic processes of technological, organizational and institutional change;
- interconnections - from an evolutionary perspective - of individual decision-making processes and interrelations between organizations and institutions;
- direct application – from an organizational perspective – of the determinants connected to the mechanisms of learning, creativity and tacit knowledge.

A far-reaching project as the one proposed by cognitive economics in its interconnection with evolutionary economics needs firm foundations, a rigorous methodology, and proper analytical tools in order to become fruitful.

As regards the theoretical foundations, there are now several "historic" works, which highlight that in the analysis of economic phenomena the attention focused on the cognitive aspects is – sometimes implicitly – well-rooted. From Marshall to Hayek, from Simon to Kahneman (citing only a few of the most well-known names), the cognitive approach to economics has been developing by means of more and more explicit and qualified contributions<sup>1</sup>. One might remark that apparently this literature consists only in criticism of the foundations of mainstream models, considered unrealistic and substantially inapplicable and inadequate for description. This is certainly true, but only in part. The *destruens* dimension of Simon's criticism of the inconsistency of absolute rationality; of Coase's criticism of the neo-classical theory, unable to define nature and role of organizations; of Hayek criticism concerning the actual role of human knowledge or of institutions in economic processes – to cite only a few examples – are only the first necessary steps towards the confutation of models that prove to be inadequate to interpret, describe and apply to reality. In fact, criticism is only one side of the coin. The same authors have planned a route for the development of a new paradigm and, by drawing on their pioneer works, the literature on the subject has later proposed new theories: those developed by Allais, Kahneman and Tversky and certainly by Simon, concerning decision-making, or the many theories of the firm of the last decades, or more generally all the theories connected to the neo-institutionalist approach. Such contributions are so rich and promising that we may foresee that in the near future the old neo-classical paradigm might be abandoned.

Moreover, it is important to point out that this approach draws on a part of Marshall's thought that has been so far considered of minor importance. We refer in particular to the Marshallian ideas that organizations are one of the factors of production, and that learning processes are relevant in decision-making mechanisms. In more explicitly cognitive terms, we refer to the parallelism which Marshall detects between nature and workings of the mind and the structural characteristics and dynamics of organizations<sup>2</sup>. It seems that cognitive economics can now develop the wealth of ideas of this approach, which has been largely neglected during almost all of 1900, because of the predominance of the aseptic neo-classical paradigm, which is rich in formalizations but lacks in deep interdisciplinary analyses<sup>3</sup>.

With reference to the analytical tools used in the context of cognitive economics, we will point out the one which, from the second half of the 1980s, has been able to synthesise all the peculiarities of such approach, thanks to its intrinsic and applicative character: path-dependence<sup>4</sup>. All the

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<sup>1</sup> For a historic reconstruction, see Rizzello 1997. For a detailed anthology of the cognitive approach from Marshall to Kahneman, see the two volumes edited by Egidi and Rizzello (2003). Finally, for the recent developments in cognitive economics, see Rizzello (2003).

<sup>2</sup> Raffaelli (1994 and 2003) has systematised Marshall's thought on the subject

<sup>3</sup> Brian Loasby has been one of the more active scholars in emphasising the cognitive aspects of Marshall's thought. We might cite several of his works, but for a review of his thought on the subject you can see Loasby (1999).

<sup>4</sup> Path-dependence can be generally defined as a property of complex dynamic systems, whose presence implies that in a given space of exploration it is impossible to know all the possible paths, and every decision-making act is dependent on the previous paths of experience (both if we refer to a single individual or an organization or we describe the evolution of institutional structures). At the beginning path-dependence has been applied to economic history, economic geography, and economics of innovations.

These applications

- i) demonstrated that small random events lead to rigidities in the systems, converging towards sub-optimal equilibriums;
- ii) explained the peculiar structure of industrial plants;
- iii) explained the way how innovations spread.

More recently, path-dependent analyses have been applied also to the research into nature and evolution of institutions and into individual decision-making processes, thus directly extending the field of application to cognitive and experimental economics.

