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Original Research Article

Husserl's Phenomenology and Arithmetic

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Abstract

This article presents the Husserlian conception of arithmetic, based on its psychological and phenomenological analyzes. Our goal is to analyze what Husserl presents as a structure of subjectivity, through the experiences of number consciousness. We start from the logico-psychological problems linked to the foundation of mathematics to restructure the subjective substance that governs the conceptualization of scientific foundations; we go through representative psychology to measure the objective dimension of arithmetic and see that number, as quantity, proceeds from a psychic construction. We clarify the path followed by Husserl in the development of phenomenology as a descriptive science, where subjectivity is a condition for the possibility of knowledge. We arrive at the result according to which, scientific objectivity is the corollary of a subjective a priori.

Keywords: Arithmetic, phenomenology, psychology, representation, subjectivity, number theory.

INTRODUCTION

The main objective that we pursue in this article is to present the contours of a subjective a priori as the foundation of scientific theories, within the precise framework of the philosophy of Edmund Husserl. We mean by a priori subjective, the fact that subjectivity is prior to objectivity; that knowledge, on the subjective basis, would logically precede empirical experience. It is a question of recognizing that scientific theories would have primordial subjective sources.

We target the analysis of the Husserlian number theory in order to restructure the subjective substance, which raises the logico-psychological problems linked to the foundations of science in general, and of mathematics in particular. It is therefore not surprising that one already finds, in the philosophy of arithmetic of 1891, Husserl's reflection on the concept of number in its psychic representation.

Our problem consists in showing that in Husserl, digital knowledge, in its psychic structure, is the foundation of subjectivity. How does subjectivity appear in Husserl's phenomenology? Is it not from knowledge in its intentional dimension, that is to say in its digital representation?

By way of hypotheses, we start from the historical analysis of the place of subjectivity in philosophy to show that transcendental phenomenology in Husserl is based on digital criticism (first hypothesis). We establish a parallelism between the heuristic structure of subjectivity and the psychic representation of numbers (second hypothesis). The term heuristic, glued to subjectivity, designates the fact that subjectivity has several dimensions, which are related to the different ways of consciousness to relate to the object.

Our thinking is divided into four points. The first point deals with the analysis of the concept of subjectivity from Descartes to Husserl, and shows the scientific novelty brought by the latter compared to the former. The second point describes the debates that mathematics went through during the Husserl period. The third point takes us to the heart of Husserl's analysis of the concept of number. In the words of Bernard Jolibert, it will be a question here of defining the concept of cardinal number and the psychological nature of numeration as an essential act of arithmetic thought [1]. The fourth point raises the epistemological problem of the relationship between objectivity and subjectivity.

METHODS

Our method will consist in reading Husserl's texts transversely, presenting the different sides of a phenomenology of arithmetic. Phenomenology is only accessible to a phenomenological method. Husserl's philosophical texts are situated in the perspective of phenomenology, understood as a method. To enter their intelligence, it is necessary to follow the method that underlies their writing. Thus, we will attempt the essence of the underlying of subjectivity, a discovery of the essence component of intentionality, a radical reduction in the relationship of thought to the world. In other words, by seeking a content-otherness, a concrete older than all presence, we will analyze the experience of Husserlian phenomenology to establish the character derived from objectifying intentionality.

Husserl, as we know, to implement the project of phenomenology, envisaged as a method, reduction (generalized doubt). Reduction essentially consists of putting the empirical and psychic elements of the concrete data in parenthesis (eidetic reduction), the meditating subject (suspension of judgment), the consciousness of others (transcendental reduction). Phenomenology discovers that all consciousness is intentional, that is to say that the characteristic of consciousness is to be an aim, an activity which aims at its object and goes towards the world (transcendence). In one sentence, all consciousness is awareness of something.

But phenomenology, as we envisage it, by privileging sensible content, appearing beyond what appears, conjunctures and circumstances, in a word matter rather than form, will define itself as a phenomenology of what escapes theoretical consciousness. It will be a question of digging the ground of experience, below the *noetico-noematic* correlation, in order to deny the original character of objectifying intentionality. Such a phenomenology will no longer propose to see and describe what appears in the light of knowledge, but it will try to approach, in an oblique or transverse movement, the beyond of all vision.

The return to the very things, as they are given in the original intuition, will be accomplished in an effort always recommenced to let pierce the non-given or the "non-giveable" of any gift. For the relation with numbers is absence in presence (presence as separation), distance in proximity, non-coincidence, that is to say, destitution of the proper and deviation in the origin. In the relation with numbers, mind is instituted and inhabited by the Other who, in this same movement, withdraws by giving himself.

RESULTS AND DISCUSSION

The Primacy of Subjectivity

Philosophical thought, faced with the scientific development of the 16th century, has put the central role of subjectivity back on the shelf of scientific research. Various methods are used by philosophers to access or rediscover subjectivity as the starting point for the development of knowledge. In The Rules for the Direction of the Mind, exposed in 1628, then in the Discourse on Method [2]. René Descartes breaks with the interminable scholastic reasoning and theorizes the cogito, thus founding the system of science on the knowing subject in front of the world he represents. The famous phrase "common sense is the most widely shared thing in the world" [2] and the famous phrase "cogito ergo sum" "I think therefore I am" [2] update subjectivity on the one hand as the subject's own, and on the other hand as the foundation of human knowledge. Descartes therefore rediscovers subjectivity in its original sense since it breaks with first experience through doubt. He thus reverses the curve of knowledge long accepted by ancient philosophy, starting no longer from the experience of the world, but from the interiority of the subject itself.

More than a century after Descartes, Emmanuel Kant discovers subjectivity in his theory of transcendental aesthetics, and believes that there is a framework in which objects are originally given to us and which allows their representation. Subjectivity is for Kant this sensitivity to receive material representations which affect us and would be for him a limited entity since he could know the things in himself which he qualifies in Critique of pure reason 1781 of noumena. He thus establishes a dichotomy between knowable phenomena and postulates. Subjectivity is therefore not for Kant the ultimate foundation of all knowledge; because only space and time which are necessary subjective conditions since they constitute the a priori forms of knowledge.

