Globalization, Uncertainty and Decision Making: Cognition Also Matters

Bernard Cadet

Introduction

The term ‘globalization’ is usually employed to denote a recent trend of standardization and homogenization of economic policies in market economy but it is also connected, though to a lesser degree, with the designation of recent cultural and social practices spreading throughout the world. The term is often applied to various policies (in production, commerce, management, culture, etc) worked out by an organization (usually by a transnational company) which acts in the complex context of economic competition and instability.

The analysis presented in this paper is the study of globalization not at the level of results but at the level of its forms and determinants. This choice is less traditional. In fact, from the outset, globalization was a strategy or a response to the constraints resulting from modifications which affected, to put it more precisely, not so much the existing economic mechanisms but the *context* in which they developed.

The global environment of enterprises or organizations, which have changed not only the scale of their activities but also their nature, represents a worldwide network of widely-circulated information. It is necessary to distinguish two meanings of the term ‘globalization’: the state of being globalized (referring particularly to the global economy) and the act or process of globalizing which denotes the way of working out one’s strategy.[1]

We turn to cognitive globalization to deal with the processing of information as a whole for supporting the activities and survival of an organization or an enterprise. These two meanings of the term ‘globalization’ and the attention drawn to it nowadays justify a thorough consideration of the term ‘globalization’, with special reference to its cognitive meaning which underlies decision making under economic globalization.

While deciding, or, in other words, tending to choose a certain action, we all have often experienced the problem of decision making caused by the level of uncertainty that arises.

A current practice of decision making is to collect information from several sources, to think in terms of systems and organization, and then to globalize all that

[1] Merriam-Webster’s On Line Dictionary (http://www.merriam-webster.com/dictionary/globalization): *Globalization* (noun; date – 1951) 1) the act or process of globalizing 2) the state of being globalized; *especially*: the development of an increasingly integrated global economy marked especially by free trade, free flow of capital, and the tapping of cheaper foreign markets.

data in order to lessen the risk of mistakes and inappropriate choices. In this paper, my intention is to explore the relationship that exists between uncertainty, decision making and globalization within the framework of cognitive science.

The material of this paper is arranged in four parts. In the first, I analyze various decision making situations. The second part examines the notion of uncertainty and its determinants. In the third part several forms of globalization, which differ greatly in their forms of implementation, are presented and analyzed. The conclusion follows the above-mentioned three parts and suggests some new perspectives.

1. Decision making: a complex situation

1.1. Frequency, diversity and specificity

Decision making is an activity which frequently occurs – perhaps, several times a day – and often relates to quite different problems. If your son or daughter has a runny nose, should he or she go to school? What mode of transport to use for travelling to a town which is far away? And so on. It can involve current decisions the consequences of which will not be very important in the case of a bad choice. However, other decisions, for example, to have a baby or to change one's job will be clearly more fundamental because the consequences of these decisions will last longer and can change one's life significantly. The economic decisions which are taken by individuals or organizations (enterprises) such as to buy a flat or to adopt a plan of development require a thorough examination of the situation by using a certain number of related elements so as to anticipate any possible changes which may occur in the future.

One of the specific features of the study of decision making concerns situations which in many respects seem to be similar but which turn out to be different, because the acquired knowledge about a certain situation is not applicable to another one, though the latter appears initially to be rather similar. This indicates that there is a high degree of specificity and that the experience acquired under certain conditions is difficult to use for solving similar problems under other conditions at least globally and directly. Every decision depends on the unique context invoking solutions which must always be worked out carefully depending on the particular case. Moreover, temporally different components, such as preparation, reaction and adaptation must be integrated into the choice of action as well (Smida, 2003).

1.2. Structure of the problem of decision-making

A problem of decision-making is usually considered to be a confrontation between a situation (the actual event and circumstances) and a particular person (the decision maker) engaged in the process of decision making. In the case of a collective decision, the decision maker is a group of people (government, an elected council, etc.) who, *mutatis mutandis*, consider the problems and whose basic information is identical.

According to MacCrimmon (MacCrimmon, 1972: 447) “a decision problem occurs when a decision maker:

- notices a discrepancy between an existing state and a desired state
- has the motivation as well as ...
- the potential to reduce this discrepancy whereby...
- there is more than one possible course of action which may not be immediately available...
- the implementation of a course of action demands an irreversible allocation of his resources and...
- the utilities (of the consequences) associated with each choice-alternative are partly or entirely uncertain”.

1.3. Conceptual and notional indicators

At the conceptual and notional level of analysis such a definition leads initially to the idea that decision making can be regarded as an individual or collective process: the choice of *one* form of action (A_i) in the set of several (k) potentially possible actions (A_1…….A_k) that are competing and mutually exclusive. To arrive at such a result which signifies the beginning of an action a decision maker performs work which by its nature belongs to the cognitive category. In fact it involves taking information into account by using different means and processes such as perception, memory, attention, language, reasoning, solution of problems, etc.

Decision making itself has been a subject of study largely developed in cognitive terms due to the contribution made originally by Edwards (Edwards, 1954) and resulting in the foundation of a new trend called behavioural decision making (BDM) (Edwards, 1961). Since then two avenues have been open for studying patterns of decision making: one refers to the theoretical principles of a formal nature (Berger 1980), while the other is aimed at understanding the mental operations that occur in reaching a decision (Hogarth, 1980). These options are significantly different, so that it is possible to speak about paradigms in the sense employed by Kuhn (Kuhn, 1970) and by Eysenck and Keane (Eysenck and Keane, 1995) for defining a conceptual framework or school of thought. The first paradigm, used in Economics, refers to the *criterion* of the result aimed for and highlights the importance of the logical operations on the part of a decision maker (from a mathematical point of view). The second, originating in Cognitive Psychology, is *procedural* because its aim is to study appropriate operations for processing information in order to reach a decision.

1.4. Fundamental psychological references

The general principles that underlie the first models of decision making are old-fashioned but at the same time relatively simple. They are old-fashioned because they were discovered by utilitarians such as Bentham (1748-1832) and John Stuart Mill (1806-1863) during the 18th and 19th centuries; they were later slightly changed and used by ‘mathematically-oriented’ economists such as Jevons (1835-

1882) and Edgeworth (1845-1926) at the end of the 19th century and the beginning of the 20th century. Leaving aside the problem highlighted by the Paradox of St.Petersburg,[2] these models are in fact psychologically simple because the choice of action (decision making) is supposed to increase *maximal satisfaction*. As a consequence, this criterion of maximal satisfaction determining choice and behaviour is formulated immediately: it means that one will choose action A_i among all existing possibilities because that action will provide the decision maker with the most satisfaction. For several decades, this criterion was directly applied; in other words, actions were deemed to be positive if the result led to the largest quantity of advantages and benefits of all kinds. Much later certain situations were formalized in which all possible actions led to displeasure whatever action might be chosen. Under such conditions decision making is based on continuous self-reference to psychological postulates with the inversion of criteria allowing us to choose the action which causes *minimal displeasure*. Thus, the chosen action will be the one which *minimizes* displeasure or losses (for a more detailed explanation, see Miller, 1964).

