COMMENTARY

Between Physics and Metaphysics: Structure as a Boundary Concept

Ramiro Tau

Abstract The notion of structure is found to be used in a great number of theories, scientific research programs and world views. However, its uses and definitions are as diverse as the objects of the scientific disciplines where it can be found. Without trying to recreate the structuralist aspiration from the mid XX century, which believed to have found in this notion a common transdisciplinary language, I discuss a specific aspect of this concept that could be considered a constant in different perspectives. This aspect refers to the location of the notions of structure as *boundaries* in the different scientific theories. With this, I try to argue that the definition or presentation of a structure configures in itself the frontier for scientific knowledge, defining at the same time implied ontological assumptions. In order to discuss this hypothesis, and taking into consideration the double origin of contemporary notions of structure –the mathematical and linguistic line–, I revise several theoretical perspectives which made explicit the relation between structures and knowledge, and their relation with the real: the arguments on physical knowledge by Eddington, structural anthropology, structural linguistics, Lacanian psychoanalysis and Piaget's genetic psychology.

Hypotheses non fingo.
    Isaac Newton 1687

    The stimulating work of Papanicolaou, *Beyond Eddington's argument* (2014, in this issue), in which the perspective of Sir Arthur Stanley Eddington on the nature of thinking and its relationship with the material world is revised, confronts us with a persistent philosophical question: what is the fundamental nature of things? This problem had always the contradictory condition of being both central and peripheral regarding the field of scientific knowledge. Pursuing an always impossible answer,

R. Tau (✉)
National Council for Scientific and Technical Research (CONICET), National University of La Plata (UNLP), La Plata, Argentina
e-mail: rtau@psico.unlp.edu.ar

science ran through an incessant search for the knowledge of the nature of their objects, only under the condition of avoiding the question on their essences. This means that the issue on the ultimate foundation of things and its knowledge seems to be found behind every theory, in spite of having never been a declared aim. Being detracted to theoretical speculation, the question on the world's substance cannot initiate any of the strategies which science unfolds in its knowledge gaining process. Nevertheless, implicit or explicitly, empirical sciences lie on a variety of ontological hypothesis, though such assumptions stay out of their control or verification.

Defining reality and what knowledge of reality is, thus, an avoided though inevitable matter in empirical sciences. In spite of keeping it out of reach from their methods, the intellectual efforts to define the actual scientific aims can help to build a philosophy regarding the world's ultimate nature. I am not saying that philosophy must be subjected to science but the frontiers between both fields seem to define each other in a set of crossing references.

As Papanicolaou points out, Eddington roughed out an argument that contributed, together with other authors' works that followed the Kantians steps, to the definitive withdrawal of ingenuous realism. In their philosophical considerations, we can find references to notions belonging to rising material sciences, mathematics, and to a variety of psychological assumptions about perception and access to mental events. However, in this article I will focus in a particular notion which transversally crosses Eddington's thinking: the notion of *structure*. As I will try to show, this notion operates as a boundary concept between different fields of knowledge inside Eddington's system, and allows, thus, a convergence of physics and metaphysics.

Having in mind this leading and very general hypothesis, I asked myself if this function of the notion of structure, recognized in Eddington's thought, can also be found in the core of other theoretical perspectives having used this notion. To assume the consequences of these questions would entail revising a great number of theories, especially those registered in the so called "structuralism", exceeding the limits of this exposition. However, in an attempt to verify the feasibility of my questions and the reasonability of this hypothesis, I will revise, very briefly, four theoretical approaches, quite different from each other, where a privileged use of the structure notion has been made. The selection might be considered arbitrary and it is, as a matter of fact. Nevertheless, I believe that the perspectives or views in question have an ideal value for two reasons. On the one side, the notion of structure we find in each of them had a positive heuristic value in development of knowledge in the domain delimited by the theory itself. On the other side, because these theories to which I refer to, were characterized for having raised and discussed openly the relationship between the theoretical assumptions and the ultimate nature of objects or entities considered. In my revision I will try to characterize the theoretical roots of the notion of structure employed, the coincidences and differences between the dissimilar meanings, as well as the acting part of this notion in the search for an answer to the ultimate nature of world's matter.

The Structural Correspondence in Eddington's Neutral Monism

Eddington, with a Cartesian spirit, tried to establish a philosophy that agreed with physics in his time, specially, with the emergent relativity and quantic mechanics. The

implications of these theories were developed by him in a speculative conceptual construction, where he tried to combine *physics* with *weltanschauung*. His philosophical thoughts, in which he tried to systematize a vision of the material world's nature, wore down the prestige and popularity he had been entitled to as a science disseminator. Both his arguments and his conclusions were undermined by the critics they received, "primarily because his thinking was so unorthodox, but also because his ideas could be ambiguous and even confusing" (Gherab-Martin 2013, p. 500). Aside from this complaint about his lack of precision, Eddington has been called an idealist and a mystic. His statements on the mental substance as the only substance in the world, contributed to the fact that he was normally remembered as an idealist who was against all ontological materialism and dualism. Yet, there are reasons to believe that his position, heiress of the many Bertrand Russell's ideas, settled on the neutral monism doctrine, rather than on spiritualist monism (Demopoulos and Friedman 1985; Gherab-Martin 2006; Russell 1912, 1919, 1921, 1927; Yolton 1960). In fact, Eddington believed in the possibility of overcoming the matter–conscience dualism, a dualism based in the assumption that in the external world, we can find an incommensurable substance in comparison to the one which characterizes conscience (Eddington 1939). This break up of all substantial dichotomies was possible, so he stated, thanks to the *structural correspondence* postulation between conscience's sensations and the "external world". Avoiding dualism through the notion of structure was obvious too in Russell's Philosophy, as Eddington himself admitted. Regarding this particular monism, he objected, specifically, the idea of certain phenomena, as time and space, being subjective and having objective aspects at the same time. In this criticized dualist description, the subjective aspects would be a result of things in themselves and would express in phenomena, dividing two substantially different worlds: that of things and that of conscience. On the contrary, the monism supported by these authors implies that the knowledge of the thing in itself, to which we can have access to, is based on the structural correspondence between the phenomenon and the thing. As so, the transmittable propositions with meaning should be real for both worlds or for neither of them. Hence, following Russell's reasoning, substance duplication would have no meaning, since the assumed two worlds identify each other on and for a unique structural substance.

Now, what kind of structure is Eddington referring to when he points out that what is possible to be known is exclusively structural? What relationship is there between his conception of structure and the world's nature?

There are two interesting questions –specially treated in both *The nature of the physical world*, from 1928, and *The philosophy of physical science*, from 1939– which are outlined over and over again by the curves in Eddington's thought. The first one could be expressed in the following way: what can we know from the world? And the second one: what is actually what we observe? We notice, firstly, that these questions refer to the kind of entities involved in knowledge, and not to the process through which we attain knowledge. However, the answer to this essences matter might have a solution based, not in pure speculative reasoning, but on the analysis of scientific knowledge production's own strategies.

Taking physics as an example, Eddington (1939) stated that knowledge is always, in a strict sense, structural knowledge. To fundament this statement, he referred to the relationship between factual sciences and mathematics. In this relationship we must

bear in mind that, natural facts mathematization does not simply consist of using descriptive nomenclatures or notations, which would be an unsuccessful codification. Mathematization leads us to new knowledge only if it can explain the world structure. In order to understand this, we can assume we dispose of a series of entities, labelled A, B, C. We can suggest relationships and comparisons between each of these entities and the operations which transform an A entity into a B one –or any other possible conversion between them– are labelled P, Q, R. In its turn, P, Q, R processes can be compared with each other, so to obtain a new group of operations –or hyper-operations– X, Y, Z, which transform P to Q, R to P, and so on. All this means, to Eddington, a simple notation on which there is no mathematical participation, and it consists, in a strict sense, in a useless symbols proliferation that leads to no fresh knowledge.

