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Chapter 3

Decision-Making in Complex Dynamic and Evolutive Systems: The Need for a New Paradigm

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Abstract

For contemporary psychology, decision-making represents behaviours, which are very different from automatic responses. They are developed by implementing integrative cognitive functions adapted to the finalities sought and the situation to treat. Through the diversity of epistemological choices for instance, research in previous decades focused on the individual choices expressed by situations or contexts with a stable structure. The new problems of life in today's society lead to making decisions on societal problems (climate, energy, etc.), which bring into play systems and no longer variables. This chapter has four aspects. After having characterised the decision-making process as a cognitive behaviour (1), having recalled the best known traditional models (those of Economics and Psychology) (2), this chapter deals with the properties of complex systems (globality, interactivity, dynamism, and scalability), which render decision-making difficult (3), and concludes with the necessity of a change of paradigm by pointing to paths to follow (4).

Keywords: dynamic complex systems, cognition and complexity, complex decisions, errors of decision, paradigm change

1. Introduction

For a long time, before using electronic devices of navigation, sailors used to check their progresses using points of interest (POIs) as marks of their journey. These were particular points rich in information (a cape, an island ....) allowing the sailors to reduce uncertainty about its position. This is a typically cognitive process which allowed the sailors to mark out their route and see how they were progressing. Metaphorically, the term may be used in the study of decision-making to describe the cognitive work of the decision maker watching out for indications to ensure that his line of thought progresses in such a way as to enable him to make a final choice: that of deciding the course of action to be embarked upon.[1]

This chapter sets out to analyse several strategies or several models drawn up to give an insight into the decision-making process which, by definition (since several choices are possible), always takes place in a context of uncertainty. A large part of the cognitive activity of the decision maker is directed at lessening this, by processing the information available in various ways. It is structured in four parts. The first part presents decision-making as a form of conduct and behaviour, so enabling it to be studied from the point of view of psychology. The second part, for the benefit of readers who are unfamiliar with these questions, analyses two commonly used decision-making models which, notwithstanding their differences, have this much in common: they make it possible to give an account of individual decisions. The third part, in a more innovative way, undertakes to study a very particular type of super-individual decision that concerning groups of human beings exposed to risk situations. How do those responsible for safety, whatever their particular role, take their decisions to avoid the generalisation of harmful consequences? Their ways of approach, very different from individual strategies, open up new perspectives. Situations like this have two advantages for researchers: (1) substantive (i.e. do the actions carried out lead to satisfactory responses to the critical case?); (2) epistemological (i.e. how does one represent or conceptualise these situations?). The fourth part attempts to analyse the consequences of a development of this kind. The epistemological questions they give rise to are so important that they radically change the traditional decision-making models. This being so, there is a need for a changed paradigm amounting to no less than a "scientific revolution" of the kind described in Kuhn's famous work.

2. Taking a decision: a complex and integrated form of conduct

For psychologists, more than just behaviour—a term which might suggest a certain automatism of response—decision-making is a specific form of conduct. First of all, the choice of this term underlines the fact that such processes must not be reduced to the extremely visible and observable aspects of the explicit choice of one course of action in preference to other (often many other) possible ones. Secondly, it introduces a constructivist option. The decision is constructed progressively and that which marks its culmination (the choice of the course of action to be embarked upon) is necessarily preceded and justified (sometimes in an approximate or erroneous way) by phases implying cognitive information-processing activities (perception, attention, memory, etc.) which "explain" the choice arrived at. Decision-making is also a process which presupposes freedom of choice, which is defined in time and consists of several stages. The two principal operations are the search for information and the assessment of its importance, which we will call weighting.

[1]For stylistic reasons and to simplify writing, the masculine form is used in this chapter. This does not imply preference or discrimination. What is said is equally applicable to male and female decision makers.

2.1. An initial definition

One of the best known definitions of the entire process of decision-making is that of MacCrimmon [1], characterised by the accumulation of stages identified in his account of the subject. A decision maker "observes a gap between an existing state and a desired state and has the motivation as well as the potential to reduce this gap, while more than one possibility of action exists which may not be immediately available, a kind of action requiring an irreversible allocation of resources [cognitive in this case], and while the benefits [consequences] associated with each choice are completely uncertain" [1]. Each choice consists, according to him, of resolving a problem (MacCrimmon uses the expression "decision problem").

