

The Transcendental Foundations of Science¹

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Abstract

It is a philosophical naiveté to believe that the object of science is some ready-made world out there that the scientist, free of any preconceptions, simply stumbles upon. Of course, there is a world out there, given to us through the senses, but that must be intentionally elaborated to become a world for us and a possible object of scientific inquiry. The intentional constitution of the world of science supports and “justifies” a priori conceptions about the empirical world, even those of a logical nature, that are, then, properly transcendental rather than metaphysical. My goal here is to investigate what these presuppositions are and on what they are based.

Keywords: Science, Presuppositions, Transcendental, Phenomenology

In the introduction to his lectures on the classification of sciences of 1927 (Husserl, 2001: 7) Husserl says that before any science there is a world “that is already pre-given for us in life as an evidence”. Which world is this, one may ask, the pre-scientific *life-world* where we live our daily lives, as the quote seems to suggest, or some world *beyond* the life-world, the scientific world properly speaking that is uncritically presupposed in science as “the” world out there? In fact, both. Both are *given* in the sense that their sense of being is not *questioned*. But neither is given in the sense of being out there as ready-made things we simply stumble upon. The being of the world, be it the life-word or

¹ *Paisana Lecture*. Lisbon, October 2017. To the memory of Lilian da Silva

the world of science is *constituted*, pre-determined in its *essential* aspects, and such a predetermination is a *necessary precondition* for life and science. How the world of science is constituted for a science of this world to be possible according to an ideal of science is my main concern here.

Now, focusing our attention on the empirical science, is the world of the *theoretical* scientist different from the world of the *experimental* scientist, the latter maybe the life-world where theorizations are put to test, the former a construct based on it? If we take Husserl's word on the matter (for example, Husserl [1954], henceforth quoted as *Crisis*, §9), empirical science, theoretical or experimental, has only one world; the world of *theoretical* science is *also* that of *experimental* science. Theories of empirical science are not confronted with the raw sensorial perceptions of the life-world, but with perceptual experience already *conveniently re-interpreted* from the perspective of theoretical science. The world of the experimental scientist and that of the theoretical scientist are *the same world, even when*, as is often the case (for example, in the mathematical sciences of nature), *it is a highly idealized world*.

The life-world, despite being where the scientist lives his life and carries out his investigations by either theoretical or experimental means, is not usually the *object* of his investigations, unless, of course, the science in question is a purely descriptive one devoid of any further theoretical interest. As Husserl says (Husserl, 2001: 193): “[T]he pre-scientific man does not know any other world, nor does the scientist, if his theoretical interest is simply descriptive”. The theoretical attitude proper, however, which seeks for regularities and laws to master an *open infinite* domain of *possible* (not only actual) experiences does not belong in the life-world.²

The *perceptual* world, although a given of science, is not *passively* given. Perceptual experiences are *not* raw sensations, but sensations organized in a system with a sense that already betrays intentional and proto-intentional actions. The perceptual world, objectively considered, is the *objective correlate* of the open infinite domain of *all possible* perceptual experiences of a subject

² Therefore, no science, in particular no empirical science, can do without an *a priori* determination of the field of possible experiences available in its domain. This is a task for transcendental philosophy, on which the validity of the methods of science and even the *logic* of scientific reasoning depend.

in general, and extends further than what is offered in *actual perception* to any subject in particular. This extra of being and meaning emanates from transcendental subjectivity. The perceptual world “out there” is an *intentional construct* based on actual experiences standing as the noematic counterpart of the domain of all perceptual experiences in principle available to a subject. Therefore, since the a priori (transcendental) determination of the objective perceptual world is intimately correlated with the transcendental determination of the open infinite system of all subjective perceptions of a subject in general, I will refer to either ambiguously as the perceptual world.

In a certain sense of the word, the perceptual world is *inferred* from the *perceived* world. This, of course, is a peculiar kind of inference, largely biased by *a priori* presuppositions that although *not* extrapolated from actual perceptual experience pre-condition to some extent, formally if not materially, all possible experiences. For example, we cannot — out of *necessity* — ever experience anything that is *inconsistent* with a lived experience that still holds valid, i.e. that was not cancelled. Contradictory experiences cannot co-exist. This *universal impossibility* is not, and cannot be itself a fact of experience; it must then be an a priori presupposition.

