International Journal of Philosophy
2014; 2(5): 60-71
Published online November 28, 2014 (http://www.sciencepublishinggroup.com/j/ijp)
doi: 10.11648/j.ijp.20140205.11
ISSN: 2330-7439 (Print); ISSN: 2330-7455 (Online)

On perception and some consequences: The world, the brain and infinity

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To cite this article:
Alfred Abächerli. On Perception and Some Consequences: The World, the Brain and Infinity. *International Journal of Philosophy.* Vol. 2, No. 5, 2014, pp. 60-71. doi: 10.11648/j.ijp.20140205.11

Abstract: This paper presents a new type of perception that consists of adding something to the sensory data that is not present in any of the brain states or in sensory data of the past or present, not even implicitly. This capacity to create structural novelty, which is called 'completion' done by the open brain, is the key to resolving many epistemological problems (paradoxes of knowledge). Combined with real infinity in the world, it gives, together with incommensurability and intentionality, a clear account of objectivity, conceptualization, free will and other problematic issues. We call this 'objective multi-relativism,' allowing several incommensurable truths referring to an identical invariance in reality. Finally, good faith and bad faith are introduced as epistemological principles, which are the driving forces that allow us to agree or not on something incommensurable. This is not a theory of knowledge but just a logical study of what would happen to the above issues if the different considered forms of infinity were the case.

Keywords: Paradox, Perception, Infinity, Incommensurability, Intentionality, Completion, Open Brain, Good Faith, Bad Faith

1. Introduction

Among the philosophical writings, from the Greek classics to the most contemporary authors, one confusion strikes me as a fundamental lack of understanding of the essential feature of our cognition, and that is *perception*. This essay is about this unexpected shortcoming that has to my knowledge not been identified elsewhere. The most common problematic view can be summarized by saying that perception is based on the immediately given of present sensory data, as well as, for some authors, the immediately given of existing brain states. The process to go from this to a perception can be quite complicated, for example, involving continuous interaction between the brain and the environment [1]. What is distinctive about this questionable view of perception is that nothing is added to the two immediately givens above. On the contrary, until now the typical feature of perception is that all superfluous sensory data not related to the perception is eliminated, and that there is too much information that has to be removed for allowing the isolated perceived item to exist.

This text holds that, although, of course, some sensory data are not needed for a given perception, the essential feature that makes perception possible, even in the simplest case, is not taking away the superfluous[1], but rather adding of the unavoidably lacking, something that is not in the immediately given of sensation and brain states. Such regeneration is essential for perceptions in our cognitive operation at any level, including, but not limited to, theories. This *completion*, as it will be called here, might even be the only possible key to themes like conceptualization or understanding. The same might turn out to be the case for intelligence or creativity.

2. Summary of the Basic Elements

Perception refers neither to sensation (the sensual capture of data) nor to conceptualization (concepts, predicates, statements) but to something in between, which is the perceptual judgment in mind. Perceptions can be external, which is the initial sensual perception of items of the outside world, or internal, where an internal brain structure is at the base of the perception.

[1] Sensory data are considered by the brain as much in their totality as it is physiologically possible. If there is a loss of data, it is rather a type of fading away because, of course, not all details of all sensations can be stored. However, in the most general case, everything outside a perception is as significant as what is part of it. See end of chapter 5.1.

Our approach deals with all kinds of representations in the human mind, in all its forms, be it natural language, a formalized theory, or any other type. The mental processes proposed here are flexible enough to include as well all types of nonformalized representations, which in our understanding also contain nonlinguistic parts, even more than what is related to expressions, signs and symbols.

This flexibility is made possible by considering an environment of freely[2] generated brainwaves that at some moments develop a similarity with what arrives in the brain as sensorial information. In these sensorial waves and in interaction with the existing brainwaves, some aspects are amplified, others are dimmed, until a typical pattern emerges that allows identification of something. For such perception, it is not at all necessary for such an identified pattern to already have a name, nor is it necessary for it to have already been perceived. But it is essential that this process of perception involves structures that have not been present before – not even implicitly – in what is called the open brain.

The resulting view is called 'objective multi-relativism'[3], which involves a multitude (in fact, an infinity) of different theories[4] that can all be true to exactly the same degree, even if referring to the same reality. The keywords for that are *incommensurability* and *intentionality*.

Incommensurability means that two items cannot be transformed one into the other by a finite number of steps. It is this feature that allows simultaneous objectivity in a multi-theory environment. If contradiction arises among two correct representative systems, this is due to incommensurability and not to relativism per se. What is also important is that this does not at all support the "anything goes" of Feyerabend [2]. An infinity of statements and theories must also be clearly wrong.

Intentionality is a common topic in modern philosophy, but its precise mode of operation still involves a great deal of fuzziness. A clear account will be given of possible cognitive processes from which intentionality follows in a natural and clearly understandable way.

This different conception is connected to very specific possible structures in mental operations. It is the new idea introduced here – that the essential characteristic of perception is the capacity to add something fundamentally new – which will enable understanding of intentionality. It will also give an explanation how brains can operate successfully in worlds of any imaginable complexity.

Besides an adapted cognitive processing, based on completion, infinity is the key property that provides an understanding of such issues. This will make possible a clear foundation of truth in the already mentioned multi-theory environment, where even apparently contradictory representations can be considered as truly referring to the same reality. We claim that one logical possibility to avoid inconsistencies and any form of paradoxes is to postulate a real infinity in the world. Philosophy is so full of not understood topics precisely because until now, most of the time, it has not included this enlarged possibility of conceiving the outside world and the very special type of mental operation this requires. Once the new way of seeing perception is integrated, all the fields of philosophical inconsistencies open up and allow a conception of cognition that overcomes these problems. This will be the basis for a consistent foundation of truth, objectivity and realism.