2.2. Different perspectives

A definition is rarely neutral, and this one, formulated with members of the managerial class in mind, is characterised by a series of operations to be carried out successively, therefore presupposing the existence of a (meta-) process of control and integration, and of verification by retrospective loops, not mentioned in the formulation but nonetheless indispensable to ensure the validity of the whole construct.

It is not surprising that MacCrimmon's definition does not totally suit psychologists who are more interested in the previous stage: knowledge of the mental processes and the choice of the strategies planned by the decision makers. Among them, there are some who will criticise this definition for being too segmental, cumulative and prescriptive, and for its failure to give a more important place to the conditions of the time (in economics), the physical environment of the time (in the determination of risk-management strategies), social dimensions (judicial decisions), the pressures of the world of the time (political decisions) which have a determining influence on choices. Strictly focused on rationality, a definition of this kind leaves little room for motivation, sensitivity, desire, emotions, not to mention pleasure, and so on.

2.3. Constructing a decision: what are the processes?

We will consider two principles as being justified both by the evidence and by observations so that the analytic processes may continue to have an acceptable level of general applicability. Decision-making takes place: (1) in an environment or context which is an integral part of the problem but of which the role is too often minimised if not totally hidden; (2) epistemologically, decision-making is constructivist in nature, which means that it progressively develops and becomes more refined on the basis of representations of the world which become all the more operative as the occasions multiply and the information becomes more diverse. Decision-making in this perspective is therefore an illustrative example of a type of conduct resulting from the putting into play of dynamic processes [2].

2.4. Managing the decisional space

We owe the introduction of the topological dimension in decision-making to Lewin (1890–1947) and his field theory [3, 4]. The characteristics present in the field are a component to be taken into consideration, and this leads to a very broad view of the decision which cannot be limited to dealing with certain intangible visible indications or to reproducing learning processes. In elaborating any concrete decision, the information is extracted from a context, and some of this information, according to its nature or intensity, will be accepted as valid by the decision maker on a cognitive basis. Each piece of information used must be assessed in accordance with the context and, where applicable, with the framework in which it happens to be inserted [5]; these two characteristics give it a "salience" [6] of variable intensity. As Lewin has shown, the field which contains all these pieces is not homogenous; it has hills or rough areas which are characteristic points because they are the cause of certain dynamisms.

3. Two traditional models of decision-making

With regard to decision-making, the two most well-known models (among the various existing) are summarised here: that of the economic decision and that of the behavioural decision [7].

3.1. Economics

Economics was the first discipline to formalise decision-making in the full meaning of the term, that is, by establishing a binding axiomatised system [8]. We shall limit ourselves here to indicate in a summary way the salient elements of a branch of study which is still extremely active. The economist's problem consists of assessing among **n** mutually exclusive actions $\{\mathbf{a}_1 \ldots\ldots \mathbf{a}_n\}$ that will give the greatest satisfaction in a given situation, on the one hand, and to a specified decision maker, on the other hand. Therefore, the objective consists of ordering the outcomes (**1**) according to the preferences of the decision maker ($a_3 > a_8 > a_1$, etc.). To do this, the decision maker constructs a "decision tree" containing "routes" and "stages" (called knots) which represent possible pathways to be followed. At each knot, the decision maker must opt for a way which will bring him to the next stage and so on to the end (to the "leaves") which indicates the expected consequences of each action. (For a more complete presentation, see [7] Chapter 2). Each of the end points is evaluated numerically taking its frequency into account [assessment of the probability (p) that it will take place taking uncertainty into account] and the subjective value (i.e. for the decision maker concerned) of the utility **u** of the consequences attached to it. It should be noted that, even though the context is that of economics, the consequences are not determined in monetary amounts (objective references) but in subjective units of utility (u) [the satisfaction it can afford]. The value attached to the same sum of money varies in fact according to the individual fortune already possessed so that utility is a more general reference than monetary value. The two indices are combined in a multiplied form, that is, p*u. The outcome (leaf) which has the highest p*u numerical value is that deemed to constitute the best consequence. Climbing the tree in reverse therefore makes it possible to determine the "best" action to be executed. This model, known as subjective expected utility (SEU), therefore refers to a numerical validation criterion ultimately obtained by the observance of axiomatic properties.

