THE LONERGANIAN REVOLUTION IN THE UNDERSTANDING OF SCIENTIFIC RESEARCH

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Abstract

In his *Insight. An essay on human knowledge* (1957), chapters 2 to 5, Bernard Lonergan draws a rational reconstruction of science and summarizes its precepts of research, as well. The author demonstrates how scientific insights can be one of the possible responses to the universal human desire of knowledge. By revolutionizing the understanding of scientific research, the author changes from an object-oriented methodical perspective to a subject-oriented heuristic one that requires the scientist to be attentive, intelligent, rational, responsible and passionate for his, or her, research if he, or she, wants to be objective.

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1. SCIENTIFIC HEURISTICS

Let us begin by a preliminary issue: scientific literacy. In the 19th century, Europeans were required to learn how to read, write and count in order to integrate the industrial society. Today, in order to participate in the "information society" or "society of knowledge", we need to be familiar with science, we must have some degree of scientific literacy. Science shapes our world, not only on the fast-evolving technological forum but also in the social forum of human affairs.[1]

Science is not easy. When questions of public interest arise - renewable energies, nuclear waste, transgenic plants, gene therapy, euthanasia, over-debt, migrations, money creation, industrial patents, etc. – there are many complex concepts we must master if we want our opinion to matter. Nowadays, we can only form a valid and respected critical opinion by enriching our scientific culture and, in so doing, we can then become active participants in a multitude of current issues and can free ourselves from the pressure of interest groups.

Culture now emerges from the natural human desire of knowledge. What Bernard Lonergan calls the "pure unrestricted desire" of comprehension, knowledge and goodness is an unlimited capacity to ask all sorts of questions and face every sort of problem posed by life. When it comes to science, this is not an easy task. The public knowledge of science comes from the mass media. However, scientists do not trust the media and journalists tend to blame science for its complex information. The end result is inadequate media coverage of scientific affairs.[2]

The requirements of a scientific culture cannot be solved by technical instruction. A technician is someone who solves an immediate problem without grasping the complexity of the underlying theoretical processes that precede his or her intervention. A scientist knows how to create appliances, a technician only knows how to run them and the consumer, or end user, just wants a hassle-free use of them. The gap between scientists, technicians and consumers is increasing. The only way we can awaken from the unconscious and massive use of science and technology is to go back to the natural human desire of goodness, as Bernard Lonergan put it: "*The problem of self-knowledge that human beings face is no longer an individual problem, inspired by an ancient sage. It has the dimensions of a social crisis and it is legitimate to see there the existential challenge of the 20th century*".[3]

Epistemology is the branch of philosophy dealing with the nature, possibility and foundations of scientific knowledge.[4] As a meta-scientific language, it covers the whole process of scientific creation, scientific research, and technological appliances. A meta-scientific language is usually presented as having a descriptive and a normative aspect, correlated with the distinction between contexts of discovery and justification. This distinction goes back to Hans Reichenbach,[5] who points to the difference between how science is done and how it is rationally reconstructed, how the scientist conducts his/her research and how we understand him/her.

However, such neo-positivistic separation between contexts of discovery and justification, between the products of science and its production method, hinders epistemology itself and scientific literacy. It does not help society to find its way through the complex world of science. Bernard Lonergan, in his work *Insight. An essay on human knowledge* (1957, 1992),[6] noticed this major flaw and undertook a revolution in epistemology and ethics of scientific research; by a new concept of scientific heuristic, he overcame the positivist hegemony in philosophy of science and opened the way for a better scientific culture.

Insight broke away from the normative epistemology that dominated the philosophy of science until the late 1950s. Published in 1957, it precedes the contributions of authors such as Thomas Kuhn and Imre Lakatos, and its revolutionary approach incorporates a monumental array of data and evidence from both natural and social sciences.

"Scientific Revolutions", *i.e.*, the episodes of discontinuity in the history of science, have as a semantic correlate the metaphor of "Copernican revolution", used by Kant to identify a rupture with philosophical dogmatism and by Freud to illustrate the disruption caused by the discovery of the unconscious. [7]

The "Lonerganian revolution" in 1956 about scientific research has affinities and differences with Kuhn's 1962 book. It shares the concept of scientific paradigms and scientific revolutions, but it is radically different when considering that there is complementarity and not incommensurability between paradigms.