The perceptual world is an open infinite totality that contains but extrapolates actual perception, it is in part immanent, in part transcendent, in part intuitively given and in part *intentionally constituted* from the immediately perceived. This world, object of both lived and still un-lived experiences, must be *intentionally constituted* – formally if not materially – for an *objective* science of the perceptual world to be possible. We will soon see how.

But the perceptual world is not always the *immediate* object of scientific interest, even though it remains its *primary* object of interest. Besides extrapolating the domain of lived experiences, the constitution of the world of science often extrapolates the *possibility* of perceptual experience. This happens, for instance, when, for methodological purposes, the scientific interest shifts from the perceptual world itself to a formal-mathematical manifold standing for it. As Husserl discussed in *Crisis*, with this shift, which marked the beginning of modern empirical science, the perceptual world recedes to the background and a *mathematical* substitute takes its place on the forestage of scientific drama.

Although characteristic of modern physics, the mathematical substruction of the empirical world is in principle available as a methodology to all empirical sciences. There is nothing special in the material world that makes it more amenable to mathematical treatment than the world of living beings, for example. The *fact* that mathematics has a more restrict domain of applicability in empirical sciences other than physics is merely circumstantial.

Summing up, the world of science, even experimental science, is *not* the world as actually perceived, but the world as *possibly perceivable*, intentionally constituted from actual perception, often further idealized into a world *in principle* inaccessible to perception, only mathematical reasoning. These strata of intentional action usually go unnoticed and unaccounted for; to focus attention on them is a *philosophical*, not scientific task. Intentionality acts on passive sensorial experience actively producing a world that contains more than what can be extracted from experience. This world is partly perceived and partially hidden and for it to exist it must be *constituted*.

The perceptual world, despite containing more than what is perceived is *in principle* perceivable, if only indirectly, even when harboring theoretical constructs such as neutrinos and black holes. Its mathematization, however, is not even in principle perceivable; the mathematical world is out the reach of perception. Thus, the world becomes an object of reason and its relationship with the perceptual world is not only merely representational, but also instrumental. In mathematization, the empirical world emerges as a mathematical manifold subjected to strict mathematically expressible legality. This, however, is not “the word out there”, but a *methodological devise* with which to explore the *formal-structural* aspects of the perceptual world, the only *real* world.

In any case, the world of science is an *intentional product*, given to science to investigate by whatever means it deems adequate. Therefore, to say, with Husserl, that the world of science is pre-given does not mean to say that it is simply out there, that science simply stumbles upon it, but that it is *intentionally constituted prior to the scientific involvement with it*. The pre-donation of the world opens, consequently, an array of problems concerning *intentional constitution* which Husserl calls the *transcendental* problems (Husserl, 2001).

It is important to keep in mind that there is no gap between the world “out there” and the world of immediate experience. From the perspective of

empirical science, the world “out there”, the empirical world, *is* the perceptual world. There is no place here for the Kantian dichotomy between phenomenal and noumenal worlds. The idea that the world of science is the phenomenal world but that there is a noumenal world beyond it inaccessible *in principle* to perception is an anti-scientific metaphysical prejudice.³ Indeed, if knowledge is grounded in experience, there is no point in positing a world inaccessible in principle to experience, and then to knowledge. The empirical world, being the objective correlate to the infinite open totality of *possible* perceptual experiences, extrapolates any actual experience, but is not inaccessible *in principle* to perception. The *complete* experience of such an infinite world can, of course, be only an ideal.

But if the complete experience of the infinite world is the ideal of science, the *ideal* scientific theory must necessarily be a *complete finitely* (or *recursively*) *axiomatizable* theory where one can derive all truths about the world but no falsity from a *finite* (*recursive*) set of fundamental facts. The world such theory describes, then, must be in Husserl words a *definite manifold*, that is, a manifold that can be completely described by a finite (recursive) set of basis truths. In his words, the theory “rules over infinity as a definite deductive theory” (Husserl, 2001: 212).⁴

The empirical world is an intentional production presupposed by scientific activity proper that is not *questioned* by it. A world is simply *given* to science; to question the donation of this world, that is, to face the transcendental problems, is a *philosophical* task.

To talk, however, about *the* empirical world is somewhat misleading. There are as many empirical worlds as there are empirical sciences and the same science may contemplate sometimes radically different worlds throughout its historical development. The world of classical physics is not the same as that

³ The mathematized world of the mathematical science of nature is another matter. Although it is inaccessible in principle to experience, the perceptual world can be ideally represented in it.