It is so self-evident that economic phenomena are irreversible and dependent on history that – as David (1997) maintained – it would not be necessary to explain it, if the standard economic theory had not invested so much energy in developing a historic system.

phenomena analysed by cognitive economics are characterised by historic time and, as a consequence, by irreversibility and self-reinforcement mechanisms. As already argued elsewhere (Rizzello 1997 and 2003), this is evident already at a neurobiological level, when we take into consideration the human mechanisms through which external data are perceived and the relevant knowledge in decision-making processes is built. If individuals learn it is undeniable that their decision-making processes depend on their previous experience and on their memory. Moreover, as complex phenomena are linked to the fallibility of human decisions and to unexpected outcomes, (both individual and organizational) decision-making processes design sub-optimal and non completely foreseeable trajectories ending in lock-in ambits, which can be avoided (lock-out) only on the basis of complex mechanisms that can be understood, once again, only through cognitive characteristics<sup>5</sup>.

Nevertheless, the idea that in this kind of approach history matters is linked not only to the irreversibility of the phenomena under investigation, but also – as maintained by David (1994) – to the fact that such phenomena occur within an institutional dimension, which is, as such, a carrier of history; this often happens by means of an inert reproduction of the mechanisms that have produced it. Besides, the institutional dimension standardises, also in a social perspective, the peculiarities related to judgement and perception of the outcomes of actions, and, by doing so, influences (sometimes stops) the evolution, also in the presence of propulsive drives towards change (Colombatto 2003).

We have made quite a complex – though concise – picture of foundations and tools which can corroborate the validity of this path.

Nevertheless, we have not mentioned yet what is probably the most used tool in this field: experimental economics. This is a very heterogeneous discipline, too, and it is widely used with differentiated methods. In recent years, a number of outcomes reached in the context of experimental economics have demonstrated that human decisions show systematic deviations from rational decisions, and that very often the “errors” persist even when the rational solution is explicitly proposed to the subjects. This happens in decision-making processes carried out by both individuals and groups. From this perspective, the intermingling between cognitive and experimental economics is evident. Still, it is necessary to underline that the analysis of their intermingling is quite complex because experimental economics cannot be merely considered an “instrument” of cognitive economics. It is more correct to say that they influence each other. Indeed, if on the one hand we cannot consider experimental economics as a branch of experimental economics, on the other hand many experimental analyses are strictly connected to fields of investigation of cognitive economics. Therefore a series of methodological problems arise which are still open and will be dealt with in this paper.

At the beginning we will outline the chief characteristics of the major lines of research in experimental economics, also with reference to the historical development and to methodological issues. Then we will have an in-depth look at the relevance of the experimental method for the analysis of learning and coordination processes under uncertainty. Finally a few examples will be supplied of the application of the experimental method to cognitive economics.

## **2. The lines of analysis within experimental economics**

The few works analysing the historical evolution of experimental economics usually indicate the following three lines of analysis (see, for example, Roth, 1993).

### **1) *The experiments on markets***

This is probably one of the most flourishing areas in experimental economics. Several of the most well-known articles belong to this group. In particular a test described by Chamberlain (1948) and

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<sup>5</sup> Also in this case we find an extensive literature. Only a few examples: Egidi-Narduzzo (1997), Dosi-Metcalf (1991), Egidi (2003), Novarese-Rizzello (2002), Novarese (2004b). With reference to the line of research concerning path-dependence in institutions, see the classic North (1990) and the more recent Witt (2003) and Rizzello-Turvani (2002).

later studied by Vernon Smith (1962) is often cited. These are the first scholars who tried to reproduce the competitive market assumed by economic theory in a laboratory, consisting – in that case – in a class of university students. At the beginning they were mainly interested in demonstrating the way how this form of market works.

The range of interest of this line of analysis has then extended and it now covers institutional mechanisms, types of auctions and different forms of market. The general objectives have been extended as well, and now they include what Roth (1991) defines “social micro-engineering”, i.e. designing and testing markets and auctions before they are implemented, as a consultancy for public institutions.

## 2) *The experiments on individual learning processes*

The first known experiment in this field, carried out by Thurnstone in 1931, belongs to this group. He tried to empirically determine the shape of an indifference curve. To this end he asked the participants in the experiments to choose among different (hypothetical) baskets containing alternative quantities of hats and shoes.

His article was published on a journal of psychology. Indeed, experimental economics was born in the margins of economics, but – as shown by this example – the experiments were based on very traditional models. In order to better understand the relation between mainstream economics and experiments, it is interesting to remember that Thurnstone’s work was critically commented by Milton Friedman (in an article written with Wallis in 1942): the environment is artificial, the choices hypothetical, therefore the experiment is little useful.