The purpose of this paper is to describe Lonergan's revolution of epistemology by describing and evaluating scientific research, its methods, by means of several questions 1) What is scientific heuristics? 2) Why are classical and statistical approaches complementary? 3) What are the canons of research? 4) Why is probability central for natural and social sciences? 5) What about schemes of recurrence and emergent probability? 6) What is the relationship between *cosmopolis* and society?

2. COMPLEMENTARITY IN SCIENCE

In chapters 2-5 of *Insight*, and marginally in chapters 6 and 7 – one third of the work - Bernard Lonergan presents science as a type of heuristics that has affinities and differences with other types of human knowledge. He takes his cue from the state-of-the-art of mathematics and relativity physics to shows how reality is never a "set of things" seen or imagined, but rather an "identity" which science may come to know through attentive experience, intelligent apprehension, empirical testing and rational statements embodied in scientific laws or models. Understanding is very different from imagining. Lonergan takes up the lesson of Gaston Bachelard, for whom the abstraction needed for the appropriation of science is indistinguishable from the language in which its concepts and theories are formulated.

Lonergan emphasizes the affinities between scientific knowledge and other forms of knowledge - common sense, philosophy, theology - before highlighting the differences. The initial position of a scientist is akin to common sense and philosophy: seeking insights about what is still unknown. From here on, the heuristic paths split. While common sense is satisfied with apprehending the relations human have with things, science analyzes the intelligible relations among things themselves, and philosophy seeks to overcome the subjectivity of common sense - *doxa*- and the specific objectivity of science- *episteme*.

The radical distinction between *doxa* and *episteme* was established by Plato and Aristotle as *philosophers and scientists*. Aristotle demonstrated that to know (*episteme*) is to capture the universal in the particular and then judge whether that is the case, or if it exists. To know "*the nature of*" is to find the universal; the particular individuality belongs to "the empirical residue". However, Aristotle was not aware that sensitive similarities only convey a provisional classification of reality. Similarities of things in their relationship with us - *secondary qualities* in modern philosophy – are sufficient for a taxonomy or classification of plants, animals, rocks, or words and constitutions, as exemplified in Aristotle's biology, astronomy, rhetoric, politics;[8] they are insufficient for further analysis. Euclid's geometry stands at the opposite pole of ancient science, as pure calculus, without regard to experience.[9]

The birth of modern science needed more than a juxtaposition of empirical observation and mathematical calculations. Modern science began, according to Lonergan, when Galileo insisted that it was necessary to pay attention to the similarities of things among themselves.[10] The astronomical theories of Copernicus, Brahe and Kepler were transformed by the method of testing hypotheses. They achieved results by applying the new method of experimenting, testing and formulating laws. Lonergan points out the paradox of trying to apply a method that "makes way" to the discovery of what is still unknown. Is it really possible to have a method of discovery for what it is not yet discovered? How can we know what we do not know? The answer is: by creating a heuristic structure.

The *new science* created by Galileo was one of the most powerful heuristic structures of human history. It analyzes phenomena, events and situations that occur regularly. At first glance, it seems that events occur either due to necessity or randomly, as Jacques Monod put it.[11] Lonergan's discovery is that events may be just a coincidence on one level and, at the same time, be systematically related on another level of reality. The universe does not work according to determinism, nor according to a series of hazards, as in the chaos theory;[12] it works with probabilities.

Matter and nature "work" with long scale numbers and time. Probability consists in the measurement of how actual frequencies actually differ, yet not systematically; systematic divergence, on the other hand, is randomness. Given sufficient time and space, it becomes very likely and most probable that remote possibilities are realized. This is the paradigm of contemporary science based on probabilities.

Lonergan's way to clarify the contemporary vision of the universe as "emergent probability" and a "common house" is enhanced by comparison with previous cosmologies.

Contemporary science is as far as the old Aristotelian idea of cosmic order as the idea that the universe as a "well-regulated clock" – according to Galileo, Newton, Voltaire and Laplace, with or without a "watchmaker". Contemporary science explores the presence of the unsystematic in the universe. Organisms, plants and animals go through stages of evolution; quantum theory states that subatomic elements can jump from orbit to orbit; economy experiences unexpected price developments; genetics establishes probabilities of ancestry, etc.