In turn, Johann Gottlieb Fichte, a young Kantian, considers subjectivity as the appearance and exteriorization of phenomena. This is why he conceives of phenomenology as the doctrine of the apparition. Wanting to give an unshakable basis to human knowledge, Fichte in the Foundation of Natural Law, discovered intersubjectivity in order to complete the Kant system developed in the Critique of Pure Reason (a system which should be called phenomenology but Kant eventually replaced this name by that of transcendental aesthetics). Therefore, in Fichte, subjectivity necessarily calls for intersubjectivity. As for Georg Wilhelm Friedrich Hegel, a contemporary of Fichte, in his phenomenology of the mind, subjectivity can be read through his dialectic of the experience of consciousness. Subjectivity in Hegel would be a datum of consciousness necessary in his experience of the world; and the study of the exploration of phenomena, a phenomenon taken as the moment of the appearance of a determination of knowledge, would be phenomenology.

Also, all these philosophical conceptions on subjectivity that we have retraced show the importance accorded by philosophers on this notion, which is so complex because it is variously understood and discovered. The philosophical remark made is that subjectivity tends to be confused with consciousness. However, there is no confusion that holds. Because subjectivity is the most appropriate and natural way for consciousness to know; therefore consciousness is the mental faculty allowing to comprehend subjectively (subjectivity) external or internal phenomena. In other words, one is the faculty, the ability (consciousness), the other is the process, the natural possibility, the way of knowing (subjectivity). Consequently, subjectivity plays a capital role in the advent of knowledge since it appears, beyond all philosophical conceptions which are, a return to oneself after an affection, contact, relationship with the world of objects. It is therefore not a solitude of the mind, but a datum configured in the psyche and is intended to be the basis of knowledge. It was this conception of subjectivity that caught the attention of the German author Edmund Husserl in the 19th century. This is where the title of our research topic is justified. It is a question of thinking about subjectivity in the Husserlian device of knowledge.

It is widely known that Husserlian phenomenology is a transcendental subjectivity, that is to say, a theory of knowledge based on the primacy of the subject. As such, Husserl intends to reorganize all scientific knowledge from the human psyche. In the seventh paragraph (§7) of the Krisis, Husserl notes that we have become aware, at least in a very general way, that the human philosopher and its results have by no means in the whole of human existence the simple meaning of a cultural goal that is private or limited in one way or another [3]. This remark is undoubtedly the synthesis of a reflection coming from a retrospective look on the history of philosophy.

A mathematician by training with a doctorate on the concept of number, Edmund Gustav Albrecht Husserl (1859-1938) procured in 1884 the phenomenology of Hegel's mind and followed during the winter of 1884-1885 the courses of the famous psychologist of the era, Franz Brentano, on the practical philosophy and empiricism of David Hume. This is how he distinguishes himself from mathematics (and from the sciences with their cult of blind objectivity without prior subjectivity) and turns towards philosophy, and in this case towards psychology. It was therefore not surprising that we find under his pen, after the philosophy of arithmetic of 1891, in Logical Research (1900-1901), an impetus towards questions of conscience. In the second volume of Logical Research (Research for Phenomenology and Theory of Knowledge), after a first volume (Prolegomena in pure logic) devoted in particular to the objectivity of logical forms, Husserl updates considerations that give back to subjectivity its role and place. In this volume, subjectivity is understood through the concept of intentionality which gives it the status of foundation of knowledge; so that intentional experiences and their contents find their explanation and foundation in the process of affect (subjectivity), in the way in which consciousness is affected by phenomena. Intentionality thus justifies the relationship of subject to object; and subjectivity therefore appears, in contrast to objectivity which is the first and most naive dimension of the understanding of the object, as the most elevated level giving the meaning of the object.

This fundamental achievement of understanding but also and above all of the discovery of subjectivity by Husserl in Volume II of Logical Research will be reinforced and refined in the Guiding Ideas for a phenomenology and a pure phenomenological philosophy to which Husserl adds, and this by philosophical necessity , to the concept of subjectivity that of transcendental. In other words, in Ideans I, it is no longer a simple subjectivity, but a subjectivity which wants to be transcendental, so that it is the subject in his psyche which is the condition for the possibility of knowledge, therefore foundation of the donation of objects. Subjectivity as a foundation is understood under the expression of noesis as an act of transcendence itself (act of thinking); it thus represents the way in which the object is targeted, and nevertheless highlights the phenomenological attitude which denounces the opposition of the subject and the object by seeking in experience the unity of a meaning prior to all dualism sterile.

In the Cartesian Meditations (1929), Husserl discovers subjectivity after putting the world or epohesis in parentheses. It is here, in reality, that Husserl makes phenomenology a philosophy whose starting point is subjectivity. The beginning of the Cartesian Meditations perfectly illustrates what subjectivity is in its first dimension: "Anyone who really wants to become a philosopher will once in his life have to turn in on himself" [2]. Subjectivity is first of all this effort of self-reflection, only to be later this withdrawal after contact with objects. In Cartesian Meditations, subjectivity springs up after a total reversal of all knowledge. The continuation of Husserl's remarks shows, not only the Cartesian position, but also and above all the perspective that subjectivity gives itself: "and within oneself try to overthrow all the sciences accepted so far and try to reconstruct them" [2]. Husserl wants to refound knowledge by taking subjectivity as a base to bring out the evidence (ego cogito as transcendental subjectivity). The question of subjectivity is here at the heart of the resolution of the science crisis.

In Husserl's posthumous texts (1926-1935) grouped together in the work titled “phenomenological reduction”, subjectivity is better understood through intersubjectivity. In these texts, Husserl makes it clear

that subjectivity, sprung up as a result of the operation of the epoch, makes a synthesis, accounts for the inner life of oneself in relation to the world. Here, subjectivity is intersubjectivity; this dimension of subjectivity is a confirmation of knowledge because the effective meaning of phenomena is given to it.

Thus, from Volume II of Logical Research to his posthumous Texts, Husserl discovers subjectivity differently, and this associated with certain mechanisms of consciousness - In Volume II of Logical Research, subjectivity is discovered and understood through the concept of intentionality - In Ideans I, subjectivity is grasped from the notion of noesis, noetico-noematic correlations, so that it relates not to transcendental realities, but to a priori possibilities - In Cartesian Meditations, Husserl discovers the subjectivity after the operation of the epochè - In his posthumous texts, subjectivity can be read through intersubjectivity.