3.2. Psychology

Psychology was the second discipline to set itself the task of modelling decision-making. Although it took the preceding concepts as a basis, this school of thought has led to a very different model form. In 1953–1954, the psychologist Ward Edwards [9, 10], applying the validation methods used in psychology, in particular predictive validity, installed a team of researchers in a Las Vegas casino to study the decision-making of professional players. These persons who live off gambling takings consequently on decisions made in a context defined clearly by rules (those of the game) but where chance also plays a part represented an appropriate sample of decision makers who have, in a short time to decide and to assume the effects of their choices. The initial objective of the team of psychologists was to verify the SEU theory, but it became apparent that the players' decisions were not based on any of the axiomatic elements necessary for the determination of p*q and consequently were not related to the SEU criterion. The decisions taken were based on behavioural information processing in which knowledge, learning and intuition seemed to play an important role. A new investigational pathway was therefore opened up under the name of Behavioural Decision-Making (BDT) [11].

Very soon, Simon [12] underlined the fundamental differences existing between these two conceptions of decision-making, that of economics, which is axiomatic and organised with a view to attaining an end (maximise p*u), and that of psychology, which also identifies an objective to be achieved but sets out to achieve it in a procedural way (implement relevant information-processing procedures). These procedures, which would later be called cognitive, were to lead to new modelling forms [13] used even in economics with behavioural economics [14]. The frontiers between the disciplines had therefore become permeable, a very welcome development.

3.3. Managing an intermediate system

Schematically, the decision-making process consists of transforming all kinds of semantic units present at the mechanism entry point into behavioural forms of action choosing which mark the outcome of the process. Between these two extreme points, there is an organised network of information which will undergo processing. Seen from the topological point of view only, the decision consists of processing an intermediate system which is a generalisation of the notion of intermediate variable (or intervening variable or mediating variable) often used in psychology and defined as "a hypothetical variable postulated to account for the way in which a set of independent variables control a set of dependent variables".[2] The notion of an intermediate system is nothing other than the generalisation of that of the intermediate variable with the retention of the epistemological notions of postulated and hypothetical entities (based on the decision maker's knowledge), on the one hand, and causality, on the other hand (i.e. the incoming variables influence the outgoing ones and so produce effects). Functionally, this intermediate system, which from the methodological point of view is a construct, constitutes a reserve of informational resources organised in the form of networks or "dormant" information clusters. When judiciously activated by the decision maker, these networks make more effective decision-making possible.

[2]Collins English, 12th edition 2014, Harper Collins Publishers.

This is demonstrated by work in the area of Management Science on the complex entities constituted by enterprises in which the "right" decisions make it possible to achieve competitive advantages and the blossoming of the company. It has been shown in [15] that the management of an intermediate system in American small and medium enterprises (SME) enables this enviable objective to be achieved. At this point in our account, we may consider the decision maker as an agent who picks and processes information from a system at a halfway point between perception and action, a kind of reservoir holding pertinent indications drowned in a mass of information items most of which have no causal relationship with the question under consideration. Such a task can only be difficult.

3.4. The cognitive difficulties of decision makers and their reactions

There are many works dealing with the difficulties, mistakes, false ideas, shortcuts and approximations affecting the action choices of decision makers [6, 13, 16], leading them to making poor-quality decisions. Therefore, as not to over-encumber this account, we will not list all these but rather classify them under three headings: structural difficulties, information-picking difficulties and processing difficulties, each category being illustrated by a single commentary.

Structural difficulties are those corresponding to inaccurate or erroneous mental representations of the global organisation of the intermediate system, more often than not implicitly considered as being simpler than it is in reality. This is the case when the decision maker (cognitively) elaborates a decision tree which is not exhaustive and when (in the actual situation) he finds himself confronted with the task of implementing real eventualities but ones not forming part of the initial plan. The decision tree has two functions, one to classify, and the other to predict. Used principally in Economics and Biology [17], it is the forerunner of classification algorithms and has a predictive value with regard to the choice of action, for any new observation.

Information-picking difficulties are frequent. The information items of use for decision-making are not, in real situations, isolated and salient as they might be in a laboratory experiment. To use them, the decision maker is obliged to search for them on the basis of their salience (or saliency), which therefore entails the necessity of a prior mental representation. Salience is a function of the purposes assigned to the action. The point is to pick salient information for a very specific decision and not to decide by using the most obtrusive (visible) elements in a given field. This latter strategy leads to a decision bias called salience bias [6–13] consisting of processing extremely visible information items but ones not relevant to the question under consideration.

