PART TWO

LOGICS OF DISCOVERY

3

An Introduction to the Epistemology of the Social Sciences

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Since their appearance in the 19th century, the social sciences have made undeniable progress, both from the point of view of knowledge that they provide us on social reality and from their practical use in the daily management of society. This is also true in Africa.

We should, however, recognize, at least as far as our continent goes, that such progress runs the risk of being slowed, if not compromised, by what we consider the dominant paradigm in these sciences. This paradigm is empiricism, which we will return to later, and which is all the more problematic because we live in a time of social changes of all sorts which make the subject of these sciences more and more complex, and which requires them at the very least to revisit their tools and approaches.

Reflecting upon science, its procedures, the value and the limits of knowledge which it provides us on the world is, by definition, the vocation of epistemology. But it is also to accept that science can make itself the subject of questioning, still all the more necessary because it happens in the middle of a "crisis," that the paradigms, theories, methods and concepts that it had successfully used up to now are faced with new problems or "polemic facts" (Bachelard), which crop up in their fields of application, and which impose the need and sometimes the urgency of modifications, of revisiting, even reconsideration, without which acquired knowledge becomes obsolete and new scientific progress impossible. This is, after all, valid for all the sciences, whether they be natural, human or social.

But for the human and social sciences in particular, in addition to the recognized need of epistemology for all the others, we can add other specific considerations that increase this need. These considerations are linked to the nature of their subject as well as the relationship that the researcher himself, who is an integrative part of it, maintains with his subject, which will necessarily have consequences

both on the methodological level and that of the value of knowledge produced. Those are aspects which, as we will see, have implications in the debate on the question of the epistemological status of these sciences, and on the legitimacy of their claim to be sciences in their own right, a legitimacy still contested by specialists of so-called "hard" or "exact" sciences in the name of a conception of scientism based on the model of natural sciences at a particular stage in their historical development.

These are a number of questions that we will be sure to address in this text which is, however, mainly concerned with reflecting on the nature and necessity of epistemology, but also with shedding some light on the concept of science as it refers to a knowledge of a particular type, with the various issues which its definition and practice include.

Epistemology in General

In accordance with its Greek etymology (*episteme*, knowledge, *science* and *logos*, study), epistemology can be defined as the study of science in general. Its objective is to reflect on science, and what distinguishes it from other types of knowledge, on its criteria of definition, on the methods and procedures of the production and validation of its results.[1]

Such as we have just defined it, and except in overly extending understanding, epistemology does not exhaust all of the dimensions of scientific knowledge. There are other possible approaches to science, as for example the sociology of science, which understands it as social activity, the anthropology of science, which understands it in its cultural dimension, the psychoanalysis of science, the economics of science, the politics of science, the history of science, etc. Each of these approaches, in its own way, allows us to shed light on science.

There is also the question, too complex to be addressed here, of the relationship between epistemology and the history of the sciences. Even if we do not see how rigorous and concrete thought on science could save the cost of information as precise as possible on the process of the formation of concepts, theories and approaches at one moment or another in the development of scientific activity, there are nevertheless differences in approach between the two.

But epistemology is not only a reflection on science in general. There is also an epistemological practice which, instead of dealing with general problems of science, concentrates on a particular scientific discipline of which it tries to understand the specific problems. It is in this way that we sometimes speak of "particular", "local", "regional" or "special" epistemology.

However, whether it be general or special, epistemological reflection is subject to another distinction. We speak of external epistemology when, as is often the case, epistemological reflection is conducted outside of science, i.e. by a non-scientist by training. For example, in the organization of teaching, epistemology is an integrative part of the philosophy course and its practice is reserved in general

for philosophers who are not necessarily trained in the concrete disciplines concerned. This gives rise to a sort of contradiction which leads specialists of particular disciplines to feel – and sometimes rightly so – with respect to this epistemology, which comes to them from the outside and which sometimes gives the impression, not always without justification, of attempting to regulate them – the same distrust as artistic creators with respect to art critics. Such an impression has often pushed some scholars to engage themselves in an epistemological reflection on their own activity, but not always, moreover, with all the success that direct knowledge of their subject could hope to do. We then refer to *internal epistemology*, to be understood in the sense of autonomous reflection by specialists of a given scientific field on their discipline. That can seem, *a priori*, to offer a greater guarantee of relevance to epistemological reflection. Yet, this is the case only if the person in question has been trained to go beyond the simple use of knowledge and instruments of his own discipline, to develop a lucid and demanding critical reflection on them. Unfortunately, this is not always the case: the training of scientists in our universities thinks nothing of such reflection on science which is rejected as related to "philosophy " or even "metaphysics."

The concept of science in epistemology

In a famous formula, Aristotle stated, "At the beginning was surprise." Man's nature is not to content himself with living in the world, passively watching phenomena take place and asking no questions about them. On the contrary, from the beginning, the world "surprises" Man. It presents itself to him as an enigma, a set of mysteries to decipher, fuelling all manner of questions to which he should find appropriate responses, not only for simple reasons of intellectual curiosity but also to be able to survive in a sometimes hostile environment. Where does the world come from and where do the beings that inhabit it come from, and the realities which compose it? Why is there something rather than nothing? How does it come about that things happen in a certain way and not another? Are the appearance, succession and disappearance of events and phenomena related to pure chance or instead causes? If need be, are they understandable by Man? These are the fundamental questions that Man asks himself.

We believe that it is from this point of view that we should explain the existence in all human society of myths, legends, tales, artistic practices, religions, with the objective (though not exclusive) of conferring an intelligibility on the world and the phenomena which take place there, i.e. of providing men with a satisfying explanation of what is happening there, to be able to control it, both by thought and by action. Otherwise, the human species could not survive in a nature that it, of all the species, is the least well prepared to dominate. Despite their differences, all these approaches have a common denominator: recourse to the principle of causality. Indeed, they all start from the idea that everything obeys a cause, whatever its nature may be – mysterious or accessible to human reason.

However, the forms of intelligibility that myths, stories, legends, religions or art propose, give rise to a causality in the sequence of phenomena and events which always remains shrouded in mystery, insofar as it refers to realities which transcend human reason. It is thus through faith, simple belief or collective traditions that it makes its presence felt. After all, this is what explains the unfortunate tendency to reduce these explanations to the simple domain of the irrational. It is justified if, by "irrational," we mean what does not proceed from reason in the logical sense of the term. But this way of systematically denying – and without other forms of trial – the intellectual approach at work in myths, stories and legends is fallacious if we understand by "irrational" something totally contrary to reason and totally foreign to it.

Indeed, if we extricate ourselves from a strictly rationalist and ethnocentric conception of rationality , these approaches can be considered "rational" in several ways. They are first rational to the extent – as we have previously stated – that they presuppose that everything has its reason, that they obey an open or hidden reason, accessible or not to human understanding. They are also rational insofar as, even if the intelligibility that they ensure is not produced in accordance with rules, criteria and procedures of reasoning judged to be valid according to principles of Aristotelian logic, they do not clash so much with reason. Thus, there is nothing rationally shocking in the idea that instead of being the simple result of the evolution of matter, man was created by God. Moreover, there is not necessarily more logical consistency in the structure of Darwin's explanation, than in a Dogon or Bantou myth of the origin of man; if the rules of construction of the consistency are not necessarily identical, it is only the narrowness of a view of a certain rationalism which smacks of positivism that sees a "childhood of the mind" (Hegel) in mythic or religious thought.

These considerations would seem to be all the more necessary in that they include implications in the debate on the epistemological status of "endogenous knowledge," disqualified in the name of the same narrowly ethnocentric conception of rationality and knowledge. They should not, however, mask the fact that "science," in the precise meaning when it concerns epistemology, remains, despite everything, a qualitatively new knowledge, obeying its own criteria of definition,[2] having its own procedures of production and validation of knowledge, supposing a certain number of conditions, and evolving according to particular modalities.

More precisely, in the sense where it interests epistemology, the concept of science refers to a system of rational, objective and universal knowledge related to a given domain of the real, which allows us to discern, between phenomena and events which are produced within it, necessary and constant relationships which we call laws, which we can go on to explain what is happening in this field or predict what can happen there and thus be able to act effectively on it. Let us clarify this definition.

Systematic Nature

A set of disparate, fragmented bits of knowledge without any link between them, even if true, does not yet constitute *ipso facto* a science. In order to speak of a science, in a domain of the real, this knowledge must not only be true but ordered and structures in a coherent whole, on the base of principles and of a rigorously developed and scrupulously applied a approach.

Rationality

We have noted above that rationality, except if we understand it in too narrow a sense, cannot be considered an exclusive attribute of science. But the criterion of rationality, as we apply it here to science (itself understood, not in the sense of knowledge in general but of a particular knowledge, of a qualitatively new type), means two things. On the one hand, that science explains phenomena and events which are produced in the world by resorting to human reason as instrument of discovery and analysis, and not to any elusive cause. On the other hand, that the discourse and approach chosen to do this are totally respectful of the principles and formal procedure of questioning such as they are established by logical science.

