Jean Fourastié

ON THE AUTONOMY OF THE LIVING BEING

"What I wish to make clear . . . is . . . that from all we have learnt about the structure of living matter, we must be prepared to find it working in a manner that cannot be reduced to the ordinary laws of physics." Thus the founder of quantum mechanics, Erwin Schroedinger, expounds in a recent book "the obvious inability of present-day physics and chemistry to account for . . . events" which occur in a living organism.[1]

This record of bankruptcy is the great disappointment of our time. Until about 1925 our predecessors thought that, in instituting the physical sciences, they were forging the arms that would permit us, their descendants, to work out the human sciences; they thought that once inanimate matter had been explained, it would be possible, little by little and step by step, to explain first the simple animate elements, then the compound, and finally the most complex of living beings. They thought they were laying the first steps of a limitless staircase which successive generations would raise progressively, using the same methods, the same tools, the same concepts.

Translated by James H. Labadie.

1. Erwin Schroedinger, *What Is Life?* (New York, The Macmillan Company, 1945), p. 76 and p. 2.

Now, we in 1956 find ourselves not at the summit of a majestic pyramid, but rather wandering amid a swarm of disparate constructions, just about as irregular as New York City, where skyscrapers of 600 to 800 feet and higher are found side by side with three-story buildings. And in the panorama, it is the physical sciences that represent the skyscrapers. Far from resting on the sturdy platform furnished by the physical sciences, as had been predicted, the social sciences remain miserably at ground level and form the slums.

The present situation of science, then, is disappointing first of all in the opinion of those whose minds hunger for syntheses and deplore the absence of a unity of knowledge. These are not mere cerebral or esthetic preoccupations, as some readers might believe, for this *disparateness* of modern science engenders a profound demoralization of spirit in the world today. Since, in seeking to explain the universe and his own presence on earth, he finds no simple directive, but rather a proliferation of partial ideas which he cannot in general understand with exactitude, each living being is likely to create for himself a personal philosophy, insufficient and erroneous as may well be imagined, and strongly influenced by the immediate preoccupations of his own social class, his own national or racial group. These incomplete and incorrect, but tenacious, philosophies are responsible for the anxieties and the opposing claims that we see endlessly degenerating into anarchies within nations, and into international tensions. Is not the failure of science to fulfill its pacifying and edifying role as rapidly as our ancestors hoped due to its fragmentary and contradictory aspect? Every opinion finds arguments in the arsenal of science. Each of our skyscrapers is individually exciting, but together they are confusing, like a city without a plan.

We shall not consider here the sociological results of current scientific anarchy, serious as they may be, but rather its purely methodological consequences which are also of great importance. For if we are unable to construct the human sciences on what we acquire from the social sciences, our efforts do not add to those of our ancestors but are rather independent of or even contradictory to them. Instead of placing our constructions atop the buildings they have raised, we find ourselves obliged to lay our own foundations; far from building to noble heights, we are here mired in clay or malodorous marshes, seeking tools, materials, and a new base of operations, which are hard to find in endlessly moving soil. And during this time, our colleagues in the physical sciences continue to erect their arrogant skyscrapers from which the human element is excluded, so that those of us who have tried and are still trying to take them as a basis for the human

sciences have reached an impasse. As a result, we have lost instead of gained time through the classical sciences.

Thus science, that great hope of humanity, runs the risk of becoming divorced from the human: "The current scientific revolution appears to us to relegate the human species to an infinitesimal space on one tiny point lost in immensity."[2] "What value can man ascribe to his science if he cannot use it to understand his own history?"[3]

And the man in the street asks what good is a science which can predict fifty years ahead of time and within 1/100 of a second the next eclipse of the fourth satellite of Jupiter but which cannot compute the probability of a riot in the square of the Prefecture at Nantes the night before the riot takes place.

Under the circumstances, must we forego the application of scientific method to the human sciences? Can the words "human" and "science" properly be used together at all?

Many of our contemporaries, at least in the Latin and Oriental countries, consider as definitive the inapplicability of the sciences to human affairs. They think that in reality scientific method is effective only in the realm of inanimate matter, and that elsewhere only the ancient systems of knowledge are applicable: humanism, ethics, religion, intuition. We have summarized elsewhere[4] the reasons which justify a different opinion: if scientific knowledge is not all of human knowledge, if it now leaves and will always leave room for ethics and religion, it does at least extend to the entire domain of the observable universe. And man is an observable phenomenon.

Our problem is then to show how to fill the moat separating science from humanism, how to reconcile the predetermined and therefore predictable order of the physical sciences with the unpredictable disorders which social life usually presents; to show, in a word, how the scientific method can serve our understanding of daily life.