In the light of all these analyzes, it must be said that subjectivity in Husserl is variously perceived and apprehended; although all these perceptions of subjectivity are provisional, because all of them lead to the same ideal, that of being a transcendental subjectivity. Subjectivity, as a datum configured by the universal structures of the psyche, is discovered or rediscovered after several mechanisms of consciousness. If heuristics (from the ancient Greek eurisko, "I find") is a term which signifies the art of making discoveries, and structure gives the sense of composition, of description of organized elements of a system, then the heuristic structure of subjectivity in Husserl evokes the idea that there are in Husserl several ways of arriving at subjectivity (those which we have stated in the works of Husserl cited above), but with a single fundamental methodical claim of evidence which would be apodictic. Here we raise the question of the discovery of subjectivity in Husserl.

In the following our research we will present the problems raised by Husserl in the philosophy of arithmetic. We will see the basis of the Husserlian concern to restore the subjectivity at the origin of knowledge. We will be at the heart of logical-psychological analyzes of the concept of number. We will try to outline the obstacles which are at the root of the non-progress of science. We will lay the groundwork on the problem of the inference of intuition in mathematical theories. This aspect will shed light on the Husserlian impulse to strive towards the quest for a subjective a priori at the basis of science.

Then, we will delve into the psychic representation of the concept of number where we will engage in psychological analyzes establishing or better restoring subjectivity to the foundation of knowledge. Here we will have the opportunity to identify the problem of Husserl and Frege concerning the cardinal number, Frege's refusal to consider the number as a subjective element. This problem will shed light on the Husserlian position of what he means by number.

Finally, we will thematize the basic problem which undermines the science of overestimating objectivity at the expense of subjectivity. So here we will have a general view of the ignorance that pervades science to exclude, if not to deny the fact that the conceptualization of scientific concepts proceeds from a subjective a priori. Here we will engage in a critique of psychologism, therefore we will elucidate Husserl's passage from psychology to pure phenomenology. We will thus show the limits of psychology in the mechanisms of grasping phenomena, and will lay the foundations for a phenomenology which will turn out to be the foundation of knowledge.

The Crisis of the Foundations of Mathematics

The science crisis manifests itself specifically through the math crisis. The Husserlian impulse towards questions linked to consciousness derives from an in-depth analysis of the sciences. In fact, from Husserl's point of view, it is the description of the human psyche that would be the place of the evaluation of knowledge, and mathematics would be no exception. Besides, being considered as the model of a rigorously scientific deduction, mathematics constitutes the starting point of an adequate criticism of science. Husserl therefore begins to take a closer look at the foundations of arithmetic, if not the concept of number. He is interested in it with a philosophical motivation to rehabilitate and above all to recognize subjectivity in the process of establishing knowledge. He makes this state of affairs: "The interests which have led mathematicians to come into contact with philosophy so often came from the state of their own science" [4]. This fact illustrates the reason for our thinking about mathematics, in this case number theory.

We have to retrace the crises that mathematics experienced during Husserl's time. It is a question of justifying the why of psychological analyzes of the fundamental concepts of mathematics; more precisely that of the number as target; by questioning, with regard to the latter, errors of understanding due to an abandonment of the subjective dimension of the discovery of knowledge, and therefore to the psychological mechanisms of knowing.

In fact, it is urgent for Husserl to resolve the problems linked to the foundation of the sciences and mathematics which Descartes shelters from doubt, it seems rigorously scientific, constitute the ideal starting point for such a critique of knowledge. It is certainly true that we recognize the prosperity of mathematics in important knowledge, but the fact remains that it has engendered unfortunate consequences due to errors, to a lack of psychological analyzes, therefore to the absence of a subjective look at the departure of all research.

Here is how Husserl justifies the need for clarification at the heart of the foundations of mathematics:

"When the most essential or most immediate consequences were drawn from new principles, when the errors due to the obscurity which prevailed over the nature of the means employed and the limits of operational security became more and more frequent, that then began to appear with ever more force and finally in an inescapable way the need to clarify, to examine and to assure logically the acquired; to make an in-depth analysis of fundamental concepts… " [4].

This Husserlian observation applies to all sciences as well as to mathematics. Hence the need for clarification of the foundations of mathematics: this is the task assigned to philosophy via, at first glance psychology, if not ultimately phenomenology. In reality, the multiple mathematical theories running around here and there in an attempt to resolve by themselves the problems which have undermined mathematics since their foundation, aroused keen interest from philosophers, who in turn take a metaphysical and logical look at this crisis of foundation of mathematics.

From a logical point of view, this is what Husserl writes:

"Indeed, since the new logic, in contrast to the old, conceived its real task as that of a practical discipline (a technology of just judgment), and that it tended towards a general methodology of sciences (…), it found numerous and pressing reasons to take as a particular objective questions relating to the character of mathematical methods and the logical nature of their fundamental concepts and their fundamental propositions [4]."

Among these numerous and pressing reasons, we must cite those relating to the logicism advocated in particular by Gottlob Frege and Bertrand Russell. For them, pure mathematics has two characteristics, namely the generality of discourse where the consideration of existing individuals is excluded, and the deductibility of mathematical discourse where the inferences that structure mathematical discourse are formal implications. Indeed, these inferences affirm not the propositions themselves, but the necessity of their connection. For supporters of the Vienna Circle, mathematical discourse only pretends to be a formal truth. It would therefore be possible to reduce mathematics to logic since the logical laws seem to be the laws of truth.

Consequently, the logical definition of the number, far from being reduced to the concrete operation of counting objects, consists in the reference to the numerical equality of two classes. In other words, two classes have the same number if it is possible to establish a bijective relationship between their respective elements. This logicism has created a crisis within mathematics as it is ontologically committed to classes. This logicism seems to protect mathematics from all criticism of the phenomenal nature of its basic concepts. It is here that the analysis of Husserl's number theory finds its necessity, because for Husserl it is necessary to clarify the axioms (we will come back to this with the debate of Husserl and Frege).