This is one of the major criticisms often levelled at experimental economics. We will discuss it below, as this opinion is quite widespread among economists.

The works by Allais (1953) and Kahneman and Tversky (1979 and 1992) are far more important in the ambit of this line of analyses. They were developed after Von Neuman and Morgenstern (1944) introduced the theory of expected utility.

These experiments – often repeated by other researchers with more or less relevant variations – have pointed out systematic violations of the axioms of invariance, transitivity and dominance, which lie at the basis of the theory of expected utility. In fact, the subjects use heuristic decision-making rules and make systematic errors in their choices.

It is useful to remember the basic version of this group of experiments (which we cannot analyse in details here). The procedure used by Allais in 1953 was very simple. He used hypothetical questionnaires with no remuneration. The subjects had to make two choices between different alternatives. The first choice was between the alternatives A and B, the second one between the alternatives B and C. Each alternative was characterised by a different outcome, certain or uncertain. The outcomes of the various alternatives were:

Alternative A	Certainty to earn 100 francs
Alternative B	* Probability 0.1 to earn 500 francs * Probability 0.89 to earn 100 francs * Probability 0.01 to earn 0
Alternative C	* Probability 0.11 to earn 100 francs * Probability 0.89 to earn 0
Alternative D	* Probability 0.1 to earn 500 francs * Probability 0.9 to earn 0

It is possible to demonstrate that, according to the expected utility theory, if a subject prefers A to B, he should also prefer C to D. But the experiment demonstrated that many subjects preferred A to B and D to C, thus contradicting the theory’s assumptions.

The outcomes of this series of tests were also used by Kahneman and Tversky to develop a new model: the Prospect Theory. Such theory is consistent with the empirical evidence gathered.

Among the empirically gathered data which were included in the model an important aspect concerns, for example, the propensity to risk. In several contexts individuals are more adverse to losing than they are attracted by equivalent earnings. According to Kahneman and Tversky, for the subjects of the experiment the value of a little loss is almost twice as high as the value of an equivalent gain.

Moreover, in the Prospect Theory the expected utility function is replaced by a value function. The results are weighed with decision-making weights that are a function of probabilities but are not probabilities. The outcomes of the choices are assessed by subjects with the reference point of the *status quo*. Therefore there is no assessment in absolute terms.

### 3) *Experiments on game theory*

There is a strong connection between experimental economics and game theory. Several authors maintain that the development of experimental methods in economics may be attributed to those researchers who have worked on the game theory, since the models proposed by such theory can be empirically tested immediately.

A particularly important experiment - which we mention here as it is one more term of comparison with the examples we will propose below - is the one carried out by Drescher and Flood in 1950 (described in Flood 1952, 1958).

Two subjects had to interact in the context which later became well-known as the *prisoner's dilemma*. The participants in the game interacted for many rounds in the same conditions and with the same partner. It turned out that the subjects chose cooperative behaviour instead of the opportunistic behaviour foreseen in the model.

Nash himself commented upon the results. The difference between the experimental and the theoretical outcomes was due to the fact that the subjects interacted for many rounds. Such comment pointed out an important aspect on which attention has been focused in the following years.

## **3. Cognitive experimental economics**

In a previous work (Novarese and Rizzello 1999) we pointed out a possible fourth line of experimental research, which is quite recent and needs to be further developed: the object of the study here is individual and organizational learning, and the experiments are connected to cognitive economics (see also Novarese 2003a).

Relevant examples of this approach are Cohen and Backdayan (1991), Egidi and Narduzzo (1997), Novarese and Rizzello (2002 and 2004), Egidi (2002).

In the next paragraph we will illustrate in detail the peculiarities of this group of works and the difference between them and more traditional experiments.

It is necessary to underline now that the proposed classification is of course - as it often happens in these cases - arbitrary and problematic for a number of reasons.

Take, for example, game theory. It is not difficult to determine which works belong to this line of research, but the same works might belong also to any of the other groups. Indeed, game theory has been used to develop models concerning markets, individual reasoning and learning.

Nevertheless, from the point of view of the historical evolution of experimentalism in economics it is important to keep these works separate. As highlighted by Innocenti (1995), game theory and the experiments carried out by Rand Organization in the 1950s are extremely relevant and peculiar. As seen, probably experimentalism owes a great deal to the game theory.

