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Central theses of the logical empiricism*

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Abstract

Given the importance of the philosophical movement known as Logical Empiricism, in past and present history of science of philosophy, nothing more necessary than being clear about its foundations. With this purpose, this article makes a systematic presentation of the central theses of Logical Empiricism, based on its programmatic documents. The presented theses are as follows: 1) The empiricist thesis, knowledge about nature is synthetic; 2) The knowledge of logic and mathematics is analytic; 3) The verifying principle as demarcation criterion between science and metaphysics; 4) The logical analysis of language as a philosophical method; 5) The unification of empirical sciences; and 6) The structure of scientific theories.

Key words: Analytic, science, metaphysics, reductionism, synthetic, verification.

Introduction

The heading *logic empiricism, (or also, logic positivism, neoempiricism, or neopositivism),* of the philosophic perspective inaugurated by member of the Circle of Vienna, fairly shows the principles it is founded on: an empiricist vision (positivist) of knowledge (scientific), and the use of logic analysis method. The first principle is epistemological, since it supposes a theory of scientific knowledge, and the second one is methodological, because it focuses philosophic work on logic analysis of language. In addition, logic empiricists will place these two principles to serve two very concrete objectives: rejection of metaphysics s in science, and unification of science. Logic empiricists stated these aspects of their philosophy in the pragmatic document *The scientific conception of the world: The Circle of Vienna,* written by Hans Hahn, Otto Neurath, and Ruldof Carnap in August, 1929, and dedicated to Moritz Schlick, around whom the group the group had consolidated. Where they say, for example:

> We have characterized the *Scientific conception of the world* in the fundamental through two traits. *First*, it is empiricist and positivist: there is a single knowledge of experience based on what is immediately given. Through this, demarcation of legitimate scientific content is established. *Secondly,* scientific conception of the world is distinguished through application of a determined method, such as the one of *logic analysis.* (Hahn, Neurath and Carnap, 1929;115).

And immediately afterwards they mention the second one of the two proposed objectives: "The hope of scientific work relies on achieving the objective of unified science, through application of that logic analysis to the empirical material" (Hahn, Neurath and Carnap, 1929;115).

As it may be seen, the first thesis contains two sub-theses, which I consider underline the subtle and basic distinction existing for logic empiricists between empiricism and positivism: the empiricist thesis is equal to the criterion of justification of knowledge on reality, "there is a single knowledge of experience and it is based on what is immediately given," and the positivist thesis is the use of this same criterion as a demarcation criterion between science and metaphysics, "through this, demarcation of legitimate scientific content is established."

Logic empiricists also characterized their philosophic perspective as a direct opposition to Kant epistemology, this is, as the rejection to *a priori* synthetic judgments; through their own words: "Precisely in *a priori* rejection to the possibility of synthetic knowledge consists the basic thesis of modern empiricism… it only recognizes statements from experience on all types of objects, and analytical statements of logic and mathematics" (Hahn, Neurath and Carnap, 1929;115). In summary, we may state that the following six theses compose the philosophic answer by logic empiricists:

1) The empiricist thesis: knowledge on nature is synthetic

2) Knowledge of logic and mathematics is analytical.

3) The verifying principles of the meaning as a demarcation criterion between science and metaphysics.

4) The logic analysis of language as a philosophic method

5) Unification of empirical sciences

6) Structure of two levels of empirical theories.

Now, this may not drive us to think logic empiricism as a monolithic philosophical movement, free from controversy, since, as we will see, some of these topics will be subject to different interpretations.

Analytical /synthetic distinction

One of Kant virtues of epistemology is that it founds natural sciences and mathematics under the same principles; both of them are built *a priori* on the same base of synthetic judgments. And this thesis is opposed by any empiricist perspective on knowledge of the reality. This is why, logic empiricists assume as maxim "the negation of a priori knowledge;" ¿What such pretentions are based on? They main argument they claim is related to revolutions surged in the second half of XIX Century, and in early XX Century in Mathematics, Logic and Physics. In Mathematics there is the case of appearance of non-Euclidian Geometry in the middle XIX Century; in Logics, appearance of formal logic or mathematical developed by Frege by the end of XIX Century; and in Physics, statement of theories of special and general relativity by Einstein in 1905, and 1916, respectively; and quantum mechanics in 1925-1926.