Another crisis that ignites the mathematical foundations of the Husserl period is the formalism supported by David Hilbert for whom, mathematics presents itself as a pure construction of the mind. For Hilbert, the task of mathematicians is to deduce theorems from axioms which are neither true nor false. Validity is now only based on the structure of the statements, and not on the nature of what they are talking about. The truth of mathematics is reduced to their internal coherence, that is to say to the non-contradiction of the propositions.

The debate on this formalist conception was revived by the theorems of incompleteness of Gödel who affirms that any coherent and recursive formal system containing arithmetic, has a proposition which is neither demonstrable nor refutable. Furthermore, this proposition is however "true" in the intuitive sense of the term: it formalizes the assertion that the theory is consistent; this is a logical debate that revolves around mathematics, thus proving the disruption that mathematics undergoes in the understanding of its basic concepts. This is why the analysis to which we will engage will give us the opportunity to understand that in reality the fundamental problem is the non-recourse to the subjective dimension at the start of any conceptualization of the fundamental concepts of mathematics.

Let us evoke another case of crisis encountered by mathematics at the time of Husserl: the intuitionism defended in a paradigmatic manner by LuitzenEgbertusJanBrouwer for whom, mathematics has an intuitive foundation. For him, Without intuition, logic turns out to be sterile. Thus, according to intuitionist logic, one cannot eliminate double negation (which classical logic does): "¬¬ p" cannot be reduced to "p". It follows that "¬p∨p" is not a theorem. These refusals are justified by the fact that in intuitionist logic "q⇒r" means that "from a demonstration of q I can build a demonstration of r", but the statement "¬¬ p⇒p" does not allow build a demonstration of p from a demonstration of "¬¬ p".

According to Husserl, Brouwer thus conceived of intuitionism as a philosophical positioning on mathematics and had greeted with skepticism its formalization given later by Arend Heyting. From which intuitionist logic will be born a constructive logic.

All these problems that punctuate the foundations of mathematics at the time of Husserl are logico-psychological. These are positions posed as postulates without any phenomenological foundation. And so logic, the limit domain situated between philosophy and mathematics, endeavors to clarify mathematical methods and formally analyze the basic concepts of mathematics. Only the solutions that Husserl provides come from psychological analyzes of the fundamental concepts of mathematics. Note that Husserl is a disciple of Brentano, and therefore the solutions he advocates are imprinted with psychological inspirations and will ultimately be phenomenological solutions. So for Husserl it is a psychology which would be transcendental phenomenology. Besides, Brentano develops a psychology where the intentional act is the key concept and refers to the constitutive relation of consciousness with the object. This is why it is not surprising that a psychology developed from such a postulate evolves towards a phenomenology. It is this psychology that Husserl will remember from Brentano and keep in mind the concept of intentionality.

It must therefore be said that apart from logic which is interested in the foundations of mathematics, it so happens that psychology also raises relevant problems at the heart of mathematics. Psychology, writes Husserl, raises "questions which relate to the phenomenal character and the psychological origin of representations of space, time, number ... [4]." That said, the psychology opens the door to a phenomenological look at the fundamental concepts of mathematics; although the problem lies at the heart of mathematics itself.

We therefore need to review and analyze these controversies which undermine mathematics as well as possible. Husserl gives this reason: "The resolution of these subtleties has an essential interest for philosophy, it suffices to refer also to the many errors, fraught with consequences, which were committed inside mathematics themselves, as a result of false conceptions of the concept of differential, etc., [4]. ” For Husserl, the difficulties lie in things themselves, in mathematics themselves. One reason that justifies the crisis at the heart of mathematics is "the disorderly separation of research which has been an obstacle to progress [4]." Husserl adds by clarifying: “The intimate systematic connection that exists within this chain of problems would have required that the organization of work be successively serialized in a natural way; but in fact each one followed his particular interest and sought to understand in himself what could only be understood in his dependence on something else” [4]. So to speak, the problems of mathematics must be treated as a whole, and this from their fundamental concepts (therefore the simplest) and not by the plurality of theories which do not take into account a logical-psychological analysis of these concepts.

By way of comparison, let us take the following two theories: the theory of space or analytic geometry of Hermann Helmholtz and the geometry of Euclid. Although Euclid is a predecessor to Hermann, for the sake of consistency of our reasoning, we will begin with the analysis of Hermann's theory. This uses the analytical calculation method to resolve the questions of principles relating to the axioms of geometry. And for Helmholtz, this analytical geometry calculates with pure concepts of magnitude and does not use any intuition in its demonstrations. On the other hand, Euclidean geometry proceeds in a purely intuitive way. The question is this: does analytical geometry not also presuppose certain facts of intuition? If not, as Husserl would say: "How indeed would we otherwise arrive at these general prescriptions according to which any geometric figure can be defined in an algebraic way by an equation, and then be transformed from any algebraic relation into a geometric relationship? [4]. Here arises the problem of axioms. Should we swallow a proposition considered obvious without any demonstration? Or submit it to a logical-psychological analysis? It is clear that for any understanding mind the conversion or the relation of arithmetic to geometry rests on the particularities of our representation of space, therefore on intuitions; since space designates an extension, abstract or not, or the perception of this extension, better still the form of our sensitive experience.

Also, an essential question arises: what are the facts of intuition on which is based the possibility of applying general arithmetic to geometry? Here we are at the heart of the problem of clarifying the relationship of arithmetic to geometry; numerical and axiomatic relationship whose controversies we mentioned above; something that Helmholtz did not take into account when developing his theory. It should be noted that the basic problem which arises here is that of the boundary domain situated between mathematics and philosophy, since we are talking about the inference of the facts of intuition in mathematical relationships.

The aim of the call of philosophy in mathematics is to clarify and subject to analysis first the simplest concepts and relationships in themselves, therefore first, then those which are more complicated and more dependent. We are interested in the first ones which are at the foundation of mathematics, but in a precise domain, that of arithmetic. In reality, it must be admitted, if not recognized, that beyond all mathematical categories, the first term is the concept of number. Because indeed, the concept of number constitutes the only foundation of elementary arithmetic. This is why, to believe Husserl, "it is with the concept of number that any philosophy of mathematics must begin" [4].