It is necessary to turn to the research done by Loomes and Sugden (Loomes and Sugden, 1982) and by Bell (Bell, 1982) for obtaining some indication of how to treat the generalized values of 'displeasure'.

- The first among them is *regret* which has two forms. It is possible according to the first assumption to regret not performing the correct action (the results of which could have been closer to the criterion than those obtained via the action actually carried out): it is a post-regret about the decision related to a non-optimal choice of action. But there is a second possible assumption about the choice which presupposes a feeling of regret experienced by a decision maker about an action not performed at all in the past before the necessity to make a choice has arisen in the present: it is an anticipated regret or pre-regret about a decision influencing the choice of a future action. It is also possible for a decision maker to adhere to an intermediate option in which he will be less engaged and which will bring about less regret, instead of choosing the option the results of which could be estimated to be the best. Any eventual losses will be fragmented and distributed among different possibilities of action according to a strategy that we could call the strategy of prudence or even of fear.

- In the second case emotionally associated states such as deception, disappointment, lack of gain and lack of bitterness were studied according to the same principles (Connolly, Ordoñez et Coughlan, 1997; Gilovitch et Medvec, 1995).

1.5. Utilitarianism and cognitivism

From the psychological point of view we call these options utilitarian, postulating that we are in the presence of '*homo placens*', i.e. a decision maker simplified to the extreme as his choices for acting are considered to depend only upon a single value of reference: the experience of maximal personal pleasure.

[2] See Editor's Notes.

This aim, however, is not evaluated in any absolute, definite or blind way, i.e. without taking into account circumstances and implications. Quite the opposite: this is a strategy of *contextual* determination of maximum satisfaction. The decision maker can adjust the level of demands to the conditions existing in the environment.

Thus, the notion of maximal satisfaction is always relative and will be determined by a decision maker for a particular situation. So, consequently, the notion will involve, if not calculation, at least an act of cognitive evaluation. All criticism emphasizing the simple character of utilitarianism has arisen from a confusion between general and particular.

As things stand, the general principle must be treated as a theoretical reference, which is simple; the specific dimension, which is examined in this article, corresponds to the 'implementation' of decision making in a given situation. What is the maximum of satisfaction? It seems clear that the reference to principle in itself is necessary but it is far from being sufficient for explaining behaviour. Behaviour is, in fact, variable, thereby pointing to the importance of the cognitive contribution.

Cognitive acts have two successive stages. The first is the stage of *calculation*, which is meant to determine according to the situation and various available resources, what can be the maximum of satisfaction (or the minimum of displeasure) which, thus, is not a fixed thing a priori. In favourable contexts the maximum of satisfaction will be evaluated to a much higher degree (the choice of maximal gains with all positive results); in unfavourable contexts (when all results are expected to be negative) the target defined will be much more modest and can be limited to the least significant losses.

The second stage is that of defining the *strategy* to be adopted: the target is decided upon, as well as the way and means to be used for achieving that target. Comparisons between individual behaviour and choices demonstrate considerable diversity. In order to reach the same degree of satisfaction, different ways, information and processing are used: we call these Vicarious Strategies (VS).

Thus, on the whole, from the utilitarian initial perspective all the cognitive components concerning globalization relate to the management of the situation.

The determination of an optimal action requires taking into consideration preexisting experience and data which differ depending on the decision maker and the particular situation, according to the person's preferences and referential knowledge. It may happen that the consideration of these elements will lead the decision maker to postpone the search for immediate pleasure, so that other values become more important than immediate pleasure. A decision may also be taken because of obligations or constraints of some sort limiting the possibility of immediate personal satisfaction. In social and technical complexes (industries, big enterprises, transport, etc.) decisions depend on other determinants and the dichotomy pleasure-displeasure is no more than a distant reference. Thus one can see that the interest of researchers shifted progressively from criteria models to

procedure models based on the logic of processing (Bayes' theorem, for example[3]). After remaining obscure for some time, since 1995 such determinants as emotional states and the state of pleasure have been reintroduced as major determinants for behaviour and decision making and constitute at present an important field of research for psychologists (and also economists) on the issue of decision making (Ritov, 2006).

All in all, cognition is more important for human beings than pleasure or economic gains and it is this 'cognition person' who is seen as using these models (Weil-Barais, 1993). In fact obtaining a state of satisfaction implies calculation and the choice of strategies which can only be produced by a highly developed and diversified system engaged in the processing of information.

2. Uncertainty: perception and processing

2.1. A frequent characteristic

One of the main difficulties which cognizing decision makers come across is that all their considerations of action, including choices, are carried out while having to deal with an irreducible complication to the task at hand: uncertainty. How, in fact, can we achieve sufficient certainty guaranteeing that the preferred action will indeed produce the consequences estimated to be the maximization of pleasure? The more recent observations easily show that the action initially thought of as positive (i.e., as an action potentially increasing pleasure) can in the end turn out to be negative in certain cases (generating displeasure).

For example, we come across complaints about hospitalization which, although necessary for treating an illness , *sometimes* turns out to generate other diseases – yet in the *majority of cases* the decision to hospitalize a patient brings positive results. We can also evoke situations when the action taken to diminish displeasure proves, in some cases, to cause other forms of displeasure. Staying in the domain of health, there are secondary consequences which *some* forms of medication can cause, leading to displeasure for *certain* people.

In similar examples which could be added, the difficulty in decision making reveals an *absence of generalization* and thus a lack of certainty as to the consequences of the action. Any given act chosen in similar circumstances may produce different effects: it may increase the pleasure of well-being or the quality of life (in the majority of cases), but it may also increase displeasure (in some cases). Since it is impossible to work out a completely unambiguous assessment, the job of decision making becomes remarkably complicated due to the introduction of uncertainty.

These very simple examples illustrate the importance of the omnipresence of uncertainty in the process of decision making. There can always be different possible effects, expected results, consequences, circumstances or ways to develop or to be taken by people and systems used for a great number of activities. And every time uncertainty is ready to interfere since it is one of the dimensions which

[3] See Editor's Notes.

is *necessarily* integrated into the process of decision making. All predictions, anticipated actions, prospective actions will become attached to the definition of its importance and effects.

It is not an insignificant paradox that decision making has to include uncertainty in order to bring about more certainty in decision making, rather than discarding uncertainty completely. In fact, if we refuse to face up to uncertainty, we will certainly have some unpleasant surprises or failures in the future. The feeling of certainty and overall control of development in the future represents one of the ways of decision making (showing too much self-assurance) which must be challenged, especially when it comes to the choice of an action. Taking uncertainty into account as a part of any analysis of a situation does not reveal an optional choice: it is the main epistemological necessity, not to say a guarantee (about which one is not certain any more) of the quality of the decision.

2.2. Different sources of uncertainty

To begin with, uncertainty in decision making is not a single-level general characteristic, as one could think at first. Three different forms of uncertainty can be clearly differentiated. The first belongs to situations, the second concerns information and the third involves actual circumstances.