Appearance of non-Euclidian geometries led, in a first place, to differentiate what pure geometry is (mathematical), from applied geometry (physical): the latter one inquires into the structure of physical space of the world, while the first one is an abstract, conceptual and logic construction, which has nothing to do with experience or reality. And this latter poses serious consequences for Kantian conception of mathematics founded on *a priori* basis, since if so, it would not be possible to build systems of pure geometries contradictory among themselves. But the fact that non-Euclidian geometries may be built demonstrates otherwise, since the characteristic of these geometries, as shown by their name, is that at least one of their axioms denies any of Euclidian geometry axioms, therefore any non-Euclidian geometry results contradictory to the Euclidian one. Therefore, logic empiricists conclude that pure geometric knowledge (mathematic) is not a priori; and at not providing knowledge on the natural reality it may neither be a posteriori nor synthetic; therefore, it is analytical.

Old logic or classic held the predicative propositions as the unique base of analysis, which are of the form S is P, where predicate P attributes a property or attribute to the subject S, while the formal logic or mathematic, in addition works with the theory of relational propositions and the theory of variable propositional functions, and introduces, in addition, all of a symbolic formalism similar to the mathematics. One of the important projects within this new logic, was conceiving mathematics as one of its branches, this is, it was expected to prove that all concepts and posture of mathematics could be derived, respectively, from basic concept or propositions of the logic. Therefore, the nature of logic knowledge is similar to the one of mathematics, and, therefore, it is also analytical.

Regarding the natural knowledge, in addition, the revolution initiated by non-Euclidian geometries was completed by Einstein's theory of general relativity, a showing that the physical space is non-Euclidian, contrary to Newton's proposal, and as thought by Kant. And, in a second place, Einstein's theories and theories of quantum mechanics, are not only founded on principles contrary to what is proposed by Newton mechanics, but they have also been confirmed by a large number of experimentations. Such revolutions in physics would not be possible if mounted on synthetic principles *a priori*, which are apodictic, necessarily true. Therefore, logic empiricists conclude the principles of physics as in general, knowledge on the natural world, should be synthetic, should be justified on experience, and therefore, are related to this world.

In synthesis, the first theory of logic empiricism is the empiricist idea, according to which, knowledge on natural sciences, (as the one of social studies), is synthetic, this is, "it is based on what is immediately given." While knowledge of formal sciences (logic and mathematics), is analytical. In other words, the various statements of ordinary language and scientific may be classified as analytical or as synthetic. Let´s see this in a more detail.

Logic empiricists do not understand analyticity exactly as Kant does. For Kant, analyticity is related to the conceptual analysis, while for the first ones, it is related to meaning of the words; as Coffa claims:

> Kant's disregard of non-psychological dimension of semantics could have led to mistake the analytical for the purely conceptual… Analysis of any concept does require the concept to be understood, but foundation of any *qua* analytical judgment content just requires its structure to be understood. (Coffa, 1991:44).

More precisely, for logic empiricists the truth or falseness of any analytical statement depends not only on its form or logic structure, and meaning of its terms; therefore, its truth or falseness is independent from the state of the world: truths and analytical falseness say nothing about the real world.

Therefore, there are analytical statements which depend only on their logic form, such as logic truths or tautologies[1] and logic falseness or contradictions. The statement "all bachelor is a bachelor" is true for its manner and independence o of the content or meaning of its terms, since 'bachelor' may be changed for any other term, such as 'dog' without changing the value of the truth. This is, the anterior statement is true because if possess the logic form or logic scheme '$\vee x, x = x$', which is the principle of identity. The laws or third excluded, and no contraction of the logic are also tautologies. In synthesis, the value of the truth of tautologies and contradiction only depend on their logic form.

1A term introduced by Ludwig Wittgenstein in the l *Tractatus Logico-Philosophicus*, 1922, see paragraph 4.46.

But there are also true analytical statements which are not logic truths. For example, the statement 'all bachelor is non-married' is true in virtue of the meaning of its terms and its logic form. This is, the statement is true because bachelor means the same as non-married and, taking this latter into consideration, the original statement has the logic form, too '$\forall x$, $x = x$'. Mathematic truths are also of this type and, therefore in a first instance, they would not belong to the logic; for example, '2+3 = 5' is a statement which truth depends on the content, on meanings, of each side of the equality, but not only on its form. Finally, the above examples lead to observe that an analytical truth does not say anything about the world, its truth is independent from what is given in the reality; in other words, an analytical truth is a necessary truth, it is truth under any conceivable circumstance, therefore its negation is impossible.

In addition, synthetic statements say something of the real world, therefore, their truth of falseness depends on how reality is. Also, what negation says of a synthetic statement is possible, it is not contradictory. Thus, the analytic / synthetic distinction is founded on the necessary / contingent distinction: true statements of formal sciences are all necessary, and those referring to this particular world are all contingent. All statements of empirical sciences, (physics, chemistry, biology, sociology, etc.,), are synthetic. For example, the principle of causality 'all effect as a cause', 'all bodies are extensive' and 'all bodies are heavy', are synthetic statements because they speak of this real world, and therefore, have to be justified parting from experience. Remember that for Kant the first statement is synthetic a priori, the second is analytical, and the third is synthetic.