Last but not least, the fundamental importance must be mentioned that will be given to the distinction between good faith and bad faith in the mental attitude of human minds. These two extremes of intention will explain how we agree or disagree on multiple incommensurable expressions about the world.

What has been mentioned until now contains all the necessary tools to avoid cognitive paradoxes. It covers a new cognitive triad[5], an infinite world – its incommensurable representations – and an open brain, of which as a first step, additional details will be given hereunder for the world.

3. A Complex but Accessible World

Two types of infinity in the world will be discussed: the infinitely small and the infinitely big. For both, corresponding mathematical structures exist. Thus, why should the world not be constructed according to such conjectures? The present conception goes far beyond existing physical theories and shows that the world can be much more complicated than what any such theory has until now imagined. The goal is not to pretend anything about physical theories but to show the complexity that is generally possible.

For the infinitely small, a field that is already part of established science is the so-called nonlinear dynamic systems, more popularly known as *chaotic systems* [3, 4]. The *strange attractors* [5] that explain the behavior of such systems are infinitely fine structures. They are similar to fractals [6, 7] in which the same patterns appear over and over when going down in scale. Such infinitely fine structures are generated by very simple mathematical equations.

In order to unify quantum physics and general relativity, Nottale proposes a fractal space-time [8, 9]. Although this is controversial, it shows the complexity of what is possible as mathematical structures potentially at the base of physics. As mass must be distributed in space, this means that if space-time is fractal, matter must also be fractal. Also, quantum chromodynamics results in the fractalization of the atom (pictures in [10]). Is the sequence of atom, proton/neutron/electron, quark not an indication that matter can be structured towards smaller and smaller entities[6]? One can have philosophical doubts that one quark (or any other

[2] How this might happen precisely is explained in chapter 5.2.

[3] Or objective multi-realism, which in our thinking amounts to the same.

[4] Or, of the more general representations in the above sense.

[5] It is important that it is not only a dyad of world and representation and that this triad functions completely differently from other triads described in literature (for example, C.S. Peirce).

[6] Even outside of string theory, there is a whole bunch of proposed particles smaller than quarks, including preons, prequarks, subquarks, maons, alphons, quinks, rishons, tweedles, helons, haplons, Y-particles and primons. See [11].

smallest entity) is identical to another of the same type. There must be small structural differences, just as a specific tree is not identical to any other tree[7].

And this is only the beginning of the complexity that is theoretically possible. As previously stated, fractality appears in relatively simple contexts and it can be held that in the real world things are even more complex. Indeed, the most complicated imaginable mathematical structure is infinitely fine like a fractal but without repeating patterns, just different patterns appearing over and over as you go down in scale. This is the most general case: structures being infinitely fine having no derivatives and not being continuous.

It is also possible to imagine infinitely fine structures having derivatives and being continuous for those who want to conserve these features. An example is the so-called baker's transformation, named after an imaginative baker who treats his dough flattened in one layer by folding it in the middle and flattens it again to reach the initial size and so on, an infinity of times. The result is an infinitely fine, continuous mathematical structure having derivatives at every point. Similar but even more complex continuous structures can be imagined that do not have the constant amplitude of the baker's transformation. The idea of folded structures is also important in another regard. One exciting view of things is that all future phenomena are folded in infinitely fine structures and that they unfold and become bigger as soon as the conditions allow it.

These – not exhaustive – examples explain the potential for complexity of the infinitely small. Also, why should there be nothing smaller than the Planck length, which is just the result of a single theory and applicable in very precise contexts (e.g. quantum physics)[8]? In any case, the idea of a world going on to smaller and smaller infinite structures is nothing new. As it is well-known, it was proposed, among others, by Anaxagoras and later by Leibniz.

With regard to the infinitely big, the situation is similar. Here too, no reason makes us believe that the extension of the world should not be infinite. The universe according to the Big Bang theory can only be one aspect of the whole truth, as it must be embedded in something more. It is easier to imagine that the world goes on infinitely than that it has a border. Because if it has a border, the question of what is beyond the border must be answered. There cannot be a border without anything beyond. Otherwise it would not be a border. Also mathematics, where infinity has been handled in a very natural way since Cantor [13] and Dedekind [14] may help us to understand the infinitely big as something quite natural that is just part of the world's properties.

In between these two extremes, the world is organized according to layers[9] with entities – objects – on any scale. What could be downwards from atoms has already been presented. Upwards, there are molecules, colloids, microscopic objects, macroscopic objects (including living beings), associations of objects (meadows, forests, cities, societies, etc.), celestial objects (suns, planets, comets etc.), galaxies, galactic clusters, maybe several universes. This must go on into even bigger things.

From the observation that all natural objects always begin small and then grow, it is overall consistent with the present ideas that they originate from an infinitely small variation[10], a *bifurcation*[11] that *ceteris paribus* is at its origin. Such can be the starting condition for the above-mentioned unfolding of structures to become as big as they are allowed. The bigger structures or objects play the role of *channelings*[12], which can be either promoting or attenuating. In the positive case, they allow the increase of the fluctuation to develop and to grow until becoming an object by itself. In the negative case, the channelings do not allow the bifurcation to grow at all or make it disappear very quickly. A first form of incommensurability is created by such processes, the infinitely fine bifurcations and the channelings at a higher level. In terms of scale, the creative energy of the world comes thus from bottom up. The regulating items come from top down.