Objectivity

Scientific knowledge aims to render an account of reality such as it is, which implies that it is the most faithful possible to the nature of its subject and correlatively, that it is the least possibly marked by "subjectivity" in all its forms (feelings, desires, philosophical, political, moral, religious, etc. convictions). We have deliberately chosen the word "aims" because in reality, objectivity, in the sense of total and perfect appropriateness of the knowledge and the reality on which it bears, is an ideal towards which science can aspire rather than an objective which it attains.

Universality

This criterion can be considered as the result of the two preceding ones. Indeed, if knowledge is conceived of in such a way that it is accessible and acceptable by reason, which Descartes termed the best shared thing in the world, and if it is developed in a way be to able, by its objectivity, to realize the "agreement of minds," it should be recognized as valid and acceptable by anyone of good faith and fairly competent in the matter, indiscriminately of social origin, or personal convictions and preferences. But on this point as well, it is also important to stress that the universality of scientific knowledge cannot be understood in an absolute way anymore than absolute objectivity is possible.

Laws

In the sense that we understand it in epistemology, different in certain relationships from their legal sense, laws are not pure inventions of the human mind even if the mind discovers them, develops them and formulates them. They are inherent to the nature of phenomena and events to which they apply. They are the expression of general, constant and necessary relationships. What do these three adjectives correspond to? First, we cannot speak of a law when we are dealing with a phenomenon or a particular event, or a particular aspect of a phenomenon or an event. In other words, we cannot make a particular case a law or a general process. Nor can we speak of law when we are dealing with a phenomenon or an event which is not able to be repeated identically in identical conditions. We cannot speak of a law when we are dealing with a phenomenon or an event which only happens exceptionally or which, depending on the case, can appear in different forms. Therein lies the consistency of scientific law. Finally, the law always expresses what happens and what cannot happen, what always happens necessarily when we match up phenomena or events in identical conditions.

Monitoring

Even though it is only implicitly included in the definition of science such as we have previously formulated it, this is an extremely important criterion. Science does not accept any idea, any explanation which is not monitorable, i.e. of which we cannot establish the truth or falseness, either by questioning, or by recourse to experience and sometimes by the combination of the two. In other words, there is no scientific knowledge without proof, the development of such knowledge implying the definition of conditions, procedures and theoretical and/or methodological means of establishment of this proof. The importance, even the supremacy accorded to experimental monitoring, i.e. the verification by facts, as we see to a large extent today in scientific practice, including in the social sciences, can be considered a natural consequence of the inductivist approach established by some as the scientific approach par excellence.

Birth and Progress of Scientific Knowledge

How does science, thus defined, form? This question includes two aspects: on the one hand, that of the birth of science, i.e. of the passage from prescientific to scientific and, on the other, that of the progress of scientific knowledge itself. We have chosen to address the first aspect in light of the epistemology of Gaston Bachelard and the second through the debate which divided the two other great figures of contemporary epistemology, Karl Popper and Thomas Kuhn.

But first we need to say several words on the question which has dominated all of the history of knowledge, that of the origin of our knowledge, in particular our authentic knowledge, a question which, as we know, has divided the two major currents of the theory of knowledge, rationalism and empiricism.

The first current cited, which we can trace back to Plato, considers that knowledge results from a free activity of the mind which should be capable of freeing itself from the knowledge that it draws directly from the senses, from rumor, current opinion or tradition which can only mislead it by making it mistake simple appearances for reality. It is the entire "idealist" tradition, represented in various ways in the history of philosophy, with some slight differences which we will not dwell on, by later thinkers like Descartes, Leibniz, Kant, Hegel, to only cite those few. Beyond differences in their respective systems, on the question which concerns us here they share the idea that true knowledge is not given but constructed, acquired at the price of a demanding, methodical and persevering effort of reason and a particular vigilance in order not to confuse essence and appearance, illusion and reality, truth and error.

A second tradition contrasts with this, that of "empiricism," associated with the names of philosophers like Hume and Locke, for whom all ideas conceived by the human mind are derived from perceptible experience which is thus raised not only to the status of source but also as foundation and guarantor of all authentic knowledge. Outside of perceptible knowledge and "facts" such as it gives us, the rest is only pure imagination. The meticulous recording and the most faithful possible information provided by the senses becomes, for this second tradition, the approach par excellence of science, whereas suspicion of them and their critique was the necessary starting point of all enterprise of knowledge claiming the status of science for the previously mentioned current.

Here, the question is not to know which of these two gnoseological approaches is the most relevant. Behind their seemingly irreconcilable opposition, each of them translates an indisputable aspect of the scientific approach.

If the respect for "facts" such as stressed by empiricism, is the best way to avoid erring in gratuitous ratiocinations, it is also a simple fact of "experience, "that the scientific mind cannot, at the risk of being mistaken, settle for taking the data that our senses provide on the world at face value, or information that we can draw from public opinion, or even tradition. For example, we "see" every day that the sun "rises" in the morning and "sets" at night and this perceptible data establishes itself with such force of truth for all ordinary men that it seems unthinkable to him to doubt this for a single moment. Yet, thanks to science, we know that it is something totally different that really happens. In fact, beyond the question of knowledge, if our authentic knowledge of the world is the result of the ability of the human mind to create ideas and concepts, the example that we have just given suggest that there is a fundamental difference in nature and epistemological status between science and the forms and the modes of representation of the real which came before it or run concurrent to it. But for some, more than a simple difference between "given" empirical knowledge, and

authentically scientific knowledge, there is a contradiction which means that the former is always an obstacle against the latter which can only form, therefore, by breaking radically with it.

That is, in fact, the central thesis of the epistemology of Gaston Bachelard, that particularly stresses the concept of "epistemological rupture" which involves both a conception of the formation of science, i.e. of the passage from prescientific to scientific and the evolution, or more precisely, of modalities of the progress of scientific knowledge, from its passage from one stage to another of its development.

From the prescientific to the scientific: the concept of "epistemological rupture" (Bachelard)

Man, as we have previously stated, did not wait for science to try to understand and explain the world. But for Bachelard, scientific knowledge does not prolong prescientific knowledge that he would gradually specify and examine in more detail. Instead, scientific knowledge sets itself apart radically and by nature. There is, rather, an 'epistemological' rupture between the two; a concept which, as we will later see, infers a dicontinuist conception of scientific progress, but which also involves a certain relationship between science and the various immediate ways of understanding the real.

Let us begin by this second aspect of the problem which requires a detour by another central concept of Bachelard's epistemology, that of "epistemological obstacle." For Bachelard,

> we should pose the problem of scientific knowledge in terms of obstacles. And it is not a matter of considering external obstacles, like the complexity and the elusiveness of phenomena, nor of incriminating the weakness of the senses and of the human mind: it is in the very act of knowing, intimately, that slowness and unrest appear through a sort of functional necessity. It is there that we show the causes of stagnation and even regression, it is there that we detect the causes of inertia that we will call epistemological obstacles and a light which always projects shadows somewhere. It is never immediate and full. The revelations of the real are always "recurrent". Empirical thought is clear, "after the fact", when the apparatus of reason has been focalized. By going back to a past of errors, we find truth in a true intellectual repentance. In fact, we understand against a previous knowledge, by destroying poorly constructed knowledge, in overcoming what, even in the mind, presents an obstacle to spiritualization (Bachelard 1967:13).

Among the "natural attitudes" which play this role of epistemological obstacle detrimental to science, Bachelard aligns himself with the mainstream of the rationalist tradition. He writes:

> Science, in its need for completion as in its principle, absolutely goes against opinion. If it happens to legitimize the opinion on a point, it is for reasons other than those which constitute opinion; in such a way that opinion is always wrong *de jure*. Opinion "thinks" poorly, it does not think: it translates needs into knowledge. By designating objects by their usefulness, it does not allow itself to understand them. We can base nothing on opinion: we must first destroy it. It is the first obstacle to overcome. It would not suffice, for example, to correct it on particular points, by maintaining, as a sort of temporary morale, ordinary and temporary knowledge. The scientific mind forbids us to have an opinion on questions that we do not understand, on questions that we do not know how to formulate clearly. And no matter what is said, in scientific life problems do not arise on their own. It is precisely the "meaning of problem" which is the mark of the true scientific mind. For a scientific mind, all knowledge is a response to a question. If there has not been a question, their can be no scientific knowledge. Nothing goes without saying. Nothing is given. All is constructed (Bachelard 1967:14).

Just like opinion, but for a different reason, immediate intuition, what Bachelard calls "the first empirical influence" also distances us from science. He explains that this immediate, empirical way of understanding the real is incapable of getting to the heart of the matter, and gives us the phenomena only in their superficial, disparate aspect, in their disorder and diversity. Directly addressing empirical knowledge, Bachelard writes:

> Prescientific thought does not hammer away at the study of a well-defined phenomenon. It is not looking for variation but variety. (...)
>
> The research of variety drags the mind from one object to another, without method; the mind then only targets the extension of concepts; research on variation the variation follows a particular phenomenon; it tries to objectify all of its variables, to test the sensitivity of variables. It enriches the comprehension of the concept and prepares the mathematization of the experience (Bachelard 1967:29).