Processing difficulties become sensitive at the junctions of the different cognitive operations implemented in succession to determine the action chosen. Three principal difficulties become evident: (1) the very poor cognitive capacities of human beings in assessing and processing uncertainty, an unavoidable element in decision-making situations. Seen as disconcerting and subversive, it is often excluded from the process, something which leads to an "over-confidence" bias [6]. This bias is noticeable in the assessment of risks (generally under-estimated) quite as much as, in the opposite direction the possibility (overestimated) of winning the jackpot in the lottery.

4. Decision-making in complex dynamic systems

4.1. Epistemological reductionism

The decisions presented in the preceding sections are characterised by having been taken in a stable, defined informational context, that is, invariable throughout cognitive processing and ending in the choice of a single action, a behaviour marking the end, satisfactory more often than not, of processing operations. These situations are modelled on a limited number of variables, the pertinence of which is based on laboratory studies, sometimes of an experimental kind, but which have always undergone epistemological reductionism [18] guaranteeing their permanence and high level of general applicability. All other variables, particular or inconstant, are removed from the model.

4.2. Complex and dynamic decisions

There are decisions of another kind, which one could describe as super-individual as they concern at one and the same time a great number of persons, which must be taken in very different conditions. They cannot be processed in a laboratory nor reduced to a few variables, so they must be considered as global in nature and their complexity must be taken into account. Unlike the laboratory strategy where variables are isolated, the entity being studied can only be seen in a global way and cannot be reduced epistemologically without distortions. Another distinctive feature: the entities under study become modified under the influence of the processing operations, giving rise to a temporal dimension (evolution capacity) and a high degree of lability in the choice of "active" variables liable to be used in taking the decision. In such cases, therefore, momentary characteristics are what one is trying to define.

One of the examples (and a very recurrent one in the summer period) which best illustrates this conjunction of complexity and dynamism can be found in the management of forest fires. These phenomena give rise to management difficulties linked to the difficulty of anticipating developments (uncertainty) and the unstable components of the fire (changes in intensity and direction). The decisions regarding the actions to be taken to contain and manage the fire and extinguish the flames are very difficult cognitively. A new element has been introduced into the situation: that of the interactions at all levels between different variables; interactions of a kind and extent which develop with time, the progress of the event and the measures undertaken at the previous stages by the action teams. The intensity of the wind, its direction, the degree of dryness of the ground, the nature of the forests, and so on determine the characteristics of the fire and the way it will develop. The interpretation in substantive terms (i.e. in terms of the present situation) of the interactions is cognitively difficult, and the decisions taken as a consequence may be qualitatively poor [19].

4.3. An epistemological turnaround

The finding of identical difficulties in very different contexts (political, legal, economic, environmental, technological decisions, etc.) where human beings perform poorly must lead one to consider the various perspectives applied to studies on decision-making. The necessary and legitimate search for the most efficient action to solve a problem, as discussed by MacCrimmon, has led researchers to design research plans inspired by the exact sciences (e.g. physics and chemistry) or disciplines, such as biology, which verify their hypotheses concerning certain very specific variables, in an appropriate place perfectly protected against external influences: the laboratory. The history of Science, in its present state, shows in fact that for certain situations (but not all), such a choice produces the safest information. Such an approach, while being perfectly scientific, cannot be implemented in a generalised way to all the psychological problems of decision-making. Certain very recent decisions, such as those concerning climate change (cf. Section 5.1) or the management of industrial or ecological disasters, cannot usefully be subjected to epistemological reduction, a crucial process in laboratory studies. In other words, it is no longer possible to isolate certain variables and manipulate them to verify their causal status.

Must one then search for other scientific approaches? If so, there will have to be a turnaround in epistemology too. The phenomena under review will have to be assessed as global entities (holistic option), to be considered in their natural state rather than in a laboratory, in the conditions in which they actually occur, and if possible in *statu nascendi* (at the moment in which they occur). The management of maritime disasters with the threat of pollution require urgent decisions. These two recommendations are in line with the principles defined by Gestalt psychology in the first half of the twentieth century [3]. These were advanced over and over again at the time but could never be measured or assessed for want of methodological options other than experimentation. The epistemological change which will make it possible, in part, to overcome this difficulty consists of conceptualising the situation being studied as a dynamic complex system.