It is also important to state that the objects of one layer are not just the addition of objects of a lower level. Each layer of the world has its own ontology[13], which is the reason why theories at different levels are as true as the theories considered commonly as being more fundamental. In spite of what is often targeted in physics[14], for example in quantum theory, no ultimate theory is possible. Each physical theory is a closed model[15] that selects some finite aspects out of the possible infinity. This gives another sense in which representations, in this case theories at the different levels, can be incommensurable and one as true as another.

Another feature that can be attributed to a reality following this view is that no aspects are in principle inaccessible. One way to express this accessibility is the here selected approach requesting that everything follows structures that can also be found in mathematics. Such a claim should not make anybody worried. The shown complexity of its structures potentially

[7] According to B. Greene [12], even string theory does not exclude that the strings might be formed by "yet-smaller structures."

[8] There is a paradox of the Planck length [15] and there are multiple scientific discussions about what is below this length. See for example [16]. Even one of the most significant domains where general relativity and quantum physics are in contradiction is in sub-Planck length [17].

[9] This is not to be taken too strictly, as sometimes belonging to a layer is not very clear. Some layers are interpenetrating, and in the most general cases, events can involve several layers.

[10] These depend in our view on structures like strange attractors or on even more complex items that are a generalization of the behavior of strange attractors.

[11] See [18], for the most famous example of bifurcations, the Lorenz strange attractor. Visual animations are available on [19]. The concept of bifurcation is generally accepted. There exists even an International Journal of Bifurcation and Chaos.

[12] They are therefore causally as important as the small variations, but not *ceteris paribus*! For a detailed discussion see [20].

[13] This is also held by the tenants of strong emergence, for example [21]. For a detailed discussion of emergence see [22] mentioning "supervenience" and "downward causation." Remarkably, [23] finds that to have "more that is really different" he needs infinity!

[14] At least by some physicists. I personally have the impression that many of them are conscious that they are just modeling reality and that every theory always has its limitations.

[15] More details and a formal definition of closed models and their counterparts, open models, of which the open brain is an example, are given in [20].

involved is significant for the argument that with infinity all existing human evidence is compatible with mathematics[16].

4. Paradoxes

The history of philosophy is, among other things, a more than 2000-year debate about how to deal with the facts of experience and about how to understand the immediately given of sensation without experiencing too much discomfort. As a matter of fact, the philosophy of knowledge is increasingly moving away from such basic concerns. It can be considered that the whole field, from positivism at one extreme to relativism at the other, is a complete failure with regard to what we naturally mean, when we say that we *know* something. Knowledge has lost all its reliability. If we say that there are brick houses on Elm Street (example by Quine), we think we know what we mean, but this is questioned by some mainstream philosophy: Quine was one of the most influential thinkers of the last 200 years.

One way to put things is to say that this query turns around the theme of *explicit* knowledge and the question if such can represent all what is significant for a portion of reality it is aiming at. If this is not possible, as seems to be the case, the state of the art does not have any possibility to still allow reliable knowledge and slithers into unshaded relativism like in the example of Elm Street. The fact that the only recognized form of knowledge having an understandable conception consists so far in explicitness is in contradiction with the clearly appearing need for intentionality and incommensurability – whose precise, clearly understandable articulation in the fabric of knowledge has until now, as far as we know, no intelligible explanation. In the following, this is referred to as the *paradoxical impregnation* of modern philosophy. More aspects of this issue are described in the following three chapters.

4.1. Some Paradoxes of Metaphysics

Remarkably, in history, most approaches try in different ways to achieve reliability of explicit knowledge by introducing separations[17] that exclude some aspects, and they all fail because such separations are necessarily artificial. Quine's proof [24] that analytic and synthetic judgments cannot be distinguished is fundamentally significant for this issue. From this results that the only way to proceed is to deal with all aspects we can directly or indirectly perceive including, above all, the *things in themselves* that must be "accessible in principle," according to the earlier presented view of the world. For this reason, although the topic is strongly related to epistemology, it is better adapted to talk about metaphysical paradoxes.

The quest for explicit knowledge is targeting direct and natural intelligibility, of which the most optimistic view is to suggest a *copy theory* of knowledge, meaning a clear, one-to-one relationship between the items of representation and those of the outside world. That such a program, although at the base of any physical theory, is philosophically difficult to realize, has been acknowledged throughout the history of philosophy since the Ancient Greeks. The most extreme resulting attitudes that do not even try anymore to introduce separations are skepticism but also the already mentioned forms of subjective relativism.

Idealism is a way to save at least a part of intelligibility by introducing a separation. It must notwithstanding be considered as the archetype of metaphysical paradoxes. Idealism makes doors and windows wide open for arbitrariness and therefore paradoxes. As the mental is the only criterion for fixing truth values, this is the approach where "anything goes" becomes reality and the paradoxical impregnation gets yet worse. Berkeley's idealism has even straightly mystified experience as dreamlike ideas that God induces in our mind. In addition, pure idealism is not possible as defenders of idealistic theories are always moving away from idealism and integrating reality in their theories as it suits them. For this reason, idealism is paradoxical even at its root (see also [25]). Nevertheless, it is recognized here that with the *existing conceptions* of perception[18], idealism is the only philosophical current that can still hold out the prospect of avoiding the copy theory in a consistent manner. Under such premises, anybody who denies the copy theory is obligatorily drifting clearly, even if more or less slightly, towards idealism.