This is an immense task—the problem of our generation. We have not the intention in this article of resolving it, or even of attempting to delimit it. The problem implies both a change in the classical sciences, which is

2. *Diogène* (French edition), No. 11, p. 4 of cover.

3. Pierre Vendryès, *De la probabilité en histoire. L'exemple de l'expédition d'Egypte* (Paris, Albin Michel, 1952), p. 9.

4. J. Fourastié, *Note sur la philosophie des sciences* (Paris, Presses Universitaires de France, 1948).

only beginning to take place, and a substantial improvement in our knowledge of "man the unknown." But we should like here to call the reader's attention to two books which are, in our opinion, steps in the direction of progress.

Written by two men completely different from each other and making no reference whatever to one another, these two works are nonetheless situated precisely in the scheme we have just traced: both proceed from a deliberate intention to extend scientific method to include knowledge of man; both postulate that this extension implies a profound modification in the classical conception of science: the entry of the human into the scientific domain will explode our current notions both of determinism and of life.

The earlier of these two works is *Vie et Probabilité* by Pierre Vendryès, published in France in 1942.[5] The date, place of publication, and the youth of the author served to deprive the work of wide circulation, at least on the international level; on the national level, it excited both curiosity and esteem, though the scientific and philosophical implications of the book seem not to have been understood. The second work, *L'Homme microscopique* of Pierre Auger, dates from 1952;[6] the world-wide fame of the author guaranteed it an immediate wide circulation, but the first commentaries published are far from having exhausted the subject.

Our plan here is to discuss these two works in order to show in what sense they may be used with profit in the realm of the economic and social sciences, either to explain already known facts more satisfactorily than is being done today, or for the orientation of fruitful research. To do this, we will first give a brief exposition of the authors' ideas, or, more precisely, a résumé of those ideas which relate to our subject and are required for an understanding of the commentary to follow.

Vie et Probabilité—The book is an essay on theoretical physiology. "The initial idea was this: the comparison of biological and physical facts enables us to attribute to the ensemble of the animal kingdom a property: animals have their own movement. . . . But the movement of an animal is a physiological act. Now, the principle of Claude Bernard states: a biological fact takes place only when all *conditions* of its fulfillment exist at once. Then each autokinetic animal must have its own conditions of movement."[7]

5. Pierre Vendryès, *Vie et Probabilité* (Paris, Albin Michel, 1942).

6. Pierre Auger, *L'Homme microscopique* (Paris, Flammarion, 1952).

7. Vendryès, *Vie et Probabilité*, p. 20. In the author's terminology, "autokinetic" thus means "having its own movement."

The very fact that living beings are autokinetic means that they are autonomous and independent of external environment. Now, relations between two independent phenomena are random (in the sense which this word has in the calculus of probabilities).

As a matter of fact, in Chapter VII Pierre Vendryès extends the theory of the calculus of probabilities to include isolated events. He demonstrates not only that randomness is objective but that it is caused by the independence of phenomena. Thus the relations between a living being and the external environment are not fixed but random.

A good example of the independence of the living being in relation to external environment is furnished by the physicochemical stability of human blood: despite discontinuous and variable feeding, despite variable external conditions of temperature, air pressure, physical effort, etc., arterial human blood remains constant. In particular, the glucose content remains within 0.2% of 1%, regardless of the sugar intake (pp. 30 ff.).

Thus the regulatory functions result in the creation of a fixed internal environment out of variable external conditions. The effect of these functions is counter-random: their intensity is therefore necessarily random (p. 21).[8]

Thus living beings may be classified in the order of increasing biological autonomy; this is a measurable and objective scale of the hierarchies of organic life (p. 116). From it may likewise be deduced the limits to the independence of the living creature, the freedom of its forms, etc. (p. 281).

Regulations in the nervous system are counter-random just as are the physiological regulations (p. 322). The life of the mind is a succession of discontinuous and independent states (p. 362); therefore it too is random (p. 365). The ethical rule is counter-random (p. 369).

"Free will is . . . a physiological acquisition. Physiological autonomy is a conquest of the animal over the external environment: out of this environment it creates its own physiological conditions. A man's consciousness of his natural autonomy: this is free will."[9]

The essence of Pierre Vendryès' thought, then, is that determinist science

8. A variable is random when its values depend on chance: the mathematical theory of random variables is designated by the name "Calculus of Probabilities."

Vendryès applies the name "counter-random function" to a function which is contrary to chance. A counter-random effect thus tends to make non-random a variable which, without that effect, would be random.

To have counter-random effects, a function must necessarily have a random intensity, since this intensity must at every instant counterbalance chance.