To make use of a mathematical tool with a practical purpose, the infinite operation successions must have an ending, a closing. This can be achieved only if X, Y, Z are proved to be not hyper-operations but just operations that were already part of the set P, Q, R. In other words, finding out that the same operation, which transforms an entity into another, helps to explain the conversion of an operation into the other. So, the infinite proliferation will be reduced to a limited set of operations –i.e., to a *group*– which does not result in a rising complexity retrogradation. This vision synthesizes the *Group Theory* and, according to our author, it presents a great usefulness to physics, since the different shares of our experience can be related to each other, and therefore be interpreted in these structural terms. A group has a structure which can be described on mathematical terms and that structure is an empty mold which does not refer at all to physical nature of entities and their relationships. Having said this, to Eddington, structure is the answer to the matter that has troubled entire generations of philosophers and that refers to knowledge foundations: "What sort of things is it that I know? The answer is *structure*. To be quite precise, it is structure of the kind defined and investigated in the mathematical theory of groups" (Eddington 1939, p. 147). Starting from these suggestions the concept of structure helps achieving knowledge abstracted from its contingent and phenomenic expression and which can be announced to others –something opposed to the isolations of sensations and possible emotions–. Structure is understood here as a mold with no other property than its relationships. So, for example, it is possible to overcome the indescribable subjective experience in the presence of a landscape, telling and comparing the perceptive experiences of two individuals. In turn, we can state that the relations existing in the external world seem to persist when they attain conscience. This shows us that there is substantial continuity. In other words, we can assure that external world relationships seem to persist at the very moment of reaching conscious, which show us a substantial continuity. However, any attempt of understanding what is underneath a known structure results impossible: there is no way of trespassing the mathematical notation and the question on the world's nature persists; only now it has shifted. Structure is, simultaneously, that what we can know and the boundary for knowledge.

The perspective I just presented is the one that offered Eddington the foundations to avoid dualism, admitting a neutral substance, which is neither physical nor mental. Knowledge would stem neither from the external world sensations nor from pure intuition. The logical set off point of knowledge is the group structure that sensations acquire in a conscience. Therefore physical world would be no other thing but an

agreement of several individuals' group structures –a position that allows our author to avoid falling in solipsism–. Saying this, apparently there would be no need to create an unphysical replica of the physical world, nor physical replicas of the unphysical world:

> "The physical universe is a structure. Of the X of which it is the structure, we only know that X includes sensations in consciousness. To the question: What is X when it is not a sensation in any consciousness known to us? The right answer is probably that the question is a meaningless one –that a structure does not necessarily imply an X of which it is the structure." (Eddington 1939, p. 151).

This quotation gives us the idea on how unsustainable it is, from this approach, to present an X of a non-sensorial nature, given that this would be a duplication of conscience phenomena, rationally unjustifiable.

On the other hand, I believe that Eddington's arguments accounting for knowledge in structural terms are disconcerting when recognizing the distinction he made between two ways of contemplating the world: a scientific form and a form proper to daily experience. In relation to this matter, according to some other authors (see Gherab-Martin 2006), Eddington's position allows to distinguish three aspects that participate in the knowledge on world facts:

[a] a mental image, which is in our minds and not in the external world;
[b] a kind of counterparty in the external world, whose nature is inscrutable;
[c] a set of indicators and graduated scales, which can be studied and related to other indicators and gradual scales by exact sciences.

Recognizing a distinction between ordinary knowledge and scientific knowledge,

> […] Joad suggests that Eddington's leading thread, points out that the second form [ordinary knowledge] comes from (b), while the first one [scientific knowledge] identifies with (c) […]. And being (c) a closed circle due to the fact that every scientific term is defined by others which are not primitive; the physicist cannot describe daily experience images based on (c).

> We think Eddington's confusion stems from separating (a) and (c) and from believing (c) to be the external world skeleton, when to what his a priori knowledge argument actually leads is to prove that (c) is skeleton of (a), that is, the mental images skeleton a scientific has before taking any empirical measure. And it is not until then, *a posteriori*, that the scientific (or physicist) compares the a priori (a) skeleton with (b) structural skeleton which comes from the external world through senses and observation. (Gherab-Martin 2006, p. 121) [t].

We understand now that the separation of a mental image from its external world inscrutable counterpart is, in a sense, contradictory with his own argument which informs of a structural continuity between the external world and the facts of the conscience. A distinction between (a) and (c) is not entirely justified if we admit that images or sensations in conscience present a number of relational properties homologous to the ones of the science theoretical system.

In spite of this possible contradiction, I consider that this perspective is settled in the unity of substance of which any knowledge can account for. Even though this is not the time to discuss his distinction between ordinary and scientific knowledge, I believe, in the same way, that Eddington's thesis accounts for the central place occupied by the structural correspondence on which a philosophy compatible with physics and logic-mathematical regularization is settled. In other words, the central point of this argumentative edification lies in the presentation of the concept of *structure*, understood as an encounter place between two levels: the phenomenological characteristics level and the physical world's characteristics one.

In the years following Eddington's philosophical publications some analogous perspectives regained notable strength, founded on the idea of a world knowable for its structural properties. It is easy to find a great amount of empirical sciences that use the notion of structure to refer to their objects of study and to take a stand on the nature of ontological counterparts corresponding to the developed perspectives. However, these uses of the notion of structure were not always based on the mathematical conception Eddington appealed to. As we will see, aside from the mathematical root mentioned, there was a linguistic orientation that fed a whole range of theoretical orientations, ambiguously named structuralism. It is possible to recognize a variable incidence of these two origins in different theoretical fields. Some courses of thought often used exclusively the mathematical structure notion, while others lied on the linguistic conception. Nevertheless, intercrossings between both origins have also been frequent. Subsequently, I will revise some of the perspectives representing the alternatives I am pointing out, with the purpose of posing the problems in order to discuss the borderline function of the notion of structure, recognized in Eddington's thinking.

From Structure to Structuralism

The notion of structure has had a specific weight of such a magnitude during the XX century that a variety of theories and scientific research programs have organized and developed around it, characterized as *structuralists*. Structure adopted different places and functions in each theory where it flourished. However, despite all these differences and their definitions –vaporous at times–, the existence of a very general and shared characterization on what a structure is, has been postulated early on (Bastide 1968; Lapassade et al. 1966; Niccolini 1977; Piaget 1968; Sperber 1968; Wahl 1968; among others).

In spite of the structuralisms conceptual double origin, it is said that the main antecedent of this movement is found in the *Cours de linguistique générale,* by Saussure, F. de (1915). Even though it is true that in his teaching, Saussure did not use the term "structure", it is widely known the funding value his researches had in order to build a structural orientation (Benveniste 1966, 1968; Milner 2002; Rodriguez and Vallejo 2011; Sanders 2004; Verón 1977). The inauguration the *Cours* initiated was achieved by its considerations on the notion of system. As we will see, the language, defined as linguistics' object of study, was defined as a systematic whole whose properties do not belong to constituent elements considered independently, but to the oppositive relationships they hold.

Saussurean thesis on language as a system of arbitrary signs worked like a conceptual mold over which the developments were traced, not just from a large part of

linguistics, but of very remote disciplines. The so called "structuralist movement" showed an expansion that brought down the initial disciplinary limits, entering the rationality of diverse theoretical fields, that had not shown convergences so far. In the middle of the XX century the named "structural perspective" directed the discussions inside European and American universities, and it fulfilled the western editors' desks with articles. From the 1960s, it was inevitable for any "actualized" intellectual not to get involved in this current of discussions from which there seemed not to exist any possible removal. As a consequence of this expansion of the use of the notion of structure, it is not surprising that a great amount of revisions and works tending to show the uses, differences and meanings of a linguistic, anthropological, psychological, social or economic structure have been published during the '60s and '70s.

The structural orientation presented the characteristics of a fashion that excelled as a new Esperanto. One of the most emphasized trades of this structural perspective was the apparent unification of heterogeneous fields with regard to their object of study, their basic assumptions and their methods. In fact, the use of a common terminology seemed to introduce a transverse epistemological dimension to all of them. For that reason, structural research, in the Saussurean sense as much as in the mathematical sense Eddington appealed to, seems to have been a pursued aim, not just for its heuristic value but also for the possibility it offered to the definition of a shared ontology.

The First Linguistic Structuralists: Ferdinand de Saussure and Roman Jakobson

Ferdinand de Saussure's linguistics and the Circle of Prague's postulates set down the foundations for a structural study of language. Initially, Saussure stated that "language constitutes a system" (Saussure, F. de 1915, p. 145) [t], and that "it is a system of signs where the union between meaning and acoustic image is the only essential thing, and where both aspects of the signs are equally psychological" (p. 80). Due to the importance of the simultaneous relations between elements, we can say that "language is a system of pure values" (p. 152). Therefore, "language is a system where all terms are solidary with one another, and where the value of each element is the result only, of the simultaneous presence of the other elements" (p. 188).