Nonetheless, the cognitive line of research we are examining is closely connected to a few of the experiments aimed at refuting the expected utility theory and at making clear the limits of

individual learning, such as the already mentioned experiments carried out by Allais (1953) and Kahneman-Tversky (1979 and 1992).

It seems to us that it is useful to separate these works from the others, in order to emphasise a few peculiarities of the fourth line of research, with reference, for example, to its origin and, above all, to the moment when researchers became aware of its peculiarities and of the methodological difficulties connected to its objectives.

From a methodological perspective, the cognitive line of research is closely linked to the empirical approach proposed from the 1950s on by authors such as Simon, Cyert, and March.

In a series of pioneer works - which at the beginning were published on important journals but later forgotten - the above-mentioned authors proposed and discussed an empirical methodology through which it is possible to develop "behavioural" models that can supply better explanations and better forecasts.

### ***3.1 The methodology of empirical analyses in cognitive economics***

As described in Novarese (2004a), in the methodology proposed and adopted by these authors the careful observation of reality is a starting point in the development of models. More data are then necessary to test those models (which are generally based on computer simulation, as it is otherwise difficult to deal with the resulting complexity) and these data must necessarily be based on empirical observations.

There are numerous instruments of empirical analysis used to gather evidence, for example:

- the protocol analysis: a subject is asked to perform a given task (the object of the experiment, e.g. playing chess) while saying what he/she is thinking; his/her statements are protocoled;
- the analysis of the eye movement of subjects who are carrying out a task requiring the visual exploration of the experiment setting (for example a chessboard, or a blackboard, or a written page ... see Rumiati, 1990 for more examples).
- interviews with managers or employees of an organization, analysis of official documents and direct observation of meetings within a firm (writing a report of the course of the meeting).

The reference point of these procedures is the empirical methodology of psychology and the managerial science, rather than the classical instruments of economics. Probably several economists think that such procedures have little to do with science and are little useful.

Therefore researchers find it difficult to have works that are based on these procedures accepted by the scientific community (and this is a serious hindrance to their use, development and improvement).

There are, actually, various problems arising from this methodology.

Gathering evidence in the field is indeed extremely difficult and expensive: it is necessary to choose the data we want to record among a wide variety of possible information. This is due to the fact that organizational learning processes are complex and many-sided phenomena, and it is difficult to break them up into their basic components. It is therefore necessary to stylise the relevant facts and follow a given model. As a consequence, the information gathered can be criticised from several points of views, it is often very personal and difficult to reproduce.

Moreover, reading and writing case studies takes a lot of time (and sometimes it is boring!). The results cannot, almost by definition, be generalised<sup>6</sup>.

There is one more crucial hindrance to this kind of analysis. Many mental mechanisms are tacit and obscure for the subjects themselves, and, therefore, they cannot be analysed by means of traditional psychological methods, such as interviews or protocol analysis.

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<sup>6</sup> One more reason why these procedures are not perfect is that there has never been a methodological discussion on the subject, despite Simon (2000 and 1991) considers these procedures fundamental for the development of the behavioural approach.

Despite its limits and the still open problems, experimental economics - when it follows given criteria – is nevertheless an almost necessary instrument, if we are to analyse certain aspects of individual and organizational behaviour.

The above mentioned authors use also other kinds of experiments to integrate the procedures described. These experiments are quite different from the ones described before. Simon-Barenfeld (1969) and Simon-Gilmartin (1973), for example, describe analyses whose aim is understating the way how subject behave, when they are faced with a new piece configuration on the chessboard. These experiments are not carried out to test a theory, they try to find the elements necessary to develop a model of the subjects' real behaviour. Therefore the analysis is quite particular and detailed, as it is not based on guidelines to be verified.

Cyert and March (1963) propose, instead, an experiment aimed at understanding the effects of individual interests on communication in a working group.

In the 1950s experimental economics had not yet developed the body of rules and practices that are nowadays indispensable to have an article accepted by a journal. Nevertheless these experiments – such as the ones carried out by Chase and Simon (1973), which analysed in details the behaviour of only three chess players – represent an anomaly.

As regards the need to micro-found individual behaviour referring to real life<sup>7</sup>, there is an evident and sharp difference with respect to traditional economic views and also to most experimental works. This is a point of similarity, instead, with the works belonging to the fourth line of research.