Verifying principle of the meaning: science and metaphysics

For logic empiricists there is a difference of nature between science (empirical sciences as the natural sciences, psychology, and social sciences) and metaphysics: Sciences have showed along their development that they really provide a true knowledge about reality (natural, psychical, and social), while metaphysics has characterized by proposing various systems of trans-phenomenal or transcendental reality to the nature that we see and experiment, which finally become inaccessible, incomparable and, in definitive, pure fiction. And it is not only this, history of science has also witnessed pollution of sciences with metaphysical ideas, therefore, it is a task of philosophy not only to achieve a science free from metaphysics but also consolidate a posture fully anti-metaphysical. When logic empiricists talk about metaphysics, they refer to the "metaphysics in the own sense, classic of the term, especially to scholastic metaphysics, and to the one of German idealism, but also to the hidden metaphysics of the Kantian and modern *apriorism"* (Hahn, Neurath and Carnap, 1929:114).

Thus, logic empiricists consider that it is possible to distinguish between science and metaphysics through an empiricist criterion, and in terms of the statement meanings; therefore, they introduce the *Verifying principle of the meaning* (PVS) as the mechanism that leads to establish whether a statement is scientific or metaphysical. In other words, the starting idea is that statements of science (excluding formal sciences, and analytical statements), are statements with a sense, because they say something on the reality, and those of metaphysic systems are senseless because they do not say anything on the world. Thus the PVS is the criterion to differentiate the scientific knowledge from the metaphysic one, that is, which makes sense from which does not. This principle is, in a first instance, semantic and non-epistemological; although, at inducing the semantic notion of meaning of a statement to the epistemological aspect of its verification, the epistemological is what prevails.

The principle says, in its general form: a synthetic statement is significant just of in principle it may be verified in experience (this is, through *what is given*). But the principle in its extreme form identifies the meaning of a statement through its verification, (See Schilck, 1930-31-97), the sense or meaning of a statement (synthetic) is the method of empirical verification of the same. In Shilck's words: "the meaning of a proposition undoubltedly consists in the fact that it expresses a define state of things. This defined state of things should be expressed to give sense of any proposition" (Schilick, 1930-31:93). In other words, a statement makes sense just if there is an empirical method to decide whether it is true of false; otherwise, if such method does not exist, such statement does not make sense. Now, since the natural thing is to suppose that every statement is significant, then it is more appropriate to suppose that every statement is significant, then it is more appropriate to grade as pseudo-statements those expressions which do not pass the PVS test. In definitive, a pseudo-statement is an expression with appearance of a statement which lack of meaning or sense.

According to logic empiricists, the various statements of science comply with the PVS, while those of a metaphysical system do not; therefore, the latter result being senseless statements of pseudo-statements. In synthesis, it is worth to highlight the following kinds of statements: the logic truths, and non-logic analytical truths, which belong to formal sciences; synthetic truths of empirical sciences, and senseless statements (pseudo-statements) of metaphysical systems.

Let's see some details related to the PVS. We should start by considering how logic empiricists understood what is given. Notwithstanding they agreed with the fundamental character of the given, since as Shilick claims: "What is given [is] an expression which designates the very elemental and therefore it is no longer doubted" (Schlick, 1930-31:90), at first they did not agree regarding what referred to *the given;* at least three versions were introduced. In one case, the given refers to the most sensible sensor qualifications, to sensations which are experienced, to sensible data or sensor impressions; for example when eating an apple, sensations such as "red", "round", "sweet", etc. In another case, and contrary to atomic sensor experiences of the previous case, *what given* is related to global sensible experiences (experiences), and similarity relationships among them. Thus, in the above example of the apple, the description would include everything related to what is experienced at eating the apple, which is not easy to describe. In the last case what given refers to objects as they are ordinarily understood, this is, it refers to physical objects space-temporally located. The description in the example would be something of this type: the apple which is red and round, tastes sweet to me. Logic empiricists finally agreed with this latter way of speaking, for physical language, since this language refers to objective public experiences, while the language of (atomic) sensations, and the language of (global experiences) experiences refer to individual experiences, which other persons may not access, therefore, this path lead to what is named as solipsism: the world I know is not a public world but the world I experiment, my world.