A further example of paradoxes is the four antimonies [26] of Kant, whose reaction to this was to demystify experience as the result of a type of built-in sieve in our mind. By this, he famously also introduced a separation. It is to him that we owe the notion of things in themselves, which he precisely declares to be not accessible to this sieve. Although Kant is not really an idealist, here he was fully into idealism, which he wanted not to be more than transcendental but which was still at the origin of a whole line of "real" idealistic thinkers, including Hegel and the German idealism.

The realistic branch of Kant's philosophy led to Viennese logical positivism, which constitutes the third example of a paradox. Initiating the linguistic turn, Carnap tried to purify language in a scientific way by basing it only on syntax, which resulted in the failure that we all know. Presumably, he came across so many, certainly paradoxical, problems that he had to reintroduce semantics[19]. He was on an idealistic drift and could not escape the need to make again the link with the things that cannot be anything else than the things in themselves.

In history, the result, since the failure of Carnap's program and the second phase of Wittgenstein[20] [27], and lately since postmodernism culminating in the work of Rorty [28], was

[16] See chapter 8.3 "Determinism and Free Will."

[17] [20] shows that, in general, absolute separations are impossible ("impossibilité de la distinction").

[18] The alert reader will have remarked that with the new type of perception presented here the situation is different.

[19] This switch is documented by Carnap, 1934 [29] and Carnap, 1942 [30], his first publication on semantics.

[20] He was, in his first phase, an important support for positivism and came up now with his language games and with seeing language as nothing more than a crutch to get in touch with reality.

that to see language as "the mirror of nature" is no more considered as a serious candidate for epistemology. Interest shifted to more pragmatic views where the things in themselves play a less important role[21]: phenomenalism, phenomenology, linguistic philosophies, cognitivism, other cognition or artificial intelligence-based approaches like connectivism. Intermediary artifacts like qualia, tokens, and sense data were introduced, which, like many of the previously mentioned theories, are once more a slide towards idealism. This is not compatible with the claim that, to repeat it, things in themselves must be part of any serious epistemological approach.

Among other multiple movements whose details would be too complex here, this paved the way to linguistic arbitrariness, as in the relativisms of Quine ([31]: sentences that can be held "come what may"[22] because of their underdetermination[23]) and Feyerabend (the already mentioned, "anything goes"). The invariance was now in the language and the door was wide open to inconsistency and contradiction. With that, we are in fact again plainly in idealism. Despite the declared physicalism of Quine, like Kant he cannot find a way to completely avoid idealism.

Concerning these difficulties, the main problem is that nobody could come up until now with an explanation, how knowledge could function in an intelligible way, if not by necessary truth.

4.2. The Problem of Reference

A further paradox is the fact that concepts are problematic because no well-defined way to identify their references has yet been found. The only really intelligible understanding of concepts that philosophy has imagined so far is by definition through criteria. That this is not enough to define the reference has been shown abundantly in literature, for example for the concept "tiger" [32, 33]. Quine has proven the inscrutability of reference [34-36]. More recent proposals, such as clusters [37], natural kinds [38] or illocutionary speech acts like ostentation[24] [39], constitute as well problematic suggestions as they do neither allow the reference to be fixed in an unambiguous way. Such is the paradox: Although most of the times in the use of concepts it seems absolutely clear what we mean, theoretically there is no obligatory way to fix their content.

4.3. Determinism and Free Will

The last paradox selected here is the apparent contradiction between determinism and free will. Determinism is intrinsically linked to the notion of causality. Any state of the universe is preceded by a sufficient previous state, its cause, of which it is the only necessary consequence. Physics has for many cases a formalism that completely describes a specific system. Such formalisms are based on fundamental laws and formed by a set of differential equations for which only one solution exists. This gives rise to deterministic systems. The question becomes whether it is possible to suppose that the complete world, including human choices and decisions, can be reliably (again in a one-to-one relationship) described by such formalism. But if one thinks that the world cannot function other than based on causality and that such deterministic formalism must exist[25], how is free will possible?

5. Completion

5.1. A New Approach

Our starting point is that in the capture of the world's physical signals, losses of information cannot be avoided: light, sound, temperature – any form of known or unknown manifestation of the world, including features that are only indirectly accessible through specific instruments like electromagnetic phenomena. That such is the case can be quite easily argued. Trivially, this can just be derived from any sensitive organ's operating principles. Whatever the type of sensual organ, we always lose some of the information available in the world. If our cognition only based its understanding of the world on the real sensitively captured information, the real empirical facts, if we are as strict as empiricists should be, we would be unable to perceive anything. Vision is the most complex sense, but even in that case, we would only see an incoherent set of dots of different colors. To recognize anything in this jumble, we need to complete the captured dots in a comprehensive way. For that, we cannot do otherwise than add something on our own that is not based in sensation. We must complete the pure sensations into something that has a sense. This is the simplest case of a process that is here called "completion," and which is the main characteristic of the *open brain*.

This means, in words familiar to philosophers, we must find the "form" or the "*Gestalt*" in the sensual information, e.g., lines or circles, to mention some simple cases. The idea is therefore not new. What might not be common philosophic matters are the following claims:

i). Completion is intimately and inseparably linked to physiological operations in brain able to physically handle real infinity.

ii). All perception is based on completion, as much in science as in any other cognitive activities of living beings. Even if we have already done a completion, and already learned it, we still have to do it again. But it will be much quicker and easier, although never two completions are exactly identical.

With regard to the first point, it was the big weakness of the Gestaltist movement not to be able to give a precise account of

[21] For an introduction to each of these currents, see Wikipedia

[22] This author's formal strength, many of whose arguments we support, made it more difficult to come up with good reasons against his view. Until now nobody presented new strong elements, as we think is the case in our conception using completion and real infinity.