To distinguish between them, it would be better to begin by analyzing forms of uncertainty in a situation of risk (Cadet, 2001) taking as an example the risk of climatic pollution connected with industrial accidents (Seveso, 10 July 1976; Bhopal, 3 December 1984; AZF Toulouse, 21 September 2001)[4] or the risk of marine pollution due to hydrocarbon after the shipwreck of several oil-transporting cargo ships (Amoco Cadiz, 1978; Exxon Valdez, 1989; Erika, 1999; Prestige, 2002, for example).

Situations of this kind unfortunately occur from time to time and demonstrate clearly the limits of applied strategies of choice if the notion of system is neglected. These situations in decision making represent an archetypical case when for a very short period of time it is necessary to manage an almost unknown system where numerous variables and numerous constraints exist, and to consider a great number of uncertainties in order to choose the modes of actions (interventions) which can reduce, as much as possible, obviously dramatic consequences for the environment and living species including human beings.

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[4] Seveso: a dense vapour cloud containing tetrachlorodibenzoparadioxin was released from a reactor at a chemical plant in Seveso, Italy, and spread widely over a large territory affecting animals and vegetation. In 1982, the EU Directive 82/501/EEC, the so-called Seveso Directive, was adopted; it aimed at preventing and controlling such accidents.
Bhopal: an explosion at a poorly-maintained pesticide plant (India) released 40 tons of methyl isocyanate gas killing more than 3,800 people in a densely populated zone.
AZF: there was an explosion of stockpiles of ammonium nitrate at the fertilizer factory 'Azote de France' in Toulouse in 2001. Though classified as a Seveso type, the catastrophe resulted in 30 deaths among the staff, many people were injured and the material damage to the city of Toulouse was enormous.

The first uncertainty is *structural*: the identification of the situation which was created by an accident. When can the situation be considered as abnormal or damaging? During those first minutes which are very important for the ultimate management of a crisis one often thinks that it is some unexpected happening or dysfunctioning rather than a catastrophe (see for example, the management of the Erika and Prestige[5] catastrophes). Initially the situation is insufficiently characterized; it is the final development which allows the best identification and diagnosis of the event. Uncertainty about the real nature of the situation arises owing to the information that follows on, but, unfortunately, it takes too long to obtain the necessary information; in the meantime, the system starts evolving according to its own dynamics which is no longer controllable or salvageable.

The second category of uncertainty is *informational*: this involves the processing of information and the use of signs for identifying the structure. The question which arises here is the following: what deduced elements of information about the situation can be used as indicators? The majority that one has at one's disposal are no more than probabilities. With some rare exceptions, the signs do provide information, so they must not be neglected but these signs do not provide *complete* information resulting in certainty, thus, they cannot be considered as defining indicators.

In varying proportions the same sign seen on the 'surface' (x_i) is to be used for identifying the type of the situation existing 'in depth' (being essential for the situation θ_i). A visible sign can present itself in the same way even though the underlying situation is different (x_i indicates either θ_a, or θ_b). So we can say that such signs do not have only one meaning: they are polysemous. They are also fallible indicators, as Hammond puts it (2000). The act (decision) is constructed gradually, beginning with a mixture of information and uncertainty and *generalizing* the data on the basis of fallible and multiple indicators. This type of act frequently occurs and illustrates another typical case: an act of a patient who consults a doctor.

The signs looked for by a doctor (x_i) in order to establish a diagnosis (θ) and make a decision (A) (therapeutic prescription) are connected with uncertainty. They do not have only one meaning, with the exception of a few cases (so-called pathognomonic signs). The same sign (fever, for example) can be present in clinical cases of different natures: this is an example of informational uncertainty which requires collecting *several* signs in order to reach an appropriate diagnosis.

The third category of uncertainty resides in the evaluation of consequences. How are they imagined in the beginning and what are the numerous factual results

[5] Erika (12 December 1999): the Erika, an oil tanker, sank off the coast of France and 37,000 tonnes of fuel polluted 400 km of shores around Brittany (France).
Prestige (19 November 2002): The Prestige, an oil tanker, sank off the Galician coast (Spain) causing a large oil spill. The spill polluted thousands of kilometers of coastline. The decision taken by the Spanish government for managing the crisis amplified the effect of pollution which affected three countries: Portugal, Spain and France. The Head of the Spanish government had eventually to admit the mistakes made and apologize.

and major permanent interactions? For example, maritime pollution with hydrocarbon (consequences) resulting from a shipwreck depends partly on the tonnage of cargo, but the consequences can be noticeably increased or decreased due to the nature of the fuel transported, the accessibility for ships, meteorological conditions, tide, geographical configuration, topology of the sea-coast, etc. How can all these sources of information be generalized under the pressure of events in order to take appropriate measures?

2.3. Difficulties of quantification

It is important for all decision makers to know the different forms and levels of uncertainty connected with quantifiers (formal option) or their evaluation (cognitive option).

2.3.1. Formal option

The reference which is generally used for the quantification of uncertainty consists in translating it into mathematical probability. The numerical value of p, $0<p<1$, must be such as to comply with three principles (Kolmorov's axioms). Uncertainty connected with the appearance of the described 'event' will find itself determined by reference to the preliminary observations relative to the appearance of the event itself ('favourable' case: n) developing during the sequence of observations carried out N times.

The probability appears here in the form known as 'frequent' (most known) determining the value of the relation n/N. The higher the numerical value (close to 1), the greater the certainty (thus uncertainty is weaker) with regard to the occurrence of the event involved. This method is generally used by technicians, forecasters, experts in industrial, technological (meteorological) and medical sectors for dealing with concrete situations.

This choice and the uncertainty underlying it expressed in numerical form requires some remarks. First of all I would observe that, unlike the person experiencing the event, the person evaluating it adopts an 'exterior' position in which he limits himself to recording observations without interfering in the situation that produces what is observed; this kind of validation of the probability is called 'objective'.

I would like also to draw attention to the fact that the numerical expression of probability enables a decrease in overall and 'diffuse' uncertainty only by locating uncertainty on the quantitative scale. This positioning allows referring to previous events, and it is the consideration of all that has passed before that makes possible any inferences about the future. This measure presupposes implicitly that the situation to be evaluated is exactly the same as those which have previously occurred. If on the contrary the previous situation shows a great degree of specificity the decrease of uncertainty will be minimal and prediction difficult.

Finally, I would point out that the epistemological choice of a numerical sign (the value of p) reveals a state of knowledge that is difficult to formulate because information and uncertainty, doubt and knowledge are mixed in various proportions.

Such a conception of probability proves to be especially helpful when applied to systematic studies with repeated observations and application of statistical methods, as in planned situations with scientific or technological recordings.

2.3.2. Cognitive option

It is interesting to establish a correlation between formalized steps, issues of scientific thought and actual behaviour while evaluating the degree of uncertainty. We all, including researchers who are experts in the field of decision making, use different approaches.

If we are choosing a place to spend a holiday, hoping that we will have a pleasant time there, we do not usually use formalized mathematical measures. In any given concrete situation we call upon cognitive functions: searching for information, mobilizing our knowledge, focusing our perception, drawing our attention to the problem, recalling in memory, investigating, considering all that we have and then use 'reasoning' based on our knowledge in order to produce an act of choice. This also means the reduction of uncertainty but is based on cognitive operations in which the decision maker is deeply involved in research and the processing of information.