Another epistemological obstacle denounced by Bachelard lies in what he calls general knowledge. Writing on this type of knowledge, Bachelard says, "Nothing has slowed down scientific knowledge more than the false doctrine of the *general* which reigned from Aristotle down to Bacon (Bachelard 1967:29)". Here, Bachelard is taking aim at the tendency – very close to empiricism, moreover – which

consists for the human mind in assembling facts to collect their similarities. He sees in this "distrust of all questions which would put forward resulting diversifications", a "laziness of distinction," and "signs of the fossilized concept."

Bachelard sees a final obstacle in "substantialism," this natural and particularly tenacious tendency of the human mind which comes down to believing that the impression that an object gives us comes from an intrinsic property, and hidden from it. He writes,

> The substantialization of an immediate quality understood in a direct intuition no less hinders the later progress of scientific thought than the affirmation of a hidden or intimate quality, because such a substantialization gives rise to an explanation which is as brief as it is peremptory. It lacks a theoretical detour which requires the scientific mind to criticize the sensation. Indeed, for the scientific mind, any phenomenon is a moment of theoretical thought, a stage of discursive thought, a *prepared* result. It is produced rather than induced. The human mind cannot satisfy itself by purely and simply linking descriptive elements of a phenomenon to a substance, without any effort of hierarchy, without specific and detailed determination of relations to other objects (Bachelard 1967:102).

For Bachelard, these "epistemological obstacles," far from being explained only by the complexity of the real or by deficiencies of our senses, find their origin in the very fact of knowing, and can, as a result, operate in the scholar's mind, mislead his approach and as a result distort his comprehension of the real without his being conscious of it. Whence the need for a "psychoanalysis" of the scientific mind.

In a sense which does not totally correspond to the practice to which this concept refers in Freud's work, the "psychoanalysis" recommended by Bachelard to free the scholar's mind from beliefs sometimes inherited from the history of his discipline which can distort his understanding of the real or the interpretation of results of his research.

On the whole, with respect to the question of relationships between the prescientific and the scientific, Bachelard, by presenting the former as an obstacle to the latter, develops an approach of discontinuity of the formation of science which will also be expressed through the idea that he has of the progress of science. It is just as much through rupture that scientific thought is formed, as it is through rupture that it progresses. Scientific progress, he writes, "always manifests a rupture, perpetually ruptures, between common knowledge and scientific knowledge, as soon as we address an evolved science, a science which by the very fact of these ruptures bears the mark of this modernity" (Bachelard 1977:207).

On what do the "continuists" base what he considers to be an erroneous conception of scientific progress? A first reason lies in their postulate which is that of "the continuity of the history." It is by virtue of such a postulate that they like to reflect on origins, they stay in the zone of the elementary nature of science.

Scientific progress was slow, very slow at first. The slower they are, the more continuous they seem. And as science slowly leaves the body of common knowledge, we believe that we have the definitive certainty of the continuity of common knowledge and scientific knowledge. All in all, here is the epistemological axiom posited by the continuists: since the beginnings are slow, progress is continuous. The philosopher goes no further. He believes that it is useless to live in new times, times when, precisely, scientific progress "explodes" from all sides, necessarily causing traditional epistemology to explode (Bachelard 1977:210).

Given that the "continuists" lose sight of the discontinuity of scientific progress, there is a second reason that Bachelard places under the tendency to attribute the credit for this progress to the "crowd of anonymous workers." He explains:

> We like to say that progress was "in the air" when the man of genius updated it. Then "atmospheres" and "influences" came into play. The further away we are from the facts, the easier it is to evoke "influences." Influences are constantly evoked for the most remote origins. We have them cross over continents and centuries. But this concept of influence, so dear to the philosophical mind, hardly has meaning in the transmission of truths and discoveries in contemporary science (Bachelard 1977:212).

It is in the education tradition that Bachelard will find a third and final reason for the continuist error. It is natural that:

> Since we believe in the continuity between common knowledge and scientific knowledge, we work at maintaining it, we feel obligated to strengthen it. We want to have the rudiments of scientific knowledge come out slowly and gently from good sense. We are reluctant to do violence to "common sense." And in methods of elementary instruction, we put off for the sake of putting off the hours of aggressive initiations, we want to keep the tradition of "elementary" science, "easy" science; we make it our duty to have the student participate in the immobility of initial knowledge. We must, however, get to the point of "critiquing" elementary culture. Thus we enter the kingdom of difficult scientific culture (Bachelard 1977:212-213)

To finish up with Bachelard, we would point out that in the background of his dicontinuist conception of the formation and progress of scientific knowledge, there is the idea that scientific knowledge, far from being able to lead to an absolute and definitive truth, can only ever be "approached," and is thus always marked with uncertainty and indetermination. As we know, this idea is totally in agreement with the state of development of physics of his time, more specifically with the discovery of the "microphysical continent" and the arrival within scientific thought of relativist (Einstein), probabilistic (Bohr), and indeterminist (Heisenberg) tendencies which fundamentally question Laplacian determinism and the concept of science which results from it. In light of this idea, scientific development

appears as an endless approach of rectifications, reworkings and redevelopments of our concepts and theories, for ever more rigor and specificity in the understanding and formulation of the subject. Narrowly speaking, then, there can be no "exact science."

In the way that we have just briefly summarized, Bachelard responds to the question of modalities of development of science, but it would be of interest to pursue the examination of the question through the debate which it sparked in the work of these two other emblematic figures of contemporary epistemology, Karl Popper and Thomas Kuhn.

The Popper-Kuhn debate: evolution or revolution of scientific knowledge?

Once formed, how does science move forward: by gradual accumulation, "growth," of our knowledge, or rather by "revolutions"? As announced above, this second aspect of the problem of the formation of scientific knowledge has sparked passionate debates in epistemology the most notable of which divided Karl Popper and Thomas Kuhn, among others.

With respect to Popper, a first difference between his epistemology and that of Bachelard, concerns the "beginning of science."

We will remember that while Bachelard sees the prescientific forms of knowledge as "epistemological obstacles," Popper considers that science, philosophy and rational thought "should all start from good sense," by which he means "all of the opinions and beliefs commonly accepted by men, i.e. all prior knowledge on which all of our knowledge is constructed."

In fact, "good sense" in Popper's work designates, "good critical sense." Commenting on this concept, Malherbe writes:

> For Popper, the starting point is always good sense, and the instrument of progress is the reconsideration of presuppositions promoted by good sense. It is by constantly transforming our prior knowledge that we form valid scientific hypotheses and are able to argue in a more and more critical way in philosophy (…) All growth of our knowledge is a series of conjectures and refutations. All our knowledge comes from errors that we have committed and our desire to no longer do so (…) (Malherbe 1979:131).

The progress of scientific knowledge itself takes place according to the same pattern; it is thus synonymous with the gradual perfecting of hypotheses and theories advanced to explain reality.

Seen from this perspective, all progress of knowledge lies, "in the improvement of existing knowledge modified in the hope of further approaching truth." According to Popper, it always occurs in the following way:

> A problem or a question (Pn) arises for a scholar and it must be solved by formulating a hypothesis (Hn). This hypothesis is then compared to experience in order to eliminate errors (EE). The modification of the hypothesis which results from this comparison engenders new problems (Pn+1) which we try to respond to with the help of a new hypothesis (Hn+1) and so on.

What is called science at a given moment is thus never anything but the set of hypotheses temporarily held to be true at that moment. This process is infinite insofar as the absolute certainty that some attach to the idea of science is only an ideal limit towards which research is headed, but which it can never reach.

We clearly see in this conception of development of scientific knowledge a reference to the biological model of the evolution of living beings as formulated in Darwin's theory, which has led to speaking of an "evolutionist epistemology." Like living beings, scientific theories are subjected to the requirements of adaptation and the struggle for life: those which survive or those which have overcome the "selection-elimination" test which here is called the trial and error method (which Popper also calls the critical method, that of refutation) which he, moreover, considers as the unique method of sciences.

Thus, for Popper, from the amoeba to Einstein, the growth of knowledge is always the same. Both can be wrong, even if, unlike the amoeba, Einstein is trying to consciously eliminate his errors and if, moreover, the amoeba dies from its errors whereas Einstein, thanks to their rational critique, can overcome them and move forward towards the truth.

In short, for Popper scientific progress lies in the improvement of existing knowledge modified with the objective of moving ever closer to the truth, which should not be understood in an absolute sense but only as a regulating idea allowing us to orient the quest for knowledge.

It is precisely this conception of development of science as a linear process of the infinite accumulation of knowledge that Kuhn rejects by contrasting it with that of "scientific revolution" of which we can only fully understand the meaning and the reach from the perspective of the concept of "paradigm" which underlies it. What do we mean by "paradigm"? It is true that the concept is fairly ambiguous in the work of Kuhn himself. Sometimes, it refers to "scientific works universally recognized which provide problems and model solutions to a community of practitioners during a certain time," works on which "traditions of particular and coherent scientific research" are based. Other times, we are referring to a set of "diverse theories having a high frequency and a more or less standardized content," that we find in "texts, classes and laboratory exercises." It acts as a "narrow network of conceptual, theoretical, instrumental and methodological postulates," or as "an implicit set of overlapping theoretical and methodological beliefs which make selection, assessment and critique possible."