9. Vendryès, *Vie et Probabilité*, p. 352.

and determinist modes of thought are not suitable for the study of the living being. On the other hand, the calculus of probabilities and the probabilistic mode of reasoning are eminently suited to it because they are suited to the study of relations among all independent phenomena. Probabilistic calculus and reasoning thus permit a better understanding of what is already known about the living being and, at the same time, a considerable knowledge in regard to what has not yet been known.

This applies at once to relations between the living being and its external physical environment, to such internal functions as nutrition, to the formation of ideas and to the relations between one living being and another. Pierre Vendryès has applied the consequences of this thought to intellectual life on the one hand, and to history on the other, in his two subsequent books: *L'Acquisition de la Science* and *De la Probabilité en Histoire*.[10]

L'Homme microscopique—We have seen that the ideas of Pierre Vendryès attempt to place a high value on the probabilistic branch of mathematics and to make it both the measuring instrument and the reasoning method of biology. Pierre Auger also deals with biology, but he seeks the support of chemistry.

The starting point of his thought may be summed up as follows: the physical laws of the "classical," which is to say macrophysical world, are profoundly different from those of the atomic or microphysical world. Now, "the living being strays from the classical world to which its scale of dimension seemed necessarily to attach it, and approaches the microphysical world" (p. 24). "The living being causes ensembles of matter such as would normally follow classical laws to follow laws of the mitrophysical type. . . . The living being is thus seen as an amplifying device which encourages that which is fundamentally irresolute in the direction of liberty" (p. 27).

Hence the hypothesis[11] that the essential part of the living being is of the microphysical order and that the rest, that is the "material ensembles" on the macrophysical scale, are merely tools in the service of the living creature.

The living being would thus seem to be an ensemble of matter, char-

10. If the first of these books seems to have disappointed no reader, the second, even in the opinion of men favorable to the author's ideas, opens but a skeptical and therefore sterile conception of history. It may be that Pierre Vendryès will reconsider this part of his work. In any case, this last book is cited here only in a few points of detail.

11. Pierre Auger presents his entire thought as a hypothesis of rational character; the subtitle "Essai de Monadologie" further underscores the abstract atmosphere of the book.

acterized by the coexistence of the *micro* and the *macro*, of the living and the inanimate. But in the total picture, only the *micro* commands and acts, while evidently only the *macro* constitutes the apparent, that is, the body visible to the naked eye. We must thus apply ourselves to microphysical realities in order to understand life; these realities are atoms and molecules. Even cells belong to the macrophysical.

The atom is the essential factor of life; if not eternal, it lasts at any rate for a very long time. It is not used up; only the macrostructures are worn out and dispersed. Atoms can, under certain conditions, unite to form molecules, certain of which through autocatalysis tend to form identical or analogous molecules.[12] A theory of reproduction and of the evolution of species is sketched out. The apparent finality of the living being and of the evolution of species is thus changed to a period of waiting on the part of stable molecules and to the utilization of possibilities.[13]

The life of the mind is also explained by the microphysical structure of the living organism. Ideas are carried by complex molecules such as are beginning to be studied by organic chemistry. An idea, a bit of knowledge, an emotion, are fixed gatherings of molecules of definite structure. The stability of these molecules is merely relative, certain ones are constantly being formed and de-formed, but their repetition gives them stability; the most vigorous ones have an evocative power. This hypothesis will be useful to us for the study of means of information in modern society, the aptitude of populations to receive new ideas, and the ability to absorb technical progress. Likewise, Pierre Auger's reflections on the fixed states of the atom (p. 13) and on the "duration of the present" for the living being (p. 61) will aid us to understand better the mental phenomena which dominate all problems properly called social.

Other economic and social implications of the hypothesis are numerous. Since our scope must be limited, we close by calling attention only to the distinction which Pierre Auger draws (pp. 179 ff.) between *tools* and *machines*. Tools, resulting from a technical selection, are agents of contact between man and the events of the exterior world. Machines, products of

12. Pierre Auger's thought may be supported here by that of Erwin Schroedinger who sees in "the aperiodic crystal forming the hereditary substance" the point of resemblance "between a clockwork and an organism." (*What Is Life?* p. 85.)

13. Stimulating as these views may be, we will not explore them further here, since the present article is limited to the economic and social sciences. Therefore we shall be content to enumerate those aspects of Pierre Auger's hypothesis that concern our field. The reader need remember only that Pierre Auger's thought, like that of Pierre Vendryès, covers a considerably wider field than appears here.

an intellectual activity of scientific character, are "catalyzing" agents, which redirect the natural course of things by proposing to them another evolution, possible although less probable.