Thanks to this kind of cognitive work, it becomes possible to formulate a numerical evaluation of probability called in this case 'subjective' (carefully assigning to this qualification its epistemological meaning which signifies 'suited only to one subject'). The reference to this subjective probability regarding decision making was put forward by Savage (Savage, 1954), then by all specialists in statistics who belong to the Bayesian trend and for whom it constitutes a fundamental reference. The observation of certain rules, namely, the condition of coherence (De Finetti, 1972), allowed them to validate the subjective reading which is carried out also on the scale [0-1], but this is due more to respect for tradition than to intrinsic necessity.

Perhaps, these operations do not give a decision maker a numerically more precise result but a more global perception of his position. This is what we call Acceptably Uncertain Cognitive State (AUCS) identified according to several features.

The AUCS is an epistemological approach which is used for carrying out the work of gathering and processing information after which a decision maker feels introspectively that his uncertainty has on the whole decreased significantly. The state of management of the situation which has now been achieved appears sufficient for enabling a choice to be made, now that uncertainty, even if not removed completely, has been reduced. The decision will be taken under diminished uncertainty, which is reduced to a level compatible with the act of choice. In situations like these, with which we have to deal every day, cognitive measures are more preferable to measures consisting in referring to a numerically expressed probability. Perhaps, the difficulty of cognition in using a numerical probability justifies this preference and explains the recorded fact of this preference.

2.3.3. The difficulties in using probability

The notion of probability raises serious difficulties in evaluation and in its use in concrete situations. A great deal of experimental research has demonstrated that fundamental axioms are frequently broken or ignored and that a number of factors completely disconnected from the statistical notion of probability (presentation, the effect of context, forms of observation, etc.) intervened noticeably in the evaluations made (von Winterfelt et Edwards, 1986).

Moreover, on account of its narrowness, the interval [0-1] is hardly favourable for quantifications which show a high degree of discrimination and sensitivity, but to our surprise the experimental results demonstrate that the modes of rendering uncertainty which seem a priori mathematically more complex – such as the odds on horses and the logarithms of these odds – are used spontaneously in horse betting and other forms of gambling (Griffith, 1949; Wise, 1970; von Winterfelt et Edwards, 1986). To these initial difficulties of quantification it would be appropriate to add difficulties appearing in real situations. I shall give only two examples. The first is the tendency to give a higher result than 1 when assigned probabilities are added to the possibilities concerning the same event. The second, well known as the 'conjunction fallacy', is demonstrated by Tversky and Kahneman (Tversky and Kahneman, 1983) in Linda's case.
It can be expressed as follows:

Linda is 31 years old, single, outspoken and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice and also participated in anti-nuclear demonstrations.
What is more likely?
1. Linda is a bank teller
2. Linda is a teller and is active in the feminist movement.

Contrary to the formal rules of mathematical calculation, 85% of subjects interrogated expressed the opinion that 2 is more probable than 1. The examples of this type are many: all agree that the notion of probability when it is defined mathematically is 'cognitively' difficult to use by those who are not specialists. Not only do the individuals or groups concerned tend to avoid using this reference but they also tend to breach the axioms on which the very notion is based when they start using this reference and feel constrained by their logical consequences. Therefore, we have to turn to other forms of reduction of uncertainty in order to understand the diversity of strategies leading to Acceptably Uncertain Cognitive State (AUCS).

3. Globalization: agents, structures and systems

When uncertainty arises in some situations putting an end to an act of choice is a natural tendency of the mind in order to conceive strategies for reducing uncertainty. Conceptually, this act is clearly defined since we are supposed to

move from a state of initial uncertainty to AUCS. The operational means applied are based on vicarious strategies (VS) which carry out an act of globalization consisting in integrating various sources of information within decision making. But this is done according to models that are too different for the epistemological principles to be clearly defined.

3.1. Definitions and theoretical approach

The term 'globalization' came into use in the USA for describing a somewhat ancient phenomenon. Since then, the term has become widely used in economy and management to designate processes of globalization affecting all sectors of an industrial enterprise, such as conception, engineering, production, commerce, research work, finances, marketing, management, etc. Globalization is likely to be studied according to different points of view, depending on the discipline at issue in the study of globalization. Economics and management are the fields most involved. Many authors emphasize that a semantic distinction between globalization and 'mondialisation' (the latter refers mostly to the macro economic level of international trade) is peculiar to the French language since in English only one term – globalization – is used to indicate the process of convergence and its results. After highlighting the changing ('Protean') character of this notion, Boyer (Boyer, 2007) has recourse to other definitions and conceptual extension during a relatively short period.

The more recent definitions emphasize the emergence of a globalizing economy in which national economies are decomposed and then re-articulated within the system of transactions and processes operating directly at the international level. The movement and dynamism of fusion and separation are interesting to study because they enable us to realize that globalization contributes to the construction of the 'system'. It possesses simple and complex elements, organization and architecture on the basis of which interactions and adjustments exist. Dimitrova (Dimitrova, 2007) emphasizes the importance of the links uniting the local and global. She also uses studies on the relationship between parts and whole, as exemplified in the Psychology of Form (*Gestalt* psychology[6]) which affirm the primacy of the whole over its constituent parts. It is equally important to note that globalization is an emerging phenomenon. Thus, an effective strategy has to be worked out by decision makers in order to respond to the powerful constraints of processing.

These constraints are numerous and urgent: decisions must be taken in complex situations the characteristics of which are intermingled and in which the interactions carry a lot of variables that are continually evolving (for example, investment decisions in the financial market) and make for significant positive or negative consequences. I would say that under such circumstances a decision maker tries to provide himself with guarantees and the possibility of knowing the situation better in order to process overall data acquisition by bringing together different variables connected with the situation. Thus, the consideration of

[6] See Editor's Notes.

something as a whole is not the measure which appears *ex nihilo*. The diffusion corresponds to the profound changes which international trade has undergone; it is important to use a cognitive explanation which is a basic feature of processing information so that we can work out decisions adapted to the examination of complex situations. Globalization is not a given mechanism imposed on us but rather an act of adaptation and response on our part.

The theoretical approach which is adopted in this article is not for the moment widely used. The idea is to explore the cognitive aspect of globalization and the possible benefits it could provide for decision making. That is why I focus on the study of processing information, with the intention of contributing to the use of globalization as an operational concept. The main argument consists in postulating that to globalize information is to combat uncertainty by achieving Acceptably Uncertain Cognitive State (AUCS). The examination of studies, in particular in the methodological field, allows us at once to distinguish various modalities of generalizing.