In these initial statements, we can recognize the germ of a general structuralist conception. Language analysis showed that it constitutes itself between two "amorphous masses" –thought and sound- and that, where "elements of two different orders are combined; this combination produces a form, not a substance" (Saussure Saussure, F. de 1915 p. 186) [t]. In this way, the formal character of language was highlighted, regardless of the content and reference. Relations prevail in this pure form, defining the system as a totality of a new order, necessary for the understanding of the constituent elements' nature.

This perspective that provides primacy to the whole over the constitutive parts (Benveniste 1968), operated a new foundation of linguistics, by defining a formal object of study, independently from the materiality of its constituents. Saussure insistently expressed that it is illusory to consider a term "merely as the union of a certain

sound with a certain concept. To define it in such a way would be to isolate it from the system it is a part of" (Saussure, F. de 1915, p. 187) [t]. Language cannot be conceived as a collection of elements that can be studied independently from the system to which they belong.

These main ideas can subsequently be retrieved in different disciplines belonging to the structuralist perspective. The thesis regarding oppositive relations that constitute a totality which always comes before its parts was the foundation of the doctrine that, years later, evidenced linguistic systems' structure. This doctrine first appeared in the dissertations, originally in French, presented in the First International Conference of Linguistics in The Hague, in 1928, by three Russian linguists: R; Jakobson, S. Karcevsky and N. Troubetzkoy. They intended to set the lines for the study of phonematic systems. The theses contained in these presentations constituted a true manifest and inaugurated the Linguistic Circle of Prague's activity (Benveniste 1968, p. 27).

With the introduction of the notion of "structure", these presentations accounted for a further development and sophistication of Saussure's notion of "system". This notion allowed distinguishing different systems by recognizing their different structures. This conceptual novelty is useful, for example, if we are in the presence of two lexical systems and their composing verbal materials are very similar; the systems' structure will allow to differentiate them.

Saussure's focus in the form rather than the content can be reencountered in Jakobson's phonology, where "elements' sensorial content is less essential that their mutual relations within the system (phonologic systems' structural principle)" (Cercle Linguistique de Prague 1929, p. 23) [t]. The form, that is, the mutual relations between elements that constitute the system's structure, is what permits the distinction and identification of systems (p. 25).

Another clearly Saussurean aspect of Jakobson's thesis is the oppositive systematicity. Regarding this matter, the following quote is eloquent:

> […] vocabulary is not a simple conglomerate of isolated words, but a complex system of words which are somehow coordinated and opposed to each other. A word's meaning is determined by its relations with other words in the same dictionary, that is, by its position in a lexical system, and that position can only be determined by the study of the system's structure (Cercle Linguistique de Prague 1929, p. 55) [t].

Furthermore, he stated that the system is subjected to an inherent legality and that it is irreducible to inferior levels: "A phonologic system is not the mechanic result of isolated phonemes, but an organic whole whose members are phonemes and which has a structure subjected to laws" (Jakobson, cited in Benveniste 1968, p. 27) [t].

As pointed out by Benveniste, in these perspectives "structure" refers to "a system's structure" (1968 p. 27). On this basis, language is characterized as a system and analyzed by its structure. In other words, "[…] each system, formed by units which are mutually conditioned, is different from other systems due to these units' internal organization, organization that constitutes its structure" (Benveniste 1968, p. 28) [t]. All of the aspects referred to the sound or the

writing's materiality do not belong to the nature of language, which is characterized as a closed relations' set that defined entities only by the relations that have some existence.

The Structuralist Echo in Lévi-Strauss' Anthropology

Saussure enabled the development of a semiotic of human facts by stating that "language is a system of signs that express ideas, and therefore comparable […] to symbolic rituals, courtesy manners, military signs […] but is the most important of all of these systems" (1915 p. 80) [t]. This way of studying language as a system of signs was developed by Lévi-Strauss' structural anthropology. Mainly, in his works *Les structures élémentaires de la parenté,* from 1949, *Anthropologie structurale*, 1958 and *La pensée sauvage*, from 1962, the concept of structure allowed him to move forward in the understanding of different cultural phenomena, such as myths and kinship relations' organization.

For example, myth's structural analysis allowed capturing something essential that does not depend on the idiomatic nature in which it expresses itself. Myths present a structure that transcends linguistic barriers found frequently in poems. This does not depend on a third essence common to different cultures, but on the fact that a myth's nature is not its contingent expression but the relations between narrated tales. Myths' differential characteristic is their structure, which has its own order and legality. Following a similar trail of thought to the one of structural linguists, who showed the systematic value of language's elements, the structural method in anthropology evidenced that myths' meaning does not depend on the isolated elements that compose them. Myths are defined by "the way in which these elements are combined. Myths belong and are a constituent part of the order of language; more so, language as utilized in the myths manifests specific properties" (Lévi-Strauss 1958, p. 190) [t].

The studies of Lévi-Strauss on shamanism also introduced the notion of structure and established a comparison with psychoanalytic method. From this point of view, the *unconscious* was characterized as a set of structures which, in comparison with the occurrence or the anecdote, are timeless (Lévi-Strauss 1958). Such an unconscious is simply the term with which they refer to a function: the symbolic function, specifically human, that applies to all men according to the same laws and "is simply, in fact, the set of these laws" (p. 183). This implies that the unconscious is empty, "as strange to images, as stomach to the food that comes through it" (p. 184). It is an "organ of a specific notion", that "only imposes structural laws to inarticulate elements which come from elsewhere –and this is all there is to its reality–: drives, emotions, representations, memories" (p. 184). This unconscious organization is equal to "all matter to which the function applies to" and this "allows us understanding why the world of symbolism is infinitely diverse in its content, but always limited in its laws" (p. 184) [t].

This structural perspective aspired to the reduction of the diverse to a few laws which organize it:

There are many languages, but very few phonologic laws, valid for all languages. A compiling of all famous tales and myths would consist on a multitude of books. But they can be reduced to a small number of simple types, where a few elementary functions operate behind characters' diversity; and complex individual myths, reduce to a few simple types, molds where fit the fluid of the multiplicity of cases (Lévi-Strauss 1958, p. 185) [t].

It is clear that the resource to structure entails a series of methodological advantages analogous to those found in phonology. Structural anthropology's filiation to linguistic is not only evident because of the correspondence between the terms that define the structural properties of the disciplines' objects of study. Lévi-Strauss himself expressed this methodological inspiration:

"[…] it is clear that the methodology I follow is merely an extension in another domain of structural linguistics' method, to which the name of Jakobson is associated […] I simply follow one of the paths traced by Jakobson himself" (Lévi-Strauss 1958, p. 212) [t].

However, I consider that this extension is not a mere extrapolation of linguistic structuralism to anthropology, due to the fact that the kind of legality at stake is specific to each field. In mythical analysis, for example, even though we proceed to the recognition of a structural organization that presents several general characteristics common to other structures, the relations evidenced are exclusive to mythical narrative and do not belong to language. Subsequently, the laws that rule the functioning of a structure are not necessarily universal laws. In spite of this specificity due to the objects of study's nature, structure operates as the limit of attainable knowledge, from a methodological point of view as well as because of the ontological presuppositions assumed.

For anthropology, the notion of structure's heuristic value lays in its ability to answer the question regarding what makes a myth able to emerge as such, different from a simple anecdote and recognized by members of different cultures. Lévi-Strauss states that the key of the matter is the recognition of its signic and systematic character. Analogous to language, but with its own structure and legality, the myth offers a subjacent dimension to all its variants. Even if their contents are different, it can express a common structure.

The search for mythical studies can organize and guide research of what seemed chaotic and inaccessible. A constant structure can be recognized throughout the infinite variety of a myth's manifestation. The *structural method* is what guarantees the passage from manifestation to structure, and thanks to which it is possible to access the form of thinking:

If structural analysis as a method is applied systematically, we can order al known variants of a myth in a series, forming a kind of permutations group, where the varieties set on both ends of the series offer, one towards the other, a symmetrical but inverse structure. An order principle is introduced where there was only chaos, and some supplementary advantage is gained by extracting several logical operations that constitute the basis of mythical thought (Lévi-Strauss 1958, p. 204) [t].

This method entails a structure modeling that must account for systematicity, grouping and adaptation of the facts:

> Firstly, a structure presents a character of system. It is constituted by elements that, if one of them is modified, they all change. Secondly, every model belongs to a system of transformations, each of which corresponds to a model of the same family, so that the set of transformation constitutes a group of models. Thirdly, the properties abovementioned, allow the prediction of the way in which the model will react if one of its elements is modified. Finally, the model must be built in a way that its functioning can account for all the observed facts (Lévi-Strauss 1958, pp. 251–251) [t].