4.4. Dynamic complex systems

In 1968, the biologist Ludwig von Bertalanffy (1901–1972) published a work in which he presented the notion of a "system" as a very extensive holistic entity [20]. "Systems everywhere around us," he observed. Only the analytical traditions inherited from previous centuries prevent us from seeing them and approaching research questions by including this aspect of globality rather than destroying it at the outset by concentrating on certain variables.

This original contribution, which highlights the potential richness of the systemic way of thinking, has been completed by the work of Cilliers on the functioning of systems [21] and on the epistemological characteristics arising out of them [22]. For this author, a complex system is an entity presenting ten specific characteristics [21]. Among the most important, we would instance the presence of numerous interacting variables where the interactions are not linear. This means that proportionality is no longer the rule so that even a very small variation introduced into the system may have major effects when exiting. This corresponds to the case found in 1972 by the meteorologist Lorenz known as the "butterfly effect", thus opening the way to new forms of non-Newtonian determinism.

Let us also consider certain characteristics of the system itself, independent of the decision maker who can only take note of them and include them in his decision. The system has a history, it is composed of networks which reflect it, it has resources available to it which in the absence of human intervention determine its "behaviour", it is usually open to the environment, has self-organisation capacities and can regulate itself because of the existence of control loops. One could say that it is endowed with an "epistemological personality", so that the decision maker is first of all an analyst and a manager of both the resources of and directions taken by the system, before being able to choose the appropriate action.

5. The necessity for and characteristics of a new paradigm

Up to the present day, very wide sectors of scientific psychology have chosen to apply the experimental paradigm in their research practices as a guarantee of the validity and replicability of their conclusions. This is, of course, not an erroneous choice, but it has now become apparent that its application is impossible in certain situations where nonetheless the intervention of psychologists is required.

5.1. Complex systems and psychology: the case of global warming

The most illustrative case of conceptualising psychological issues in terms of complex systems is that of climate change. Climate is a complex system, it possesses all the properties defined in [21] characterising this type of organisation. The global state of the system depends on multiple interacting variables most of which are nonlinear, climate evolves, "integrates" characteristics which cause it to organise itself, to change its "behaviour" and global configuration. Among these factors for change, the production of carbon dioxide by human beings is one of the best identified factors (even if still the subject of ideological disputes) in global warming. Although human beings have no variable available to them which would enable them to act directly (as would an independent variable) to limit the harmful effects of global warming as required, they must nonetheless take decisions to influence its future course, and with regard to this, the contributions of psychologists are welcome.

The very well-known American Psychological Association (APA) has set up a task force which in 2008–2009 worked on the problem of "global climate change" and all its individual and collective psychological consequences. The objective was therefore much broader than decision-making, as is shown in the final report on the work of this commission which appeared in a special number of the American Psychologist [23]. Questions concerning the forecasting of the development of climate and the perception of risks are considered but, although it underlies many points in this work, the complex system notion is not explicitly mentioned. The phrase "addressing a multi-faceted phenomenon and a set of challenges" present in the title is, however, entirely consistent with the spirit of complex systems.

5.2. Functions of the paradigm

Putting psychological objects into perspective by reference to complex systems opens up the way to a new paradigm. The old experimental-type paradigm, as we have seen, cannot account for certain important decisions. The new paradigm must enable a better understanding of them. It would seem that we are at present on the threshold of a "scientific revolution" [24, 25] made all the more apparent by this necessary change.

A paradigm is defined as "a philosophical and theoretical framework of a scientific school or discipline within which theories, laws and generalisations and the experience performed in support of them are formulated".[3] The function of a paradigm, as this definition highlights, consists of ensuring the required coherence of the research approach and verifying the compatibility between the different components necessary for scientific knowledge (the hypotheses, the data observed, the methodological tools applied to process them and the theories constructed on the basis of the results, respectively). A paradigm is the overall structure containing compatible entities.

5.3. Certain major properties characterising the new paradigm

As emphasised in [21], thinking in terms of complex systems implies avoiding the "reductionism" linked to the initial choice of certain variables forming part of a greater complex. In the experimental paradigm, only those initially considered relevant will be used and where applicable verified. This choice being initial, even if supported by hypotheses and observations, is a determining factor in the construction of knowledge. In addition, the said variables are tested in an isolated way one from the other and then put into use "artificially" outside their natural environment. This procedure eliminates from the field the knowledge produced by a great number of interactions, which could prove decisive. The paradigm of complex systems is a complete change of perspective. The decisions studied with a view to their consequences are studied globally, on the ground, in their natural environment and in specific circumstances. The importance of the results obtained is a function of the activity of networks which, as for the nervous system, become observation "units."