Whereas Max Planck's quanta theory in 1905 is, reportedly, the first illustration of indeterminism in science, Lonergan argues that it was in fact Darwin that took the lead.[13] In *The Origin of Species*, Darwin uses probability as an explanatory tool, creating a new kind of intelligibility. The strict Darwinist is indifferent to the details of the basic situation: he draws conclusions appealing to the natural selection of variations that occur by chance. In contemporary terms, it seems that random or chance variation is an instance of the likelihood of emergency and that natural selection is a matter of chance of survival.[14]

3. CANONS OF SCIENTIFIC RESEARCH

It does not matter who was the first indeterminist, Darwin or Planck: contemporary scientific research adopted its heuristic framework by describing the cosmos as a "common house" where determinism and indeterminism cohabit and establish new canons of research. It manages to know what is not yet known because it uses specific methods to search for unspecified correlations and undetermined functions.

Scientific methods act as "scissors". On the "top sheet" there is a series of generalities, assumptions and deductions that require determination; on the "bottom sheet" is a set of data and correlations. The ability to get results comes from the sharp encounter of the two sheets. Each "snip" is a discovery. The "bottom sheet" is always changing with new data which, in turn, require modification of the principled "top sheet".

This metaphor of scientific research as a sequence of "cuttings" easily captures the imagination but is, actually, based on a painstaking analysis of what Lonergan calls the six "canons of scientific research", namely: (1) selection, (2) operations, (3) relevance, (4) parsimony, (5) full explanation and (6) statistical residue. [15]

The scientific researcher must: (1) select the data of sensory experience, (2) perform operations such as observations, experiments and practical applications, (3) choose criteria to seek the intelligibility immanent in the data, (4) use parsimony, adding to data nothing but necessary laws, (5) seeking a full explanation to all data. (6) Finally, although all data must be explained by laws of a classical type, there are residues requiring a statistical explanation.

Such canons present the intelligible unity underlying various seemingly unrelated heuristic rules. Lonergan draws a rational reconstruction of science and summarizes its precepts of research as well. He demonstrates how scientific insights answer the human search for knowledge. The way he does it appears as a revolution in epistemology, because he changes the methodical object-oriented perspective into a subject-oriented one, that requires the researcher to be attentive, intelligent, rational and responsible if he wants to be objective.

The recognition of insights involved in the canons of scientific research prevents two current epistemological biases: (1) scientism, which assumes that science reaches absolute truths; (2) phenomenalism, which takes abstract definitions as concrete entities and offuscates both philosophy and common sense. Let us consider both of them.

Scientism, or the belief in the theoretical and practical superiority of science, has two postulates:[16] the conviction that scientific knowledge is superior to any other kind of knowledge and the conviction that human problems of technical, social and ethical nature can only be solved by science. As we shall see, the criticism of the first postulate requires an epistemology, and the criticism of the second - ethics.

Lonergan's epistemology fights the deterministic supposition that views the universe as subjected to necessary laws. It rejects the illusion of "the end of science" as if a final theory would come to explain everything. Some scientists argue that a grand unified theory in physics would bring the discipline to its apex; once the final rules of the composition of matter were known, it would be just a matter of time to fill in the gaps. [17]

Lonergan's explanation is similar to that of John Barrow, for whom the frontiers of science are constantly drawn by science itself. This does not mean that there are inaccessible things that scientists will never know. Science draws its own limits, for instance with Gödel's theorem, which shows the inconsistency of systems that refer to themselves, or with the uncertainty principle, in Heisenberg's quanta theory, that claims that it is impossible to determine, at the same time, the position and velocity of subatomic particles, thus putting an end to the "deterministic sleep".

Lonergan rejects phenomenalism as a pseudo-philosophical construct or a "philosophical conviction" superimposed upon real science. When Galileo and Newton spoke about the "primary qualities of matter", they were imbued with false ideas of reality and objectivity and they did not acknowledge the abstract nature of the law of gravity. The Cartesian "philosophical conviction" that *res extensa* is a "primary quality" impairs the philosopher to determine the correctly experienced extensions and durations. That same inadequacy reappears in Kant, for whom the "objective bodies" of Galileo become the components of a phenomenal world. Lonergan's rejection of phenomenalism is similar to Whitehead's rejection of "the fallacy of the misplaced concrete";[18] they both reject spurious additions to scientific insights.