The transformations group and elements properties permit prediction to a certain extent, not taken into consideration by linguistic theorization. Beyond this aspect, fundamentally, these few presented statements show the way in which Saussurean and Jakobsonian theses can be retrieved in the field of anthropology. As well as in the marital institution, where the women exchange network is essential and common to all of its manifestations, and not the family or any other isolated unit, in any other cultural fact, the system of reciprocity that characterizes language is fundamental (Lévi-Strauss 1949). Legality and relations between elements are specific to each system considered but, nevertheless, the common point of every system is the notion of structure.

The Interpretation of Lacan and the Introduction of Structure in the Psychoanalytical Field

In the work of Sigmund Freud, the term structure is used, mainly to refer to the psychological apparatus organization (Strachey 1961). This implies that this meaning corresponds to the topic point of view of Freudian metapsychology. Lacan's reception of psychoanalysis introduces a much more specific meaning of the notion of structure, based mainly in linguistic, structural anthropology and mathematics developments.

In historical terms, in the psychoanalysis developed by the second and third generation of psychoanalysts (Roudinesco 1994; 1997) the notion of *structure* was used as a "hanger" for different ideas, such as Lacan's on the unconscious or the relational character of the psyche (Evans 1996). The generic idea of an organized totality allowed formalizing the critique to atomistic conceptions from the beginning of the XX century and at the same time presented psychological constitution in relation to the field of language (Fair 2009; Lacan 1936).

However, Joël Dor points out that "Lacan applied the structuralist strategy to the psychoanalytical field. He introduced in the analytic theory articulation, some principles from structural linguistics which will originate a radical epistemological mutation in the field of metapsychological elucidations" (1994, p.14) [t]. Different from other psychoanalytic perspectives which refer to personality structure, psychological or family structure, the cross-linkage with linguistics operated a substantial theoretical reorganization (Dagfal 2009).

Even though a thorough analysis to reveal the uses of the notion of structures would present variations along the work of Lacan, I will try to highlight constant aspects that account for the limit between theoretical notions and ontological assumptions.

One of Lacanian psychoanalysis' theoretical matrixes nurtured from Saussurean linguistics. Saussure's concept of system, where elements have an oppositive value, constituted the nuclear meaning of the term "structure" in the work of Lacan (Evans 1996). For Lacan, Freud's work itself enables the introduction of certain concepts taken from linguistics in the psychoanalytical theoretic field (Dor 1994). Early on, in his work on family complexes, he presented a progressive structuration of the subject, based in the family group organization (Lacan 1938). He presented three consecutive phases, corresponding to three different complexes, showing how each of them corresponds to a particular relation between the elements at stake, which are defined in turn, by their mutual relations. Necessarily, this presentation in structural terms entailed a modification of the founder of psychoanalysis' original ideas.

A few years later, in the first meeting of the French Association for Psychoanalysis in 1953, Lacan presented his work "The symbolic, the imaginary and the real", where he referred to the need of returning to Freudian Reading. Beyond any discussions regarding the meaning of such a proposal, it is evident that any process of reading is an act of interpretation. The contrary is the source of orthodoxy, close to biblical hermeneutics. This "return" to Freud was presented with the intention to discuss Postfreudian psychoanalytical developments (Zafiropoulos 2003). Baring this aim in main, Lacan used the notion of structure, trying to deconstruct imaginary references in Freudian texts. Metaphors and narrative resources which Freud employed to make psychological dynamics comprehensible were made aside by Lacanian formalization. In this process, linguistics constituted an inestimable prime matter, and the encounter of these two fields, far from entailing a transcription from one to the other, deeply modified psychoanalytical conceptions.

For example, in the work from 1953 abovementioned, Lacan showed that there is something "structured and organized as a language" in the symptom (Lacan 1953, p.10) [t], which makes the original idea of a symptom as a ciphered message, more complex. Besides the reference to the significant order to explain the symptom's structure, Lacan presented unconscious as structured as a language: "the unconscious is structured as a function of the symbolic" (Lacan 1959, p.12) [t]. The unconscious works as a structure regulated by timeless laws –like Levistraussean unconscious– independently from the elements that it is imposed to. Taking the laws presented by Jakobson, Lacan reinterpreted Freudian condensation and displacement in phonologic terms. So, metaphor and metonymy are the two laws which regulate significant dynamic. According to Milner (2002), Lacanian psychoanalysis stated that these laws which can be found in language are not exclusive properties of the languages, but extensible to any kind of signifying chain. Lacan's unconscious is, hence, ruled by metaphor and metonymy, not because it is a particular language, but because it is structured.

Having said this, the question regarding unconscious' materiality arises. What are the entities to which its laws refer to?

Unconscious materiality is that of signifiers themselves and there is no possible reduction to another order. Language level, which founds subject and unconscious, constitutes the materiality psychoanalysis studies. Structure does not refer to any

essence but to a relation between elements. This would seem to show, among other things, that structuralism did not consist on formalization with clarifying purposes, but a true modification of theoretical ideas and ontological assumptions.

We must acknowledge that linguistics was not psychoanalysis' only external reference, which Lacan used to theorize on analytical experience. As a matter of fact, anthropology, philosophy and ethology have been frequent references. Among them, mathematical and topological references were also frequently used. However, all of these notions' original meanings were notably modified. This "deforming assimilation" produced a *sui generis* idea of structure. That is why there are so many analogy points with other structuralist perspectives. In spite of its large amount of references and transformations as a result of its reception, Lacan's thought on structure in strongly tributary of linguistic ideas. More so, even though Lacan does not refer to sign as a joint between signifier and signified, but as the relation established in a chain of signifiers, the notion of value prevails in his approach. Signifiers are defined in their enchainment creating a value that emerges from the relation between at least two elements; the meaning of a significant is not localized in the significant in itself, but in the conjunction it establishes in contact with another significant.

The fidelity of Lacan to the postulates of structural linguistics was larger than the one he kept towards other fields of knowledge. Jakobson's phonology showed the function of phoneme zero for an opposition system. Later, Deleuze generalized this idea to show that the key point of structuralisms was not the relations in oppositive terms, but the possible dynamics thanks to the existence of an empty element –or zero phoneme. Regarding this issue Lacan was also coherent with linguistics, since his own structural interpretation of psyche and symptoms was inspired in the dynamic proposed for the field of language. In fact, for Lacan, signification effects are given by the articulation effects of signifiers in a chain while Lévi-Strauss –closer to Saussurean theses in this matter– believes that elements acquire meaning by the opposition relations in a system.

Nurturing from ideas by Saussure, Jakobson and Lévi-Strauss, Lacan used the concept of structure to explain the relational character of subjective constitution. The notion of subject –in the double meaning of "agent" and "subjected" (Dagfal 2009)– is one of the concepts that evidences more clearly the absence of essences to which structural terms would refer to. The subject, different from the ego, is an effect of the relations between signifiers and is, in consequence, a space in the gap between them: "the subject in only subject in virtue of this fastening to the field of the Other" (being the "Other" the field of language or the symbolic order; Lacan 1954, p. 188) [t].

The loosing of the essence of subjectivity was one of the consequences for this encounter between psychoanalysis and structuralism. And, as for Eddington it was not possible to break the barrier of mathematical structures in order to look for was is below it, for Lacan there is not either another nature beyond the significant structure itself, at least before the clinic of the real. To look for a different reality below language, according to his perspective, would be equivalent to look for a system for symbolic system, which is impossible. This idea is summarized in the idea that there is no Other for the Other (Lacan 1975). Not only the *subject* and its field are a limit to the real, but reality itself is defined by this field of language from which there is no possible remission. Reality is a fetichization of the phenomenon, and phenomena do not veil an objective fundament. It is in the same field of language that subject and reality

appear as consistent. Not as an epiphenomenon of something else, but as a set of ultimate entities over which it is possible to pronounce oneself.