Here and now, we give our roadmap: the analysis to which we will engage, in the Husserlian device of knowledge, would be a psychological analysis of the concept of number in order to restore the subjective foundations of scientific research. This critique opens the way to our ideal, that of tending and defending a subjective a priori in the sciences. Regarding this criticism, on psychological grounds, which will be ours, Husserl reassures in these terms: "The means which it employs for this purpose belong to psychology, and they must belong to it, if such research seeks to achieve results. Insured [4]." The need of psychology to analyze the concept of number stems from the fact that number is an elementary concept, therefore little degree of complexity, and the understanding of these simple representations that is number is the key to understanding complex degrees with which consciousness operates. So start from the simple thanks to the psychological mechanisms to lend itself to an in-depth analysis of the complexes.

Keeping in mind, let us repeat, that our ideal in this analysis is to succeed in identifying the phenomenal character of the concept of number. Once this dimension is grasped, we will better understand the Husserlian claim of the subjective a priori in the quest for science; and we will be more comfortable and reassured to confirm the structure of a transcendental subjectivity in grasping the phenomena that are available to us, such as the concept of numbers elsewhere.

The psychic representation of number: quantity and collective links

It is universally recognized that there are two kinds of numbers: cardinal numbers and ordinal numbers. The problem that arises between these two number formations is that of the superiority between the two. Many famous scholars have wrongly considered that the ordinal numbers precede and are therefore superior to the cardinal numbers. The question is: what does each of these number formations evoke? Here, it is necessary to establish the share of things: the cardinal numbers (1, 2, 3…) are multiplicities, and the ordinal numbers (1st, 2nd, 3rd…) are sequences.

However, it turns out that "the sequences are ordered multiplicities [4]"; consequently, they derive from multiplicities which are the cardinal numbers. Besides, the most ordinary definition of the concept of number attests that multiplicities constitute the natural starting point of all number formation. Husserl puts it this way: "The most ordinary definition is this: number is a quantity of units. Instead of quantity, we also say plurality, together, aggregate, collection, multiplicity… [4]". That said, quantity refers to multiplicities, and multiplicity to cardinal numbers. There is therefore no doubt that ordinal numbers proceed from cardinal numbers.

Also called numbers, the cardinal numbers are ranked first because the other number words come from them; in other words, the other number words are only the result of minimal changes in the numbers. For example two, second, double, twice, half are the real base number words of two to believe Husserl. And so the character of numeration, as a cardinal number or multiplicities, also prevails for ordinal numbers. In fact, the debate opened by eminent scientists (such as Rowan Hamilton, Helmholtz and Kronecker) on superiority, it seems that ordinal numbers over cardinal numbers, shows that these scholars ignored the meaning of what is called numeration. They mistakenly thought that numerations are specializations of ordinal numbers. Here is what Husserl writes about it:

"What these scholars call numeration and ordinal number does not correspond to the concept that one ordinarily links to these names. If we take into account their usual meanings, then it remains fair that the concept of number includes that of numeration, and therefore that it presupposes it, as the mode of forming names rightly expresses [4]."

It must be confirmed here that whatever the different number formations, these arithmetic expressions contain, voluntarily or by force, the signs of numeration (1, 2, 3…). In fact these scientists pose the problem in terms of succession, what precedes between the two number formations (cardinals 1, 2, 3 ... and ordinal 1st, 2nd, 3rd) while Husserl is more native since poses the problem in terms of consequence, from what does the formation of any number arise?

Numerals are the basic concepts of arithmetic. In his introduction to the Philosophy of Arithmetic, Husserl makes this point: "In all things that concern arithmetic, the concept of numeration plays an extremely important role [4]." This analysis is a retrospective analysis on the foundations of arithmetic, therefore an analysis based on facts of intuition. Hence the need to analyze the concept of numeration (cardinal numbers). Husserl points out that "such an analysis is absolutely not used for ends which would be simply arithmetic [4]." It should be noted that the aim of this analysis, among many others, is to retrace the psychological constitution of the concept of number. This is the interest that psychology has in such a study.

Remember that quantity refers to numbers when it is a specific number. It is for this reason that Husserl writes: "The concept of numeration therefore embraces the same concrete phenomena as the concept of quantity [4]." Concrete phenomena evoke the idea of quantity of determined objects, which already refers us to the analysis of the concept of number. And so the examination of the concept of number gives us the opportunity to appreciate the relationship of the concept of quantity in understanding the concept of number. It would therefore be a question of focusing our attention on the formation and the content of the proper concepts

of quantity and number. To understand this Husserlian position, it would be interesting to open a parenthesis on the Husserlian reproaches of the somewhat daring interpretation of Gottlob Frege, to believe the words Husserl himself, on the concept of number.

Frege in his linguistic understanding of the concept of number considers that the (cardinal) number is neither a property of things nor a subjective element. He theorizes it thus: "to give a number is to state something of a concept" [5]. This implies that from Frege's point of view, the number cannot be reduced to the concrete operation of counting objects, but rather would consist in the reference to numerical equality, so that to affirm that it There are four trees in front of us says nothing about these trees: this assertion concerns the concept "tree in front of us" and states that this concept subsumes four objects. It is therefore this logicism that Husserl blames Frege for, this lack of understanding of what meaning and denotation means.

Besides, Frege distinguishes meaning and denotation to the point where the denotation would be the object to which we refer, and the meaning would be the mode of donation of the denotation. This distinction would mean that two distinct concepts refer to a single object. And Frege explains that this distinction should not be psychologized and refutes that meaning is by no means the subjective representation that each would introduce into their apprehension of number. Only by distinguishing meaning and denotation, Frege confuses that what is aimed at in the statement of a number is the concept, not the thing. Now the thing or object is already in itself an appearance endowed with meaning, and that is the phenomenon. The number assigned to the objects would represent the general concepts that are targeted and not only serve to classify or indicate, even less to count. The concept of number stuck to the object is also determined, and it is unequivocally so. In other words, the numerical attribute added to the object is determined in the determination of the object by consciousness. And worse still, number is a category that the mind conceives and is always an attribute of an object; that is to say, the number in its psychic representation already contains some something by way of quantity, without however being attributed to a factual object. So to say a number is in any case to conceptualize, and that would not be an abstraction. This is why in Husserl the number is a quantity of units or instead of quantity, we could also say plurality, together, aggregate, collection, multiplicity. This is where Husserl addresses corrections to the Frigean interpretation of the number. Husserl stipulates that there is indeed an opposition between a formal and collective sense, and a material and distributive sense in the statement of a number.