4. HEURISTICS IN SCIENCE

Once scientific research is purged of scientism and phenomenalism, the Lonerganian heuristics shows how classical scientific laws have their place and are complemented by the statistical laws discovered by contemporary science. It is the role of scientific heuristics to search for unspecified correlations and not yet determinable functions. In natural sciences, the specifications are obtained by means of measures and tables, and the insights thus obtained are expressed through a general correlation, called "function". In social sciences, such correlation is generally not quantifiable, and does not need to be, thanks to human freedom. Consequently, requisites are quite different in social sciences to establish a paradigm, when compared to natural sciences.

Let us briefly consider the advance of research in natural sciences. Classical (or modern Galileo's and Newton's) science deals with occurred phenomena, holding other factors constant (*sic ceteris paribus*); contemporary science deals with aggregates of events. These aggregates can be as different as gas molecules, subatomic particles, birth balances, financial flows, etc. While the laws of classical science report on the consequences of certain facts, contemporary science informs us about the facts themselves, creating a new kind of heuristic structure that Lonergan calls "statistical". Each individual event follows classical laws, but overall probability is determined by statistical laws; this rule is valid for every kind of science, be it physics, genetics, biology, meteorology, economics, sociology, psychology or any other. [19]

In statistical heuristics, deductions are limited to short-term forecasts indicated by probabilities. Compare, for example, the movements of the planets to the vagaries of weather. Astronomers know how to predict eclipses when they get all relevant data; meteorologists cannot know the initial weather conditions that would enable them to make absolute predictions. Astronomers are confident about the time of past and future eclipses; meteorologists tell us with a caveat what will happen tomorrow, let alone in a week, a year or a century. We may say that astronomers analyze phenomena whose probability of occurrence is or tends to be 100%, while probability in meteorology never reaches this limit.

As systematic processes are reversible, determinists say that the universe is systematic; once a situation is known at any given time and according to given specific laws, its past, present and future consequences can be evidenced. Now, what happens is that a statistical method is required to analyze systematic processes for which no single overall intuition exists. An important consequence is that systematic processes, like movements of planets, are monotonous, whereas non-systematic processes, such as the weather or economic phenomena, have greater divergence. [20]

Scientific intelligibility, corresponding to the "classic" discoveries of Kepler, Galileo and Newton, is captured by the direct view of functional correlations between elements.[21] We understand the phases of the moon and falling bodies as events necessarily resulting from previous events, on equal terms. Scientific statistical intelligibility, on the other hand, is captured by inverse evidence with no direct evidence in support. Science understands that many events, that are not functionally related, are grouped around an average in a given time and space. If a subset of random events regularly varies from this average, we seek factors that regulate this subgroup, governed by classical intelligibility and captured by direct evidence.

We can summarize these considerations indicating that classical science discovers functional correlations between data and statistical science discovers ideal frequencies (probabilities) among data

5. THE WORLD OF EMERGENT PROBABILITY

Lonergan's heuristics of probability undoes the problem of causality, so dear to Hume and Popper, whose theories of induction and falsificability are hopelessly dated. Probability has a mathematical expression in natural sciences, based on intelligibility acquired by direct insight. Whenever verified, probability sets a limit towards which converge the relationships between future measurements. If data converge, deductions are possible, as well as forecasts.

Interestingly enough, probability opens a bridge for establishing a paradigm of social sciences, something that Thomas Kuhn deemed undone. There are phenomena whose research requires what Lonergan calls "genetic intelligibility" grasped by a direct evidence of the moving factor.[22] We find such models it the development of cells, viruses, stars, plants, human intelligence, human morality, etc. Finally, what Lonergan calls "dialectical intelligibility" is captured by an inverse evidence that there is not a single factor sustaining the development; instead, there are at least two factors which modify one another, while changing the moved entity. [23]

What kind of universe can be known by the concomitant validity of classical and statistical laws? An encyclopedic answer would consist of an exhaustive description of the peculiarities of the universe. A better answer is given by Lonergan when he compares the dynamics of scientific insights in ancient, modern and contemporary science. The concurrent validity of the classical and statistics laws allows him to describe the general properties of the universe to which they apply. Classical laws indicate what happens once the necessary conditions are met, keeping other factors constant. Statistical laws indicate the frequency with which these conditions are expected to be manifested and deal with occurrences or events' aggregates.