Structural Aspects of Cognitive Development in Piaget's Genetic Psychology

Locke (1690) pointed out that the substance, which is, what remains in what changes, −from Latin *substantĭa*, derived from *substare*, "being under"–, is "something" that lies beneath an object's sensorial qualities. It is an aloof notion, irreducible to any perceptual qualities, but which is, at the same time, implied in all of them. One of the main paradoxes that, years later, Piaget observed in child cognitive development has its roots in this fact. This paradox states precisely that the notion on the amount of substance is previous to the notions of weight and volume, which seemed to depend more directly from perceptive registry. Surprisingly, the notion on the amount of substance, being far more abstract and not being able to be reduced to any of the perceptive qualities adjudicated to a physical object, is the first to be attained in the development of physical quantities. Piagetian explanation for this observation is complex (Piaget and Inhelder 1941; Piaget 1975) but I can briefly mention that this strange sequence of appearances is a result of the progressive structuring activity of the real (or "of reality"). Logical structures that define the organization of thought, explain this sequence constantly encountered in research (Piaget 1959). The notion on the amount of substance is a logical precursor of the notions of weight and volume. Following this trail of thought, we can say that development proceeds through an increasingly complex hierarchic structuration.

These Piagetian theses allowed refuting Empiricist explanations which intended to derive facts' knowledge from a direct register of experience. More importantly, they permitted showing that what we call "reality" is a result of a *structuration*, of a series of cognitive coordinations that transform themselves and, at the same time, transform the world.

Having said that, what does Piaget mean by structure when he uses this notion to explain thought development? What theoretical references can be recognized in this particular kind of structuralism? What is the relation between this notion of structure and his ontological assumptions?

I will try to show that, unlike the theorizations revised previously, Piaget's psychology nurtured simultaneously from the mathematical line –used by Eddington– and the linguistic one taken up by different structuralisms. To this end, I will examine the specificity that lead to this double reception, and the ontological background implied in this perspective.

Piaget pointed out that "the notion of structure appeared in psychology since the beginning of this century [XX], when psychology of thinking from the Würzburg School opposed to […] associationism" (Piaget 1968, p. 49) [t]. Structural thinking precursors in psychology can be recognized in the attempt to retrieve the complexity that escapes Angell's functional or Dilthey's analytical psychology. This way, he traced a start for structuralism in psychology independently from linguistics, recognizing the School of Würzburg and, later on, the Gestaltpsychologie, as its genuine precursors (Piaget 1968; Schiavon Ogioni, Lima de Souza, and Silveira de Queiroz 2009). Particularly, this last theory and its notion of totality, constituted the most important reference in his own conception.

Nevertheless, mathematical structures were object of reception in Genevan genetics. The Bourbaki, a group of mathematicians who elaborated "mother" structures, were a privileged reference in Piagetian ideas. These mother structures "correspond, in a very elementary way […] to the necessary coordinations for any intelligence's functioning" (Piaget 1968, p. 27) [t]. Structures and, particularly, the group, constitute tools that allow studying and explaining development, since they configure transformation systems and can account for the differentiation of a group in several subgroups, and for the possible steps that lead from the former to the latter.

Structure function in Piaget's work was instrumental, since they were used as flexible theoretical tools in the study of natural thinking (Inhelder and de Caprona 1990). In a strict sense, Piagetian theoretical system was not oriented by the search for structures in facts, but the notion was employed to account for processes that characterize the subject of knowledge's coordination of actions. I must point out that, even though the notion of structure is widely spread through the theory, −the work *The Structuralism*, from 1968 accounts for this– I must anticipate two fundamental differences with other "structuralist" theories. Firstly, mathematical references and references to Gestaltpsychologie, were in no way mere extrapolations of forms with which psychological processes were "read" (Castorina and Palau 1982). Formal models were transformed accordingly to observational data contrastation. This was one of the main reasons why logicians considered Piaget a psychological reductionist and psychologists considered him a logical reductionist in turn (Lourenço and Machado 1996). Secondly, genetic psychology did not search, as an ultimate aim, to find structures in order to obtain knowledge on facts. Essentially, in Piagetian program, there is not a *dictum* which establishes that the only or the ultimate possible knowledge is the structural knowledge. This assertion, as we will see below, which was supported by Eddington, is not the one that legitimated the use of structures in genetic psychology and epistemology. Piaget took mathematical structures to *model* thought organization. However, structure as a system of self-regulated transformations is different from any form and independent from its content, and can only become a "true structure" if a theory can account for it and explain the whole system of its virtual movements (Piaget 1968).

The question we must answer is on what was the mathematical notion of structure Piaget employed, in order to adjust it, later on, to cognitive processes found in the subject.

Piaget used structural analysis as the most appropriate tool for researching cognitive system organization and relations. According to Inhelder and de Caprona (1990), structures were used as flexible instruments to turn intelligible the studies on thought. As I will try to show in what follows, the so called operatory logic was a formalization of structures that accounted for intellectual operations (Piaget 1947, 1950, 1964, 1970). This operatory logic had its reference point in the logical-mathematical notion of structure (Castorina and Palau 1982), a generic notion that included several mathematical notions which can me synthesized in the following way. Firstly, every structure is constituted by a set of elements of an unspecified nature. Secondly, one or more relations can be established between elements of this set. Finally, the conditions that such relations must fulfill are given. Different kind of relations and conditions they must fulfill, will give rise to different mathematical structures. For example, if the elements of a given set are related in such a way that given three arbitrary elements, the relation between the first two determines uniquely the third, it is said that such a

relationship is a composition law or *operation*. If an algebraic structure presents a unique law of internal composition and certain specified conditions are fulfilled – associativity, neutral element, inverse element– it corresponds to the structure of a *group*. Otherwise, when a relationship between any two elements from the set does not determine uniquely a third, but simply confirms or denies an ordering relation between them, it is said that the structure is an *ordering* structure. One obtains different ordering structures –such as the reticulate– as a function of the properties satisfied by this ordering relationship. These types of structures are some of the *mother structures* of Bourbaki group.

Piaget found that all actions children carry out –such as classifications or seriations, among others– present psychological organization forms which can be described in terms of mathematical structures. However, as I pointed out previously, he did not proceed to a literal application of mathematical structures, but elaborated, starting on these, other structures that allowed formally describing thought's specific operations. These structures were called *operatory* (Castorina and Palau 1982; Piaget 1964).

How was the notion of structure used to explain knowledge? The notion of group is a clear example of such a use. In mathematics, a *group* consists of a set of elements (G) related through a binary operation (·), which satisfies the following rules:

–   The operation must be associative, i.e. (A·B)·C = A·(B·C)
–   There must exist a neutral element *e* (*identity element*), which satisfies that, given an element a which belongs to (G), a e = e·a = a
–   For any element a, that belongs to (G), there exists the inverse b, such that a·b = b·a = e (being e the *neutral element*). (Bogopolsky 2008).

Piaget used the notion of group to postulate, for instance, that the spatial displacements of a baby –elements from the set *G*– compose –meaning that the operation that links the elements in the set is *composition*–. At the same time, these displacements fulfill all other conditions: associativity, existence of the neutral and inverse elements. Using this model he named *practical group of displacements*, he managed to formalize in structural terms, perceptual and motor actions starting on the first months of life.

Likewise, he utilized the concept of structure to explain the conquests of posterior levels in cognitive development resorting to *groups*, *reticulates* and to a hybrid of the latter called *grouping*.

The *grouping* is a key example of an instrumental use of mathematics, since it was presented to specifically describe natural thought. Far from attempting to adjust facts to a natural mathematical order, the *grouping* structure presents certain conditions which are not necessary in mathematical groups –contiguity, tautological property (A + A = A) and absorption (if A in included in B, then A + B = B)–.

Regarding the *reticulate*, it consists of a set G of elements linked by a partial-order relationship –not all elements are linked–. A relation can be considered as ordering relation if it is not symmetrical and is transitive. In every classification, for example, there is a partial ordering relation and this allows considering classification as a structure of order. In the reticulate, there is an upper limit which, in the case of classifications, is that of the classes of larger extension in which are included others of smaller size; and an inferior level that refers to the minimum class included in the considered set (Castorina and Palau 1982) [t].

In general terms, there are three common aspects to a Piagetian definition of the term structure:

> […] a structure is a transformations system, which implies laws as a system (as opposed to the properties of the elements) and that is conserved or enriched by the interplay of its transformations, without these using exterior elements or going beyond their own frontiers. In one word, a structure comprises the three characteristics: totality, transformation and self-regulation.

A structure is composed by elements which are subordinated to the laws that characterize the system as such; these composition laws confer the set of properties other than the elements'. Regarding this matter, Piaget points out that

> […] what matters is not the element in itself, or a whole that imposes as such without being able to precise how it imposes, but the relations amongst the elements. In other words, the composition processes or procedures, being the whole the result of these relations or compositions whose laws are the system's laws. (Piaget 1968, p. 13) [t].