⁴ A *definite manifold*, then, is one for which there is a finitely axiomatizable complete theory. The most fundamental presupposition of empirical science, then, is that the empirical world is a definite multiplicity (or manifold). The *mathematical* science of nature goes one step further and presupposes it to be a definite *mathematical* manifold.

of quantum physics, the world of thermodynamics is not the same as that of statistical mechanics, the world of Newton is not the same as the world of Aristotle, the world of physics is not the same as that of chemistry, and so on.

However, although scientific worlds may differ from one another (even when they have the same objects, for example, the world of bodies simply as such in space and time and the world of *living* bodies), they are all worlds, instantiations of the *idea* of a world under the scrutiny of science, whose task is to produce, in a systematic and methodic manner, by the cooperative efforts of scientists maybe separated in space and time, theoretical systems of truths about the world. We can then identify *two* sets of transcendental problems, those concerning the intentional constitution of *particular* worlds and those concerning the constitution of the very *idea* of a world given to science.

Intentional action posits worlds with a *sense* that belongs essentially, that is, due to how they are constituted, to them. Intentional meaning manifests itself as *presuppositions* about the world whose constituted meaning it is; or better said, as *transcendental presuppositions*. Transcendental presuppositions are not, in a proper sense, scientific. Scientific presuppositions are amenable to verification and can be shown to be right or wrong, transcendental presuppositions are not testable and are true as long as the positing of the world to which they refer remains valid.

Intentional presuppositions express the meaning intentionally attached to *regions* of being as *proper* sub-classes of the largest ontological domain, that of objects merely as such, and are thus *synthetic truths*. Being, however, prior to and conditioning experience, they are *a priori*. Transcendental presuppositions are, therefore, in Husserl's sense, *synthetic* (or *material*) *a priori* truths. A *prioricity*, however, is no guarantee of irrevocability, since any intentional positing can at any time be cancelled. Nor is a *prioricity*, to the extent that it is material, a sign of universality, since its scope of validity is confined to particular ontological regions. As Husserl says, "all a priori [...] is a norm for all possible knowledge of experience" (Husserl, 2001: 118). Material a priori is the a priori of material domains, i.e. proper subdomains of the domain of all objects. The analytic a priori, on the other hand, is the purely formal a priori concerning objects merely as such.

From a naïve "naturalist" pre-phenomenological perspective, transcendental presuppositions present themselves as *metaphysical* hypotheses. From a

phenomenological point of view, however, that is, under the action of the phenomenological epoché, which cancels metaphysical allegiances, constitutive presuppositions are properly transcendental. Phenomenology opposes to the metaphysical *belief* that there is an independent world out there, already fully constituted and existing in itself to be investigated by science the *understanding* that the world of science is an intentional construct, objective but not independent of intentional action. According to the metaphysical *thesis*, the being of the world is a matter of fact and contingency; from the phenomenological perspective it is, instead, a matter of right and necessity.

But there is no necessity that is not self-imposed, in particular the transcendental presuppositions that go with the intentional genesis of the world(s) of science. In a pre-phenomenological naturalist approach, in which the world to be known and the knowing subject are kept apart, science sometimes must advance hypotheses about the world, some of them in principle verifiable, some unverifiable. The former are the scientific hypotheses, the latter, the metaphysical. But the fact is that the worlds of science, with their *intrinsic sense*, although pre-given to science and independent of scientific validation, do *not* exist independently of being intentionally posited and the presuppositions expressing the sense of these worlds are, therefore, neither scientific nor metaphysical but properly transcendental.

The transcendental presuppositions of *science* can be revealed to philosophical inquiry in a form of *transcendental deduction*. How *the* world (or *a* world) must be like for a science of the world (or of *this* world) to be *possible*? This question admits two formulations, one concerning particular sciences, another any science whatsoever. In the first case, presuppositions have restricted scope and may have only provisional validity, changing as the positing of the relevant world changes in one way or another, if it does. For example, the Aristotelian world is a field of actualization of potentialities and scientific explanations are supposed to involve a fourfold notion of causality – efficient, causal, material and formal. The world of Newton, on the other hand, is a system of aimless bodies in interaction under the action of forces and explanations involve only efficient causes and mathematically expressible laws relating causes to effects. Aristotle and Newton, then, embrace different conceptions of what *empirical reality* is and what counts as a scientific explanation. I call different positings of a world, different *world conceptions*.