[23] For a detailed discussion of underdetermination see [40].

[24] Quine [41] has shown that ostentation is not a solution.

[25] Bohm [43-45] has shown that a deterministic theory exists even for the probabilistic wave aspect of quantum physical objects.

how their claims could be clearly intelligible [42], for example, as explanations of at least a near-physiological level. Such possibilities using the present approach of completion with the help of infinity will be suggested in the following chapter. This will allow us to go beyond all objections that are generally made against the idea of Gestalt as an intelligible cognitive principle.

The second point confirms that in no domain can the one-to-one relationship between knowledge and the world be saved. Even in physics, our perception is always more than what could be written down as a formula or any form of explicit language. That means, as we have seen, for example, more than the syntax of a scientific language. The deep reason why all cognitive activity must be based on completion is that this is the only way to transform the infinity of the outside world into something finite that can be handled by the brain. Once the completion of the infinite points of a circle is done, it becomes a single, thus finite, object. Be it in science or for the nonrepetitive patterns of everyday life, the issue is always the same: Use completion to regenerate the infinity of the given world in a way that finite useful aspects[26] can be extracted.

All we can know is therefore depending on the aspects selected when we intentionally perceive. Each perception itself is the result of a continuous interaction with other brain processes, with existing knowledge, conceptualization, and with other already existing brain internal perceptions. All this is conditioned by what is here understood as intentions. The selection of the adapted completion is thus triggered by all the data available at the inlet of perception (as previously mentioned, external or internal), but also by the intentions we have. This gives a clear account of intentionality: Depending on what we intend, the open brain will stabilize on one or another perception, each of which can be incommensurable with the other.

However the really important point we want to make is that all this is permanently determined by completion where the brain is giving something on its own in order to allow consistency of all these elements. The precise set of all such consistent brain processes, including all forms of completion, will be called the *representational frame*, which must exist for all statements, theories or in the most general case for all types of representations, including all we count as such, as previously explained.

Such representational frames are not only defined by what part of a perception is, but also by what is not. A point apparently does not need infinity. Nonetheless, the only way to perceive it is by excluding the infinity of points not being part of the specific one. The same scheme applies to sets of unconnected points or to sets of any dissociated occurrences being part of a perception. What defines them is the infinity of their relations outside of the proper percept.

5.2. Perception as Completion in the Open Brain

Completion is thus necessary for cognitive operations at all levels of complexity. It applies to all types of perception, that is to say, external or internal. The following discussion looks in greater detail at how perception by completion functions. To understand something, from the simplest concepts to the highly complex structure in worlds as pointed out, we need a system different from all that can be done by a digital computer. Even if such a computer is programmed to trace the continuous lines between the dots, this does, of course, not mean that it understands what a line or a circle is.

A fortiori, in the general case, involving much more complicated situations, a program reproducing the essential features of cognition cannot exist. It cannot exist because no explicit program – no explicit language – can go out of its class of commensurability and generally address forms or other types of real infinite varieties. Any understanding – real understanding and not sterile reproduction – needs structural incommensurability in brain and the ability to manage forms and recreate them out of "nothing." Things must result in a true triad where the open brain creates real innovation and uses its creativity to generate adapted finite structures that were never said, never seen and never thought before, not even in any imaginable way of being *implicit in any of the preceding states of the brain*.

It is evident that with such a new form of perception it is necessary to consider differently the physiology of the operational principles of the open brain. It is possible to explain at the earlier requested near-physiological level how such brain can generate structural novelty that has never been given to it before. The crucial point for the good functioning of the open brain is that the process of perception has, on the one hand, structures already existing in certain parts of the brain, for example related to memory and structures that define the problem to be solved, and on the other hand, according to the properties of completion introduced above, must be completely freely generated mental states – incommensurable with any other state – which have to be induced by infinity to guarantee the openness of the brain and which stabilize on a possible candidate for the intended perception. One way of achieving this is to use the already mentioned infinitely small in bifurcations of multi-dimensional strange attractors. In this case, the whole infinitely big[27] outside the brain will contribute to the generation of novelty in the brain.

To give an example, it could be the gravitational interaction between certain brain structures and fluctuations outside of the brain anywhere in the universe. Such structures that have to be chaotic, thus sensitive to very small variations in the environment, exist in the brain [46][28]. In the extreme, to paraphrase a famous formulation, it is the butterfly effect on

[26] In repeatable science, the issue is precisely to find the completions that allow us to prepare portions of infinite reality in a way that they have a finite behavior. But the more I think about it, the more I am convinced that this has nothing to do with universal laws sufficient for describing all other reality.

[27] For practical purposes infinity might be replaced by very big or by just something outside of the brain. But for having a completely consistent argument we need real infinity. See [20].

[28] In the last 25 years, the study of chaotic structures in the brain has become an established branch of science.

the brain of an elementary particle at the limits of the known universe.

This justification might not be the right feature really implemented in the human brain, but it shows that it is in principle possible to have a physiological generator of infinite structural novelty under the condition that the space inside the brain is continuous and that brain is sensitive to chaotic variations or any other type of sensitivity to very small variations in the environment, maybe even much more complex than what is currently understood as "chaos." What is essential is that brain, being, once the sensorial input given, a closed system according to all existing views, becomes open to non-sensorial physical interaction with the outside and creates through this structural novelty.

As soon as we understand the need for such a true triad involving a really open brain, we will no longer try to use the dyads of explicit algorithms, formalisms, or deductive logic as only operational principles of cognition[29].