Let's see some examples expressed by Shilick himself in his article 1932-1933: 'There is a 3,000-meter high mountain on the hidden face of the Moon´ it is a statement which by then was verified, in fact, but which notwithstanding could be verified in principle, therefore the statement is significant, although not known whether it is true or false. While if a Physicist states that the statement 'The electron as a nucleus inside it' without telling how such nucleus could be detected, either indirectly through certain effects, then it could be concluded that the statement is senseless, does not make sense, there is no way to verify it, and therefore it is metaphysical. Finally, statements belonging to the proper kind of metaphysics. The same form as metaphysics has been always understood excludes the possibility that its statements may be verified, since the metaphysics always goes beyond of what us given. Concepts such as *Thing in itself,* which is supposed to be behind phenomena we experience, and *The absolute,* which is behind the whole reality, are transcendent non direct or indirectly accessible to experience, therefore, they may not be verified; these concepts are senseless, they are metaphysical.

But these examples and other, as we see below, evidence the difficulties faced by the PVS, this is, the pretention of identifying sense through verification. The case of the electron nucleus is similar in certain aspect to the metaphysical entities, since in both cases it is clear that we *understand* what is wanted to express; therefore we have to conclude that affirmations on the nucleus of electrons, thing in themselves and the absolute make sense, are significant, although it is really true that they are not susceptible of being verified. In definitive, it is not right to equal the significant to the verifiable, "although testability is certainly a sufficient condition for signification of propositions, is not necessary" (Mahner nd Bunge: 1997:77), since if any statement is verifiable is because it is significant. In other words, as Mahner and Bunge propose, it is necessary to turn PVS over: "the possession of meaning is necessary for testability" (Mahner y Bunge: 1997: 77); in order to test a statement, it is necessary to start by understanding it, this is, the statement should be significant.

A second type problem surges with scientific laws, for example, the physical ones. It is not possible to fully verify the law 'All metals exposed to heat expand'; which is verified are particular cases; this or that metal dilates with heat. Here we are in front of the problem of induction stated by Hume: we may not explain the supposed need of the laws of nature. The conclusion is that the PVA attack directly the back bone of science, the laws of nature, which would a senseless at not being possible to be fully verified.

A third problem is related to theoretic statements of science, which includes theoretic laws and in general, is similar to the case of the electron nucleus. As we will explain in the heading *the two-level model of language: writing of empirical theories,* the starting point of the two-level model of language, which dominated the interior of logic empiricism, which is the scientific knowledge, is characterized for not being restricted or limited unique and exclusively to the scope of what is observed; since really, such knowledge goes beyond, at proposing a subjacent world which goes beyond this phenomenal ambit of the observable, and postulating certain entities, with their respective properties, and relationships among them. The science, at postulating such subjacent world, introduces new concepts to refer to it, and, therefore, new terms. In this manner the logic empiricists introduced the observational /theoretic dichotomy, according to which, the scientific language is divided into an observational language and a theoretic language: the first ones refers to the directly observational, and the second one to the theoretic, to the non-observational.

Newtonian mechanics allows a good illustration of the above. In one hand, this theory explains various phenomena related to movement of bodies on the earth, and celestial bodies. In the first case, movements such as body falling, the one of missiles, the tilted plane and the pendulous one; and, in the second case, movements as the Moon, the planets, and the Earth. In the other hand, we could state that this explanative power of the theory, comes from introduction of new concepts, such as mass and force (think in particular, of gravity force), which are related among themselves, and to concepts already known, such as acceleration, through such known laws of movement and the law of universal gravitation. The theoretic character (non-observable) of the force of gravity, lays on the fact that it is not a force which acts by contact but at a distance, which is transmitted at a great velocity (seemingly infinite), and with no energy spending. Gravity is transmitted in the vacuum, it does not requires any means, and it is not possible to detect it directly but through the effects produced among sufficiently massive bodies.

The difficulty surge here is how to explain the PVS to the terms of theoretic concepts and, as a consequence, to the principles or laws composed of these, since given its nature, it becomes clear that they cannot be directly verified in the experience, in such a manner that they would become non-significant and, therefore, the theoretic world which is one of the important pieces of modern science, would be matched to metaphysics.

For the logic empiricists, it is clear that a theoretic statement could not be directly verified, although it could be directly verified by logically rebuilding it based on statements referring to the immediate experience. But to achieve such reconstruction, and given the language division into observational and theoretic, there should be mixed statements which link theoretic statements to the observational ones, for the first ones to be significant. The logic empiricists named these statements *mixed rules of correspondence,* in such a manner that, in definitive, it was possible to verify, (in reality confirm, as seen below), a theoretic statement through observational statements which it is related to. Now, this verification may not be complete, since if so, it would imply that theoretic terms may be defined in observational terms, in such a manner that they would become observational, and therefore, superfluous; and, in addition, this would become contradictory to observational / theoretic dichotomy, which was the starting point. As it may be seen, the achieved situation is very similar to the one of the metals case, presented above.