With the support of these various definitions – and the list is not exhaustive – given by Kuhn, we could see in the paradigm what, at a particular stage of the development of science, allows the community to communicate and agree on the admissibility of the formulation of questions and responses to provide for them, i.e. on what it can recognize as scientific because it is in accordance with principles, rules and procedures, the validity of which is consensually accepted within it. By choosing this concept of paradigm, writes Kuhn,

> I want to suggest that some recognized examples of real scientific work – examples which include laws, theories, applications and experimental systems – provide models which give rise to particular and coherent traditions of scientific research. (…) It is the study of the paradigm which, mainly prepares the student to become a member of a particular scientific community with which he will later work. As he joins here with men who have drawn their bases of knowledge from the same concrete models, his work will rarely lead him to disagree with them on fundamental points. Men whose research is based on the same paradigm adhere to the same norms in scientific practice (Kuhn 2008:30).

The paradigm thus understood refers to the conservative, traditionalist side of science, i.e. to what Kuhn calls "normal science" which is spread through professional training of researchers, in textbooks and in well thought of and approved scientific reviews. It is also according to the dominant paradigm that ranks, privileges and academic status are distributed with their social or even material implications. An essential characteristic of the paradigm is its "incommensurability" which closes it in on itself and makes dialogue from another paradigm impossible.

As long as the facts to be explained fit without difficulty into the "conceptual boxes" of paradigms, it is "normal science" which continues to function. Scientific activity is then reduced to increasing knowledge of these facts and, more precisely, as Kuhn writes, their correspondence to predictions of the paradigm all the while refining the formulation of this paradigm itself. Scientific activity is reduced here to the resolution of simple "enigmas." "Novelties" can probably appear in normal science, but they are not born out of nothing. As Kuhn writes:

> They emerge from ancient theories and inside a matrix of ancient beliefs concerning phenomena that the world contains and at the same times does not contain. Normally, these novelties are much too esoteric and abstract to be observed by a man who has not received serious scientific training (…). On the contrary, starting from research undertaken as part of his doctoral dissertation, the practitioner of a mature science continues to work in regions that the paradigms inherited from his education and the research of his contemporaries seems to be able to successfully analyze. In other words, he

> tries to elucidate the topographic details of a map of which he knows the major lines in advance; and he hopes – if he has a depth of view allowing him to identify the nature of his field – to one day devote himself to a problem which will give rise to the unexpected (…). In the mature sciences, the precondition for most discoveries and all new theories is not ignorance but the recognition of a failure in knowledge and existing beliefs (Kuhn 1980:287-288).

It may happen, however, that scientific activity, in its normal course, runs into an "anomaly, " i.e. facts of phenomena which keep at bay the explanatory power of science on the basis of the paradigm in effect, particularly by questioning the effectiveness of concepts, theories and method admitted up until that point by the scientific community. When a paradigm shifts, not only are "the source of methods, fields of problems, and types of solutions accepted by a whole mature scientific community at the time" changed, but also the necessity of the "redefinition of the corresponding science," just as "the criteria by which we distinguish a real scientific solution from a metaphysical speculation" change. Kuhn explains that the tradition of normal science which emerges from a scientific revolution "is not only incompatible with what was happening up until then but also incommensurable." The incommensurability of paradigms makes the derivation of a new theory from a previous theory impossible.

The impossibility for "normal science" to integrate these anomalies into its framework of intelligibility then plunges the scientific community into a state of "crisis" which cannot itself be overcome by a "scientific revolution."

Scientific revolutions which thus appear as "non-cumulative episodes of development in which an older paradigm is replaced, in its totality or in part, by a new incompatible paradigm," (Kuhn1983:131) does not only intervene in the epistemological sphere. They also have a sociological impact, if not political as well. Kuhn points out, moreover, that it is completely on purpose that he uses the word revolution which normally belongs to the political register. As in politics, beyond a simple paradigm shift, all the institutions, rules and all criteria of recognition which are shaken within the scientific community are reconsidered from the feeling that they have ceased to be able to function a in satisfactory way. Thus, it is not only new theories which appear, but also new scientific authorities, new criteria of cooptation and recognition within the community, new educational texts and programs, with all that they include by way of reconsidered acquired knowledge, interests and sometimes purely material advantages which were obtained on the basis of the overturned paradigm.

We then understand that, always following the example of political revolutions, the supporters of the old paradigm put up a good fight and we sometimes have to resort to methods of mass persuasion, or even violence[3].

It is all of these considerations which constitute and clarify the way in which Kuhn conceives of scientific progress. We can clearly see the difference between his conception and that of Popper in the following:

> Contrary to dominant opinion, most new discoveries and scientific theories are not simple additions to the existing reserves of scientific knowledge. In order to assimilate them, the scholar should normally rearrange the intellectual and technical equipment on which he based them, all the while pushing aside some parts of his belief system and previous practices and discovering meanings and new relations between other elements. Assimilation once again involves the reassessment and reorganization of the old, discovery anew involves the reassessment and reorganization of the old; discovery and invention in the sciences are intrinsically revolutionary. Therefore, they require precisely this flexibility and open-mindedness which characterize, or even define the divergent thinker. Thus, we should admit the need for these characteristics going forward. If these qualities were not the prerogative of numerous scientific researchers, there would be no scientific revolutions or very few scientific revolutions (Kuhn 1983:131).

The Scientific Approach: Questioning Logic and Experimentation

The scientific approach includes two fundamental aspects, namely questioning and experimentation. The first is more characteristic of sciences like mathematics and logic, although, as we will later see, it cannot be lacking in any science (don't we speak of "experimental questioning" in the natural sciences?), whereas the second, first considered the prerogative of the natural sciences, has a tendency to be established as a criterion par excellence of any scientific approach.

Logical questioning

In defining the criteria of scientific thought above, we spoke of the concept of rationality. One of the definitions that we have given for it, is that which is in accordance with the principles and requirements of logical thought, such as they were formulated by Aristotle.

In science, the principles of logical reasoning function not so much as a means of knowledge production as a way to organize thought to make possible agreement on what can be held to be true or false. Yet, these would seem to be a minimum when we are dealing with coming to conclusions which we expect – unlike those in metaphysics which are the subject of endless discussions – will achieve agreement. They are both the formal condition and guarantee of the possibility of a universal knowledge.

Classical logic is based, as we know, on three principles which are: the principle of identity (a thing is always identical to itself, its "same old self"), the principle

of the excluded third party (between A and not A, there is not a third possibility) and the principle of contradiction, which we also sometimes call the principle of non-contradiction (A and not A cannot exist at the same time and under the same relationship, the two absolutely exclude each other).

No question of our going into detail here in the statement of these principles, and even less of our dwelling on the controversies that they can arouse. We would simply note that "without these principles, the very exercise of thought appears impossible," stresses A. Virieux-Reymond, who considers that they orient the activity of all thought which claims to be rigorous and rational. He writes the following on this subject:

> For people able to be mistaken as we are, the three fundamental principles which direct our activity of judging in its affirmations and its negations are mutually involved and they intervene directly or indirectly in all approaches of reflective thought. Indeed, as unstable as the data are that we want to use to create science, it is necessary (for fear of not being understood either by others or even ourselves) that once a term is defined a certain way, another meaning not be given to it during the exposé, without warning the reader or listener, whence the principle of identity; it is also necessary that a term and its negation not be attributed at the same time in the same relationship and the same point of view to the same subject (whence the principle of contradiction), nor that a third possibility intervene between A and not-A – which we repeat, should not be identified with not contrary to A: it is what is not A, what is other than it without its necessarily being diametrically opposed as the contrary (excluded third) : if this were the case, the negation would lose the valuable apagogic power that it has since a third possibility could slip in between A and not-A and the negative thought would become unusable: the negative statement denounces our errors by inviting us to search for the true judgment other than in the denied fact. Without the two latter principles, questioning by the absurd becomes unusable (Virieux-Reymond 1966:59).

Logical questioning is not, however, sufficient in and of itself to confer a scientific value on knowledge. The type of truth that it enables us to obtain, i.e. the formal consistency of the structure of statements such as those we can discover in the syllogism, is not necessarily synonymous with appropriateness with the real. By way of illustration here, we can take the famous syllogism of Socrates, "All men are mortal; Socrates is a man, thus Socrates is mortal."

From the perspective of formal validity, this proposition is absolutely indisputable as its conclusion naturally follows from its premises. But if we keep its formal structure all the while changing the terms, we can observe that it can, however, be false in the facts without losing this formal validity. For example:

"All students in the social sciences are intelligent; Charles is a student in the social sciences, thus Charles is intelligent." This statement, although it has the same form as the first, can be true or false, depending on the result of its comparison with reality – i.e. with Charles and his real academic performance.