6. Truth and Objectivity

6.1. Back to a Natural Understanding

This discussion will be centered on statements. Those can be true or false. In the case of a set of statements, we can also talk about consistency, compatibility, or contradiction. The notion of truth here can be used without apprehension, as this is problematic precisely because of the paradoxical impregnation that is the thing to overcome. Such here considered truth is intimately linked to objectivity. Something that is true has to be objectively so[30].

It is further important to realize that a clear natural notion exists about something being true or something being false. If somebody says, "Every month I pay the rent on my apartment," there are clear and obvious natural ways to check whether that statement is true or false. Likewise, if a boy has broken an expensive Chinese vase during the absence of his parents, it is clear that if he says, "I did not break the vase," this is false.

These examples show several things. First, they prove that a natural notion of truth exists that is not purely linguistic, but directly linked to reality.

Secondly, they illustrate our conception of incommensurable bifurcations. The reason why the boy broke the vase is an imperceptible fluctuation in his nervous system. If it was an involuntary accident or a voluntary act like in anger, such subtle fluctuation at its origin can in the earlier given conception of the world be nothing else than infinity based (for example, as bifurcation in the boy's brain). It is also a possible but incommensurable world where the vase would not have been broken. The world where the rent has not been paid is as possible as the one where it was paid. Yet the two worlds are incommensurable due to different bifurcations in the involved brain. This gives another way how incommensurability arises. When two incommensurable opinions are confronted, this is fundamentally because of different appreciations of bifurcations, already existing in the past or possible in the future, and the impact they can have. In this respect, in our modern world bifurcations in brains are the most common source of this form of incommensurability. Open brains can "feel" the infinitely small originating from bifurcations, for example those done by other brains, but also those happening in the world outside of brains. If trained with the philosophical thinking presented here, they will succeed in doing that to an even higher degree.

Thirdly, they show situations where, if we do not agree, we need a clear intention not to do so. In general, the intention not to agree can be unconscious, but in the present examples, the interesting point is that we need conscious bad faith. Our examples show that in many situations someone with good faith will naturally agree. If he does not agree, he must clearly be *aware*. He must know that he has no intention of agreeing. If somebody has voluntarily not paid the rent, he must be aware that he is lying when saying that it was paid. The boy must be aware that he is not telling the truth if he insists on saying that he did not break the vase.

The problem is, of course, that in a world of infinite variety, bad faith, whether conscious or not, is always possible. Whatever the situation is, even in the case of repetitive science, in no way can the expression of a class of commensurability, that means no representational frame, be made obligatory for everybody. The problem of reference is significant and sufficient to support this assertion. Nonetheless, there are, of course, many other, more complex issues like those already mentioned: statements, theories and representations in general. In all these cases, the only way to have a common identification of an element or a set of such is by meaning the same, or said differently by the intention of implicitly addressing the same and by constantly adapting the completions in a way that satisfies this common intention. This raises the notions of good or bad faith to the status of epistemological principles.

Incidentally, the point is that truth exists in the sense that there are true statements about which agreement is possible among people with good faith; that is, among people that do not have, consciously or not, any particular intention not to agree. Moreover, it is possible that these true statements, on which such people intentionally agree, truly correspond to a real fact in the world, of which the statement intentionally expresses at least one real aspect, the one intended, finite selection of true aspects out of the infinity that exists in the most general case. It is no philosophical problem to hold that among open brains, agreement on true statements is purely a question of willingness to do so. That, of course, does not mean that if several brains willing to agree on some aspects have the same opinion, this becomes a truth. Error is always threatening.

6.2. Knowledge beyond the Explicit but Still Intelligible

After having done this analysis properly and after what has

[29] All practically useful methods for doing this have until now followed such lines. Even neuronal networks do, as they can be simulated by a digital computer's software.

[30] But objectivity does not mean a single truth. See below in chapter 6.2.

been explained about the new process of perception, no philosopher facing the incommensurabilities and infinite sets of reference in the outside world, can insist anymore on explicit truth. The key issue is that the references in the world are not structured homogeneously. The objects of cognition are in the most complicated cases infinitely entangled like in bifurcations or other strange attractor-like behavior. That means that the causal chains pass through incommensurable structures that cannot be explicitly addressed. Furthermore, because of the infinite levels of description that we have to posit for escaping paradoxes, any explicit description of objects and processes at a given level is necessarily incomplete. There are always bigger or smaller beings not contained in such description but also having an influence.

Nonetheless, there is a nuance in which knowledge can still be considered as intelligible, without having the ambition or the need to include explicitly all aspects of what it refers to. The key for that is the already described capacity of completion to recognize, every time it is applied, the finite patterns that fit best to the situation after having regenerated the relevant infinities. Confronted to incommensurability in the world, perception und representation can only implicitly, through intention, follow the needs of every situation. Such truth is possible but its expression is not necessary. The best we can hope for is an intelligible functioning of cognition in which, according to the near-physiological description given for completion, two open brains, if they want so, can mutually "imitate" any truth (in German "*nachvollziehen*," literally "post-execute," sometimes translated as "comprehend"). What matters for philosophy is the possibility of truth and that all such truth is *always valid only inside a very specific representational frame.*

With regard to objectivity, on such grounds, truth and objectivity do not represent a bijective relationship. Whereas, as already mentioned, a true statement has to refer to an objective reality, for no reason must a portion of objective reality correspond to only one statement, only one set of statements, only one theory or, as most generally said, only one representation. This gives the earlier requested explanation[31] of how knowledge can function otherwise than by necessary truth. It all depends on which finite aspects are selected from the infinite possibilities that are each incommensurable among themselves. This is the signification of objective multi-relativism.