This is why the logic empiricists made a re-reading of the PVS, where made clear that principles of a theory of theoretic statements may not be fully *verified* through observational tests, but they are more or less either or not *confirmed* by such tests; disregarding in this manner the certainty of theoretic principles and, in their place, clinging to their hypothetic character (See Carnal 1963, pp 57 and 59). This fact led to a flexibilization of the PVS, which the same logic positivists considered as a *liberation from the logic empiricism.* The PVS was changed for the *confirming principle of the meaning;* now, it is required for the theoretic statement to be only confirmed at any degree, and not in whole, through its observational implications. Carnap, verly well expresses this change of mind, in comments he adds in 1957 to the re-edition of his writing *The old and the new logic* in 1930-31, in these words:

> A scientific proposition may not be determined simply as a true or false; it may just be confirmed more or less son the basis of given observations. Therefore, the old principle of verification stated

for the first time by Wittgenstein was substituted for the more elastic requisite of confirmability (Carnap, 1930-31:151)[2].

Logic analysis of language and philosophy

La tesis metodológica del análisis lógico del lenguaje de la ciencia trae asociada la importante idea de que no puede ser una pretensión de la filosofía elaborar sistemas teóricos (filosóficos); la filosofía es solo eso, análisis lógico del lenguaje de la ciencia. Cito aquí en extenso a Carnap:

[...] the new *scientific method of philosphing,* which may be briefly characterized by stating that *it consists of the logic analysis of the propositions and concepts of the empirical science.* By so doing, the two most important traits which distinguish this method from the traditional philosophy have been noted. The first characteristic trait consists in the fact that this philosophing is realized in a close contact with the empirical science, therefore, any philosophy is no longer considered as a dominion of knowledge by own right, equal or superior to empirical sciences. The second characteristic trait shows what the philosophic work consists of, on the empirical science: it is explanation of propositions of the empirical science through a logic analysis. More specifically, in the breakdown of propositions in their parts (concepts), in a step by step reduction of the concepts into more fundamental concepts of and from propositions into more fundamental propositions. (Carnap, 1930-31:151).

This conception of philosophy is directly derived from how logic empiricists assume science. Science is understood as a group of statements systematically arranged, where each statement of the system says something about natural, social or human psychis reality, either direct or indirectly. This is equal to say that science is significant, tells about the world; and, inversely, all expressions which may not be linked to reality in this manner will be a significant metaphysical statement. Therefore, if statements of philosophy were significant, they would belong to science; and, inversely, of not, they would belong to metaphysics. In conclusion, the unique respectable path left to philosophy is to clean science from metaphysical elements which introduce by contraband, clarify those scientific concepts which are confusing or ambiguous (points which sometimes are ignored by scientists), unmask metaphysical systems which present as respectable by showing the vacuum of their statements, and being clear and accurate in everything which it proposes, contrary to the dark and the non-examinable. In summary, according to Wittgenstein's words: "Philosophy is not a doctrine but an activity" (TLP: 1992, 4.112): Philosophy is a clarifying activity, but not construction of theoretic systems of knowledge. There are no philosophic problems as such, what there are, are scientific problems where philosophy cooperates by seeking explanation and meaning. This is very clear in *the scientific conception of the world (1929):* "Clarification of philosophic traditional problems lead us, in part, to unmask them as pseudo-problems and, in part, to transform them into empirical problems, and then submit them to judgment by the science of experience. The task of the philosophic consists of this clarification of problems and statements, but not in proposing "philosophic", own" statements (Hahn, Neurath and Carnap, 1929:112).

Now, for logic empiricists, the best instrument of philosophy to perform this task of conceptual clarification and metaphysical asepsis, is the formal logic, which main promoter was Frege by the end of XIX Century, and which consolidated by the early XX Century through Russell, Whitehead and Wittgenstein's works, mainly. As it is natural,

As natural, the logic analysis methods of language should be satisfactorily combined with application of empirical principles. This is, the exam of a particular problem should be guided by established empirical principles, in such a manner that their application is oriented by the logic analysis of involved concepts and arguments.