It is thus that in the analysis of digital, as regards for example the plural of men as Frege wrongly conceives, it must be stressed that this term "indicates the quantity determined, the numerical attribute which added to it gives it a determination and classification, it determines how much [4].” In other words, no distinction between the concept and the specific object. And so “a clear dependency relationship is then clearly formed between the concept thus determined and the numeration of the enumerated objects. With the concept, the number is also determined, and it is unequivocally determined [4].” This is Husserl’s explanation of Frege’s errors on the number. And Bernard Jolibert, grasping the quintessence of Husserl's remarks to Frege, writes in these very significant terms: "The cardinal fault of empiricism is to erroneously reduce the digital given to the empirical given. The number implies a collective bond which requires real construction work [1].” Let us therefore remember that the number states something, it does have a content (the examination of the concept of quantity will provide us with ample information), and its conceptualization is the work of the subject in his psyche. The notion of collective links that we will develop here will pose the representation of the concept of number as pertaining to the human psyche.

Thus, if it is admitted that number is a quantity of units, it goes without saying that the analysis of the concept of number, as a physical fact refers to acts; therefore to psychic acts. This is why this analysis of the concept of number lends itself to psychological analysis. And so, whether it is the definition that Leibniz gives of the concept of number: "an incorporeal figure, formed by the union of all things [4]", that it is that of Locke: "the most general number of our ideas, applicable to men, angels, actions, thoughts, in short to everything that can be or be thought [4]", or again the old definition error of the empirical school of John Stuart Mill: "the fact stated in the definition of a number is a physical fact [6]", the constitution of the concept of number is a matter of psychic acts. Here is how Jolibert easily presents the Husserlian position on the concept of number:

"In reality, it is acts of thought and not material or mental content that the number endeavors to determine. Their operational objectivity goes far beyond the sensitive reality where they can find a possible application. What Husserl sees is that the use of numbers, far from leading to an empirical return, releases them on the contrary. Thanks to him, thought is no longer subject to the sensualist limits within which Mill maintained calculation. Number becomes an objective, albeit abstract and general being. It is determined outside of any tangible spatial or temporal reference. He attains the status of determined and stable representation [1]."

In fact, to better understand the psychological analysis of the concept of number and understand the natural implication of the subjective a priori in the constitution of said concept, it would be interesting to

take an analytical look at the different kinds of relationships between the arithmetic contents called collective bonds. In fact, the concrete phenomena (multiplicities), from which the concepts are abstract, are on the one hand physical facts and on the other psychic facts, and can be united in a collective way, thus making disappear all the relationships whose domain is limited by the nature of the particular content. In this sense, the collective bond becomes, if Husserl is to be believed, "a whole of a particular kind, the parts of which are linked by certain relations which are exclusively specific to it [4]." In fact, to understand the collective relationships of concepts to which psychological consciousness plays a crucial role of description, we must refer to this definition given by J. St. Mill of what he means by relation:

"Objects, physical or mental, are related to one another by virtue of a complex state of consciousness. And they are related to each other in as many different ways, or, in other words, they have with each other as many distinct relationships as there are states of consciousness specifically different of which they are both parts [6]."

Clearly, the notion of collective links stipulates that the relationships between concrete mathematical phenomena are thought together in a psychic perception, but interpreted (i.e. phenomena) each in its own sense (hence the physical facts of one side and psychic on the other). That said, the analysis of the particular relationships between concrete phenomena (multiplicities) is a psychological analysis; therefore of a certain return to the psychic domain where subjectivity echoes.

On this subject, Franz Brentano, in Psychology from an empirical point of view, explains that any relation between physical and psychic phenomenon is not always made intentionally. Because the psychic phenomenon is an act consisting in noticing, in wanting, while the physical or contained phenomenon is what is noticed, wanted. This leads us to say that even the analogy, which at first glance appears to be a psychic phenomenon, would be, in this Brentanian analysis, a physical phenomenon. This conversion is justified by the fact that these relationships are of a particular kind. This is called collective bonding.

It should therefore be pointed out here that the phenomenon of relation is a psychic phenomenon; it's the act of linking content. It is here that we must reaffirm the role of the subjective a priori in mathematical compositions. Husserl writes: "The contents are precisely unified here only by the act, and it is therefore only by a particular reflection on him that this unification can be noticed [4]." And so, in collective links, a unification can be noticed intuitively in the content of the representation, but not in the physical link.

So let's remember that all unification comes from the psychic act. Husserl clarified in these terms: "Collective unification (...) consists only of certain psychic acts which include the contents by unifying them [4]." He also brings this clarification:

"A whole is formed when a unitary interest and in it and with it at the same time an act of unitary remark detach and embrace different contents for themselves. Collective bond can therefore also be understood only by thinking about the psychic act by which the whole is produced [4].

This Husserlian explanation allows us to say that we can think of a multiplicity of things in an act. Here, the problem of subjectivity is clearly posed. Collective bonding concerns mental life. To tell the truth, each time that we are brought to analyze a simple phenomenon (such as number), each time that we try to represent a relation even though simple, we would be there in the process of performing a psychic act with a view to to notice or to unify, to account. Husserl draws this conclusion: "This psychic relationship is therefore an indispensable psychological precondition for all relationships and all relationships in general [4]."

Thus, all the ingredients are there to say that the arithmetic relationships between them as a whole are the work, not only of physical connections, but also and above all of psychic relationships. In any case, this is the analysis that the psychological nature of collective bond gives us.