We must remind the reader, for a misunderstanding on this point would be serious, that it is not our aim in the present article to comment upon the ideas of Pierre Auger and Pierre Vendryès from the biological point of view (which is, however, their chosen field) nor from the mathematical and physicochemical (two points of view constantly taken by the authors) nor even, except incidentally, from the point of view of philosophy (though both are essentially philosophical works). Our attention will be confined to that part of the authors' thought which seems useful for the economic and social sciences.

Our comments will be divided into three groups, those which apply equally well to both works, then those more directly applicable to the work of each author.

GENERAL COMMENTS

1. An understanding of man is important in all branches of the human sciences; Pierre Vendryès and Pierre Auger suggest some basic considerations in this area, bringing to the questions "What is life? What is man?" answers which are obviously partial, though stimulating and constructive, and doubtless contributing to a better understanding of what we already know and to the more effective discovery of what we don't yet know.

Auger and Vendryès suggest to us two important aspects of the living being, the first having to do with its internal structure: it is essentially microphysical; the second concerns its relations with the exterior: these are not predetermined but random. But these two characteristics, discovered independently, are doubtless neither contradictory nor even independent: the conservation of microphysical molecules, essential substructure of the human being, must imply and produce stability of the internal environment, since the external environment itself is variable. Or again: the existence and conservation of basic microphysical molecules results in the autokinesis and the autonomy of the living being; and this autonomy in turn results in the probabilistic character of the living being's relations with the external world, and notably the counter-random character of the functions of nutrition and relations among living beings. The conservation and the autokinesis of basic microphysical molecules thus has as conse-

quence and as condition for existence the autonomy and the autokinesis of the physical body of the total living being (macrophysical); and this autonomy of the macrophysical being implies random relations with all the other bodies which are independent of it.

The following definition is thus possible: the living being is, from the point of view of experimental science, an element of the observable world which possesses the three following characteristics: it is basically constituted by autonomous molecules; it is autonomous; it has random relationships with the external environment.

If the being in question belongs to the animal kingdom, it must be added that autonomy is accompanied by autokineses. For man it should be added that certain of these basic molecules are likely to assume forms which conserve and engender ideas, that is, incomplete acts limited to the microphysical, but communicable from one man to another by specialized signals.[14]

As a researcher in the social sciences, we are inclined to extract from this definition of man the three following characteristics: macrophysical man is directed by microphysical mechanisms; from his basic microphysical structure he derives the *autonomy* and the *autokinesis* of his body and of his thought; from this autonomy results the random character of his relations with the external environment.

Each of these three characteristics, the last two stemming from the first, implies a multitude of important consequences for the interpretation of economic and social facts already known and for research into those which are as yet unknown. Notably from the point of view of descriptive and explicative types of reasoning, we must guard against (under pain of sterility and error) the application to one category of facts those modes of thoughts, the intellectual tools, suited only to another category: the reasoning, the measures, and the calculations of the microphysical and of organic chemistry are the only ones suitable for the study of the structures of acts properly called living; the reasoning, the schemas, and the calculations of classical determinism are suitable for the machines and tools which constitute the macrophysics of the internal environment; the reasoning, the schemas, and the calculations of probability are suitable for the study of relations between the living organism and the external environment and especially for relations among living organisms.

14. This will be comprehensible only to those who have read Pierre Auger and especially the chapter "Homo Sapiens." We shall speak of it here only incidentally. Besides, unless we are mistaken, Auger does not write that ideas are "incomplete acts"; the hypothesis is ours.

2. This schema requires a revision of our ideas on the nature and the method of scientific reasoning. Our two authors are content on this point with a criticism of current thought which we find insufficient: they call for the introduction into the classical scientific arsenal of only those instruments whose necessity they themselves have felt (probability for Vendryès, microphysics and organic chemistry for Auger). Scientific method, for us, is multiple. At least in the present state of things, we must renounce unity of method and it is not even useful to try to reduce to unity diverse methods which should instead be arrived at spontaneously and empirically.

Scientific reasoning needs to have at its disposal, progressively, a great variety of modalities, of which classical determinist reasoning forms but one of the poles.

As a matter of fact, classical determinist reasoning[15] is applicable to only a fraction of the sensible world, that of connected ensembles—a well-known type being the solid macrophysical body. By systematically confusing science and determinism, our ancestors committed an excusable, though grave, error. By according an enormously preponderant place to classical mathematics in our scientific schools, we are continuing (and unfortunately, through inertia, will continue for a long time) to open for our children only one of the roads to scientific knowledge and (which is more serious) to close others to them. For many of them will pass their active lives applying these modes of thought to fields of the sensible world for which they are not designed, like trained carpenters trying to use their saws and planes in a steel mill. And these efforts, pointing up as they do the resistance which enormous areas of the real world offer to science, are not merely sterile, but positively harmful; they gradually spread the idea that the scientific spirit itself is powerless in these areas, while in reality only the determinist mode of scientific method is ineffective.