Despite their differences, different world conceptions are all conceptions of a *world* given to science and must therefore endorse the more general presuppositions related to a domain of scientific enquiry simply as such.

One particularly important aspect of Newton's conception of empirical world, inherited from Galileo and Descartes, is that the world is a *mathematically* structured manifold. As Galileo's famously said, the book of nature is written in mathematical characters and no one ignorant of the mathematical language shall be able to read it. This is interpreted as meaning that nature is, at its core, mathematical and there can be no true science of nature that is not mathematical.

Read in metaphysical key, this view raises a genuine problem: if nature is indeed *in itself* mathematical and would be so even if no man existed, considering that the mathematics used in the mathematical theories of nature were created in most cases not as a result of observing nature, we would have to accept the existence of some mysterious link between man's mathematical creativity and nature, a sort of pre-established harmony. The existence of a "pre-established harmony between pure mathematics and physics" has indeed been alluded to by no lesser a physicist than Minkowski in his famous essay "Space and Time" (the very last sentence). The problem of the applicability of mathematics in empirical science can only be treated, and the mystery dispelled, from an idealist perspective (see da Silva, 2017).

Only if physical nature as understood in the modern mathematical science of nature is, as Husserl argued in *Crisis*, an intentional construct in which mathematics enters as an essential component the relevance of mathematics in natural science comes out naturally. Nature is mathematical only because *we made it so*, and we made nature mathematical so we can deal with it mathematically. Mathematization is, as Husserl emphasized, a *methodological tool*. A very efficient methodology that, however, has no serious metaphysical consequences besides the fact that empirical nature has a structure that one can idealize in mathematical terms. A structure, it is important to emphasize, that can be traced, at least partially, back to the proto-intentional actions that make perceptions out of sensations.⁵

⁵ Besides idealizing the structure of perceptual nature in mathematical terms, science often extends these *phenomenological mathematical models* into more mathematically

The world and any world, as already emphasized, are intentional productions coming into being shrouded in layers of meaning intentionally attached to them in their intentional positing. Intentional positing is prior to and preconditions any experience of the world by the means allowed by the positing itself. The intentional construct “physical world” of Galilean-Cartesian-Newtonian physics, to give another example, conceived as a mechanism regulated by mathematically expressible universal laws presupposed by classical Mechanics is not the same world-conception of 19th century Electromagnetism, where forces acting immediately at distance are replaced by fields whose actions travel through space at finite velocities. These are different world-conceptions, harboring different presuppositions.

But there are even more fundamental presuppositions, on which the very *possibility* of an *objective* science depends. For such a science to be possible, the world must, for example, be *objectively available and cognitively accessible* as the *same* world to *anyone* in possession of the adequate scientific instruments. It must also *transcend* any particular presentation, opening up to a horizon of further presentations of yet undisclosed aspects and properties. The world of objective science is, in a word, *transcendent*. In the words of Husserl:

[T]he world that is given to us [...] [is given] as a communal world [...] as a world unique and identical in all the changes of its individual elements; pre-given, then, as this same world in a persistent structural form that impregnates *a priori* all that is in it as to its being and being-so, its logical structure, its modifications and non-modifications, its causes and its effects, etc. (Husserl, 2001: 103).

The world must also be *objectively (or ontically) complete*. The *idea* of science requires that no meaningful question about the world is *in itself* undecided and poses as an *ideal* that any meaningful question about the world *must* be answered, that is, the *ideal* of the complete disclosure of the being-so of the world in a *complete* theory. This requires the world to be a *complete* being. This means that any situation *in principle factual*, i.e. any situation expressible by a

elaborated systems, which however are not always supposed to represent perceptual reality.

syntactically and semantically meaningful assertion of the theory deemed adequate to express possible facts of the world, must be already intrinsically decided as to its factuality – it must either be determinately a fact of the world or determinately not one. There cannot be situations that are *undeterminable* as to their factuality as *a matter of principle*, although there may be situations that are *as a matter of fact* undetermined given the means available to science at a given time.⁶

Another presupposition, the most fundamental one as to the possibility of science as a *rational* endeavor, is that the world is *consistent*, that is, no possible situation in the world can be simultaneously a fact *and* not a fact. The world is consistent with itself as a matter of *principle*.