Paradoxes and controversies appear exactly in the same way as in the sculptures of Markus Raetz (see Fig. 1; more similar examples from this artist can be found on the Internet). The same item seen from one angle says, 'oui' (yes), while from another angle it says, 'non' (no). An infinite number of angles (points of view) can be found in between the two interpretations. Such is the pictorial illustration of how two contradictory perceptions can be both objectively true at the same time, thanks to their incommensurability having its origin in the infinity of possible points of view.

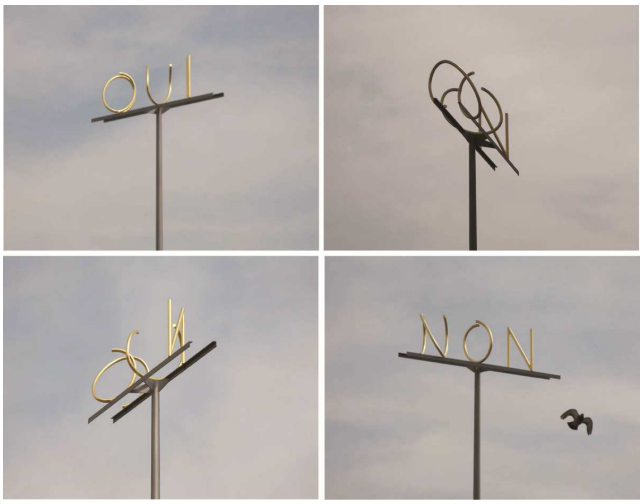

Figure 1. *Markus Raetz, "Oui-Non", 1996-2000, sculpture in place at du Rhône, Geneva (Switzerland).*

From this emerges the last way in which incommensurability can appear. Any occurrence of reality can always be considered from infinite points of view (like the angle in the above example). These points of view are conditioned by the intentions with which we approach this reality. Flip-flop pictures also illustrate this issue, which is sometimes also called a Gestalt switch. In "real life" there are types of representational frames based on very subtle completions, needing to understand real infinity, thus incommensurability, already at the base of the representational frame. All types of inter-human conflicts, probably the most important case of questioning of truth, have to be seen from this perspective. In a large number of them possibly both of the parties are right. If such conflicts cannot find another solution, in many socioeconomic systems the civilized method is to settle them by judges. Unfortunately, in many other cases much harsher methods are selected. But neither method has anything to do with truth and philosophy. Nevertheless, education with the ideas presented here could undoubtedly contribute to better management of conflicts.

Another bunch of examples for this type of incommensurability comes from the fact that some individuals do have much more knowledge of a given portion of reality or are well-trained for some very specific skills. They will, of course, have a completely different perception than average human beings, e.g., a photographer or a cameraman will perceive beautiful views where others see nothing special.

7. Realism

The minimal result proven by the above reflections is that it is not necessary to abandon reality as being in a precise way, independently of our perception. It is not a problem to have the invariance in the world, even if the representations derived from this world are not invariant. To avoid confusion, it must be mentioned that the brain structures at the base of such representations are, of course, like the outside world invariant. The not invariant representations are created at the moment their "finite useful aspects are extracted" (chapter 5.1) in the

[31] See end of chapter 4.2

brain.

However, the notion of objectivity exists independently of any paradoxes and incoherencies in our representational systems. The fact that infinity cannot be expressed explicitly does not mean that it cannot exist in the world independently of our brains. The apparent need for counterintuitive understandings of reality, as in existing forms of relativism, is purely the result of a wrong understanding of perception, of the unconsciousness that in an open brain an individual can understand inexpressible infinite features.

Even a world involving infinity can be real and understandable, although never understood in all its aspects *at once*. No finite, explicit system of representations is able to have access at once to all the elements of an infinite reality. There is, in particular, always something outside of a given explicit law. Moreover, any explicitly formulated truth is always wrong in some sense. If one wants absolutely to have a slogan, it would not be "anything goes" but "anything is wrong"[32]! This is the case for the multitude of existing physical theories that could until now not be unified. Always each of the theories is wrong in some contexts.

The reason for this is that with a world as referred to there must be an infinite number of representational frames. But reality stays the way it is and all its aspects are accessible even if the great majority of them are still to be discovered by new incommensurable representational frames; such as, new conceptual approaches, new measuring instruments, new experimental setups. According to this conception of reality, efforts to find one single unifying theory are on the wrong track: It is neither possible nor necessary to do so.

8. Explanation of the Paradoxes

According to dictionaries, paradoxes are *seemingly* inconsistent or *apparently* contradictory statements. They are thus not real and it must be possible to resolve them by an adapted solution. The world itself cannot be paradoxical. Only in representation can paradoxes arise.

Indeed, once the idea underlying the new features discussed has been grasped, it becomes rather simple to avoid all of the paradoxes pointed out. It seems reasonable to postulate that any forcing of infinity into finitude will necessarily lead to contradiction if, during the cognitive treatment, this finitude cannot be reenlarged with different types of infinity as is the case with completion, and which allows several incommensurable finite aspects to be extracted according to the needs and intentions of the moment.

8.1. The Paradoxes of Metaphysics

Before coming to conclusions about the paradoxical impregnation and the paradoxes of metaphysics, a certain number of observations have to be made.