The second pole of the modes of scientific reasoning, already classical, is treated as a very poor relation in the schools;[16] this is the calculus of prob-

15. It should be quite clear to every reader, whatever his national and educational background may be, that I mean by this the type of reasoning of classical mathematics, such as is employed in classical geometry, differential and integral calculus, rational mechanics, macrophysics, etc. May I point out that Pierre Vendryès uses on this point a different terminology, which I find ambiguous, which has certainly been prejudicial to a wider diffusion of his thought, and which may trouble the reader: he calls "rational" that which I here call "determinist." Thus Vendryès mistakenly restricts the meaning of the word "rational," since in present-day language the calculus of probabilities is no less "rational" than Euclidean geometry. To me as to the average Frenchman the word *rationnel*, like the word *raisonnement*, is applicable to every process of thought that is capable of serving as a support for knowledge.

16. In France, for example, the calculus of probabilities figures neither in the programs of elementary mathematics nor in those of specialized mathematics. A twenty-year-old student

abilities. It is applicable, however, to a very large part of the sensible world, not only that of experimental statistical probabilities, already a considerable field, but also, as Pierre Vendryès has mentioned, to relations among all independent phenomena, even those considered in small numbers. For example, while one of the chosen fields of determinist mathematics is the solid state of bodies, one of the chosen fields of probabilistic reasoning is the gaseous state.

But between the gaseous and the solid states we know that there are others, notably the liquid state, and the indefinite range of viscous states. Thus determinist reasoning and probabilistic reasoning are but the two poles of one variety (among a surely indefinite number) of modes of measure and of calculi, of descriptive and explicative modalities. For the phenomena of the sensible world are not all either connected or independent. In fact, they are generally neither connected nor independent, in the sense that they are neither entirely connected nor entirely independent. They are in an intermediate state which we will call "conditional"; this state varies from the nearly connected to the nearly independent; the unprecise range of states such as pasty, viscous, elastic, etc., indicate to us their physical representations. It is in this immense field, which includes almost all the facts of interest to the average man, those with which he is in daily contact and which provide him both enjoyment and pain, that the failure of science is today patent. And the deficiency of science in this great domain threatens to isolate it from the human sphere. But this, as we are here maintaining, is not really a question of a deficiency of science but only of a deficiency in its determinist modality.

3. It is true that identifying the cause of weakness does not suffice to eliminate it. We are beginning to know what sorts of reasoning must no longer be employed, but we don't yet know which ones should be used. We are at least prepared, however, to begin the search; and experience shows that when man begins to search, he finds. The difficulty lies not in finding the answer but in asking the fruitful question.

We know now that it will be necessary to use a great number of modalities. Numerous different tools will be needed to work this large domain, but several of them are already available. First, those which Pierre Auger and Pierre Vendryès have already found: the former by turning to the images and to the intellectual atmosphere of physical microchemistry and

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can have attended 1,000 hours of mathematics courses without having heard probability mentioned.

transposing them into biology; and it is our intention here to propose a new transfer from biology to the social sciences. Likewise, there already exist sciences and partial sciences which give us examples of modes of thought profoundly different from both determinism and probability: the the quantum mechanics of Schroedinger, the wave mechanics of Broglie, etc.

Pierre Vendryès, in the first phase of his thought (1941), recognized only probability along with determinism; beginning with *Vie et Probabilité*, however, he attempts to add the quasi-random to the random: he states that certain behaviors which are not absolutely independent give rise to *Brownoid* movements, similar to the (purely random) Brownian movement: thus the movement of a fly is *Brownoid*.[17] At the present time he avowedly leaves room for what I might call "conditionism,"[18] and makes much more use of the quasi-probabilistic method than that of pure probability.[19]

So among the tools useful for deciphering the immense "conditional" sector obviously figure quasi-determinism and quasi-probability, as well as modes of thought already created in the various natural sciences and modes of thought close to them. But my feeling is that it is necessary to use every means at our disposal when the darkness is so complete, and I should not hesitate to suggest even so discredited an instrument as finalism, provided that it be used to stimulate thought instead of to deaden it, as was generally the case in the past.