3.2. Additive Globalization

When one has several (n) indicators (or several variables or signs) connected with the same entity E, it is advisable to use the first form of globalization for assessing (e.g. present or future situation, a candidate, a state of a system, etc); this is simply the addition of n-values of signs in order to obtain the total T characterizing this entity, say T_E. It is a simple strategy of addition where one considers the total T_E as involving less uncertainty than each indicator separately. This strategy is more clearly presented if we use a coefficient (α), keeping in mind the fact that some signs are very good indicators (α is high) while others are only of average quality (α is weaker). Thus, we have: $T_E = \alpha_1 x_1 + \alpha_2 x_2 \ldots\ldots\ldots + \alpha_n x_n$
This could be applied, for example, to examinations at universities (in France, at least, when the assessment of a candidate T will be determined by taking as a total his marks x weighted by coefficients α obtained in n subjects). The decision of the examination board (success or failure) is determined by an overall mark T_E. This additive strategy is one of the simplest, and due to its simplicity it is more often used. Other arithmetic rules could serve as a reference to totalization, as has been shown in the functional theory of cognition by Anderson (Anderson, 1996). Studies in *integration* of information relate specifically to the moment when all the data has been collected and evaluated and when it becomes necessary to 'integrate' (i.e. to globalize) all this information in order to obtain a preliminary overall judgement before making a decision. The experiments carried out by Anderson (Anderson, 1996) show that procedures of integration of signs vary. Sometimes, they appear to observe elaborate arithmetic rules (strategies of weighted average, a multiplying model, etc).

3.3 Correlational globalization (linear)

The option which consists in collecting elements of information for evaluation of the situation is also used in other types of paradigms, for example, linear

correlation. Let us suppose that a decision maker is to evaluate an entity in its totality (*S*) (an event, a situation, an opportunity, etc) and that to do it he has some information or indication of the values *x* (x_1…….x_n) which include, at the same time, information and uncertainty (see Figure 1).

The n signs (x_1…… x_n), characterizing S represent points of observation which are at the same time distinct and similar and which, if united, will enable S to be specified. The conceptions worked out by Brunswik (Brunswik, 1955) and known by the name of the Lens Model were developed in other research where these conceptions became the object of study in the framework of the theory of social judgment (Brehmer et Joyce, 1988), thus furthering our understanding of the acts of cognitive globalization. They allow us to model all types of situations aiming at evaluation or diagnosis by means of networks of correlations existing between different signs.

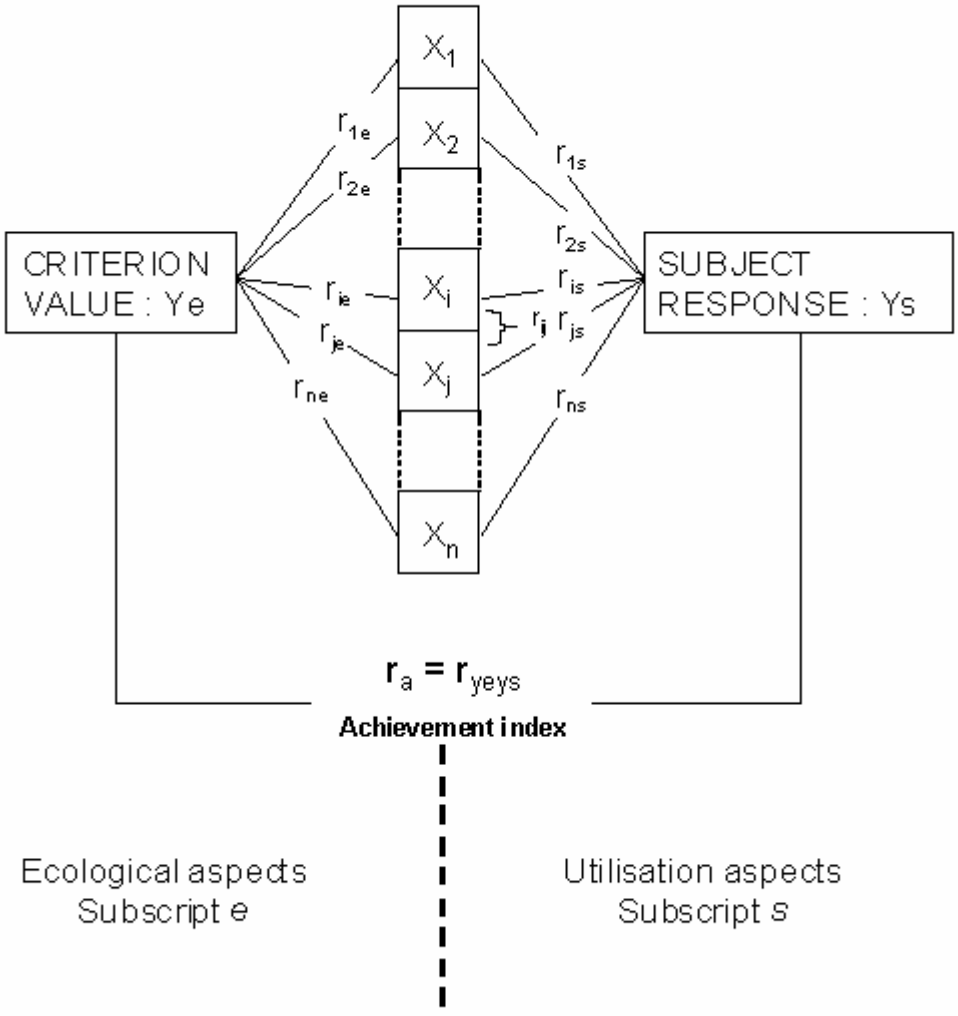

Figure 1. Simplified representation of the Lens Model

Actually, it is necessary to know the overall value Y_e (criterion value) characterizing the entity *S* at a given moment. This could be the state of an enterprise or an individual (illness for example, for which signs *x* will be symptoms). In all circumstances, the model implies that the entity *S* is a *reality* in the external world and that Y_e denotes a state or an 'equilibrium' structure influenced by active forces. The influence and overall result Y_e which are existing facts in the natural milieu are represented in the section on the left of the Lens Model called *ecology* and noted by the symbol *e*. The task of the decision maker is to construct a representation or an image as precise as possible of this reality; the operational mode in the section on the right in the diagramme is called correspondingly *utilization* and noted by the symbol *s*.

To sum up, on the left there is the 'reality' (*e*) and on the right there is a representation which the decision maker constructs (*s*).

How does the evaluation work? It reflects the passing from the diversity of signs *x* to the unique value which finally characterizes the entity under consideration. It deals with the act of globalization and the use of networks of correlations existing among the signs. The values *x* called proximal variables (cues) are, *de facto*, connected with what emanates and underlies the entity itself (*S*) and this connection is expressed numerically. All these signs are in correlation with one another (r_{ij}) and the criterion value Y_e (r_{1e} … r_{ne}) called distal value. The task of a decision maker is to know Y_e from the decision maker's point of view (to know the real state of the illness before prescribing a course of treatment).

The way in which different indicators are used, either underestimated or overestimated, (r_{1e} ….. r_{ne}) leads to the 'response' that is a distal value of the use Y_s which is to some extent an image of the Y_e that has been constructed.

This act needs commenting upon.