We should, however, note that deduction, which is the type of logical questioning which we have mentioned here, is not the only sort. There is also induction which, because at the very least it escapes the critique that we have just made of the deductive approach, in that it starts from observation, is presented by some as the true approach to science. Induction, we should recall, is the approach which consists in starting from the largest possible set of observed facts to draw a general conclusion from them. It thus presupposes the fundamental postulate of empiricism, according to which all of our authentic knowledge derives from experience. We will have the chance to return to a more in-depth look at this form of questioning when we address the experimental method.

In the mean time, we can already note why, no more than the purely deductive approach, induction does not constitute the noble pathway of scientific knowledge. We can criticize it for three limitations.

The first limitation of induction lies in the quality of knowledge it provides us. This knowledge can never be certain, as successfully stressed by Popper, one of the most resolute adversaries of inductive knowledge. Given the inventory of particular facts which can never be exhaustive and observations not infinitely repeatable, it is always to be feared that a new observation will refute the preceding ones. It is not, Popper tells us, because up until now no one has seen a black swan that the statement "all swans are white" is an absolute certainty. Indeed, from the point of view of logic, nothing stops us from thinking that a swan could be black or affirming that a black swan can never exist. Furthermore, and this is the second limitation of induction, I can only understand the statement that "all swans are white" if I know what a swan is, which, in accordance with the postulate of induction, is only possible following observations. This is why induction is in itself a sort of vicious circle. Finally, induction is related to immediate experience, to what Bachelard called "initial knowledge" which is incapable of criticizing itself and rising to the level of the development of concepts and the establishment of laws.[4]

Given all of these reasons, it is then important to successfully distinguish the inductive approach, strictly speaking, from the experimental method which we also call experimental questioning.

Indeed, if the two are similar in that they confer a significant place in scientific knowledge on facts, they differ from each other in two fundamental aspects, namely, the way in which they each understand the concepts of "facts" and "observation" and also the way in which they posit the relationship between theory and experience which is, moreover, related to the first aspect.

The experimental method

The importance of this method which has allowed science to progress considerably is such that it is worth our while to spend a bit more time looking at it. We should stress both its role and its originality in the history of scientific thought. Carnap writes:

> One of the principle characteristics which distinguish modern science from that of the previous periods lies in the very particular significance of what we call the "experimental method." All empirical knowledge is, at the end of the day, based on observations but they can be obtained in two ways which have an essential difference. When we use the non-experimental method, we play a passive role. We content ourselves with looking at stars or flowers, noticing the similarities and differences, and looking for regularities which can be expressed as laws. On the contrary, in the method of observing which we call experimental, we take an active role. Instead of waiting for nature to give us situations to observe, we try to create them. In other words, we engage in experimentation (Carnap 1973:47).

In the presentation normally made of it, the experimental method – first and foremost that of the natural sciences before being considered as the single method that all the sciences should apply to deserve their status as full-fledged science – includes three necessary moments: observation, hypothesis and verification. We find a detailed exposé in the work of Claude Bernard who was the main theoretician of this (Bernard 1966).

Observation

Unlike the logician, or even the mathematician, the scholar in the natural sciences starts with facts. He observes phenomena such as they unfold before his eyes in their diversity and apparent disorder to try to understand them and to render an account of them in a satisfactory way for the mind in the way which they appear, develop, link together over time and space, and then disappear. But the idea that the scholar starts with the facts is worth specifying for fear of being false.

The first detail to add is that the scientific fact, unlike the "gross" fact such as we see in purely empirical observation, is a constructed fact rather than a given. In other words, it is the particular interest that it assumes for the scholar, the fact that for one reason or another it creates a problem with respect to his own scientific theories or acquired knowledge of existing science, which pushes us to be interested in one fact more than another, to attach more importance to one fact over another. In other words, not only is the scientific fact always a selected fact (thus all facts do not have the same value for all scholars or even for the same scholar), but also it is immediately imbued – if we might express it this way – with theory. It is with respect to this point of view that Claude Bernard says that "science always starts from a preconceived idea."[5]

Unlike the passive or even blind look that the common mortal casts on the sequence of phenomena, that of the scholar is directed by his own scientific questioning. Of all the facts which appear to the eye of the scholar the only ones worthy of interest are those of which the existence calls out in one way or another to the researcher. It is in this way that Bachelard speaks of "polemic fact."

The hypothesis

The facts observed by the scholar do not "speak" of themselves; their intelligibility is not immediately obvious. This is why, once the researcher has defined a field of research, he should be able to propose a temporary explanation which is, in the etymological sense of the word, the formulation of a hypothesis. It is at this stage that we probably most see the creative imagination of the scholar in the production of knowledge. A good hypothesis should be necessary, plausible, strong, fecund, and open.

Necessity: When the arsenal of laws and scientific theories available is sufficient for making a fact or a phenomenon intelligible, we do not need to try to "reinvent the wheel." The hypothesis should thus imperatively be able to – if it is confirmed – allow science to progress, either by reworking or challenging its former laws and theories and, at any rate, by enriching, deepening and broadening.

Plausibility: Even if this is only the test of the verification that a hypothesis should be accepted or refuted (for good), its admissibility still requires a prior condition. For this reason, it has to be plausible, i.e. we cannot reject it immediately on the basis of a rigorous logical argument or confrontation with laws, principles and scientific theories duly established.

Force: When the scholar is looking for hypotheses, a number of them can appear to him and this plurality is in itself an excellent thing to the point that he should not deprive himself of working on the maximum possible number of hypotheses. But all hypotheses are not the same. First, we must always be aware of the most tempting hypothesis because it can mislead the scholar, and often it does so. We should also be aware of the most practical hypothesis, the most comfortable for the mind because, upon analysis, it can prove to be fragile. A good hypothesis is thus the one which was temporarily chosen at the end of a Darwinian process of natural selection, i.e. the fight for life.

A hypothesis can be considered strong when it resists all of the demanding attempts to refute it. It is only when it has survived the test of rational critique better than all the other rival hypotheses, like the wrestler who covets the champion's flag in the ring, that it can be chosen among all. But the value that it derives from its competition with other credible hypotheses is temporary.

***Productivity*:** A productive hypothesis is one which opens up real prospects for the research by allowing the researcher to make progress and possibly to reach a conclusive scientific result. In other words, it should lead somewhere, and thus have heuristic value.

***Opening**:* This last characteristic extends and completes, as it were, the one that we have just discussed. Indeed, in order not to block research, not to neglect or overlook any prospects which might be suggested to it, in order not to compromise in advance any possibility, the hypothesis should be open to the numerous logical or experimental reasons that the scholar might have to redevelop, rework or reformulate it, or simply reject it for another; i.e. the scholar should not cling to his hypotheses no matter what as if it were a question of life or death for him.

This means that research is a permanent risk: the researcher always runs the risk of being rejected at his starting point, contradicted in his initial intuition and hypotheses. But even when it fulfills all the criteria that we have just outlined, the hypothesis can only be accepted after having been successfully submitted to the test of verification.

Verification

The determinative importance given to verification is a logical result of the inductivist postulate which the conception of science copied from the model of the natural sciences is based on. By inductivist postulate, we mean the idea that from a given set of particular identical and corroborating facts, we can derive a general law valid for each of these particular facts.

And the objective of verification is to show that the hypotheses formulated from a set of facts can by validated by the successful comparison with other facts of the same type. Verification, in the sense that we mean here, is also a result of the fact that the scholar accepts nothing which has not been subject to proof. It can, depending on the sciences, work in different ways. The physicist and chemist, for example, proceed by trying to reconstitute the elements which the hypothesis is based in the laboratory to see if it renders a conclusive account or not. In another natural science, biology, verification is not always done in the laboratory, and sometimes presents difficulties for ethical, moral, or religious reasons for following the approach used in the sciences of inorganic matter. This impossibility of experimental verification is not only valid for biology. Carnap also gives the example of astronomy.

> In astronomy for example, we cannot deviate a planet from its orbit to see what will happen. The objects studied by astronomy are out of reach; we can only observe and describe them. Sometimes, the astronomer is able to reproduce in the laboratory similar conditions to those that we find, for

> example, on the surface of the sun or moon, and observe what happens in these conditions. But this is not a true astronomical experiment. It is a physics experiment which is of interest for astronomy (Carnap 1973:47).

Furthermore, we must understand that, even subjected to the most honest, scrupulous verification possible, a verified theory is nonetheless still a temporary theory. We must always bear in mind that the possibility of the discovery of new facts, or technological innovations allowing us to refine understanding of the real, requires that we go back to the drawing board with such a theory, either to restrict its field of validity and its explanatory power, or to simply reject it for a new theory more likely to throw light on this field.

Finally, verification, such as practised in the experimental method, and contrary to what the narrowly positivist conception of science thinks which confuses it with an essentially quantitative "thing-centered" approach" of accumulation of "facts," of "data" and showing figures which speak for themselves, involves a constant back and forth between theory and experiment, the first highlighting the second, and the latter validating the former. It is this dialectical relationship between theory and experience in all authentic scientific approach that Claude Bernard summarizes in these terms allowing us, in the process, to come back to the difference between experiment in the popular meaning of the term and scientific experimentation:

> The complete scholar is the one who embraces theory and experimental practice: 1) he observes a fact; 2) an idea about this fact is hatched in his mind; 3) in view of this idea, he reasons, institutes an experiment, imagines and realizes the material conditions of it; 4) from this experiment new phenomena result which must be observed and so on. The scholar's mind is in a way always situated between two observations: one which serves as a starting point for questioning, and the other which serves as a conclusion (Bernard 1966:55).