This aspect of the structure constitutes its totality character. By defining the whole through its composition laws, that is, by the composition procedures and by the way in which these elements are combined, structured totalities are structuring. In this line, all structuring activity is a system of transformations. We can say it is a system of transformations because it presents possible composition laws. These possible transformations define the whole as such and constitute it in a structuring system of transformations, structured in turn. This is why "all known structures, from the more elementary mathematic "group" to those regulating kinship, are transformation systems". (Piaget 1968, p. 15) [t].

Finally, structures are characterized by their self-regulation:

> […] this selfregulation implies their conservation and a certain closure. If we consider these two resultants, their immediate consequence is that a structure's inherent transformations do not lead beyond its frontiers, but only engender elements always belonging to the structure and keeping its laws (Piaget 1968, p. 17) [t].

Structure closes over itself, even though this does not mean that it cannot be included, as a substructure, in a wider structure (Piaget 1968, p. 17). A structure's selfregulation consists precisely in the stability of its frontiers in spite of the permanent construction of new elements.

This succinct round allows us to have an idea of the use Piaget made of mathematical structures, which he configured accordingly to the object of study's specific characteristics: knowledge development.

As I anticipated, in his theoretical formulations notions correspondent to structural linguistics can be found. Language, as a general semiotic function, is the result of a preverbal intelligence. And the relations between pre-verbal and representational level are of structural equivalence, since the semiotic level reconstructs in a new one, analogous

relations to the ones attained in the previous level. Regarding this matter we find both mathematical notions which allow explaining group properties, as well as Saussure's considerations on a system's properties.

Totalities and the properties that emerge from relations, and not from elements in themselves, account for a structural conception that transcends mathematical description (Vonèche and Parrat-Dayan 1994). As a matter of fact, even though Piaget recognizes only three main logical-mathematical structures in the life-span –*group of displacements*, *concrete* and *formal operations*– he also recognizes organizations in each level defined by their location in the whole. The definition of *scheme* itself –as the structured set of action's generalizable characters (Piaget 1967, 1970)– helps understanding why the interesting part of an action is not its contingent materiality but its relations with other actions throughout time.

Notions such as value, significant, systematic relation were key in this theoretical perspective. The first sensorimotor actions as well as those observed in representational levels depend on a structural organization that is not defined by the addition of isolated schemes but by their relations, in the same way as in a language system. Perception is also understood as an activity that organizes itself in a field where perceptual properties emerge from the relations between elements. Action becomes interior thanks to semiotic function which was conceived following Saussurean model. The unit of the sign, guaranteed by the relation between a signifier and a signified, is the result of the differentiation, heiress to play and imitation (Piaget 1945). Generally speaking, differentiation and integration processes, or parts to the whole differentiation processes, that account for development in all of its levels, imply an oppositive valence system. Scheme's meaning does not come from an isolated experience with objects, but from relations between schemes. In other words, meaning is the result of differentiations within a cognitive system considered as a whole in itself. As in language, a scheme's value is pure negativity, since it is not determined by elements' essence, but by not being what other elements are.

A paradigmatic example of this systematic conception is the access to operatory thought. Reversibility, that characterizes this type of thinking, is a result of a progressive coordination of observable positive and negative aspects. In this way, a deformed piece of mass maintains constant its amount of substance, in the eyes of a child, only if he is able to conceive an exact cancellation of reductions in one dimension, against increases in another one. This coordination between positive and negative aspects explains the emergence of a new notion: substance conservation. We can see then, that in this explanation, the child's new notion is not the product of a new scheme but the coordination between schemes existing in previous levels, when the child did not admit to the conservation of a deformed object or liquid changing container. Briefly, I am referring to the emergence of a property that does not exist in any of the elements – schemes– considered isolatedly, bur in the relations these elements establish among each other.

These considerations show the way in which Piagetian psychology coordinated two lines into an integral view of structures. This reception is not a reduction of one of the lines to the other. Linguistic perspective could seem subsumed to the mathematical one, since mathematical structures, being open and closed at the same time, permit explaining the interplay of conservations, transformations and engendering that Saussure's diachronic-synchronic linguistic tries to explain. Nevertheless, the

continuity between pre-verbal intelligence and access to language –that for Piaget entails semiotic capacity– seems to indicate that such a reduction is not possible in his system. Language or any other manifestation of semiotic function, such as mental images, differed imitation or the different forms of representation, are the result of a systematization of mental actions. And actions' systematization cannot be reduced to groups or groupings –or any other kind of structure– since the values of the elements of the set do not always come from a system of transformations. This aspect, referred to negative and contextual value of an element, does not seem to appear in the mathematical conception.

Structure and Boundaries

The previous discussion, even though partial and limited to a few theses, is enough to evidence the polysemy of the notion of structure. However, the different conceptions share some characteristics which I would like to discuss.

As if it were a metalanguage common to all its speakers, the notion of structure shaped a scientific unification pretension many times intended through the history of sciences. And as linguistic problems were redefined and its field was momentarily unified with Saussure's theses, other empirical sciences showed analogous consolidation moments, under the light of a renewing structuralism (Lévi-Strauss 1968; Nola 2012). The presented cases are more than enough to show some of the consequences of a notion, plastic enough to be a part of completely different paradigms, and to define, in each of them, the limits for the studied objects.

Firstly, the double origin for contemporary structuralism is quite clear. The linguistic line as the mathematical line shaped a particular way of understanding structure. At the same time, even though we recognize that multiple ramifications converge in any of these two almost mandatory reference points, we cannot identify only two paradigms. With this, I would like to show that these two origins do not correspond to two different world views. Ontological assumptions in these two sources were not mechanically transferred to the disciplines they inspired. Each of the disciplines heiresses made a novel use of the notion of structure, mainly regarding their conceptions on entities that define the scientific study field.

I believe that this is a result of another consequence. The different uses of the notion of structure, even corresponding to diverse ontological assumptions, show a shared function. That is to define the limit between contrastable scientific knowledge and philosophical knowledge. In all of the reviewed cases, structure is presented, implicit or explicitly as a *borderline concept* that delimitates the field of scientific knowledge. Operating in the frontiers, the structure establishes the separation between contrastable knowledge and reasoned faith; between knowledge that progresses and knowledge founded in an axiomatic, methodological or naïve acceptance of certain premises.

Doubtlessly, regarding these two forms of knowledge, scientific and philosophical, there are multiple relations. In fact, knowledge on nature and the reality of world entities seems to consist in the attribution to empirical reality of an ontological counterpart which belongs to the theory with which we explain reality (García 2000). In the different theories that resort to the notion of structure, the definition of theoretical concepts in itself modulates possible knowledge on the real.

The theoretical orientations revised in this work have discussed and constituted the borderline in which structures operate. A structural perspective, such as Eddington's, involves a series of problematic ontological assumptions (Wójtowicz 2012). The definition of a mathematical structure closed on itself would define an isolated platonic world, and the escape route to this enclosure is the introduction of an assumption that consists in assuming an isomorphism between world structures and mathematical structures. As I tried to show, this thesis does not lead to world substance duplication, but to the acceptance of a sole substance which manifests in structural terms. The only things which can be known are the relations, and the presentation of an existence beyond the structure is reduced to absurdity. It is not about the impossibility of accessing what is beyond the already known. The mathematical sign cannot be penetrated because the question regarding a "beyond" lacks sense in itself. Structure is therefore a limit for knowledge which does not divide an object in a known aspect and an essential background.

In turn, structural linguistics development striped cognitive entities of all positive references. There are no objects defined by an essence or a materiality, but by their relations in a system. Even though there is no pronouncing regarding the world's ultimate nature, objects can be known only through the weave of relations they are inscribed in. This can lead to a reification of structures, turning them to independent objects from any other reality. However, there are no clear criteria to decide if this structuralism states anything on other entities than those belonging to the structured system. It is clear though that what can be known is a relation, the structure of a system, and not an essence. There is no materiality that defines by itself and language is the maximum expression of this referrals system. These theses have been the via *regia* for the dismantling of any pretention of ultimate access to essential knowledge of stuff.

Structural anthropology, with Lévi-Strauss, used the study of abstract relations to explain and formalize recurrences of some culture facts. This structural orientation distinguished the real in itself from the structure that allows its knowledge. In an attempt to unravel if reality is in fact structured or if structuration is an effect of the observer's models, Lévi-Strauss stated that the notion of structure does not refer to "empirical reality", but "to the model built accordingly to it" (1958, p. 251) [t]. Empirical reality seems to have a certain degree of inaccessibility beyond structural models with which it is "read". An anthropologist can only pronounce himself over empirical reality by understanding the meaning which emerges from the relations among elements. There is no possibility to attain facts' meaning studying them isolatedly, in the same way a myth is not defined by its characters or scenarios separately from the series of events and relations' structure. As in natural facts mathematization, structure is an empty form, which, with an instrumental purpose, makes world facts intelligible.