- The correlations used are generally linear which makes them simple and multiple. These correlations are the basis on which the act of cognitive globalization is made, allowing the *x* indicators to move towards the values taken as a whole *Y*.
- The *x* indicators can have various values. A 'good' sign will be an increased correlation (it will characterize *S* better), a sign less relevant will correspond to a weaker correlation. After combining them in the same configuration or after 'globalizing', the *n* signs provide the undoubted advantage for knowledge thanks to the reference to convergence of information as opposed to isolated indicators.
- The correctness of the decision depends, of course, on the precision with which different real correlations of an ecological section *e* are effectively used in an appropriate manner by the decision-maker in a given situation (the section of use *s*). Cognitively the signs are generally used by decision makers in a sub-optimal way that to some extent highlights the difference between the sections on the left and those on the right. Certain important signs are then regarded as unimportant, while other, less important, signs are treated as important; this results in an increase in the distance between Y_s and Y_e

- The correctness of the model is validated by the proximity which exists between Y_e and Y_s. It is expressed by achieving sign (r_a), which denotes the final correlation existing between distal values. So it is the degree of the connection between Y_e and Y_s, i.e. between reality and its representation, which will be used for validating the construction.
- The complementary indications specifying the significance and utility of certain statistical indices in the case of linear prediction can be found in Slovic and Lichtenstein (Lichtenstein, 1973), Hammond, McClelland, Mumpower (Hammond, McClelland, Mumpower, 1980), Cooksey (Cooksey, 1996).

This type of globalization occurs in medical diagnoses and in technological activity. A physician will collect clinical signs or laboratory indicators concerning the patient until he assembles a coherent set of associated (correlated) signs which will permit him to make a diagnosis – that is to identify the patient's 'underlying' state *S*, with which all these signs are connected, originating from the pattern made by *n* signs. In the same way, in a complex industrial process, an engineer who is responsible for production mechanisms has to foresee the indicators of proper functioning or dysfunctioning in order to take appropriate steps. In the narrower meaning of the term, it is necessary to learn to 'read' – it would be more correct to say to 'decipher' – the network of correlations in order to draw significant information from it, especially on the matter of risk assessment (Cadet, 1995).

These modes of evaluation are now also used in psychometrics and the question often discussed in this domain is that of how to evaluate a subject (entity *S*) with regard to *n* tests each providing a mark *x*. The calculation of the coefficient of multiple correlation *R* (integrated value) provides the best possible value for characterizing the person (Ley, 1972) because it is this value which to a great extent reduces uncertainty through the convergence of *x*-indicators.

3.4. Globalization in networks

The quasi-natural extension of correlational globalization demonstrates the importance of stable links between constituent parts in the network in the final processing of categories of information necessary for constructing behaviour. The network is a specific functional pattern composed of modules (or units) connected by paths (or routes); it thus has a spatial organization. In all initial 'networks', the modules were located in linear fashion like successive stages following each other. This type of location is typical of Shannon and Weaver's (Shannon and Weaver, 1949) theory of Information based on the model of the telephone line with a chain of processing stages (emission, coding, transmission, decoding and reception).

The first machines that simulated cognitive process ('Logic Theorist' by Newell, Shaw and Simon, 1957[7]) already made use of the notion of a network and mode of organization; these were later to acquire increasing importance, as we shall see. More recently, studies of human cognitive functions (HCF), from the more basic (perception, memory) to the more elaborate (language, reasoning, decision), have

[7] See Editor's Notes.

contributed to the advancement of the idea of organization in terms of a network consisting of units connected to each other and interacting with each other. Seeing an organization in the form of a *network* was later confirmed by two sets of recorded facts: experiments demonstrating normal functioning where each HCF can be visualized with the help of imagery technique such as PET (Positron Emission Tomography) or MRI (Magnetic Resonance Imaging); and the study of the forms of pathological functioning in which the failure of one element or the unit leads to the complete dysfunctioning of HCF involved (Parkin, 1996).

I shall mention only one example, that of Marr's (Marr, 1982) conception which laid the ground for a great number of subsequent studies showing that the reference to a network is fundamental in the processing of visual information. The structure of a network, the existence of units and paths that connect these units, the role of regulating structures (responsible for feedback and central regulation) are invoked for explaining both normal functioning and normal functioning with some deficiencies, for example, the change in cognitive blindness (Rensink, 2002), and also the pathologies of different forms of visual agnosia (Parkin, 1996), or dyslexia (Wright and Groner, 1993).

The generalization of the reference to networks concerning facts about numerous cognitive functions is connected with the emergence of a paradigm (in the sense of a school of thought) called *Connectionism*.

That term reminds us of the importance assigned to the flow of information that circulates between specialized units linked to each other by paths transmitting neuron impulses and/or between certain units and the external world. Thus each function belongs to the organized complex entity as regards its cognitive architecture capable of processing information which is either permanent or stochastic. This latter category is particularly important because it facilitates matters considerably by including prospective activities (future organization), prognosis (development, for example) and prediction (results). The adoption of this functionalist perspective cannot but raise some debates and the classic response is to illustrate connectionism by reference to McClelland and Rumelhart's (McClelland and Rumelhart, 1986) studies and to that group of researchers who rely on the notion of Parallel Distributed Processing (PDP). The PDP is a model which conceives of knowledge as resulting from the activity of a network where there are many coexisting forms of links connecting these patterns and allowing them to be simultaneously activated.

The connectionist model PDP has general properties which are worth mentioning. The interconnected units, which we can compare with agents, provide, in general, rather simple and clearly defined functions: for example, identifying sound, shape, relief, etc. None of these taken in isolation can represent the behaviour of the whole. Each represents a specialized part. Thus, it is the connection of data and the coordination of actions on the acquisition of which effective behaviour eventually depends; this, in turn, leads to the fulfillment of the assigned objectives. When a single unit, or pathway, or controlling element or a central executor proves to be deficient, so that the expected consequences cannot be attained, the system starts dysfunctioning and the behaviour does not lead to the

assigned aim. In neuropathological psychology the problem can lie in the difficulty of processing one specific category of information (verbal, spatial, graphic, memory traces, etc.) because of the failure of the unit specializing in it. But there are also more general problems which are called a 'trouble of strategy' (Mazeau, 1997), in which the planning of an action is responsible for the failure to organize a sequence.

In non-pathological contexts, such failures also take place, but they last for a short period of time. This implies that in this case of decision making one or several important characteristics have been neglected. Thus, with failures, accidents or catastrophes, it is possible to demonstrate a deficiency in the 'human factor' highlighted in some categories. In the first category, there are all kinds of imprecision connected with the fact that one or more elements of information have not been taken into consideration: there is, therefore, an information deficit. In the second category, all errors committed refer to the nature of the situation involved; they show that the decision maker thought that he was in a certain type of a situation whereas in reality he was in another one: this is a deficit in identification. Errors of diagnosis illustrate this type of confusion, leading to incorrect choices of action. The third category deals with the construction of cognitive maps or mental representations inappropriate to the situation involved.

Initially constructed for transcribing spatial representations, these cognitive maps are meant for use in written or verbal descriptions (Taylor et B. Tversky, 1992) and are sometimes called maps with texts. These maps play an important role in mental representation because they enable everyone to create a virtual reality that is especially helpful in processing information. We could say that the correctness of any chosen action depends directly on the precision and complexity of that representation. The mistake which is most often made is that of acting on the basis of simplified constructions and schemata[8] already used, even though the actual situation is new and complex. Connectionist globalization can be defined by some key concepts such as specialization of parts, existence of networks, dynamic aspects (communication established inside the system and with the environment) – in other words, things that make us treat the given behaviour as that of a whole.