Whereas endorsing an Aristotelian instead of a Newtonian conception of empirical reality does not jeopardize the possibility of an objective empirical science, regardless of its efficacy, denying that the world is an objective, transcendent, objectively complete, consistent, epistemically accessible world, subsisting out there as the same world regardless of eventual changes of state, bars the way to an *objective* science aiming *ideally* at a *complete* description of the world.

Being prior to experience but beyond the possibility of validation or invalidation in experience, the presuppositions just mentioned are properly *transcendental* presuppositions whose validity emanates from *intentional subjectivity*. Being preconditions of our scientific praxis, they are more fundamental than world conceptions, which belong all as particularizations to the more general genus “world” as a domain of scientific concern. Such presuppositions accompany, often in the background, not only our theoretical involvement with the world of science, but also our pre-theoretical involvement with the life-world of ordinary life.⁷

⁶ Gödel’s theorem of incompleteness does not have any consequence for this presupposition. The theorem only says that for most mathematical theories (far from all) there are *truths* of the domain that are unprovable *in the theory of the domain*, it says nothing about the existence of assertions whose *objective* truth-value is *in principle* undeterminable.

⁷ For Husserl, one arrives at the conception of the world of science by *imaginary variation* from the immediately given, the life-world (see Husserl, 2001).

The most fundamental transcendental principles of science, those required as preconditions of *any* objective science can be formulated ontologically as well as logically. In *ontological* formulation, they express the a priori aspects of the world, required for it to be object of an *objective* science. About this, Husserl says (Husserl, 2001: 105): “the being of a world is not in itself, in the sense that it would be indifferent to the possibility of true knowledge; in fact, both are in necessary correlation, and this prescribes to the being of the world itself a necessary structure, an ontological structure.” In *logical* formulation, they express the *principles* that are *justified for reasoning* about such a world. Either formulation has an *objective* and a *subjective* version. In ontological formulation, the presuppositions are (see also Husserl, 1974):

I) *Uniqueness and permanence* of the world:

- 1) *Objective version*: the world is an *universum* of “events” existing objectively “out there” as the *same* world (even though its *state* can change in time). “Events” are state-of-affairs completely determined *sub specie aeternitatis*.
- 2) *Subjective version*: the *same* world can be object of different subjective experiences.

II) *Objective Completeness* of the world:

- 1) *Objective version*: any “event” of the world that is in principle possible is either a fact or not a fact, *tertium non datur*. No possible “event” is in itself undetermined (although it can be undetermined *for us*). The world is “complete”, that is, a *maximal* system of facts.
- 2) *Subjective version*: any possible “event” is in principle experienciable; the domain of experiences is *ideally* complete. A characterization of the notion of possibility for events is, of course, called for. I will deal with this issue in a moment.

III) *Consistency* of the world:

- 1) *Objective version*: no two *facts* of the world cancel each other. No event coexists with another that implies its *non-existence*.

- 2) *Subjective version*: no two *actual* experiences can cancel one another. No experience can coexist with its opposite (i.e. the experience with the same content, but in the mode of *frustration*).⁸

The clarification of *logical principles* as transcendental presuppositions counts as a *justification* of these same principles; *the justification of logical principles lies in their clarification as transcendental presuppositions*. Logical principles cannot be proven, for they are principles, i.e. unconditioned conditions, but they can be justified as principles *imposed* upon us by our conception of a world under scientific investigation. One does not choose one's logical principles, one chooses a world, so to speak, logic follows behind.

There are three basic logical principles, identity, non-contradiction and bivalence. They are valid for reasoning about the domain of concern of any *objective* science considered simply as such, i.e. insofar as it is the domain of an objective science, prior to any actual scientific investigation and independently of other presuppositions. An immediate consequence of this is that logical principles are *not* universally valid in the sense of being valid in no matter which context. Their validity depends on the sense of being intentionally attached to the domain where they are supposed to rule. Logical principles are independent of the material content of the assertions over which they rule, provided, however, that this content is confined to the world on whose intentional sense they depend. Different worlds, with different senses of being, may require different logics. Intuitionist mathematicians, for example, do not recognize the validity of classical logic, where the principle of bivalence (*tertium non datur* or excluded-middle) is true, *because* they have a conception of mathematical domain – and, then, of mathematics – that differs from that of classical mathematicians. Classical principles refer to a world that is objectively given and objectively complete, intuitionistic principles to one that is neither one nor the other. For the intuitionist, the mathematical world is a world in the making, emanating in a temporal process from subjective intuitions. The question as to which is the correct logic for mathematics depends solely on whether one conceives the mathematical world to be an objectively given and objectively complete world or not, independently of which ontological status

⁸ For the meaning of *frustration* as an *intentional* experience see Husserl (1972).

one attributes to it. But we can argue that if mathematics is an *objective* science, intuitionistic mathematics cannot be the right way of doing it, if not classically reinterpreted as a mathematics of *processes*, not *objective facts*.