Lacan used mathematics and topology in different opportunities, but his notion of structure was, as in Lévi-Strauss, strongly linked to linguistic notion. I could not even say that Lacan operated a mathematization of psychoanalysis, even though his use of topologic formulas and figures is frequent. The particular use he does of these objects is completely different from those of any other empirical discipline that resorts to the use of topologic formulas and figures on a frequent base. The notion of structure in Lacan does not seem to coordinate, in a sort of synthesis, both variants –something that is characteristic of Piaget's work–.

The question regarding reality in the work of Lacan –and maybe in psychoanalysis in general– gains notable relevance. Since Freudian first formulations, reality was incessantly an object of questioning. The postulation of psychological reality (Laplanche and Pontalis 1964), which does not have to correspond to observed facts by different actors, seems to have been the set off point for a series of conjectures regarding the statute of entities such as fantasies, unconscious representations or symptoms. In Lacan, the notion of structure referred to the symbolic field –the structure of language– is the key to unravel the underlying ontology. The signifier level is a closed order on itself, which signifies thanks to interplay of referrals. This way,

> The quality evoked by the term "real" has a characteristic which distinguishes it from other qualifying terms. We can define "blue" from an absolute perspective, independently from other colours (thanks to its wave length). On the contrary, the quality of the "real" is not established negatively, reporting it to what it is not, that is, a representation, and this one being an image or a word […]. In this occasion, image and word come together, as a function of what neither one is […]. This relativity disturbs when it refers to a dimension which intuitively would be placed as absolute (Pommier 2005, p. 165) [t].

The negativity of this signifiers sliding entails a relativity of the signified. Reality in Lacan seems to be only relative, and the imaginary and symbolic dimensions capture aspects of the stuff which cannot be trespassed to access a beyond:

> If the symbolic dimension (I) of the sensation only captures the surface (the image of the stuff), if the symbolic of the signifier (S) does not speak of this stuff other than by other signifiers, and, hence, in its absence (in the hole of its being), then the real is situated on the one hand, regarding the imaginary which works as a screen; and on the other, regarding the symbolic which pierces it: it could not be expelled definitely to the field of the "non symbolizable", since the symbolic has only meaning as a function of it. […] It is impossible, then, to consider the real following the philosophical modality and to treat it as unknowable, always beyond intuitive knowledge of the world which offers us their imaginary and significant representations (according to the point of view which considers the real as a *Far West* constantly trying to be colonized) (Pommier 2005, p.166) [t].

Pommier's consideration shows that entities relativisation which psychoanalysis operates, is coherent with the structural thinking that underlies. Language structure supposes a circuit of referrals and dynamics analogous to those observed by phonologists. Reality is, hence, inscribed in a symbolic order or in its imaginary manifestation, without the need to postulate a beyond, an inaccessible noumenon. There is no impassable structure that veils the fundamental stuff.

Piaget's Genetic Psychology, coordinating its developments on mathematical and linguistic structures, assumes a different position regarding the real. This position, which could be called critical realism or constructive realism states that reality exists, but it is only possible to know of it what action schemes allow us to –built from the interaction between subject and object–. That is, there is something we can call reality, but we can only know of it what we can do with it. The explicit question, regarding the

existence of a world independent of knowledge was posed e by Rubinstein to Piaget, in a discussion that took place in the Academy of Sciences of the USSR:

> Do you think the world exists prior to knowledge? Piaget answers then: this is another problem. In order to act on the object, it is necessary an organism and this organism is also a part of the world. I think that evidently, the world exists prior to knowledge, but we do not divide it in particular objects but in the course of our actions and through interactions between the world and the environment. (Ferreiro and García 1978, p. 18) [t].

The organization of the action in schemes defines the limits of the knowledge object, but it always leaves a rest, a beyond the object, which is unknown. Hence, this reality that is beyond knowledge is an X we can only affirm exists. Knowledge is the progressive conquest of the real, which takes place in unknown territory. The assertion on an independent existence of the cognoscente subject's actions lies, for example, on the resistance that objects present to assimilation. The fact that there are disequilibrium between assimilation and accommodation seems to be proof of the existence of an X prior to all knowledge (Piaget 1936). Even though, knowledge on X is impossible by definition.

Structuralism was never interpreted by Piaget as a philosophical doctrine, but as a method (Inhelder and de Caprona 1990). However, in this psychology we can observe a tight relationship between theoretical postulates and ontological assumptions. The theory itself allows us to assume an existence independent from the cognoscente subject, or at least, it does not contradict it. Alternatively, we could assume a radical constructivism, where reality is created by construction, instead of being progressively conquered. Nevertheless, accepting the notion of accommodation, or the coordination of multiple perspectives in peer interaction, it is much more coherent to assume an existence prior and independently to action organization.

The question which lingers in these definitions is about the nature of the real in itself. Knowledge objects are not the real, but that of the real which the subject can know through its structured actions. Thus, the border between a known and an unknown but assumed reality is defined. However, this border does not account symmetrically for entities on both sides. We only have access to one of them and the other remains veiled.

The different positions revised show different ontological considerations on reality and its structure, and beyond. Through different ways, Group Theory and structuralism of linguistic current postulated the need of closed systems that avoid unnecessary referrals. This aspect which refers to the closure of the structure is the one I believe characterized best its statute of *boundary* or limit. Structure is not a downgrade to any other level, but the ultimate level of possible knowledge and to trespass it, conduces outside the ranges of science. In the same way as Newton declared not to have the means or the interest to conjecture a hypothesis outside his description of movement, structuralism constituted its own touchstone in the structural level. This is partly due to a methodological strategy. Saussure expressed that "far from the object preceding the point of view, it is the point of view which creates the object […]" (Saussure, F. de 1915, p. 73) [t], showing that theoretical assumptions configure the limits and entities of the field of study. However, what interests me, especially, in all of these consider-ations is, precisely, the beyond of possible knowledge, the nature of defined facts, and

the relation of these postulates with the ontology implied. I believe structure is a transdisciplinary notion that permits to find, inside each scientific discipline, the frontiers with metaphysics. More so, I consider it a *boundary notion* and a compass to orient intellectual efforts dedicated to answering the question on the world's ultimate nature.

References

Bastide, R. (1968). *Sentidos y usos del término estructura en las ciencias del hombre*. Buenos Aires: Paidós.

Benveniste, É. (1966). *Problèmes de linguistique générale*. Paris: Éditions Gallimard.

Benveniste, É. (1968). *Estructura en lingüística. En R. Bastide (Comp.), Sentidos y usos del término estructura en las ciencias del hombre* (pp. 25–30). Buenos Aires: Paidós.

Bogopolsky, O. (2008). *Introduction to group theory*. Zürich: European Mathematical Society.

Castorina, J. A., & Palau, G. D. (1982). *Introducción a la lógica operatoria de Piaget*. Barcelona: Paidós.

Dagfal, A. (2009). El encuentro de Lacan con Lévi-Strauss: del poder de la imagen a la eficacia del símbolo. En AA.VV., *Lévi-Strauss en el pensamiento contemporáneo*. Bs. As.: Ediciones Colihue.

Demopoulos, W., & Friedman, M. (1985). Bertrand Russell's The Analysis of Matter: Its Historical Context and Contemporary Interest. *Philosophy of Science, 52*(4), 621–639.

Dor, J. (1994/1996). *Introducción a la lectura de Lacan. El inconsciente estructurado como un lenguaje*. Barcelona: Gedisa Editorial.

Eddington, A. S. (1928/1929). *The nature of the physical world*. New York-Cambridge: The MacMillan Company/University Press. [The Gifford Lectures, 1927].

Eddington, A. S. (1939). *The philosophy of physical science*. New York: The MacMillan Company [Tarner Lectures, 1938].

Evans, D. (1996/2007). *Diccionario introductorio de psicoanálisis lacaniano*. Buenos Aires: Paidós.

Fair, H. (2009). Contribuciones desde el post-estructuralismo lacaniano al debate epistemológico sobre la objetividad y la neutralidad valorativa. *Revista de Filosofía, 63*(27), 35–63.

Ferreiro, E., & García, R. (1978). Presentación de la edición castellana. In J. Piaget (Ed.), *Introducción a la epistemología genética* (pp. 9–23). Buenos Aires: Paidós.