> Claude Bernard continues that, in experimental questioning, there is such a tangle between what results from observation and what belongs to the experiments that it would be impossible and, furthermore, useless to want to analyze each of these two terms in their inextricable mixture. We just need to remember that the *a priori* idea, or better yet the hypothesis, is the stimulus of the experiment, and that we should go at it freely, provided that we observe the results of the experiment rigorously and completely. If the hypothesis is not verified and disappears, the facts that it will have helped us to find will nevertheless remain established as immovable materials of science (Bernard 1966:27).

Scientism as "Ideology" of Science

The principles and the criteria of scientific character outlined above, principles that no scholar can violate without losing his title to be considered a scholar, have often been diverted and denatured by a attitude which claims to be representative of science, all the while being its pure and simple perversion: scientism.

Scientism is an "ideology" in the exact sense that Karl Mannheim, like Marx, gives this word. It is: a vision which denatures real scientific practice, and gives a "false awareness" of what scientific practice really is. Thus we should not, as we often do in everyday speech, confuse the adjectives "scientific" and "scientistic." The authors of a collective work on epistemology write that:

> Scientism is the scientific belief according to which the results of sciences are placed above all philosophical critique. This paradoxical act of faith which, in the name of reason, denies reason, leads particularly to the assertion that philosophical questions, indeed questions from the various social sciences, can be resolved only through the natural sciences. It is an extreme form of reductionism, or a corruption of the methodological approach which is established as an absolute in the name of a supposed rationalism which is precisely the opposite of well understood rationalism, i.e. of an open rationalism (Arago 2006:158).[6]

One of the most important scientistic principles lies in the idea that knowledge par excellence is scientific knowledge. This idea has as its corollary the disqualification of all other forms of knowledge as if there could be no other truth but objective truth. Now, let us take the case of the believer, not the false believer, but the authentic believer: the subject of his faith has the same force of evidence for him as a mathematical or physical truth. Obviously, a "positive" mind (in the meaning that Auguste Comte gives the word) could, in the name of the scientific necessity of proof, reject this evidence, but it could not found this refusal on the principle that he invokes. Indeed, if it is true that it is impossible, for example, to prove the existence of God on empirical bases, it is just as true that we cannot found the refusal of this existence on the same empirical bases. The reason for this is that the observable depends on the state of our senses and their abilities to faithfully record the data of the external world and represented them to us as such. Yet, everyone knows that we can believe that we saw what we have never seen, like the traveler who, lost in the middle of the desert, thirsty and hungry, sees oases on the horizon with their fresh water source. Mirages of this sort, of which we could provide numerous examples, are a part of objective reasons that we have to distrust our senses. Didn't Engels say on this subject that empiricism is the most direct path leading to mysticism?

Another objection is that something can be real without being visible. Microbes, obviously, existed before the microscope. Their reality was as indisputable as when it became so after the discovery of this wonderful instrument which today allows us access to the unfathomable depths of the infinitely small. Some realities, including non-existence, cannot be established on the basis of observation but that the human mind can indeed see, would run the risk of simply seeing their existence denied by an empirical conception of reality which would reduce it to observability.

Another aspect of scientism which could provide an occasion for critique lies in its objectivism. It is an aspect which, along with others, has particularly attracted the attention of Popper. It might be all the more interesting for us to stop and look at this aspect, given that Popper's critique of it is based on a double conception of the status of scientific theories and the method of their production which creates the originality of his epistemology.

The absolutization of the concept of objectivity in science first proceeds from the idea that certainty is possible in science, which is for Popper an illusion which results, according to him, from what he calls "the old ideal of the episteme, the ideal of an absolutely and demonstrable knowledge (Popper 1984:287)" which, he continues, "proved to be an idol." The homage rendered to this idiom "not only represses the audacity of our questions but, moreover, compromises the rigor and honesty of our tests" so true is it that "what makes the man of science is not the possession of irrefutable truths, but the obstinate and audaciously critical search for the truth."

Scientific certainty is thus a simple illusion and all our scientific theories are only simple "conjectures," which ruins "*the absolute authority of science*"(Popper 1979:190), by virtue of this "fallibility" which is the very mark of our condition of man, without meaning the renunciation of all idea of truth, insofar as the idea that "error is possible and that the search for certainty, or even a high probability is vain does not mean that we are wrong to seek the truth (Popper)." Indeed, this quest presupposes that "the truth is our goal."

In any event, continues Popper – and it is through his criticism of scientism, of the idea of truth which is inherent to it and of the method on which truth is based – we emerge upon what Popper considers the approach par excellence. This approach is diametrically opposed to the "verificationism" of the inductivist experimental method, such as defined above following the example of Claude Bernard, and which will be taken up again in their way by Wittgenstein and the theoreticians of the Circle of Vienna.[7]

For Popper, "we can never empirically justify (...) the claim that a scientific theory is true" (Popper 1982:23). This is the chance for him to denounce the conception of the scientific method, which he calls "methodological naturalism,"

a conception which, according to him, is often "reasonably believed," including by specialists in the "social sciences." This methodological naturalism, he defends,

> sets requirements of the sort: begin by observations and measures, including, for example, statistical research; then move on to induction and generalizations and the formulation of theories. In this way, you will approach the ideal of scientific objectivity, insofar as this is possible in the field of the social sciences. You should be aware of the fact that objectivity is much more difficult to attain in the social sciences than in the natural sciences (insofar as it can ever be attained). Because objectivity means the absence of a value judgment (…) and that which the social sciences practices can only – in very rare cases – emancipate itself from the values of the social class to which it belongs to achieve a certain degree of neutrality and objectivity (Popper 1979:83).

In reality, for Popper, this is not the right scientific method, either for the social sciences or for the natural sciences, nor is there one method for the former and another for the latter. There is a single, unique scientific method which, for Popper, is not the experimental method but the hypothetical-deductive method, or "trial and error," (he speaks again of "critical method"), which Popper summaries in this way:

> The theoretician will do his best to detect all false theory in the set of rivals not refuted; he will try to "catch" them, i.e. for each of them, he will try to imagine cases or situations where the theory will probably fail if it is false. He will then try to fine-tune rigorous tests, and crucial experimental situations (Popper 1987:76).

In light of this conception of the scientific method, scientific objectivity depends "uniquely and exclusively on the critical tradition which, despite resistance, often makes possible the critique of a prevailing dogma (Popper1987:89)" In other words, it

> is not a question of the individual, with the exception of interesting men of science, but a social question which results from their mutual critique, of the friendly division of work – or hostile between scientists – of their collaboration as much as their rivalry. It thus partially depends on a series of social and political conditions which make this critique possible ...
>
> No matter which science is considered, this objectivity, Popper continues, can only be explained by social concepts such as competition (both of men of science among each other and different school of thought), tradition (namely, the critical tradition) the social institution (for example, publications of various competing reviews by competing editors), free discussion, including politically tolerated discussion (Popper 1987).

A last aspect of scientistic ideology which we think deserves to be noted and which is, furthermore, connected with what we have called objectivism, lies in the ignorance or refusal to consider the idea that, no matter how scrupulous and vigilant it attempts to be, the activity of the researcher necessarily suffers from a certain number of extrascientific factors of which he is not always conscious, or that he believes to have eliminated by his approach. But without his knowing, they interfere with his research and at the very least call on him to put the results in perspective. This is what we call the "unthoughts" of scientific work.

Such "unthoughts," that the scholar should be able to recognize at the risk of deluding himself about the value of his work, which means that he agrees to submit to a certain "psychoanalysis" as recommended by Bachelard, can be of a number of sorts – philosophical, religious, cultural, ideological, moral and even epistemological.

We will illustrate our statements with the help of several examples.

Philosophical unthoughts

The attitude of the scholar can be inferred with or even trapped by implicit philosophical positions which can be a barrier that distance him from the knwoledge of reality. There are no scholars, for example, who do not implicitly adhere to the philosophical thesis that the real is knowable by the mind, even if there can be differences of opinion on the degree of knowability of this real, which also comes under philosophy, because rejecting such an idea, is to disqualify *a priori* the ambition of knowing the scientific project itself. However, the scholar can have the conviction not only that what he is doing has nothing to do with philosophy but even that it is only fully and authentically in philosophy insofar as he knows how to completely rid himself of philosophy. Yet, we know that there was a whole current of contemporary epistemology, namely logical empiricism that is also called logical positivism, from the Circle of Vienna whose program was precisely to eliminate "metaphysics" (understood here as traditional philosophy).

With respect to this philosophical unthought, Althusser spoke of the "spontaneous philosophy of scholars," a philosophy that they are able to more or less repress when science is developing normally, but which resurfaces when their science enters into a "crisis," which leads them to "throw their philosophical fit."