Lonergan's revolution in epistemology entails a parallel revolution in cosmology, as it explains our universe as one in which both kind of laws – classical and statistical - combine as "schemes of recurrence"[24], under the principle of "emergent probability." [25]

Bernard Lonergan assumes that processes operate according to classical laws and manifest according to statistical laws; this combination gives us the order of the universe. Cosmology describes its general properties, whereas each science deals with its specific properties. This comparison is independent on the successive content of each particular discipline. Therefore, it is not affected by advances in research, since it does not deal with the content, but with heuristic structures; on the contrary, advances in research are needed and the passion for science is exhilarating as it explores new territories.

Epistemological conclusions allow a cosmology, due to the isomorphism existing between knowing and being. Acknowledging the *nonsystematic* in both nature and human action, enables science to create successive disciplines and levels of research, corresponding to different layers of the cosmos. As an outline, we may say that unsystematic physical relationships point to systematized pluralities at chemical level; biology systematizes irregular appearances at chemical level; human psyche introduces order in the level of biological residue; the unsystematic in the psyche can be systematized at top level of rational consciousness, or *noesis*. Finally, it is a philosophical question if further systematization can be carried on.

6. SCHEMES OF RECURRENCE

Lonergan takes a cue from Darwin's theory of evolution that defines nature as the gradual accumulation of "sensible qualities" and can be described as phenotypic characters.[26] Yet, these "small variations" must be understood by scientific research as intelligible relationships: "*These combinations of variations … are relevant to schemes of recurrence. For the concrete living of any plant or animal it may be regarded as a set of … recurrent operations … Within such schemes, the plant or animal is only a component. The whole schematic circle of [operations] does not occur [solely] within the living thing, but goes beyond it into the environment* ".[27]

By "scheme of recurrence" Lonergan means a series of events or "operations" linked together by natural laws. Schemes of recurrence can be "*represented by the series of conditionals, If A occurs, B occurs; if B occurs, C occurs; if C occurs, A will recur*"[28] where the intelligible connection between the occurrence of A and B, between B and C, etc., is defined by a scientific law.

Basic schemes of recurrence have a low probability of evolution which means, for instance, that the cycle of water is the same as millions of years ago. On the other hand, nature operates with large numbers and long time intervals and thus facilitates the emergence and survival of new entities, such as organisms and precisely the human, who freely accepts to establish human schemes of recurrence in society and history.

We can indicate as many examples of "recurrence patterns" as we wish, provided we choose scientifically described processes: planetary movements, water and nitrogen cycles, biological rhythms of species of plants and animals, development of body cells, business cycles, cycles of migrations and so on. All these heterogeneous processes have different stages in which each change is offset by a change of opposite sign, in order to restore the original situation. A body infection, for instance, stimulates the patient to restore health, unless his immune system is affected. Price inflation detonates unemployment that, in turn, decreases consumption and reduces inflation. Psychology shows feedback behaviors because, despite their freedom, human actions are also responses to stimuli.

There is an important distinction to make between the possible, the existing, and the probable. Creation of the possible is remote, because it requires that all classical laws are verified. The probability of the recurrence scheme depends on the non-occurrence of events which disturb it. The present is what exists now, within a specified framework of time and space.

This account of the dynamic processes of the universe is characterized by what Lonergan calls "emergent probability." His account is generically evolutionary but without the materialistic biases of neo-Darwinian thought. Materialism assumes that ultimate reality is known through physical contact, or sensation. Lonergan counterpoises that sensation is only a component of reality; it is intelligibility that gives us access to the heart of reality. Nowhere is this more evident than in Lonergan's concept of "emergence."

7. EMERGENCE

Emergence has always been a problem for materialism, which tends to regard underlying matter or elementary particles as unchanging. Against materialism, Lonergan argues that science seeks to understand how events are intelligibly articulated within schemes of recurrence. Whenever new schemes begin to function, new intelligibilities may emerge. The question is: how does Lonergan's formula avoid materialistic postulates with no need to invoke any kind of "intelligent design"?