García, R. (2000). *El conocimiento en construcción. De las formulaciones de Jean Piaget a la teoría de sistemas complejos*. México: Siglo XXI.

Gherab-Martin, K. J. (2006). Filosofía de la ciencia y monismo neutral en Arthur S. Eddington. *Thémata. Revista de Filosofía, 36*, 100–127.

Gherab-Martin, K. J. (2013). From structuralism to neutral monism in Arthur S. Eddington's Philosophy of physics. *Studies in History and Philosophy of Modern Physics, 44*, 500–512.

Inhelder, B., & de Caprona, D. (1990). The Role and the Meaning of Structures in Genetic Epistemology. In W. F. Overton (Ed.), *Reasoning, necessity and logic: developmental perspectives*. Hilsdale: Laurence Erlbaum Associetes.

Lacan, J. (1936/1975). Más allá del "principio de realidad". En J. Lacan, *Escritos 1* (pp. 67–85). México: Siglo XXI.

Lacan, J. (1938/2001), Les complexes familiaux dans la formation de l'individu [La Famille]. En J. Lacan, *Autres écrits* (pp. 23–84). París: Seuil.

Lacan, J. (1953/2005). *Le Symbolique, l'Imaginaire et le Réel, en Des noms-du-père*. Paris: Seouil.

Lacan, J. (1954/1978). *Le Séminaire. Livre II. Le moi dans la théorie de Freud et dans la technique de la psychanalyse, 1954–55*. Paris: Seouil.

Lacan, J. (1959/1988). *Le Séminaire. Livre VII. L'ethique de la psychanalyse, 1959–60*. Paris: Seouil.

Lacan, J. (1975/1982). *El Seminario XX, Aun*. Buenos Aires: Paidós.

Lapassade, G., Goldman, L., Kolakowski, L. Mallet, S., & Vernant, J. P. (1966/1975). *Las nociones de estructura y génesis: Sociología. Las ideologías religiosas. Arte*. Buenos Aires: Nueva Visión.

Laplanche, J., & Pontalis, J. B. (1964). Fantasme originaire, fantasmes des origines, origine du fantasme. *Les Temps Modernes, 215*, 1833–68.

Lévi-Strauss, C. (1949/1993). *Las estructuras elementales del parentesco*. España: Planeta-Agostini.

Lévi-Strauss, C. (1958/1970). *Antropología estructural*. Buenos Aires: Eudeba.

Lévi-Strauss, C. (1962). *La pensé sauvage*. París: Librairie Plon.

Lévi-Strauss, C. (1968). Los límites de la noción de estructura en etnología. En R. Bastide (Comp.), *Sentidos y usos del término estructura en las ciencias del hombre* (pp. 31–35). Buenos Aires: Paidós.

Cercle Linguistique de Prague (1929/1970). Comunicación serie B. El círculo lingüístico de Praga: tesis de 1929. [Travaux du Cercle Linguistique de Prague]. Madrid: Alberto Corazón Editor.

Locke, J. (1690/1999). *Ensayo sobe el entendimiento humano*. México: Fondo de Cultura Económica.

Lourenço, O., & Machado, A. (1996). In Defense of Piaget's Theory: A Reply to 10 Common Criticisms. *Psychological Review, 103*(1), 143–164.

Milner, J. C. (2002/2003). *El periplo estructural. Figuras y paradigma*. Buenos Aires: Amorrortu Editores.

Newton, I. (1687/1982). *Principios matemáticos de la filosofía natural y su sistema del mundo*. [*Philosophiæ Naturalis Principia Mathematica*]. Madrid: Editorial Nacional. [On-line english versión: http://cudl.lib.cam.ac.uk/view/PR-ADV-B-00039-00001/].

Niccolini, S. (1977). *El análisis estructural*. Buenos Aires: Centro Editor de América Latina.

Nola, R. (2012). Varieties of structuralism. *Metascience, 21*(1), 59–64.

Papanicolaou, A. C. (2014). Beyond Eddington's argument. *Integrative Psychological & Behavioral Science*.

Piaget, J. (1936/1966). *La naissance de l'intelligence chez l'enfant*. Neuchâtel: Delachaux et Niestlé.

Piaget, J. (1945/1959). *La formation du symbole chez l'enfant*. Neuchâtel: Delachaux et Niestlé.

Piaget, J. (1947). *La psychologie de l'intelligence*. Paris: Librairie Armand Colin.

Piaget, J. (1950). *Introduction à l'épistémologie génétique 1: La pensée mathématique*. Paris: Presses Universitaires de France.

Piaget, J. (1959/1967). *La genèse des structures logiques élémentaires*. Siuza: Delachaux et Niestlé.

Piaget, J. (1964). *Six études de psychologie*. Genève: Gonthier.

Piaget, J. (1967/1979). *Biología y conocimiento*. Madrid: Siglo XXI.

Piaget, J. (1968). *El estructuralismo*. Buenos Aires: Proteo.

Piaget, J. (1970). *Psychologie et épistémologie*. Paris: Editions Denoël.

Piaget, J. (1975). *L'équilibration des structures cognitives : problème central du développement (Études d'épistemologie génetique XXXIII)*. Paris: Presses Universitaires de France.

Piaget, J., & Inhelder, B. (1941). *Le développement des quantités physiques chez l'enfant*. Lausanne: Delachaux et Niestlé.

Pommier, G. (2005). *¿Qué es lo "real"? Ensayo psicoanalítico*. Buenos Aires: Nueva Visión.

Rodriguez, F. G., & Vallejo, M. (2011). *El estructuralismo en sus márgenes*. Buenos Aires: Del Signo.

Roudinesco, E. (1994). *Histoire de la psychanalyse en France* (Vol. 2). Paris: Fayard.

Roudinesco, E., & Plon, M. (1997/1998). *Diccionario de psicoanálisis*. Buenos Aires: Paidós.

Russell, B. (1912/1995). *Los problemas de la Filosofía*. Colombia: Ed. Labor.

Russell, B. (1919/1920). *Introduction to mathematical philosophy*. London: George Allen & Unwin.

Russell, B. (1921/1989). *The analysis of mind*. USA and Canada: Routledge.

Russell, B. (1927/1992). *The analysis of matter*. London: Routledge.

Sanders, C. (2004). *The Cambridge Companion to Saussure*. United Kingdom: Cambridge University Press.

Saussure, F. de (1915/1983). *Curso de lingüística general*. Madrid: Alianza Editorial.

Schiavon Ogioni, F., Lima de Souza, M., & Silveira de Queiroz, S. (2009). Gênese e Estrutura: a Gestalt numa discussão piagetiana. *Schème-Revista Eletrônica de Psicologia e Epistemologia Genéticas, 2*(4), 181–193.

Sperber, D. (1968). *Qu'est-ce que le structuralisme? Le structuralisme en anthropologie*. Paris: Editions du Seuil.

Strachey, J. (1961). *Introducción. Das Ich und das Es. En S. Freud (1923/2008), Obras completas: El yo y el ello y otras obras: 1923–1925 (pp. 3–11)*. Buenos Aires: Amorrortu Editores.

Verón, E. (1977). *El análisis estructural en ciencias sociales. En S. Niccolini (Comp.), El análisis estructural*. Buenos Aires: Centro Editor de América Latina.

Vonèche, J., & Parrat-Dayan, S. (1994). La partie, le tout et l'equilibration. *Philosophica, 54*, 9–42.

Wahl, F. (1968/1975). Introducción General. En M. Safouan, *¿Qué es el estructuralismo? El estructuralismo en psicoanálisis* (7–14). Buenos Aires: Losada.

Wójtowicz, K. (2012). Object realism versus mathematical structuralism. *Semiotica, 188*, 157–169.

Yolton, J. W. (1960). *The philosophy of science of A. S. Eddington*. The Hague: Martinus Nijhoff.

Zafiropoulos, M. (2003). *Lacan et Lévi-Strauss ou le retour à Freud* (pp. 1951–1957). Paris: Presses Universitaires de France.

Note

[t] The translation is mine.

Ramiro Tau Doctoral research fellow at the National Council for Scientific and Technical Research (CONICET), Argentina. Thesis: "The development of the child's notion of death". Professor in the Chairs of *Genetic Psychology* and *Current Trends in Psychology*, National University of La Plata, Argentina. Currently teaching and researching in the fields of Genetic Psychology, History of Psychology, Epistemologyand Theory of Social Representations.