Religious unthoughts

For some, not only does religion have nothing to do with science, considered by some as its absolute antithesis, but it is also considered the greatest enemy of science, the greatest obstacle to the development of scientific thought. The opposition of the two would be that of faith and reason, incompatible in their

respective natures in each of them. In other words, to be scientific would be to be rational to the end and radically eradicate from science everything that was even remotely related to faith. However, things are not so easy.

First, it is frequent to see scholars very reticent to commit to themes or directions of research, not always because such directions could not advance science, but rather because unconsciously for them, taking such directions "would hurt" their religious convictions in one way or another, without the reason for their reticence being totally apparent to them, or they refuse the interpretation of one scientific result or another by invoking scientific arguments which sometimes only hide religious convictions. Nothing illustrates this idea better than the often passionate debates that the theses of Darwinian evolutionism on the question of the origin of man provoke between supporters of the opinion according to which man's appearance is the result of a long evolution of the species, and those who believe that he was created by God and in his image. Obviously, it is rare to hear scholars who reject the first thesis say that they do so in the name of religion but it is instead arguments – scientific to their mind – with which they challenge it. We can also say, in the same vein, that the debate which during Galileo's time, pitting supporters in the scientific community of heliocentrism against those of geocentrism which was also the official doctrine of the Church, had a religious background which was not always obvious for supporters of this second idea.

Ideological and political unthoughts

Here we find here a perfect illustration in the distinction which was legal tender during the period of Stalin between "bourgeois science" and "proletarian science." This distinction resting on the postulate that the objectivity proclaimed by scholars and the presumed neutrality of science were only subterfuges aimed at masking the fact that all truth, even scientific, has a class character, and thus that truth in science was only a matter of the class wars. One of the consequences of this idea – which fortunately did not last long, but unfortunately had the time to create serious damage in the evolution of science in the ex-Soviet Union – was a delay in the development of genetics dedicated to genomics for having postulated the existence of the gene. The idea of a reality being able to escape from the principle of becoming was considered contrary to the ideological foundation of the state and, for this reason, deserving of the most severe sanction.

This example also shows how, in the name of a certain political or ideological conformity, the scientific community can end up defending theses which, in reality, have nothing to do with science.

It is also this ideological unthought that Lenin wanted to bring to light in his famous work entitled, *Materialism and Empiriocriticism.* All of Lenin's effort in this work was to show that the interpretation by a good part of "bourgeois" scholars

of the time, of the discovery of atomic energy as proof that "matter disappears" had, beyond a simple scientific debate, a hidden ideological meaning. It was, according to Lenin, a way for these scholars to refute the existence of matter, to undermine the foundation of materialism in the name of the idea that everything is in the end definitive energy, i.e. to show that only idealism is in accordance with science. For Lenin, it was thus no more and no less Marxist ideology and its political and social plan which was targeted in the end.[8]

Cultural unthoughts

The scholar is first and above all a man, i.e. a social being, member of a human community whose cultural values deeply impregnate existence. From this point of view, and no matter what effort he may make and what desire he may show to want to distance himself from the opinion and collective representations of his community, he cannot totally detach himself from it. This cultural context always acts in a particular way on him. This is even more true in the social sciences, where it is more obvious that the research subjects are culturally connoted, over-determined. If this cultural determination does not appear explicitly through the results themselves, it can be felt very clearly first through the interpretation of these results. We can more easily find an illustration of this idea in the social sciences where, a belief or an explanation rejected as false or absurd through a given cultural prism can have a completely rational basis when we understand it in light of the concrete cultural context which is particular to him.

The cultural determination of science can also be expressed through the very idea that we have of science. We know that Europe has lived for a long time with the idea that there can be no science other than western science, all knowledge being produced then often disdainfully disqualified as part of the murky universe of myths and superstitions peculiar to "prelogical mentality", thus prescientific, if not antiscientific. Thus in Africa, we are struggling today, through debates on the status of our "endogenous knowledge," for a "decolonization" of the concept of science which enables this knowledge to be recognized as automatically having a scientific status. However, there are a number of scholars, not only Western but even African, who, naively or deliberately, have transformed themselves into the apostles of a universalist conception of the idea of science which is only, in reality, the expression of a cultural prejudice which proceeds while being concealed. The supporters of this attitude do not even wonder how the people to whom they refuse this science could have been able to live through the ages if they had not been able to have sufficiently valid knowledge of their natural environment, their natural milieu to allow them to resolve the problems that it presented to them.

The reference to these unthoughts of science is not at all aimed at disqualifying the ambition of the scholar to produce knowledge which has chances of being rendered universal. It is to push science towards more humility and scholars to

more modesty and moderation in the way in which they understand and present the value of their activity. We must arm the scholar with the vigilance necessary in view of an idea which presents science as exempt from all forms of prejudice, whereas the mind of the researcher is always full of prejudice, but also to understand that the "reality" behind which he has the tendency to take shelter to defend his theories, far from being a "given," is quite often only a simple philosophical, political, ideological, religious or cultural construct. Besides, these considerations are of great importance for the epistemological status of the social sciences.

Some specific problems of the epistemology of social sciences

If we stick to the criteria of the scientific character that we have laid out above, the epistemological status of social sciences immediately creates a problem. The problematic character of this status can be basically found in three points which specify, as it were, social sciences.

a) The first concerns the nature of their subject which can be distinguished from that of the natural sciences in many respects. Indeed, the subject of these sciences is not at all identically reproducible, lends itself with difficulty to generalization, and cannot think of itself in isolation without being evaded, not to mention that it is constituted of everything which makes up the daily life of man, namely an always particular mode of insertion in reality, passions, beliefs, values, prejudices normally rejected as so many elements prejudicial to scientific objectivity.
b) The second concerns the relationship that the researcher in the social sciences maintains with his subject. Unlike the scholar in the natural sciences who can and should treat his subject as being foreign to him, and keep it at a distance which is the very condition of his objectivity, the scholar in social science is, as a social being, involved in his subject. He is, in other words, subject and object of his own research. Knowledge in social sciences is thus always imbued in one way or another with a certain subjectivity.
c) The third difference between the natural sciences and the social sciences lies in the objectivity of knowledge in the social sciences.

In going on these differences, among other things, we ended up refusing these sciences the claim of sufficient objectivity to be able to deserve to be considered as authentically scientific. Hence the need, before going further, to return to the concept of objectivity to denounce what we might call the objectivist illusion since, if we take a close look, it is in the name of such an illusion that people try to epistemologically disqualify the social sciences.

Objectivity of science and absolute neutrality of the scholar

In setting out the criteria of science as it is generally understood, we have stressed objectivity. This does not mean that the concept of science is questionable, but rather, the way in which this objectivity can be understood. Yet, from this point of view, what we have designated as an erroneous comprehension of science, namely scientism, includes a corollary just as prejudicial to science. This corollary is objectivism.

By objectivism, we mean the conception according to which science fully reproduces reality for us, such as it presents itself to us with no extraneous additions, to the point where our knowledge of this reality is nothing but the faithful and loyal expression of continuous and necessary relationships which exist between phenomena. This idea, linked to that of the absolute neutrality of the scholar, proves to be nothing but an illusion, a pure and simple myth. Popper writes,

> We cannot strip a man of science of his partiality without stripping him of his humanity as a result. Moreover, we cannot forbid or destroy his value judgments without destroying him both as man and as a man of science. Our motives and our purely scientific ideals, such as the ideal of the pure search for the truth, are deeply anchored in extra-scientific values, particularly religious ones. The "objective" man of science, "detached from all values," is not the ideal man of science. Nothing occurs without passion, even pure science. The expression "love of truth" is not a pure metaphor (Popper 1987:89).

But an even stronger reason to relativize scientific objectivity lies in the fact that science is a human work. As a man, the scholar has an existence limited in time and space. He is a finite and narrow-minded being. This is why no matter what his concern for fidelity and loyalty with respect to his subject, he can only understand reality and represent it from the perspective of this double limitation in time and space. Absolutely objective knowledge, thus capable of reproducing reality in all of its depth and complexity, is only possible if the scholar puts himself in the place of an omniscient and omnipotent God, capable of encompassing the infinity of the real, the infinity of relations which constitute it in a single look.

In other words, scientific knowledge can and should only be taken seriously when it breaks with the illusion of absolute objectivity; it knows and recognizes that it is only a simple window, opening out onto the immensity of the real, a simple "perspective" which, because of this immensity, should always and necessarily be further extended.

If absolute objectivity does not exist and if the absolute neutrality of the scholar does not exist either, if all knowledge necessarily bears the mark of human finitude, the objection of wanting to epistemologically disqualify the social sciences under the pretext that they are incapable of objectivity and absolute neutrality

becomes inadmissible. Because on the basis of the same objection, we could refuse this status to any science. Nonetheless, the social sciences bear a specific scientific character, to be understood here in the sense that they are capable of implementing a method, approaches and procedures enabling them to construct in their specific field a completely respectable objectivity, although different from that proposed by the natural sciences.