Lonergan starts by enhancing a feature of the laws of science: their conditionality.[29] As these laws of science are generic, they are also indeterminate. Newton's laws of motion, for instance, apply to any object; yet, one can deduce a specific concrete path of motion only if specific conditions are stipulated. According to specific combinations of position, velocity and mass, a body receiving an impulsion may describe an elliptical, a hyperbolic or another kind of path. According to chemistry, if octane and oxygen combine, then carbon dioxide and water will be produced; however, specific conditions of pressure, temperature, etc. are needed to produce this chemical transformation: the laws of science determine nothing by themselves; only by adding specified conditions can we determine concrete events.[30]

Lonergan used this "conditionality" of scientific laws to create his theory of emergence of schemes of recurrence. If all appropriate conditions happen to be fulfilled, then the occurrence of A will result in the occurrence of B and "if B occurs, C will occur; if C occurs … A will recur."

Now, the schemes of recurrence do not occur as spatial aggregations of material particles or random variations. They are new entities, indeed. A biological species "*is an intelligible solution to a problem of living in a given environment,*" and "*a solution is the sort of thing that human insight hits upon*".[31] New entities emerge in accordance with the laws of science, with no "intelligent design" needed to produce them. The schemes emerge when appropriate conditions are fulfilled. Hence, there are "probabilities of emergence" and "probabilities of survival" that pertain to this field of environmental conditions.

8. HUMAN SCHEMES OF COOPERATION

What is also new in Lonergan's account is to show that emergent probability and schemes of recurrence do not only occur in nature but also in human affairs, albeit in a different mood.[32] His main point is that the psychological, social, historical, economic and political schemes do not operate through blind laws but through consciousness, be it illuminated or biased, under the pressure of idols or liberated by understanding. Human intelligence is a source of innovation and of the emergence of social and economic patterns. Human action is self-correcting through insight and cooperation. Human action, however, is also blemished by stupidity and greed; social pressure and violence can provoke absolutely catastrophic results.

Human schemes consist of intelligible patterns of relationships that "*condition the fulfillment of each man's desires by his contributions to the desires of others*".[33] A republic is a scheme of recurrence with patterns of elections, legislation, trial in courts, international relations and so on. A commercial venture is a scheme of recurrence that involves recurrent transactions among buyers, suppliers, and recurrent patterns of payments for its functioning. A family is a scheme of recurrence with births, marriages, illnesses, divorces, alliances, and all kinds of mutually reinforcing schemes. This is how, sociology, psychology, economics, etc. correctly look at human affairs, grasping insights beyond the scope of common sense and preparing information for a philosophical synthesis.

Now, freedom radically distinguishes human schemes from natural processes. Human action is not only intelligible but also intelligent. The emergence and survival of institutions, corporations, nations, depend upon acts of human choice. Human "practical intelligence devises arrangements for human living".[34] These arrangements are patterns of cooperation that depend upon understanding of "what one can expect" of the other person.[35] "Common sense" accumulates insights that make possible the participation in human economic, social and political institutions by a "self-correcting" process: a) human schemes exist –> we raise questions about a better order, a better society –> we get new insights (or not) about improvements –> we undertake actions to modify current schemes –> more questions and insights are raised, or else social pressure and violence forbids them and imposes forgetfulness and so on, according to the cycle of each scheme of recurrence.

In theory, intelligent self-correction of human patterns of cooperation has the potential to respond to every difficulty. "*Humanity only poses those problems which it can solve*", wrote Karl Marx, with inveterate idealism. It can bring technological innovations and equitable economic distribution and political justice. As Lonergan notes, fully intelligent and ethical choices "cannot consistently" undertake initiatives that destroy their underlying conditions, including natural ecological conditions.[36]

9. BIAS, DECLINE AND CATASTROPHE

However, in spite of man's creativity, humanity too frequently turns away from its course towards good and produces adverse results in life, society and history. The age of scientific innocence asserting that societies live in constant progress has, long ago, come to an end; wars, epidemics, social unrest and economic disaster testify that human's march in history is fraught with disaster and oversights.

Society has the capacity to inquire every sort of problem but history discloses all kinds of evil social and economic arrangements, implemented without mind or heart. Against genuine psychological, social and economic self-correction arise the forces that Lonergan terms "biases", namely a deviation from man's natural search for the knowledge of goodness. When biases interfere with man's development, both the well-functioning of human systems as well as their underlying natural infrastructure are endangered.