Although mainstream economics has often considered experimental economics a minor and little relevant discipline, or even an approach conflicting with the traditional views (we have seen already a few criticisms; more generally, several scholars maintain that economics is not an experimental science), experimental economics has always been a useful instrument for the neoclassical approach and has always followed its paths.

For John Hey (1991), one of the major contemporary experimental economists, experimentalism makes it possible to test theories under the condition of *ceteris paribus*. Thus the economic science can test its models just like physics and chemistry (these were the reference models for economists as early as at the beginning of 1900)<sup>8</sup>.

The works we have discussed in the last paragraph are a concrete example of these ideas. Let us now consider other examples.

Hey-Darnanoni (1988) propose an experiment exemplifying the meaning of the hypothesis "as if", which is at the basis of neoclassical methodology according to Friedman (1953). In an experiment on consumers' behaviour the outcome is that, though individuals make decisions following a series of rules of thumb, nevertheless they reach optimal results "as if" they were able to maximise. Therefore, the neoclassical decision-making model can survive the passage from the hypothetical world of theory to a more realistic (though this is still a laboratory context) situation.

This is the aim of experiments: test these aspects and compare different theories. As a consequence, it is necessary that, in the experimental design, contexts are similar to the ones described in the reference theories.

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<sup>7</sup> This fact is also connected to and influences interdisciplinarity, which is its integral part.

For the analysis of decision-making processes, for example, to understand the real mechanisms used by individuals we are exchanging views with psychology. Sometimes such dialogue covers also methodology, which is quite different for empirical analyses.

<sup>8</sup> "This experimental way constitutes, of course, the prevailing methodology in many of the hard sciences; physics, chemistry and biology all consistently use the experimental approach. For such sciences, experimental tests of theories are crucially important; only by subjecting a theory to test under the same controlled condition as those under which the theory itself was generated can a theory be properly tested. The same logic should apply in economics, especially if economists continue to borrow other aspects of the methodology of hard sciences" (Hey 1991, p.9).



Kelley-Friedman (1999) propose a game in which the participants are asked to forecast the price of a good. Such price is determined on the basis of a linear stochastic process with two independent variables. The participants know the model, but do not know the parameters. In each of the 480 rounds of the game, their task consists in determining the price, starting from a series of values of the independent variables. At the end of each turn they are told the actual price.

The experiment is designed to test the model of "least square learning" (see, for example, Marcet-Sargent, 1989): the subjects do not know the models' parameters (they do not own perfect information), but they can learn them in the course of the experiment. The data gathered with this experiment are therefore used to assess the subjects' ability to estimate (implicitly) the actual parameters.

Certainly the situation proposed in this experiment (as well as the way how data are interpreted) is still closely connected to the theory. Moreover, neither the concept of learning used, nor the situation examined (estimating the parameters of a known model) pretend to be real.

Also a few experiments which were proposed from a critical perspective towards mainstream economics, such as the ones carried out by Allais (1953) and Khaneman-Tversky (1979, 1992) are, nevertheless, closely connected to traditional models. In fact, they take their start from the expected utility theory, which becomes a touchstone and, above all, defines the situation under investigation, characterised by risk rather than uncertainty. Therefore, all possible choices are known with the respective occurrence probability: these situations can be modelled by means of lotteries, it is easier to handle them, but they are far from most real situations individuals have to cope with.

This is why these experiments are not in the same group as those concerning cognitive aspects, whose perspective is different.

In fact, as already seen, Hey (1991) refers to experiments as an instrument to test and compare theories under *ceteris paribus* conditions, while, in the introduction of one of the most relevant articles of the new line of research, Egidi and Narduzzo (1997) underline a different aspect: the experiments' aim is gathering empirical evidence concerning aspects which would be otherwise difficult, or even impossible, to analyse.

Other differences ensue from this alternative view, concerning the kind of experiments carried out and the way how data are analysed. Moreover, an important aspect is the different maturity level reached by the two approaches. The cognitive approach, despite its solid roots in the history of economics thought, can be considered a new science. As a consequence, there are no alternative models to be tested, but there are new hypotheses to be defined and this is a priority for empirical analyses.

Usually, in cognitive experimental economics, the contexts used have no immediate reference to specific theories (and sometimes they even exclude situations which might immediately be seen as "economic" choices).