Therefore we shall cite in conclusion only two other "systems of knowledge" which appear to me particularly useful in the economic and social sciences: *The Theory of Games* of von Neumann and Morgenstern, and typology with fragmentation in time and space which I have employed in several of my works and whose principle I explained in the pages of this publication.[20] We wish only to add that many articles published in *Diogenes* may suggest to the person doing research in one discipline the use of a reasoning used in another, in the interests of freeing ourselves from determinist classicism.

4. We wish to make clear that in no way do we believe that these different modes of action (which should be employed by man to understand

17. Vendryès, *Vie et Probabilité*, p. 333.

18. Cf. Vendryès, *De la Probabilité en Histoire*, p. 297.

19. As, for example, in the interpretation of the experiment on tadpoles, *De la Probabilité en Histoire*, pp. 278 ff.

20. J. Fourastié, "Predicting Economic Changes in Our Time," *Diogenes*, No. 5.

the different phenomena of nature) correspond objectively to different categories of the real. We believe much more strongly that they are subjective, relative to the infirmity of our mind and especially, as indeed has been said, to its "unicity" as opposed to the complex multiplicity of the universe. (This is to say that a single clear thought is at our disposition at any given instant, to understand a world which, at that same instant, presents an indefinite number of observable realities.)

A single phenomenon is predetermined, random, or conditional according to the point of view from which it is observed, that is, according the scale, the aim, and the duration of the observation. Hence the existence of the "law of large numbers." Example, Pierre Vendryès' taxi driver:[21] if he is observed for several days the graph will soon show the location of his garage, where he takes his meals, then the railroad stations, theaters, etc. Preponderance overtakes randomness, then determinism overtakes preponderance.

Thus determinism would seem to be a property of the observation as well as a property of the observed phenomenon. It would be the establishment by the observer of the invariability, the identity of a connected ensemble. It can be deduced that as long as this ensemble exists it will keep the same properties; but this is the same as saying that if it loses one of its properties, even without the disappearance of the others, it becomes another phenomenon. So determinism is linked to existence. Either copper does exists, in which case it has the "properties" we know, or else it does not exist.

Where no determinism is found is among existing things, which are not stable according to our scale of duration. But one can always find a duration sufficiently small to establish whether a phenomenon is constant or determined (my motionless hand or by hand writing the word "word").

Inversely, there are always one or several "scales" of observation where anterior determinism vanishes, that is, where the linked phenomenon disappears. Now in social material one is forced to pass endlessly from one scale to another and from one duration to another (see par. 9 below).

ON THE IDEAS OF PIERRE VENDRYÈS

5. Pierre Vendryès' theory provides a rational setting for statistics in general, and for demographic, economic, and social statistics in particular.

21. Communication to the Statistical Society of Paris: *Bulletin de la Société de Statistique de Paris*, October, 1954.

It takes into account that all economico-social statistics are susceptible to two types of experimental error: the first subjective, stemming from informational errors of the statistician; the second objective, stemming from perceptible variations in the phenomenon being measured.

The existence of the first type of error is fully recognized, but we believe that its nature has still to be properly understood and that we are still incapable of correctly calculating its full extent: the theory of probability should make this calculation possible.

The second has, practically speaking, no place in current statistical practice; its examination should lead to evaluation of the differences between successive intensities of a phenomenon within a given period of time and the value taken by the statistics at a given moment of that period.

The probabilistic theory of economico-social statistics should permit us first of all to grasp the exact meaning of a statistical number obtained by the current method, in relation to reality, then to improve the statistical representation of that reality: this reality is not a number, but a family of numbers obeying Gauss's law; schematically, current statistics provide us with but one of the numbers of this family, without even telling us the place of the number in the famiiy. The end in view is to give us the essential elements of Gauss's curve, which is in fact the only real representation of the phenomenon. (The fact that Gauss's curve is effectively representative we learn from Vendryès' theory: if the statistical events are rigorously independent, the curve is rigorously Gaussian; if not, we should call it "Gaussoid.") From this point of view recent developments in the method of sounding can be considered as both a verification and an application of Vendryès' theories.

6. The autonomous character of the human being accounts for a large number of demographic, sociological, and economic facts, from the risks borne by the individual (actuarial) to stock market speculation.

I can only indicate some of these here, by way of examples.

7. The aim of economic activity is the satisfaction of man's needs. It is therefore important to observe the connections existing between the needs and consumption of each individual, national consumption and national production.

Now, Vendryès tells us that individual food needs are random about a mean: for man can and in fact does satisfy the constant requirements of his internal environment by variable intakes of food. But these deviations from the mean obey Gauss's law. This fact is of considerable importance for studies of consumption and forecasts of food consumption. We are today convinced that the theory can be generalized from food consumption to

other consumptions: all human needs originate in autonomy and autokinesis; they all have a counter-random character in relation to the external environment, with a tendency toward increasing internal autonomy.