Evidence of deeply rooted evils in individuals, society and history discloses consciousness' tendencies to deny itself: (1) neurosis prevents evidence of our consciousness, (2) selfishness prevents us to see what benefit others, (3) sectarianism avoids seeing goodness in other groups. (4) anti-intellectualism prevents research, long-term planning and application.[37]

Lonergan's account of emergent probability in human societies incorporates the fact of human failure to raise questions, and refusals to act according to what they come to understand as the best courses of action. Lonergan identifies four kinds of bias provoking disfunctional activities: 1) dramatic bias as in psychological aberrations;2) individual bias in selfish disregard; 3)group bias in class, age, gender and racial discrimination; 4) general bias as carelessness about long-term consequences, as observable in economics and the environment.

A bias operates by ignoring the conscious processes of being attentive, being intelligent, being reasonable, being responsible and being passionate or earnest about each one's mission. According to Lonergan, biased courses of action that evade intelligent self-correction initiate spirals of decline, degradation and destruction of natural and cultural environments. Biases and decline have their own "logic" – the logic of vicious cycles that lead to decline and catastrophe, unless someone acts to reverse their downward trends.[38]

10. *COSMOPOLIS* AND THE ETHICS OF RESEARCH

To address the problem of social decay, Bernard Lonergan advocates a "*Cosmopolis*", the community of those who share a "global perspective" by means of philosophy. [39] "*Cosmopolis, like all other objects of human intelligence, is, first, an X, unknown until someone understands it*."[40] To understand it means to carry out scientific research with the objective attitude of someone who is attentive, intelligent, rational, responsible and passionate. [41]

Cosmopolis invites interdisciplinary cooperation and opposes skepticism.[42] Scientists collaborate by sharing methodologies and maintaining an open and dynamic attitude to the changing results of each discipline. [43] This concept of *cosmopolis* is akin to what Derek J. de Solla Price (1963) called the "Invisible College"[44] used by Diana Crane (1988) to designate the network of the most important scientists in each discipline. Scientific production is not evenly distributed as it is dependent on political and legal factors. An expression of this issue arose, for the first time, in 1993, in the UNESCO annual report on Science.[45]

The members of such an *Invisible College* do not necessarily meet in seminars or conferences. Sociometric analyses show that a small number of scientists from each discipline is responsible for a large percentage of scientific publications in their domain. [46] That is the origin of "peers", personalities involved in governmental or private committees and agencies, who judge the value of scientific publications and allocate scholarships and grants for research.

A current explanation of scientific research follows the tenets of the Frankfurt School and of its "negative dialectic". Habermas, for instance, asserts that science and technology were an instrument of human liberation since the Enlightenment, but the "dialectic of reason" perverted them and "bourgeois rationality" became an instrument of man's enslavement.[47] Operational rationality or "instrumental reason" is a form of bourgeois culture and a bureaucratic form of domination. The followers of the Frankfurt School, who abound in post-structuralism, postmodernism, feminism and cultural studies, do not offer an alternative to social and political determinism. [48]

Lonergan's revolution in epistemology goes in another, much more fruitful direction: the object of scientific research is built by subjects, namely the community of scientists working under universal canons. This constructivist point of view has gained acceptance in recent decades even in the natural "hard" sciences. The validity of statements depends upon the consensus of groups who support the "construction" of reality. Statements are not more or less "real", in an absolute sense, but simply more or less informed or sophisticated. [49] Lonergan argues that science depends on consciousness, because the subjectivity of the well-formed scientist is the source of objectivity and the result of universal insights.

Cosmopolis allows greater autonomy, as Fourez wrote: [50] 1) It allows each person to increase his/her potential and ability to work in a competitive society; 2) It disseminates knowledge to participate in public debates, not leaving to technocrats the decisions of general interest. 3) To appropriate technical objects, prevention and cure of diseases, social and economic dynamics, etc.4) To increase the autonomy and ability to negotiate with holders of "relevant knowledge".