Before proceeding I must say a few words about language and meaning. A language suitable for describing a given world, in our case, a domain of theoretical inquiry, must, first, contain symbols for all the categories by which the world is structured – objects, relations, and the like. Second, it must have all the logical resources to express what is *a priori* seen as *capable* of disclosing itself to consciousness in the mode of either intuition or intuitively empty representation; second-order language must be required, for example, or generalized quantifiers, etc. Third, the grammar of such a language must reflect the *a priori* rules of combination of both formal-ontological and material-ontological categories. Syntactic rules for the manipulation of the symbols of the language, no matter what they denote, must reflect compatibilities and incompatibilities of formal-ontological categories, i.e. the highest and most general ontological categories – Object, Relation, Property, and the like. Semantic rules, on the other hand, must reflect compatibilities and incompatibilities of *material* categories, which are *proper* subcategories of formal categories – Physical Object, Visual Property, and the like. Assertions that are built in conformity with both classes of rules are both formally (syntactically) and materially (semantically) meaningful. Only they are *meaningful* assertions about the world. Situations *in principle possible* in the world are those and only those expressed by meaningful assertions.

We can now formulate the principles of logic:

1) Principle of *identity*: This principle can be formulated thus: $A=A$, where the variable “A” stands for a name (of an object or a fact, i.e. an identifying description). It is implicit in this formulation that each “A” occurs in a different context of naming and referring. One could read the principle as saying that names always denote, provided they are used non-ambiguously, the same object or fact in a given context of reference. However, one could not identify objects of different experiences as the same objects if they were not *capable* of appearing as the same in different experiences; for example, if objects were supposed to be *immanent* to experience and consequently vanished with them. The principle of identity, then, is saying something about objects and facts of the domain of reference and, correlatively, the domain of experiences available

to the subject. *Objectively*, the principle states that objects and facts in the domain of reference (where the principle is valid), to which one can refer by naming, preserve their identity in the flux of experiences. *Subjectively*, that different experiences can be experiences of the *same* object or fact. One would not be justified in supposing that names are “rigid designators” across experiences (adapting an expression of Kripke’s) if objects could not manifest themselves as the same objects in different experiences. The validity of the principle of identity, then, depends on the transcendental presupposition that objects and facts of experience can subsist as the same in the flux of experience. About this, Husserl says: “Identity means the possibility of coming back to the same place and by an act of recognition to have the experience of something perfectly similar” (Husserl, 2001: 61). Or still, “it would not be possible to predicate beyond the present, or verify this predication, if past perception and what was perceived in it were not capable of being reenacted anew, or that which was recalled of being intuitively clarified.” (Husserl, 2001: 149-150). In short, without the presuppositions on which the principle of identity is rooted no science would be possible.

One can also approach the issue from the perspective of truth. From this perspective, the principle of identity states objectively, that truth-values are stable, i.e. that once a truth-value is attached to an assertion it remains attached to it and, subjectively, that once an assertion is judged to be true (resp. false) it must, in any further judgment-act, be also judged to be true (resp. false). In short, truths can be stocked. Again, according to Husserl: “All that we designated as being, as a substrate of truths, we mean as being in itself, something that is not only for us in an instant of fortuitous belief or the experience of an instant, but that remains as the same when we no longer experience or actually think of it” (Husserl, 2001: 59).

For this to be justified idealizing presuppositions are required. Subjectively, that different judgments can refer to the *same* state-of-affairs and, objectively, that states-of-affairs persist in being. In other words, no matter the angle of approach, the principle of identity of formal logic states that objects and states-of-affairs persist in being and can re-present themselves in different experiences (unless, of course, they cease to exist). This can only be so if the *domain* of experience in question, that is, the system of objects and states-of-affairs is *meant* as an objectively existing domain that remains the same in the flux of

experience. In short, *flux of consciousness* (or *experience*) *does not imply flux of being*.