One of the primary aims is the analysis of real human learning mechanisms and the mechanisms of conscience development in situations characterised by uncertainty. This is why we abandon the traditional context in which the subjects are informed of the most relevant variables (and they are only asked to make a choice). Here the participants in the experiments face new situations, in which problems need to be solved, choices are not limited and can be analysed not only in terms of numbers (there is a switch from risk to uncertainty).

Often in these games subjects are asked to repeat the same task a number of times in order to learn. In a few traditional experiments, as well, subjects repeat the same task, but in that case learning means "understanding the game" rather than "developing new knowledge". Here, instead, we refer to a concept of learning and decision borrowed from psychology and neurobiology, and therefore closer to reality.

As the purpose of these experiments is first of all understanding the way how subjects behave in their real lives, when analysing data, the attention is focused on the description and understanding

of the factors influencing the choices made by the agents. The attention goes beyond the analysis of the differences between control groups: these differences are not always relevant (since, treatment being equal, there might be unequal responses, see Novarese 2004b).

Thus the picture is enlarged and the analysis becomes more complex: we often find out that choices are influenced by a number of factors and that it is difficult to exclude one factor to understand those choices.

Moreover, there are many heterogeneous elements differentiating individuals, even in very simple experiments.

Traditional experiments consider these factors as disturbances, whose explanation is irrelevant and should be seen as a measurement problem and/or a lack of understanding of the game rules, or as a response to the experimental environment which has proven inconsistent with the expectations. This is probably true, yet these aspects are not to be neglected (as they are crucial to understand the workings of institutions and organisations) and they can be, at least in part, explained.

The heterogeneity of subjects is indeed – also at a theoretical level – a central aspect of the cognitive approach. Therefore, it should not be neglected at an empirical level.

Indeed, a series of problems and difficulties arise, since statistical and econometric methods have been developed to find out the similarity factors among subjects, by cutting out possible individual effects. There are few instruments (such as the cluster analysis) designed to classify differences.

### ***3.2 A few examples***

Cohen and Backdayan (1999), Egidi and Narduzzo (1999), and Bonini and Egidi (1999) use a card game: "Target the Two" (TTT). Players are coupled permanently and form a team for several rounds; they are asked to reach a given arrangement of cards on the table. They can exchange cards following precise rules.

Two strategies can be implemented to solve the game. The initial card configuration determines which strategy is more efficient, in terms of time and of moves necessary to reach the solution (these are the two variables players' remuneration is based on). There are two initial configurations and two strategies. A group of subjects undergoes a training period starting from the first context. The second group, instead, starts from the other configuration. In the second part all subjects play in the same conditions.

The results are very interesting. The teams which have trained in a given context and have therefore learned to follow a given strategy tend to follow it even when the situation changes and a different strategy would be more efficient.

The analysis goes beyond this observation, trying to understand the cause of their behaviour.

The experiment has been repeated with single players performing the same task which had been previously performed by teams. The results obtained are confirmed. This suggests that organisational routinization begins at an individual level. Once a subject has found a satisfying solution for a problem, he/she tends to repeat it and to extend its validity to contexts which differs from the original ones.

Egidi (2002) continues the analysis and gives us an in-depth look of the issue: in a new experiment subjects are asked to confront a little four-sided Rubik's cube.

To reduce the short-term memory load, subjects use simplified (and therefore in some measure abstract) systems of mental representation. Being abstract, these mechanisms can apply to a higher number of situations, than the one they were originally developed for. Thus there is a trade-off between simplicity (of mental processes) and efficiency, as models are not necessarily valid also in different contexts.

The "Sum 10" experiment - proposed in different versions and specifications by Novarese (2003 a and 2004b) and by Novarese-Rizzello (2004 a and b) - follows in the footprints of TTT, but it tries to study also the relevance of opportunism in the team functioning. In this game teams of three individuals are formed, and they are asked to declare a number. The team wins if the sum of the numbers declared by the three partners equals to ten, but the number declared is subtracted from

each individual payoff<sup>9</sup>. The game is repeated for several rounds with the same teams, thus allowing individuals to adjust to each other in each team.

The subjects need to cooperate and to be co-ordinate (someone has to accept that he/she may pay more than the others). "Sum 10" can therefore be associated to the experiments on altruism/egoism, which are generally carried out in a context like the "prisoner's dilemma". Though the context is simple, "Sum 10" is extremely more complex in terms of possible behaviour and outcome, and it allows the researcher to study other aspects, such as the role of satisfaction or the relevance of subjects' psychological characteristics<sup>6</sup>.