Another point in Lonergan's thought has much to do with the ethics of scientific research and its social and economic impact. As an innovative philosopher of science, Lonergan characterizes biases and decline as opposition to the self-correcting potential of intelligence, inquiry and insight. As a Christian theologian, he states that decline is a pattern of evil or opposition to God, and that its reversal is by God's grace. He agrees with Augustine's characterization: "*evil is nothing but the removal of good until finally no good remains.*"

The interesting point is that Lonergan situates grace and redemption in relation to emergent probability. In *Insight*, he argues that the solution to the problem of evil and social decline is the emergence of theological virtues of "faith, hope and love".[51] Redemption within a universe of emergent probability will come, within the fullness of time, with the Redeemer.

With his *Insight*, Lonergan opened up the relationship between the emergent world and redemption. Other factors should be here considered: there is a dynamics of creativity and progress through intelligent self-correction; there is decline and degradation through bias and evil; and, finally, there is redemption and recovery through caring and religious love (1993, 1999a). Caring, according to Lonergan's later view, is constant in human affairs and off-sets the corrosive effects of stupidity and wickedness. To love God unconditionally is to care about everything God loves – the natural and human creation. In this respect, he announces the present day stance of ecology, of which Pope Francis' encyclical, *Laudato Si,* is an exampl. As a Christian theologian, he identifies the unconditional love found in all religions with "*God's love flooding our hearts through the Holy Spirit given to us* (Rom. 5, 5)" [52]

11. LONERGAN'S REVOLUTION IN CONTEXT

Taking into account Lonergan's revolution in epistemology and the emergent scientific research, we are entitled to ask: why was Lonergan's contribution scarcely noticed in the scientific community? Perhaps the most important reason was the successful eradication of the boundaries between contexts of discovery and justification in Thomas Kuhn's *The Structure of Scientific Revolutions*, (1962). [53]

The possibility of a unilateral normative epistemology was questioned since the Duhem-Quine hypothesis (1953), according to which scientific statements can always accommodate new experimental results: "*Any statement can be held true if we make drastic adjustments somewhere in the system.*"[54]

Imre Lakatos mentions two versions of the Duhem-Quine thesis.[55] According to a weak interpretation, there is room for rational decisions, as in the methodological falsificationism of Lakatos himself. According to a strong interpretation, one may dispense with rational rules of falsificability of empirical results.

In *The Structure of Scientific Revolutions*, (1962) Kuhn established that the evolution of science is not continuous; it hosts transformations that cannot be rationally reconstructed. If the meaning of a theory depends on the paradigm in which it operates, and if conflicting paradigms record varying degrees of verifiability, then there is no criterion for resolving conflict between paradigms.[56]

Kuhn suggests that the development of science follows a distinct pattern: normal science inside a paradigm, followed by a crisis heralding a paradigm shift and a scientific revolution; before and after a paradigm shift, the differences are incommensurable. 50 years after its emergence, the term *paradigm* has gained common usage.

With the publication of *The Structure of Scientific Revolutions*, (1962) epistemologists had a canonical text to question the existence of definitive norms of scientific knowledge and *Insight* (1957) receded into the background.

Gaston Bachelard was the first to speak about a break in the evolution of science. In order to overcome obstacles generated in the act of knowlege, the scientific mind must be formed against the facts.[57] Althusser used the term "epistemological break" to designate qualitative changes in the history of science.[58] Koyré used "intellectual mutation", "transformation through which the notions invented by the genius will become not only affordable, but easy and obvious.[59] Finally, the controversy between Kuhn and Popper in the 1960's established liquidated logical empiricism.[60]

Lonergan's revolution in epistemology went further because he inserted the logic of scientific discovery – in natural and social sciences - into global cognitive heuristics. Advances in science need a context of justification and a context of discovery. Thus, the rationality of scientific developments should be sought in the universal tendencies of human consciousness able to apply canons of scientific research.

Lonergan's final word has a deep humanistic dimension. His paradigmatic position rejects both the positivistic doctrine (verificationist) and post-positivists (falsificationist) ones, like that of Popper, and calls for more precious human efforts on the way to wisdom. In a world increasingly dependent on technology for everyday tasks, human autonomy must be safeguarded by "relevant knowledge". And, certainly, Lonergan's *Insight* is one of the most important works for citizenship and humanism in the field. *Probably*, the best, if I am allowed to give the final sentence of this paper a Lonerganian flavour.

Endnotes

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