3.5. Globalization and artificial intelligence (AI)

Clearly formulated definitions allow us to envisage modelization as an act of description and validation of the connectionist approach: it is artificial intelligence (AI) which demonstrates the advantages that result from these conceptions. To put matters briefly, artificial intelligence is aimed at constructing machines capable of realization of performances that are superior to machines made by humans. The English mathematician Turing is considered to be the first to have significantly contributed to the development of artificial intelligence by creating a machine during World War II. This author imagined a 'test' designed to find out if this

[8] See Editor's Notes.

machine had intellect.[9] Much later Newell and Simon (Newell and Simon, 1963) completed an improved General Problem Solver (GPS) project which could be seen as a system for producing 'intelligent' actions in numerous tasks.

One of the most elaborate models of AI is that of identifying patterns that followed on from the construction of the 'classifying machine' called the *Perceptron* by Rosenblatt (Rosenblatt, 1962). The principle of this appliance is simple: a flow of information coming from the environment enters the system in a form of a pattern (an input). The system processes it in the network and produces a general unique response (output) categorizing the pattern. This is, therefore, a decision making action. Since the 1960s various refined forms of the Perceptron have been constructed but its fundamental principles remain unchanged.

Generally speaking, a Perceptron is a transcription of the notion of a multilayer network (multilayer Perceptron) into artificial intelligence, directly inspired by the connectionist model PDP (Parallel Distributed Processing)

The simplest Perceptron is a system composed of three layers of units ('the cells') as shown in Figure 2.

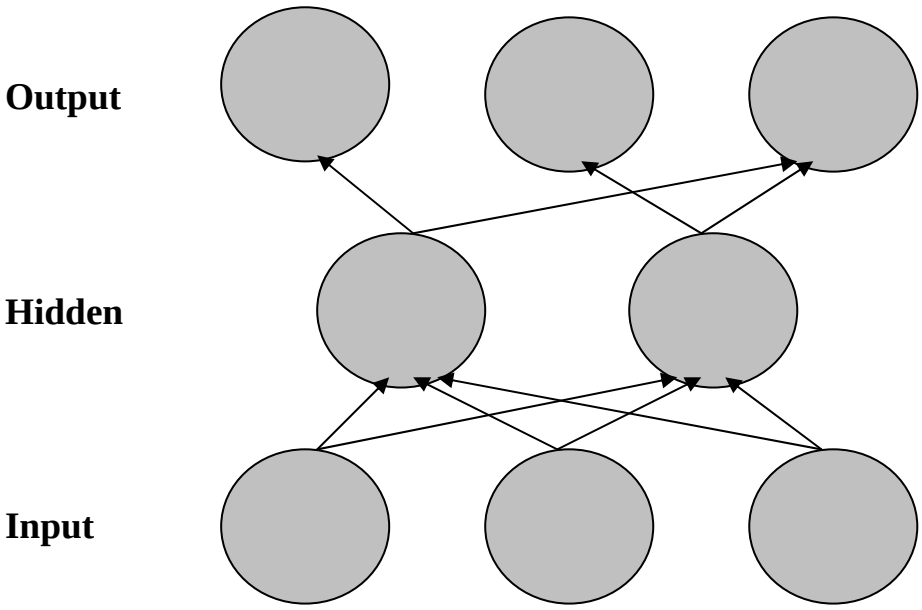

Figure 2. A multi-layer Perceptron

- The first layer (input) is composed of external units which are the captors; the analogy is to a human being with sensory receptors.
- The second layer, that of the so-called hidden units, is responsible for giving meaning by interpreting messages coming from the external layer. These hidden units detect the characteristics (features) of information patterns that enter the

[9] Turing's test: if a machine can carry on a conversation (over a teletype) that is indistinguishable from a conversation with a human being, then that machine can be called 'intelligent'.

system, identify them and work out a response. Cognitive functions in human beings correspond to these hidden intermediate units.
- The third layer (output) corresponds to the executors: they transcribe the ‘response’. Taking into account the complexity of the situations involved and their specificity, the term ‘behaviour’, which reflects an elaborate construction, should be preferred to the term ‘response’ which evokes the kind of more elementary reaction studied by behaviourists.

In addition, the structures in the units and layers have arrows, which are important elements of Figure 2. They represent the connections (paths) that link units belonging to different layers. These connections are characterized by numerous combinations and a great diversity of potential pathways. Under these conditions, the structural references (layers and paths) are the supportive material (hardware) of functional aspects (selection and processing of information).

This *network* architecture is particularly interesting for analysis, and this for several reasons.

It illustrates the mechanism that can process complex operations capable of working out differences with a great degree of precision. This is not because the units are in themselves sophisticated – indeed, they may be rather simple; it is due to the possibility of forcing information to circulate along very different paths and processing data according to differentiated procedures. Globalization of the whole set of information that comes out of the system (in the choice of actions, for example) is a carefully worked out result based on processing. It becomes possible due to the existence of the system connecting various operations, modes of organization and architecture, playing the role of determinants.

The difference in performance between old Perceptrons and their more modern equivalents is due to differences in architecture: it is obvious that the addition of a supplementary layer, even though it may be rather simple, significantly increases processing capacity and improves the handling of uncertainty and complexity. That improvement does not require a common measure of input because a wide field of interactions and re-combinations remains open.

Given that the first Perceptrons processed only linear relations, this limitation, perhaps, made people think that the system had only limited capacities (Minsky et Paper, 1969). But that in fact was not at all the case.

The multilayer Perceptron devised by Rumelhart, Hinton and Williams (Rumelhart, Hinton and Williams, 1986) marked the beginning of the success of neuromimetic networks capable of evolving and processing non-linear relations owing to the system of retroactive management of ‘errors’ called backpropagation (i.e. the backwards propagation of errors). When the network commits an error in decision output (the executive layer), that error goes back into the hidden layer so that a better adjustment will later be possible. Error often results from a mistaken determination of the importance of information in a given context – an error of equilibrium. The correction will take place at the level of a hidden layer by changing the ‘weight’ attached to the connection between the ‘units’ involved, in

other words, by facilitating the internal links or by making them more difficult. Having enhanced its database, the system will perform better when it next has to.

I would say one thing about the analogy between the Perceptron and the nervous system (NS) that is highlighted by constructors. Each unit can be viewed as a neuron which is in contact with other neurons while transmitting an impulse and receiving information (input). It is estimated that the neuron system has one thousand million neurons and that each of them can be connected with about ten thousand other neurons receiving many thousands of neural impulses. Other estimations emphasize that the NS has $2*10^{15}$ synapses creating a network the size of which is not stable. If all these connections were equiprobable the potential networks would be infinite. But that is not in fact the case. Certain pathways that are more used than others will be preferentially mobilized for processing specific tasks.

The research undertaken by Hebb from 1949 onwards and the law named after him reveal the fact that neurons which are often activated together have a tendency to re-use this association and end up by creating a network on the basis of previous experience. In such networks, therefore, we find preferred pathways and a functional architecture that provides real support to the system and agents of globalization as being more important than anatomic architecture.