In definitive, ¿what is understood by logic analysis of language? Previously to underline the emphasis on logic analysis, the first thing that logic empirical methodology shows is what is considered as the *linguistic turn in philosophy:* traditional problems and the new ones of philosophy should be approached in terms of the language; in this manner clearness and accuracy in the same are achieved; in summary, the true philosophic problems, if any, are problems of language. For example, in epistemology there is neither room for a psychologist perspective, that search for the origin of knowledge, and how it is expressed in thoughts, nor questions on applied knowledge, for example, the perspective that should be privileged, is the study of knowledge but in terms of language in

2. In the *Tractatus* the principle appears enounced in many ways; here is one: "4.063 […] to be able to say 'p' is true (or false), I have to had determined in what circumstances I call 'p' as true, and by so doing, I determine the meaning of the proposition."

which it is finally expressed. Secondly, the maximum methodological "logic analysis of language" may not be taken in the strict sense referring the pure logic, to jus formal questions, but in a wide sense related to applied logic, which includes syntax, semantic and pragmatic dimensions of language, and theories stated in a certain language. In addition, such analysis is accompanied by reconstruction, this is, many times it is important to make a logic reconstruction of the problem stated for a subsequent critic of the same through analysis.

Along this article various presentation have been made, which serve as an illustration of the logic analysis method, and all of them are expressed in linguistic terms. We begin by distinguishing the analytical statements from the synthetic ones; the the PVS was introduced, which is semantic, to exclude the metaphysical statements in any manner legitimate of knowledge, in particular of the science; and in the various cases examples were given.

Unified science: reductionism

We have made critics to some theses of logic empiricists, and many will be made, but we should recognize that they are loyal, consequent and coherent with their principles, and there is no doubt that the philosophic project of a unified science that they marked, complies with such principles. The project consists of: Uniting and harmonizing achievements of the various sciences through the *collective work,* privileging inter-subjective knowledge, search for a total system of concepts, under the same symbolism, and neutral language" (Hahn, Neurath, and Carnap, 1929:112). Sciences that would be the subject of unification would be the natural sciences (physics, chemistry and biology), psychology, and social studies. Notwithstanding we should recognize that at a first sight these sciences bear very different purposes of study (the nature, psychis, and social life, respectively), the unification project is realizable, since: at being sciences, it is possible to refer their various kinds of knowledge to what is directly given, which we directly experience; in all of them it is possible to implement the same method, the one of logic analysis of concepts and arguments; and, finally, also under the logic orientation, it is likewise desirable and possible to create a unique neutral language, with the same symbolism, which will lead to a clear communication among the various sciences, and, surely, a safe and agile progress in such fields.

If we start by recognizing that *what is given* or direct experiences are described through the physicalist language which refers to objects and processes located in the space-time, then it is clear that according to the con behavioral psychology (which dominated the epoch), it is possible to translate the various psychological concepts, which are subjective, in terms of an individual's behavior, which is expressed in terms of physicalist language proper of sciences of nature. Something similar could be possible with social sciences; its various concepts could be translated into the physicalist language of this field. Thus, the project of unified science is reductionist, but reductionism is not ontological but methodological, according to logic empiricists. There are no realist pretentions, since the purpose is not to reduce the entities of the world of the human psychis, and the social life to physical bodies and their relationships. The pretentions are methodological, psychological concepts and sociological may be translated into physical concepts; and likewise, physical concepts and sociological could be reduced to the psychological ones, since physical concepts may be expressed in terms of perceptive experiences of an individual, and the sociological ones, in a first instance are reducible to the physical ones. All what is sought is to rebuild the concepts from a field into terms of the other.

But in the reality this project is not feasible, not even in methodological terms. The fact that a relationship among concepts is established, should not imply disappearance of any one of them. This may be seen even in natural sciences. An example taken from Bunge (2007), according to the chemistry which Water = H_2O, but fluidity and the ability to evaporate are properties of water, but not of the composing molecules.

The two-level model of language: Structure of empirical theories

This heading integrates the various components of logic empiricists into a full image of scientific knowledge, of scientific theories and their structure. This image uses to be called *inherited conception* of scientific theories, taking into account the influx and dominion it held through the late 70s of the last Century. This image of sciences and theories is dominated by the observational /theoretic dichotomy of language, as we warned in the heading *verifying principle of meaning: science and metaphysics.* Likewise, it is worth to stress that logic empiricists were the first ones in developing and support the systematic theory, contained in a philosophic

proposal likewise systematic, which would answer to the question: what is a scientific theory, and what is its structure. Such conception of scientific theories has is origin, mainly in Leibniz, Frege, Russell and Whitehead's logicism, and in the formal axiomatic method of David Hilbert for mathematics.