### ***3.3 The subjects' motivation in experiments***

Gathering data concerning satisfaction is quite simple and immediate: the participants are asked to assess it with a number from one to ten at the end of each round. This method, borrowed from psychology, is used in the analysis of individual happiness, where data are gathered by means of a survey. Certainly, these data show several limits and give rise to a number of problems. Nevertheless, they allow us to carry out interesting and significant analyses, thus enriching the knowledge at our disposal.

The score is certainly the most relevant variable in determining satisfaction. Still, there are also other aspects to be taken into account.

In particular, the fact that subjects undergo a training period in which it is more difficult to gain scores (their two partners are opportunistic artificial agents<sup>11</sup>, whose behaviour is not easy to understand), increases the satisfaction they may reach later, scores being equal.

Thus, satisfaction develops according to criteria confirming Simon's model, but there are other aspects that are worth mentioning. A few players declare a high level of satisfaction also when they "punish" their partners' opportunism. Other players, instead, seem more interested in the performance of their team (or, if we look at it from another perspective, they are more interested in reaching the goal of the game, that is sum 10) than in their own.

Moreover, apparently satisfaction is also connected to the reinforcement mechanism of the choices made. Those who reached a higher level of satisfaction with a given strategy, tend to repeat it more than those who gained the same scores but appraised them less.

Another interesting result is the demonstration of the relevance of subjects' extroversion (measured by means of a psychological test).

At the end of the sessions subjects were interviewed. The game is easy, and this makes some interviews very interesting, as they can explain the strategies that were put into practice, and can give us hints as to participants' motivations.

Another fundamental point in the assessment of the results and of the general validity of experimental data, is participants' motivation.

According to the prevailing methodology, the participants in an experiment should have the same motivation as the economic agents in the theory.

Hey (1991) expressed a point of view shared by several researchers: to solve the problem arising from the fact that for the experiments in economics human agents are used instead of inanimate beings (as in physics), it is sufficient to use a proper incentive mechanism. And in neoclassical logics we find a simple solution to meet this need: subjects receive money remunerations, whose amount is determined according to the value reached in the objective function (Hey, 1991).

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<sup>9</sup> If the sum is higher than 10, the payoff is lower. If the sum is lower than 10, the payoff equals to 0.

<sup>6</sup> Moreover, in this game it is possible to let artificial and human agents interact, thus proposing an interesting cooperation with simulations.

<sup>11</sup> Subjects do not know they are interacting with artificial agents. Not all traditional experimentalists approve of this aspect, as they believe that the subjects should know exactly how the experiment is structured (they should have perfect knowledge).

This is true only in a neoclassical context, and only if we are interested in testing a model as a whole.

It is a strong hypothesis, whose validity is refuted by an extensive literature, which do not acknowledge the validity of the idea that individual behaviour follows purely egoistic reasoning, and therefore individuals are only and always motivated by money incentives. Andreoni (1993) maintains that: "laboratory experiments are designed to be neutral and to minimise social effects like kindness. Hence, regular public-goods experiments may already be eliminating a large amount of subjects' natural tendency to be cooperative" (p. 900). Nevertheless, "social and cultural propensity for kindness and generosity must clearly be very strong" and "such motives cannot easily be removed from experimenters simply by providing neutral environments and pledges of anonymity (p.892).

Therefore, in Andreoni's opinion, experiments should photograph empirical reality in very partial and particular terms, by cancelling a natural tendency so that subjects are not affected by social conditioning.

Andreoni himself, though, maintains that it is impossible to reach this goal. At any rate, if we found agents identical to the ones of the neoclassical theory, experiments would no longer be useful, as they would be simply a reproduction of theoretical models.

In a game like Sum 10, the interviews carried out at the end of the sessions show that agents are motivated by various factors. Some agents enjoy themselves and/or are interested in the game, and enjoying themselves becomes the main factor influencing their choices.

Instead of focusing their attention on gaining scores and payoffs, subjects may be pursuing other aims. It is true that this might depend on the amount of the winnings, but in real life there are economically relevant actions which do not involve high earnings.

Hence, it is important to take all these aspects into due consideration, if we are to solve possible problems of assessment (especially in experiments following traditional methodologies) and to understand the real individual behaviour and social interaction.

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