It is not difficult to see the extent to which science depends on the principle of identity. From a subjective perspective, identity concerns the domain of experiences possible in principle, it states that any object of experience can be re-identified in further experiences; objectively, it concerns the world itself. If *A* is the domain of meaningful assertions referring to *D*, the principle of identity is true in *A* if, and only if, objectively, *D* preserves its identity in the flux of experiences and, subjectively, we can undergo different experiences in *D*, intuitive or not, with the *same* content.

2) Principle of *bivalence*: This principle states that any *meaningful* assertion is either true or false (in which case, its negation is true). This, of course, corresponds to the ontological principle that the world is objectively complete and that, consequently, any *a priori possible* event, i.e. any event expressed by a *meaningful* assertion, is *in principle* an object of experience. It is important to be clear about what is meant by “true” here. An assertion is *experienced* as true (resp. false) when the situation it expresses is an object of experience (resp. an object of a frustrated experience). This is the *subjective* notion of truth. An assertion is true *in itself* (resp. false in itself) when the situation it expresses *happens* to be (resp. not to be) a *fact* of the world, *regardless of any experience of this fact*. This is the *objective* notion of truth. Considering that it is *presupposed* that the domain of experiences is ideally complete, any truth in itself is in principle experienceable. Therefore, the domain of possible experiences referring to an objectively complete domain is also a complete domain. The science of such a domain can, then, aspire to being a complete theory. Completeness, in short, as already discussed, is an *ideal* of science.

3) Principle of *non-contradiction*: It says that no meaningful assertion can be simultaneously true and false. This principle expresses, of course, the consistency of the world. Since two contradictory facts cannot subsist in the world, an assertion being true implies that its negation is necessarily false and vice-versa; the congruence of a possible situation with the facts of the world rules out in principle the incongruence of the same situation with the same facts. This principle goes deeper than the others; it concerns the possibility of an objective science in general insofar as it expresses a fundamental precondition of *being*.

Final Remarks. To conclude, there is no science without presuppositions, and they come in many shapes and forms. Some are provisional scientific assumptions that can eventually be either confirmed or disconfirmed by experience. Others are prior to experience and spell out the features worlds *must have* to be objects of science, either some specific science or science in general. In the words of Husserl:

The universal structures of the world, which contain in themselves the universal legality of the world, are divided in two groups, the universal a priori structures without which this world could not be thought as a world at all, and the universal factual structures that necessarily belong to each possible world in its individual singularity. (Husserl, 2001: 215)

The mathematical science of empirical nature, for example, requires nature to be a mathematical manifold, for otherwise how there could be a mathematical science of it? Perceptual reality is mathematized through a series of intentional acts. This process, however, is often obliterated and *mathematical* nature taken to be an *independent transcendent* reality. This, as Husserl claimed in *Crisis* is an error; for a mathematical nature to be there must be intentional actions that make it so. The most fundamental presupposition of the mathematical science of nature is that the laws of nature can be expressed in mathematical form.

But nature need not be mathematical for there to be a science of nature, provided this is not a mathematical science. However, presuppositions of a more basic character are required for a science, any science, to be possible, if this is an objective science involving a community of co-workers having at their disposal the same identical world accessible in principle to them who can consistently stock truths about the world having for ideal a complete description of it. These presuppositions appear as basic logical principles, identity, non-contradiction and bivalence (or excluded-middle). To use Husserlian terminology, they spell out the *universal a priori structure* of a world object of objective science simply as such.

What I called before world conceptions, which are transcendental presuppositions of *restricted* scope, can be abandoned without jeopardizing beyond repair the possibility of an objective science, for instance, physics.

History of science has shown that scientists are, for complex reasons not always of a scientific nature, willing to give up a world conception to adopt another. Newtonian space-time, for example, has given place to Einstein space-time, and the strict causality, individuality and locality of the macroscopic world are not features of the quantum world.

The presuppositions on which the possibility of objective science depends, on the other hand, hold faster. No objective science aiming at an ideally complete consistent description of an objectively given world can give up the presupposition that the world is transcendent (“out there”), consistent (there are no contradictory facts in the world), objectively identical (the same for all), objectively complete (completely determined in itself) and cognitively accessible (in principle knowable). This would be self-defeating. These presuppositions are neither scientific, since they are not testable, nor metaphysical, if one does not operate within the realist world view. Rather, they are transcendental principles, manifesting themselves as either *ontological* or *logical principles*. Their *justification* lies in their *clarification*, that is, in the laying bare of their intentional origins.

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