4. Discussion and conclusion

How then can the cognitive theoretical approach improve our knowledge of globalization? Apart from the evidence that ‘cognitive’ globalization presents as a strategy consisting in collecting information for the creation of an Acceptably Uncertain Cognitive State that is necessary for a decision maker to make a choice of one action among several competing and mutually exclusive actions, the cognitive approach is proof of the existence of diversified strategies. To participate in ‘economic’ globalization means, first of all, to *choose a strategy* that offers protection against risks or potential losses inherent in all decisions. Hence, ‘economic’ globalization appears to resemble a general operational mode corresponding to the natural action of the human mind when it is faced with uncertainty.

At the theoretical level cognitive globalization does not represent an identifiable object of study in cognitive psychology. For instance, there is no theory of cognitive globalization similar to theories of perception or memory or language, even if we use it in constructing our daily behaviour. However, as soon as the cognitive function is involved in the study of the collection and processing of information, it is possible to extend the idea to the explanation of the process of globalization. This apparent contradiction is due to the fact that the cognitive data on this issue lie at a level that is more differential than generalized. In essence, the studies undertaken by cognitive scientists attempt to demonstrate the evidence of the existence of several strategies. In carrying out the same processes of globalization, there are at the same time several ways that depend on the study of cognitive functions. Differentiating factors specify each form of globalization and

can be found both in the organization of systems (architectures) and explicit rules (algorithms) which permit activation of different constituent parts and the production of an elaborate result at the output level of the system.

Using Aesope's terms, we can ask the question whether cognitive globalization is both good and bad for us, whether it is at the same time a facilitation and an obstacle? In dealing with this issue, it is necessary to distinguish two forms of cognitive globalization. We reach Type 1 globalization (G1) in an ascending manner (called bottom-up). First we collect elementary information and then we 'integrate' data from the most elementary into the most complicated, thus creating a whole – this is therefore a 'from the bottom –up' way of globalization: forms or agents first, then functional structures and finally a system or an organization.

Type 2 globalization (G2) operates in a descending manner (called top-down) by making references to the already existing cognitive globalization based on a previous experience of globalization. In other words, an already existing globalization from a previous experience is applied to a new experience with the aim of globalizing this new situation. Required to evaluate situation *B*, the decision maker will refer to the situation *A* previously known to him, with its consequences. The subsequent decision will be constructed by relating *B* (unknown) to *A* (known).

This strategy has been called 'anchorage-adjustment' by Tversky and Kahneman (Tversky and Kahneman, 1974). The unknown situation *B* is linked or anchored to the known situation *A*, then this anchored situation *B* is slightly adjusted to take account of its specific nature. This measure used for globalization is regarded as heuristic, because it is an act of rapid evaluation based on simplified and minimal cognitive resources allowing a decision maker to obtain a global result for *B*. This act has typical advantages and disadvantages for an approach based on analogy: rapidity and economy, on the one hand, bias and errors, on the other hand. This form of 'reasoning', where evaluation is a transfer of knowledge from one field to another, or, to put it more simply, from one situation to another situation, stirs up deep suspicion. Fodor (Fodor, 1983) claims that the more globalized the cognitive process is the less we know anything about the subject; an example of this is reasoning by analogy, which has a very high level of globalization. Hogarth (1980) also emphasizes the imprecision, biases and errors which are associated with the use of analogy as a mode of evaluation.

In choosing how best to look upon an individual objective (evaluation, prediction) or an organizational one (business plan, joint venture, development projects, investment, estimate), it becomes important to distinguish these two forms of globalization, to promote a bottom-up globalization (G1) and to avoid as much as possible the top-down globalization (G2). It may seem paradoxical (at least to those who judge by appearances), but the best globalization for evaluation and taking decisions is not the one which comes immediately to one's mind while viewing something globally; it is more important to think about the architecture and know the processes involved. A knowledgeable decision maker will begin by using globalization for positive consequences which will lead him to prefer the

bottom-up globalization which he regards as ‘internal’ rather than the top-down globalization seen as ‘external’.

One of the important theoretical questions is the choice of strategy. What information is necessary to make one strategy preferable to all the others? First of all, the initial identification of the type of problem or situation before any further considerations are initiated. This identification is based on representations accumulated in memory in the form of ‘scripts’ or ‘schemata’ or ‘thematic organization points’ (TOP) (Alba, Hascher, 1983). The meanings of these terms are inter-related and clearly denote prototypical situations (for example, going to market, giving a lecture). One of the quickest operations in decision making consists precisely in having recourse to such scripts for identifying the *type* of the situation that we are dealing with. That identification accomplished, the decision maker comes back to the global knowledge connected with it, then tries to discover specific information for the moment, case or circumstances, which could help him in deciding the particular choice to be made. Globalization involves a synthesis between general and particular, past and present in order to process the actual situation as best as one can.

From a methodological point of view, globalization can be regarded as a topic of great interest because it concerns the correctness of the actual use of instruments for evaluation and prediction. In the most recent methodological formalizations, statistical techniques based on the common characteristic, i.e. linear, are used. The General Linear Model (GLM) is prevalent in contemporary studies even for very elaborate networks such as the central nervous system (Friston, 2005). In the diversity of statistical models, the GLM is the main technique for prediction; it provides the researcher with simple and multiple correlations, methods of analysis of variance, factorial analysis and structural analysis.

However, if we consider globalization to be the result of the activation of a network or a system, or as a unity of constituent parts – human beings, economic contexts and enterprises can be looked at in this way (Cadet, 2006) – these techniques prove largely to be non-operational.

In fact, they take into account only particular linear relations between units artificially chosen or isolated from the overall context; this results in representations that are too simplified for dealing with the management of information and taking appropriate decisions. The first necessary condition for obtaining these units is epistemological: it consists firstly in considering the network, or the system, as a whole rather than ‘extracted’ variables regarded as being representative. Such an option leads to a change of methodological paradigm. It leads in fact to abandoning the General Linear Model (GLM), considered to be artificial and reductive, and to adopting complex paradigms. Some very revealing characteristics and properties excluded de facto from GLM can be employed again. Here are some of them: dynamic systems of learning and developing (in enterprises and sports teams), conceptions relative to auto-organization, autopoiesis, activation (Collins, Loftus, 1975), emerging structures, multi-agent systems with procedures of decentralized decision making. Finally, the

very important role played by interactions within units and levels, as well as between units and levels, is worth mentioning here.

Ignored in the paradigms of GLM analysis, they manifest their effect in real situations sometimes unexpectedly and powerfully, as we see in the a posteriori analysis of technological catastrophes. Thus, the choice of setting, the collection of data, the ability to read and use this information, working out the principle of management are the challenges that face every researcher in the study of complex systems. The project of 'understanding' how globalization develops is not limited, as we can see, to managing empirically its manifestations or to constructing appropriate models. More fundamentally, the core issue of understanding globalization is the elaboration of a new theoretical framework which could be possible only after a kind of 'Copernicus's revolution' took place in epistemology. This implies that we should give prevalence to a new theoretical approach in studying the relationship between the facts of actual life and the formalisms based on them; in the meantime, judging from some very recent events, such theoretical issues continue to be neglected.

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