Epistemological impact of the complex relationship between the scholar and his subject

Another argument which has often been advanced to dispute the full-fledged scientific character of the social science is based on the nature of the relationship which exists in these sciences between the researcher and his field of research. The natural sciences imply and require a clear differentiation between the research subject, between the scholar and the field which he wants to render an account of scientifically. In the social sciences, the researcher is both subject and object of his research. He is "subject," i.e. researcher and thus required as such to respect conditions, principles, rules and theoretical and methodological imperatives of all good scientific research. He is, nonetheless, a man, and thus an integral part of his subject of research.

Obviously, his attitude with respect to the values of the society of which he is a member is not the same as that of common mortals insofar as the scholar would never be able to abandon the critical spirit and its application to his own beliefs and convictions without ceasing to be a scholar. But his beliefs and his convictions thus influence more or less, directly or indirectly, consciously or unconsciously, the choice of his themes and subjects of research or the interpretation of his results in his approach. It is this impossible total indifference of the scholar in the social sciences, the fact that he is always personally involved in his research and the fact that he cannot totally abandon questions of value, which are thought to corrupt, as it were, the nature of the scientific truth to which he might have access.

This view is based on two ideas which seem to be equally disputable. The first is that truth in the natural sciences does not contain any subjectivity. The second leads us to believe that the social sciences have no way of realizing the coefficient of subjectivity resulting from the involvement of the researcher and that they are as a result incapable of producing knowledge likely to achieve agreement.

The first idea, which seems to exclude any subjectivity in the natural sciences, proceeds from the error which reduces his total disengagement because the scholar is obligated to neutrality in these sciences.

It often happens, however, that two specialists in the natural sciences, trained in the same school, working in the same laboratory and on the same research program can have momentarily different interpretations of the same results. This

difference in interpretation can be explained by the fact that one is more intelligent, perspicacious or simply more attentive than the other in the explanation of results. It may even be a matter of questions of intellectual honesty, moral rigor, even "monetary" interests. These are definitely so many subjective aspects which a person who considers scientific work, not in the way it is meant to be conducted, but as it is really and concretely conducted, cannot deny. Moreover, scientific activity involves the handling of concepts, theories, methods and sometimes material instruments. The skill of the researcher in this handling plays an important role in the value of results. Yet, skillfulness is also a subjective element in that it can vary and always varies from one researcher to another. It suffices to say then, in a more realistic and objective way, that in the natural sciences as well, the subjectivity of the researcher comes into play even if it does not do so in such an obvious or significant way as in the social sciences. This does not mean that the social sciences have no means of containing this share of subjectivity in the limits imposed by their claim to results likely to bring about agreement.

Now we come to the discussion of the argument on which those who see the involvement of the researcher as a valid reason for disputing the scientific nature of his results rely.

Indeed, researchers in social sciences are not totally disarmed faced with the consequences of the inclusion of subjectivity in their research. The arms at their disposal to do this are not necessarily the same as those of the natural sciences. Recourse to archival sources and documents, which can be written, oral, or audiovisual and which should especially be authenticated or authentifiable, practices that can include field work (studies, questionnaire, focus group) in view of collecting reliable data, the cross-checking of these data, their interpretation and the discussion of this interpretation among peers, their critical analysis and acceptance, if necessary, of a repetition of the same process, the use, if needed, of procedures of quantification (formalization, statistical formulation, electronic processing) are so many ways which enable the social sciences today to provide the knowledge that they develop with a scientific value which is a prisoner neither of the arbitrariness of researcher, nor of caprice of his will, nor the vagaries of his competence, nor the relativity of his political, philosophical, religious, social and cultural convictions.

Besides, if society, and more specifically decision makers within society, trust and solicit more and more widely the social sciences, it can be explained in this way: Following the example of the natural sciences, they can provide knowledge allowing us to understand social phenomena; understand the share of necessity inherent in their emergence, their development and their disappearance; identify the objective tendencies which are expressed through this necessity; and, for all of these reasons, to act with a fairly acceptable effectiveness on man's social environment; enable him to monitor and direct it as best as he can, in accordance

with his interests and aspirations, the evolutions which are produced there or which are likely to be produced.

A third aspect, from which some believe they can draw arguments to contest the legitimacy of the claim of the social sciences to be full-fledged sciences concerns the "objectivity " of knowledge in these sciences. By objectivity, we mean permanent interaction, the reciprocal influence of the subject and his knowledge. Knowledge that the subject in the social sciences has, always has an influence on him and on the conduct of his research, influence which, in turn, acts on knowledge.

For the supporters of this viewpoint, by making knowledge unpredictable in the social sciences and by reducing, as a result, the margin of foreseeability possible on the basis of knowledge acquired in these sciences, this reflection holds that the social sciences are less reliable than the natural sciences which, on the contrary, are thought to guarantee a strict certainty. But the uncertainly of knowledge and, therefore, the share of indetermination that we must carefully handle in all decisions based on knowledge, is not the monopoly, as it were, of the social sciences. We know, for example, that one of the main tendencies which have fundamentally disrupted the pratice of physics and more particularly the concept of the scientific character is formed precisely by the appearance of indeterminist, probabilistic and relativist currents at the beginning of the 20th century.

Conclusion

The social sciences are sciences in their own right, but with a certain epistemological specificity. With respect to the question of whether they can legitimately claim to have the status of full-fledged sciences, we believe that we have begun to answer in reconsidering the concept of science itself and the criteria by which it is usually defined.

We have shown that the relevance of such criteria could only be accepted if they are relativized. The idea of a science capable of representing the reality of the world for us – with no additions or deletions – with complete objectivity is only a simple illusion. Once this is understood, the relative youth of the social sciences and the inevitably resulting consequences for their approaches and their methods stop being an unacceptable sin which would eternally condemn them to trial and error and uncertainty. In reality, this circumstance, which is a part of the history, but also the specificity of their subject, and of the role that the close relationship between the researcher and his field plays in these sciences, should be considered, but only to measure the not very important accomplishments by specialists of these disciplines in the development of the ways and means necessary to overcome these handicaps.

Currently, it is life itself which has decided the debate by the recognition which it has given to the utility of these sciences. Contemporary societies no longer need to be shown that the knowledge that the social sciences provide them on themselves

is useful and necessary, and sometimes even more so than in the natural sciences. Like these latter, the social sciences can make available to societies a knowledge which they can rely on to control their environment in an ever more intelligent way, find the perspectives of their evolution, and construct for themselves a future equal to the aspirations, expectations and priorities of men who live there.

Notes

1. We point out some useful works on epistemology to consult in the bibliography. But we would draw particular attention to the collective work written under the direction of Jean Piaget under the title *Logique et connaissance scientifique [Logic and Scientific Knowledge* (Encyclopédie de la Pléiade, Paris, Gallimard, 1967). Aside from an important contribution by Piaget himself on the nature and methods of epistemology, we can read here enlightening epistemological reflections from the pen of specialists of particular scientific disciplines. We can also read with interest the work of Jeanne Parain-Vial (Parain-Vial 1985).
2. We are dealing with what we could consider as a "normal scientificity", a concept that we have borrowed from François Russo (Russo 1983: 36-40).
3. On the comparison between political and scientific revolution in the work of Kuhn, see in particular pages 133-135, and on the concept of scientific revolution more particularly, see all of Chapter VIII entitled *Nature et nécessité des révolutions scientifiques [Nature and Necessity of Scientific Revolutions]*
4. On the subject of the critique of the inductive approach considered as pseudo-scientific, see: A. Virieux-Reymond (*op.cit*, pp.38-40; Carl G. Hempel, *Éléments d'épistémologie [Elements of Epistemology]*, Armand Colin, 1972, pp.15-19; W.M.O'Neil, *Faits et Théories [Facts and Theories]*, Armand Colin, 1972, pp.172-173, 278-279; Robert Blanché, *La logique et son histoire [Logic and Its History]*, Colin, 1970, pp.78-79. Karl Popper, *Logique de la découverte scientifique [System of Scientific Discovery],* Payot, Paris, 1973.
5. See on this subject, Claude Bernard, *Introduction à l'étude of la médecine expérimentale [Introduction to the Study of Experimental Medicine]*, Paris, Garnier Flammarion, 1966; see also G. Canguilhem, *La connaissance de la vie [Knowledge of Life]*, Paris, Vrin, 1965, pp.19-21.
6. It would be interesting to read pages 157 to 166 which are devoted to this concept.
7. The Circle of Vienne is a philosophical trend which started in Vienna, Austria at the beginning of the 1930s, with thinkers like R. Carnap, O. Neurath, M. Sclick, on the progress of the elimination of metaphysics. For more complete information on this school of thought, read, among others, P. Jacob, *L'empirisme logique [Logical Empiricism]*, Paris, Éditions de Minuit 1980 ; Jean F. Malherbe, *La philosophie de K. Popper et le positivisme logique [The Philosophy of K. Popper and Logical Positivism],* Paris, PUF, 1979, D. Lecourt, *L'ordre et les jeux le positivisme logique en question [Order and Games : Logical Positivism in Question],* Paris, Éditions Fasquelles, 1982.
8. On the ideological and political unthoughts of scientific work, read, among others, the collective work of Hilary Rose, Steven Rose, Jean- Marc Levy-Leblond et alii, published under the title *L'idéologie de/dans la science [Ideology of/in Science],* Paris, Seuil, 1977.

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