This approach does not set out to establish general conclusions (conclusions applicable in all circumstances) regarding decision-making, since to do this, it would be necessary to ignore many specific items of information, which exist and are active in the specific situation to be dealt with and which in fact are often decisive in the taking the decision.

5.4. The search for assessment indicators

How should one assess, measure, or quantify the activity of a complex system with a view to predicting its development and being able to decide accordingly? Physicists, the first to deal with this question when it had to be answered in their discipline, refer to the laws of thermodynamics (particularly the second law) regarding energy. This energy dimension, present in all systems, makes comparisons possible by calculating, for each system, its level of entropy. The size of the latter was for a long time interpreted as a degree of disorder, but, unlike in the experimental approaches which scrupulously avoid it, systemic disorder can here have a positive connotation. It is considered as a possible generator of further states differing one from the other while order, once it has been determined, is immutable and results in one state only.

The transposing of the laws of thermodynamics into psychology has made it possible to highlight their relevance but at a meta-psychological level: that of the global psychological development of human beings [25] and this direction is too general to characterise a particular

[3]Merriam Webster Dictionary.

system. Researchers should therefore direct their efforts to looking for multiple indicators. Since this work has been published, the needs for identifying patterns of information have been emphasised as a heuristic way to manage complex systems [26]. For instance, artificial intelligence and human cognition ("humanised computing") are articulated to create tools either for treating psychological disorders [27] or allowing recognition of psychological entities (emotions) using non-linear relationships [28].

5.5. The use of icons

The educational system as a vector of knowledge and the diversity of the contributions it makes to different pupils is an example of the differentiated functioning of a complex system, which produces measurable effects, satisfactory or otherwise. How should such a system be characterised based on the observable results it provides? In particular, when a country applies one and the same generalised system to pupils belonging to different cultures (so-called "minority" groups), what can be said of the performance of the system where total assimilation on the one hand and extreme diversification on the other hand must both be considered as mistakes? The functioning of the educational system of Chile with regard to a "minority" group with a strong attachment to its land, culture and identity (the Mapuche) was studied in an initial contribution [29]. This highlights the importance of teachers possessing the two cognitive registers (that of the "minority" concerned and that of the "majority"). Considered more globally, this conclusion illustrates the arguments advanced above on the management of the intermediate system (cf. Section 3.3).

A second contribution [30] deals with the use of icons to assess how a system (school system in this case) functions with regard to the different demands represented by different groups of pupils. The term icon was chosen to stand for homogenous configurations of information which appear at the "surface" of the system and which indicate how it functions with regard to the diverse needs of users. Let us suppose, for example, that one of these icons includes several items of information signalling a lack of mastery of the written language, the decision maker, after analysis, can then proceed to choosing the action most suitable for the sub-groups concerned.

The fact that these icons are products of the systems and not just observations or perceptions differentiates them from the normal function of icons, which is pictorial in kind. Systemic icons, it is true, also "represent" but, as they are produced functionally, they do much more than this and can justifiably be described as cognitive icons as they enable knowledge. In short, while physicists referred to the energy of systems in order to differentiate them, the Human Sciences refer to cognition as a global act making it possible to assign significance to sub-sets of information (icons) which therefore draw their significance from the totality of the system while at the same time participating in it.

6. Conclusion

Changes in society today are leading psychologists to deal with the management of complex situations which are very different from those that traditionally formed part of their area of activity. Two major developments characterise contemporary psychology: (1) new fields of activity (perception of risks, management of disasters or traumatic events, climate change, etc. (2) The importance of a global reference both in the definition of the phenomena studied and at the level of the people who find themselves involved (often large groups of the population). These changes must logically lead to an adaptation of the research and intervention strategies because the experimental method, so useful in the study of certain problems, is no longer applicable while the reliability it provided with regard to its conclusions still remains an imperative.

This chapter has attempted to present a difficult but promising approach: that of the use of dynamic complex systems to construct adaptable, appropriate, and evolutive decisions. It emphasises the necessity, once certain situations have presented themselves, of a change of paradigm so that complexity is recognised as a component in research as it already is in the forms of conduct being studied, rather than being somewhat ineptly eliminated from the start. Epistemological and methodological advances are necessary in order to develop the paradigm of complex systems in psychology, a paradigm which is already a reference in other branches of the human sciences.

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