Now let's focus on the contribution of collective bonding to the origin and content of the concept of number. To do this we will briefly analyze the concept of quantity (which we have already touched on a little above) to understand the representation that takes care of related content. In fact, in general, the concept of quantity evokes the idea of indeterminate content. Now it turns out that the content is something. Consequently, the concept of quantity is "any something (...) the concept of quantity contains only the concept of something [4]." This something comes from a representation. Husserl explains: "Obviously the concept of something owes its formation to the psychic act of representing itself, every determined object is precisely given as content [4]." That said, the something of the concept of quantity does have definite content which refers to the concept of number. In reality, the concept of quantity at this stage implies the concept of number (here we find all the lucidity of Husserl's reproaches to Frege).

Here is the explanation given by Husserl on this subject: "Any concrete quantity falls under one of these concepts, and under one of these determined concept," it has a certain number ". It is easy to characterize the abstraction which must be accomplished on a concrete quantity present, to obtain

the concept of number under which it falls [4]." Any concrete, determined quantity refers to a number. This representation of the content is only possible via the psychic act. This analysis justifies the psychological underpinnings of the concept of number.

What to retain from this psychological analysis of the concept of number? Let us therefore note with attention the psychological constitution of the concept of number: "According to our conception, two kinds of thing constitute the concept of number: 1) the concept of collective unification, 2) the concept of something [4]." These two constitutive psychological parts (that is to say, the collective bond and the concept of determined quantity) of the concept of number depend on one another. There is no collective bond without unified content. The notion of something integrates that of determined quantity, the relation of physical phenomena and psychic phenomena integrates that of collective bond. This unity founds the Husserlian conception of arithmetic since, from Husserl's point of view, "the fundamental question of arithmetic, that is to say (...) the fundamental ideas of unity and quantity present in the notion of numeration [1]", forms the psychological constitution of the concept of number. However, the notion of something is more original since it founds the concept of number, which moreover is a concept determined. That said, all this analysis is the result of a reflection on the act which represents content. There is therefore of course a subjective a priori underlying the constitution of the concept of number. It is the psychic, we repeat, which thinks of arithmetic relationships, and "number is not a simple empirical object [1]." Nor is it just a number symbol, but a concept; and who says concept, says general and abstract representation coming from a mental construction. Thus the strong rigor which seems to protect mathematics from criticism does not, let us put it bluntly, suppress analyzes of phenomenological allure and inspiration. Number is a mathematical phenomenon, it is important for phenomenology to review its phenomenal character.

The aim of our criticism is to restore the truth: that subjectivity is the basis of scientific research, although scientific objectivity seems to be wrongly mistaken as superior and prior. The psychological conclusions we have reached on the concept of number attest to the forgetfulness of the use of the subjective a priori in science. Since, let us be clear, the analyzes that we have elaborated are imbued with phenomenological ideals.

Husserl therefore proposes a return to the sources, to the psychic which represents phenomena. Knowledge is a structure of subjectivity. And scientific knowledge is no exception. Although subjectivity, let us remember, is the most appropriate and natural way of knowing. Analysis of the concept of number gives us the proof. The critique of number theory in relation to the heuristic structure of subjectivity thus goes beyond the general crisis of the foundations of mathematics to the logico-psychological analysis of the concept of number. This analysis reveals the psychological inadequacies of the constitution of arithmetic elements and suggests the phenomenological ambition to restore the role and the initial place of subjectivity in scientific research. Now we will clarify the problem, in reality, which undermines science in general of overestimating objectivity at the expense of subjectivity.

Objectivism and the subjective a priori: the scientific illusion of objectivity

Let us note this with precision: Husserl reproaches science for claiming to exclude subjectivity from the field of knowledge and to put a fortiori objectivity at the base of the construction of science, despite, however, their ignorance of the ideal world. This is Husserl's criticism of science in general. He points the finger at logicism and psychologism. This is why, here and now, we are tackling a fundamental and topical problem, an epistemological one which undermines empirical science. We approach it, remember, in the Husserlian device of knowledge. The analysis of the concept of number (which we have just detailed) has shown us the limits of science as regards the psychic representation of the concrete objects which are offered to it. This is why clarifying the problem of the primacy between objectivity and subjectivity is necessary for us to establish a phenomenological conception of the basic concepts of science.

In fact, for Husserl, science favors objectivity at the expense of subjectivity. This posture in the relation to the world distances science from phenomenal reality, or if you want from subjective reality. Therefore, objectivism is a dogmatism favoring objectivity over subjectivity, relying only on what presents itself as empirical reality, discarding all judgment as a product of pure consciousness. This tendency posits science as insufficient knowledge, incapable of providing an adequate critique of its field of action. This is why Husserl opens hostilities between objectivism and subjectivity.

In reality, the problem with science is that it overestimated the power of objectivity to the point of making it the very foundation of its method of investigation. Here is what Strasser points out exactly with regard to true objectivity: "The object is a discovery made by human subjects and that objectivity is the result of a subjective approach [7]." And so if it is admitted that the object is a discovery made by the human subject, it follows that the constitutive representation of fundamental concepts would arise from the activity of the human psyche, therefore from subjectivity. Thus, through this clarification, subjectivity is the starting point for the development of complete objectivity. It is the phenomenological vision of the description of phenomena in relation to

consciousness. Gabrielle Pfeiffer and Emmanuel Levinas make this comment, in an introduction to Cartesian meditations, on the Husserlian position regarding objectivity: "With him (Husserl) philosophy changes completely its pace, and passes radically from naive objectivism to transcendental subjectivism [8]. Here, by philosophy, we mean the expression of science in general. Thus, the latter must recognize its naive objectivism and take the step towards pure subjectivity.

The Husserlian ideal, at this stage, is to achieve a methodological revision of science in order to rethink the sources of rigorous science. It is therefore necessary to redirect science on phenomenological ground. It is therefore necessary to reconsider the way of knowing science, to review the psychological ways of perception of the basic concepts of science. Because it must be said that it is empirical psychology which induces science in the pretension of thinking that objectivity is anterior to subjectivity, since it is psychology which seems to establish the mechanisms of knowing the human subject. Only this psychology cannot raise the phenomenal character of scientific objects. This is why Husserl believes that psychology must also be reviewed so that it has a phenomenological foundation, and departs as far as possible from his psychologism. We must consider a rigorous psychology in the sense of a fundamental science establishing and ensuring in an eidetic way the scientific achievement (this psychology will therefore give rise to phenomenology).