A link is thus established between the biological and the economic aspect of man.

8. But from the economic point of view man is producer as well as consumer. His motives in these two roles are very different: the motives of the consumer are related to his person; they are, as we have just seen, to increase his individual physical and intellectual autonomy; the motives of the producer, on the other hand, are connected with the company and are to increase its power, security, profits, and production. From these motives, practically independent on a short-term basis, result tendencies toward independence, always short-term, in the production and consumption volumes of a single given product. Now, market balance requires long-term equality of the two volumes, or there is danger of a slump.

The struggle against economic crises should thus be constituted by an ensemble of counter-random processes, the main one being an orientation of the active population with the aim of reconciling the two phenomena—production and consumption—which have a natural tendency toward short-term random divergence in a system based on individual liberty.[22]

This natural tendency toward discordance between production and consumption can be considered as a consequence of the independence of producers in their relation to consumers in a free economy where each group lacks information about the other (as was clearly the case before 1930).

9. Many of the fundamental notions of classical economic science, notably the marginalist and Keynesian ideas, appear to me susceptible of a probabilistic interpretation which would at the same time enrich them and make them more coherent with each other than they now are.

The micro-economic theories especially ought to take on a probabilistic character; and consequently their relations with macro-economic theories should also present a probabilistic aspect. For want of this both become dogmatic and deviate from the real.

ON THE THOUGHT OF PIERRE AUGER

We have commented on the thought of Pierre Vendryès in a clearly economic sense; reading Pierre Auger brings sociological applications particularly to mind.

22. Cf. Jean Fourastié, *Le Grand Espoir du XX^e Siècle* (Paris, Presses Universitaires de France, 1949), Chapters II and VI.

10. The special difficulty of the human sciences in contrast to the physical sciences arises from the ease with which man ought to change and in fact does change in scale. In the human sciences, the macrophysical scale demands attention concurrently with the microphysical and the words "macro" and "micro" are here but extreme images evoking a great number of intermediate scales.

For example, in economics one naturally and necessarily considers, in regard to the consumption of mechanical energy, the total consumption of a nation: consumption by industry, by region, by factory, by shop, by dwelling unit, by individual, by hour, by day, by year, by decade, etc. Likewise, in medicine, an epidemic, a patient, a diseased organ, a part of that organ, an ensemble of cells, a single cell and so on.

In the physical sciences, on the other hand, it is easy to standardize the scales; the macrophysical world presents itself isolated from the others, and enormous intellectual efforts were required to discover the microphysical world. This is related to the stability of the time (in the classical physical sciences) and to its heterogeneity (in the human sciences). But this complexity in the domain of the human sciences stems basically from the fact that in his relations with inanimate matter man is macrophysical, while as a living person he is macro and micro at the same time, being a connected organization of microphysical molecules and macrophysical tools. The inanimate object corresponding to the living being is not his weight in copper, but an atom of copper. But man's senses perceive only the block of copper and not the atom, while they easily perceive the city and the individual at the same time.

But, as we now know, the modes of calculi and the types of evolution differ according to the scales; the man of science should therefore change intellectual tools when he passes from macro-phenomena to micro-phenomena, and from phenomena of evolution which are rapid in time to phenomena of slow evolution.

11. A theory of the aging of thought can be grafted to the theories of Auger. The child has rapidly proliferating cells; he can learn ideas or retain the memory of facts which are unrelated (as, for example, in language), simply by the "impression" of new atoms. Later, everything happens as though once the cerebral molecules have been formed, the new thought can be channeled only along ways previously traced.

Old age, finally, is characterized by a stability, a biological rigidity, which closes the mind to every new idea and even to every new combination of ideas previously received.

12. The well-known differences and oppositions which often separate rational from empirical minds rise from the method of classification which the cells of our brain have adopted from early childhood. In the brain of the former, connections are based on the rational. In the latter, they are based on sensation. The former place at the center the most "general" idea, whose *consequences* are most numerous; the latter place at the center the most useful idea, the one whose *applications*, whose sensory verifications, are most numerous.

This is connected with the fact that the second have learned and do learn all that they know just as the two-year-old learns to speak (from the fact that his parents speak); whereas the first acquire their learning by procedures analogous to those which consist of learning a language not by using it, but through grammar.

13. Pierre Auger has defined the notion of *duration of the present*. This notion dominates the problem of information, which takes on considerable importance in social life, for example (one among a hundred), in the promotion of underdeveloped countries.

The problem of the duration of the present seems to me divisible in two: (*a*) the problem of the duration necessary to perceive the sensation as such; (*b*) the problem of the duration necessary to perceive the sensation as an idea.