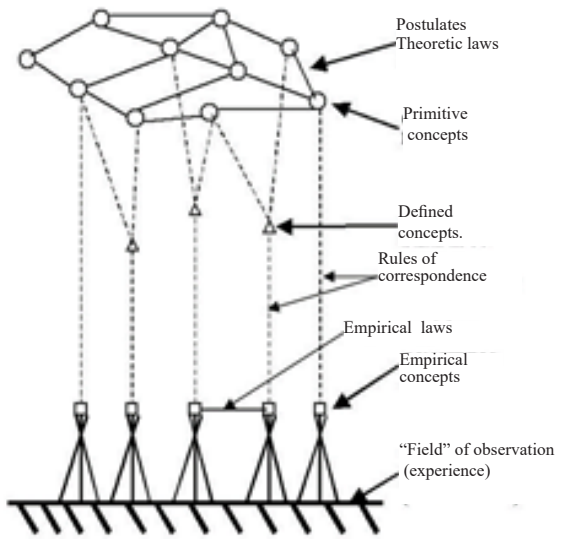
In a succinct and technical manner, and following the scheme of la figure 1[3], a theory is a group of statements deductive and axiomatically arranged, in the strict meaning. In other words, a scientific theory is an axiomatized formal calculation (or system), which axioms represent the fundamental laws (or principles) of the theory, which are partially interpreted through rules of correspondence (or interpretation or coordinated definitions) which relate theoretic terms to observation terms. This idea of theory was already clearly expressed in*The scientific conception of the world* (1929), through which is *systems of hypotheses and axioms.*

> A system of axioms fully free from all empirical implication may, at the beginning, be considered as a system of implicit definitions; through which the following is thought: the concepts appearing in the axioms are determined or, in a certain way, defined not for their content, but only for their mutual relationships through the axioms. Such system of axioms acquires a meaning for the reality just through the addition of additional definitions, such as "coordinative definitions, through which it is established what objectives of the reality should be considered as members of the system of axioms (Hahn, Neurath, and Carnap, 1929:117 - 118).[4]

The formal system (axiomatic) corresponds to the net of upper part of the scheme. The knots of the net represent the primitive concepts, and the strings the postulates or axioms of the formal system, which is disinterpreted. The axioms are equal to the theory laws, but once they have an empirical interpretation. Immediately below the net the derived concepts are found. While the lower part of the scheme corresponds to the observational level of the theory, which is directly linked to the experience, with the world. There, we find the empirical concepts or observational, and the relationships among them represent empirical laws or inductive, or of low level, such as the law *All metals expand with heat.* The two levels, the formal and the observational, are connected through the mechanism of rules of correspondence, (coordinative definitions), which relate primitive concepts to empirical concepts.

> Items frente a la figura en su orden vertical. POSTULATES Theoretic laws. PRIMITIVE CONCEPTS. DEFINED CONCEPTS. Rules of correspondence. Empirical laws. EMPIRICAL CONCEPTS. "FIELD" OF OBSERVATION (EXPERIENCE)

Fig. 1. Representación empirista lógica de una teoría científica.



Thus, rules are mixed statements, theoretic-observational, and it is through them, that the formal system acquires an empirical interpretation or meaning, in this manner turning into a theoretic system, or empirical theory. If these rules did not exist, there would not be empirical theory (or physical theory), just a mathematic theory or a logic system. In synthesis, an empirical theory is a formal system with an empirical interpretation, plus all statements derived from such theory.

Two final remarks. This model leads to clearly establish the distinction between empirical law and theoretic law; the first one is obtained through induction, and it is composed only by observable

3The figure is an adaptation of the one appearing in Giere (1988), p 25; which in turn is a reproduction of Feigl (1970).

4 Ten years later, Carnap (1939), expresses the same idea as follows: "We may first builds a calculation and later establish the desired interpretation y a way of semantic rules which contribute a physical theory as a system interpreted with a factual content" (P.124)

concepts, while the second one is normally the result from a creative act of a scientist, and it is a relationship among theoretic concepts. Secondly, this approach of scientific theories is considered as *syntactic* because it emphasizes on theories as formal systems and, according to the logic, every formal system is associated to syntax of a formal language and, in addition, the *derivability* is a syntactic notion.

Biyle's law and its relationship to Newtonian mechanics leads us to very well illustrate the various elements of a theory from the logic empiricist perspective[5]. Boyle's law is supposed to be empirical, it is an inductive generalization that relates observational concepts of pressure, temperature and volume of a gas, through the following equation: Pressure (P) = Temperature (T) /Volume (V).

In addition, it is understood that kinetic theory of gases is the one which truly describes internal behavior of gases, in turn accounting for Boyle's law, which only describes observational behavior of gases. This is, the subjacent structure of gases described by theoretic laws of the theory of gases leads to describe observable phenomena governed by Boyle's empirical law. Now, kinetic theory of gases is, in essence, implementation of Newtonian mechanics in this particular dominion, since, according to this latter, gases are composed of molecules in motion which comply with the laws of Newtonian mechanics, the laws of inertia, motion (F=m .a), and action-reaction.