Tthe cause that motivates Husserl to reorient psychology is the psychological illusion of objectivity. In other words, as Georges Thinès says, "The main reason for resorting to phenomenology is that only the latter raises the question of whether psychology can be legitimately considered as a fundamental science [9]." So we have to say here that the psychology we are talking about here is a psychology that must be a fundamental science, if not, in reality, transcendental phenomenology. Therefore, we understand that there is a difference in nature between objectivism (which is understood as a blind belief in an objectivity without prior subjectivity) and subjectivity, pure moreover; and here we show how true objectivity is the result of pure subjectivity.

This is how we allow ourselves to assert that a basic conception of subjectivity is an epistemological necessity. This brings us to the critical analysis of objective psychology. Our task in this respect will be to show the essential position of subjectivity in the process of knowledge of phenomena. It is only at the end of this understanding that we will grasp the Husserlian method and its critique of psychologism. Because, if we want the psychological work on the possibilities of knowing our psyche, if not on our representations of fundamental scientific concepts, to have a meaning, it is important to submit it to a phenomenological jurisdiction. Subjectivity must be taken into account, that is, the subject's relationship to the phenomenon (which should be most carefully considered in psychology). Here we will therefore see Husserl's passage from psychology to phenomenology in his analyzes of the psychic representation of scientific concepts, in this case those of mathematics (that of target numbers).

Husserlian phenomenology's primary objective is to unmask the dangers of psychologism, the latter understood as the tendency to base all human science on psychology. This is why Husserl is deep, he does not question the particular problems studied in psychology, but the way in which the problems are posed. It focuses on the conditions of possibility of the thing. We are witnessing here a radical trial of psychology, which was challenged in the tribunal of phenomenology. His psychologism, his objectivism are illusions detected by Husserlian phenomenology, and must be reviewed because they have led science to antinomies. These are the terms in which Politzer speaks of psychologists: "Psychologists are scientists as evangelized savages are Christians [10]." This means that psychology is scientific only in appearance, and this because of the abandonment of subjectivity (this dimension necessary par excellence). So let's keep in mind that we criticize objective psychology because it takes science away from retrospective analysis from its foundations, from analysis from the subjective dimension. Husserl reproaches psychology for its natural attitude.

Note this carefully: objectivism separates knowledge of the object from its pure interiority, from subjective reality. In other words, the object is not only grasped as corresponding to reality, but it is wrongly that reality. This psychological vision creates confusion between the objective world and the subjective world. And the scientifically pretended psychologist tends to explain reality to its only objective dimension, which is not in itself first. This conviction is that of the objectivism that science advocates.

Gaining a better grasp of Husserl's regret at the abandonment of subjectivity by science, Kockelmans writes: "The world of science must have a solid foundation on which it must be able to rely and on which it is built. This basis cannot be anything other than (...) evidence ... - the term evidence referring to the way in which the objects in question present themselves to the subject [11]." By obviousness is meant the apodictic foundation, that is to say necessary, pertaining to the activity of the subject. It is therefore clear that the quest for an apodictic foundation for science in general is an epistemo-philosophical necessity.

Still, let us ask ourselves this question: how to resolve the crisis engendered by objectivism? What method is appropriate to overcome the naivety of the scientific world? To answer these questions, let us conclude with Georges Thinès, as Husserl would have

wished deeply: "A reduction (...) is necessary to discover the world [9]." It is therefore the reduction in its different levels, from Husserl's point of view, reveals the heuristic structure of subjectivity in the representation of basic mathematical concepts, as an example the concept of number. Number theory submitted to Husserlian analysis is indebted, at least ontologically, from the primordial subjective substance to the representation of numbers. Here Husserlian phenomenology is decimated. The debate of objectivism and subjectivity opens the way for the Husserlian approach of phenomenology to easily understand how we come to know the phenomenon, and what is necessary in grasping the phenomenon? How do we represent it?

CONCLUSION

This research on number theory and the heuristic structure of subjectivity gave us the opportunity to appreciate the analysis of the psychic representation of the concept of number in Husserl, in relation to his conception of the subjective a priori. We have immersed ourselves in the heart of the primordial subjective sources of scientific objectivity. We have been able to review the psychic mechanisms which contribute to the representation of the phenomena which are offered to consciousness. We have realized the relationship between the subjectivity of the act of knowing and the objectivity of the content of knowledge.

It follows from our analyzes that the conceptualization of mathematics proceeds from mental life. The crisis of the sciences which presupposes the crisis of mathematics, requires a return to the examination of the human psyche where, naturally, knowledge is conceived. According to Husserl, knowledge in its psychic structure is the foundation of subjectivity. By questioning consciousness, we reassure that initially all empirical data comes from the representation made by the subject.

From Descartes to Husserl, philosophical conceptions advocate the primacy of subjectivity over objectivity. Thus, the heuristic structure of subjectivity which underlines the dimensions of a provisional nature, is akin to the different ways of consciousness to relate to the object.

We realize, at the end of the crises that mark out the history of mathematics at the time of Husserl and the analyzes to which he gave himself up, that science encounters obstacles which slow down its progress, obstacles due to the lack of understanding of its basic concepts. By pinpointing logicism, formalism, intuitionism and the question of the conversion of arithmetic to geometry, we come to the conclusion that the basic problem which undermines science is the abandonment of subjective substance from any research.

The concept of number, in relation to the heuristic structure of subjectivity, poses number not as an empirical object, but as a numerical phenomenon that the psyche conceives. Relating to the unity represented by the psychic act, the number is governed on the one hand by the concept of quantity (which refers to the notion of something), and on the other by the notion of collective connections which justifies unity in the perception of the object. It follows from this Husserlian approach that the number is in itself quantity and attributed to the object, it is determined unequivocally with the object.

Starting from the analysis of the concept of number, this article nourishes the ambition of orienting science to review the psychic mechanisms which contribute to our representation of scientific concepts. Psychic life is the place of the formation of knowledge, and phenomenology is the rigorous science which makes it its object of study.

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