The first problem is linked to that of the persistence of sensation, which has become classical for luminous impressions since the invention of the motion picture. But it merits study as a choice (voluntary) of the living being between the state of light and the state of darkness.

There is a minimum duration necessary for becoming aware of a fixed view, then for finding it irksome. These durations both depend at the same time upon the personality of the viewer and upon the complexity of the visible scene.

If two scenes are presented alternately, the mind generally chooses one of the scenes rather than the other. For example: seeing a village through a train whose cars, passing in the opposite direction to ours, intermittently break our view: to see the village nevertheless; to see only the train; or to see (think) the train and the village at the same time; and even to see in addition or exclusively another part of the landscape, situated on the opposite side of the tracks from the village, reflected in the window of our train during the moments when the village is hidden by the other train. Such experiments could easily be made with movie films mixing two different scenes.

Thus one thought tends to drive out another. If I am not thinking a powerful thought, I am more receptive to thoughts dictated by sensations. But if I am thinking a coherent, strong thought, it will retard or even cancel the perception of different or contradictory realities. For example, if I am used to seeing the constellations of the Big Dipper and the Little Dipper, I will quickly see the standard lines, but it will take time for me to see other lines, other designs, formed by those same stars.

Thus, the previous idea acts upon the nature and upon the delay of the sensation; it acts also upon the choice of the sensation and upon its duration. It acts as a welcome, but also as an obstacle; it is a vehicle, but also a suppression. The new thought may move among others, as in a path cut along a slope; it may also seek in vain for a way, and find none.

The difficulty of implanting new ideas must evidently be compared to that of constituting new chemical molecules with the aid of atoms already used before. From the sociological point of view, it requires the identification of successive chains of ideas necessary to implant an idea B in a brain which already possesses a similar idea A, these chains of ideas being comparable to the chains of reactions employed in organic chemistry to obtain a molecule starting with another and different molecule (synthetic processes).

These families of thoughts, corresponding to families of molecules engendered by tradition in the brains of each man, explain the existence and the active power of mentalities, whose influence appears more and more noticeable in economic and social life.[23]

CONCLUSION

These are some of the teachings that sociologists and economists can draw from the essentially biological works of Pierre Auger and Pierre Vendryès. In stressing the microphysical, autonomous, and random characteristics of the living organism, they provide us with points of departure for many explicatory attempts and many research hypotheses.

We should like to state now that our belief, fortified by experience, in the fecundity of these notions does not imply that we concur in all the developments made by the authors. In particular, as we have implied above and here reiterate, we do not believe that living beings (and men still less)

23. Cf. especially André Varagnac, *Civilisation traditionelle et genre de vie* (Paris, Albin Michel, 1948), which shows in a striking way how heavily the most ancient traditions still weigh upon social life, even in a relatively advanced country like France.

are often found among themselves and in the external environment in conditions of complete independence; instead of saying as Vendryès did, at least in his first book, "living beings are autonomous therefore independent," we would say "living beings may be placed in conditions in which they behave as if they were independent." Likewise, we still take the propositions of each of these authors for what they are, namely, hypotheses. If we have often employed the affirmative in the foregoing, it is because the conditional mood tends to destroy confidence in the very fecundity of the hypothesis and to push the new ideas into cloudy areas of the mind, whereas we would like to introduce them into the very heart of the reader's thought. Finally, we cannot approve the "materialist" bias apparent in several passages of *L'Homme microscopique;* we find it "gratuitous," that is, useless, unfounded and, in a word, unpleasant to a reader who believes in God. But criticism does not consist in exhibiting to human thought that which is useless, or already known: for this we should have to analyze thousands of books and not just the two which we have considered; and even the greatest books, such as those of Pascal, of Descartes, of Newton, are rich in errors, yet are still great books.

Therefore only the great innovating ideas of the two authors have held our attention here, and especially insofar as they are capable of generating action in the man of science. This is why questions of method interested us above all. What appears important to us is to provide those in research with the tools necessary for developing the immense domains open to the human sciences and left untouched so far for want of adequate methods.

But philosophers also face the necessary task of introducing these new modes of thought into the traditional setting. Their stake is not merely to endow future generations with the intellectual tools necessary for the understanding of an indefinitely complex world; it is also, by broadening this knowledge, to reconcile classical scientific thought with humanist thought, with the empirical thought of the average man, and with the classical thoughts of the Orient. Without laying down any of our arms, we must acquire others and thus arrive at an intellectual synthesis, or at least at a descriptive and explicative inventory of the modes of thought, which humanity sadly lacks today.