Well, let's see how the main elements of an empirical theory are presented here, this is, theoretic levels and observational, and the rules of correspondence. Volume, temperature and pressure are observational concepts, since they are easy obtained through observation, or through relatively simple measurements. The concepts of force and mass are theoretic, they do not refer to directly observable entities, but they are accurately introduced in a first time by the theory; in this case by Newtonian mechanics. Finally, we could state that the following relationships between observational concepts and theoretic concepts, that they are but approximated definitions of the first ones in terms of the second ones, act as rules of correspondence.

(1) The volume of a gas is directly related, basically, to the number of molecules of the gas and its respective mas

(2)The temperature of a gas is equal to the kinetic energy (mass and velocity), average of molecules of the gas.

(3) The pressure of a gas is equal to the average shock (F) of the molecules against the walls of its container.

The above leads to observe, in addition, how kinetic theory explains macroscopic behavior of gases; in other words, how Boyle's law is deducted parting from Newton's laws. Finally, from this perspective, Newton's mechanics is basically equal to the three laws of movement with the law of gravity, plus all of the other statements, logically deducted from those laws.

To end, it is worth to underline some virtues and deficiencies of the philosophic program of logic empiricists that will become obvious in any manner, during the fifty years following their statement. There is no room for doubt, that the various theses by logic empiricists take pride in their requirement of principle regarding clarity and precision; in addition, they assign a character of professional to philosophy of science by defining old philosophic and scientific problems, by stating implicit problems, by presenting other new ones, and implement the method of language logic analysis; everything within this new framework of systematic philosophy of science. Definitively, it is worth to recognize that they were loyal, consequent, and coherent with their principles. But, paradoxically, many of their theses and methods will be strongly criticized due to their radicality and tightness. Here are sme of these limitations. 1) The empiricism it defended, which, does not represent philosophy proper of modern science and current: while the latter has evidenced how observable phenomena transcend, empiricism assume them as an unsurmountable limit. 2) excessive emphasis on language, on analysis of language, since it sacrifices the study of science itself; interest does not fall in problems surged inside particular sciences, but in questions exclusively related to the scientific language. 3) It almost fully ignores, (not to say completely), the role of experimentation in scientific knowledge, since this is completely reduced to direct observation[6] and, therefore, the unique function performed by experimentations (as well as observation) is the one of confirming of challenging theories.

5 This illustration is also used by Sellars (1963), although not in the same manner.

6. As Weber (2005) says, for logic empiricists: "Such distinction does not have a systematic importance for epistemology" (p.129). Translation by the author.

Referencias bibliográficas

Bunge, M.(2007). *A la caza de la realidad. La controversia sobre el realismo*, Barcelona: Gedisa.

Carnap, R. (1986). La antigua y la nueva lógica. *El positivismo lógico*, México: FCE.

———. (1975). *Fundamentos de lógica y matemáticas*. Madrid: Taller de Ediciones Josefina Betancor.

———**.** (1992). Autobiografía intelectual. Barcelona: Paidós.

Coffa, J. (2005). *La tradición semántica. De Kant a Carnap*, México: Universidad Autónoma Metropolitana.

Giere, R. (1992).*La explicación de la ciencia. Un acercamiento cognitivo*, México: Consejo Nacional de Ciencia y Tecnología.

Guerrero,G . (2009). *Introducción a la filosofía de la ciencia. Documentos de trabajo*, Cali: Programa Editorial Universidad del Valle.

Hahn, H; Neurath, O; y Carnap. (2002). La concepción científica del mundo: El círculo de Viena", *Redes. Revista de estudios sobre la ciencia y la tecnología*. 9, (18), 103-149.

Mahner, M y Bunge, M. (1997). *Fundamentos de biofilosofía*, México: Siglo XXI.

Reichenbach, H. (1965). Racionalismo y empirismo. Investigaciones sobre los orígenes del error filosófico, en *Moderna filosofía de la ciencia*, Madrid: Tecnos.

Sellars, W. (1971). *Ciencia, percepción y realidad*, Madrid, Tecnos.

Schlick, M. (1986). El viraje de la filosofía.*El positivismo lógico*, México, FCE.

Wittgenstein, L. (1991). *Tractatus Logico-Philosophicus*. Madrid: Alianza Editorial.

Weber, M. (2005). *Philosophy of experimental biology*, Cambridge, Cambridge University Press.