Generally spoken, it is enough to replace all common perceptual schemes with the new, completely intelligible, overall purely physical and infinity-based process of completion, of which a further consequence is that in debates we should not discuss statements, but representational frames. Truth can only appear if we succeed in identifying common representational frames, including the ineffable intentionality that is the only way of dealing with the most complex forms of infinity. We must agree to choose the same finite aspects of the infinite reality. Once this is understood, it becomes clear that among the infinity of true incommensurable frames, each has an equivalent degree of truth, and all forms of metaphysical paradoxes, including the general paradoxical impregnation, naturally vanish away.

The problem with this, of course, is that in many cases, for example, for political reasons, people *do not want* to choose common frames. But this does not constitute a philosophical problem of possibility of truth or something related to a paradox, but a practical one of bad faith or other forms of irreconcilable intentions. A typical case is switching from one representational frame to another without admitting it.

It must be further understood that every act of perception is unseizable. In its comprehension by completion something happens – like a miracle – that escapes finite and explicit understanding. It is something of the order of infinity that is appealed to, each time we mention in the following intentionality, good or bad faith, representational frames or different classes of commensurability.

There is neither any need for epistemological absolutism. The paradoxical impregnation arises because all philosophers seem to agree that theories have to be absolute. One counterexample is enough to destroy the whole theory. The conception considered here of an infinite world does not have this problem. Truth just happens, for example, in the much more frequent cases where everybody of good faith agrees. We can calmly concentrate on them, being confident that if another truth anchored in reality (in the things in themselves) seems to contradict, there will be another choice of aspects, another representational frame of another class of commensurability that will allow a reliable account of it to be given.

What is more, even with completion there are degrees, cases in which truth is more obvious. This can be illustrated by some, not exhaustive, simple and evident examples, although also for these cases no one can be forced to accept them and they cannot be understood without completion and without intentionality. With increasing uncertainty, this begins with the conventions of natural language: What is a "typical red" is a convention but at the same time knowledge. It continues with generally accepted knowledge, like that in encyclopedias and glossaries; but also the neutral descriptions of most of what happens to us in our everyday lives, and ends with scientific statements having a clear representational frame. Even though in these fields sometimes some controversy is possible, as has been said, the fact is not relevant. What is relevant is that considered with good faith these examples of knowledge truthfully represent an aspect of the portion of reality they are aimed at. After having seen the brick houses on

[32] This applies only for this very precise context. As shown (and more examples will follow in the chapter "Explanation of the Paradoxes"), with intentionality and good will, this is different.

Elm Street, with good faith the statement that one has seen brick houses on Elm Street is not underdetermined.

Moreover, it is very important to realize that knowledge is not constructed by isolated sentences at one moment in time. Reality has some patterns that appear *in the interaction* with the world and between individuals. Between two intentional individuals using completion and being of good faith, if they are interacting for some time, they will realize quite quickly that "a cat is on a mat" and "a cherry is on a tree"[33] are two different patterns each having a well-defined signification. This also severely restricts underdetermination.

With regard to wrong statements, they also need intentionality and representational frames: They only have a sense within a well-defined class of commensurability. Of course, also bad faith is always possible here. However, when considering them together with their implicit representational frames it is easy to find statements that are clearly wrong, namely the contraries of any of the above-mentioned generally accepted knowledge as far as it is really true. Thus some sentences can, with good faith, not be held come what may. For example, with the above conditions it is clearly false to say that there are no brick houses on Elm Street, if in reality there are. In this specific case we have a very strong form of a representational frame that goes with it. It is an interesting point that such strong forms exist. Although this illustrates the question only for the most general nonscientific case, it can be reasonably expected that representational frames of similar strength also exist for science, especially for "hard" science like the cases where Newtonian physics is applicable.

Also, it is noticeable that the argument is not holism. Just intentionality, good faith, linguistic conventions and a link to a precise portion of reality are enough. No need for our experience or knowledge on the whole, a complete web of beliefs, or the entire set of statements of a complete theory. The form of knowledge described here is much simpler than, for instance, any holism[34] of the quinean type or similar.

After clarification of these points, all issues connected to idealism, be it the plain form or just the more or less slightly drifting towards it, are quickly settled. We just do not need them. Thanks to our new approach we can *without major philosophical problems* deal directly with reality and things in themselves. In any case, like absolute skepticism, idealism is no longer an approach that is really held by a significant amount of philosophers. The ones we suspected of being hidden idealists would probably deny it.

In the remaining metaphysical paradoxes, Kant and Carnap fail as they do not realize that even in the most elementary perception and in every more complex type including internal brain perceptions, the brain adds something on its own and completes the sensation according to the needs of the circumstances. Kant does not realize that in his proofs he uses different classes of commensurability, created by different completions[35]. It is neither necessary nor possible to introduce a separation. Carnap runs into trouble because each element of the syntax is learned by completion of what is known about the world and is in direct relation to the things in themselves. Semantics is nothing more than the name given to this fact.

8.2. The Problem of Reference

Through open brain and completion, the solution for the problem of reference is straightforward. To understand a concept, we must adapt our representational frames and the perceptions by completion that are at their origin, until they fit to the data available in our sensations and brain states, as well as to our intentions or to the intention of someone else we try to understand. Thus, there can be different understandings of a concept. The best we can do is to imitate them if we really have the intention to do so. For this reason, in an infinitely varied world that can always potentially bring up a tiger that does not fit to a given definition no criteria or finite set of criteria can always fit to a concept and all its possible references.

What defines conceptualization is what we mean and have the intention for. In the history of science, shortly after the discovery of the electron, there were different contradictory incommensurable conceptions of this particle [48], with some of them even being wrong. Even so, all these conceptions still meant the same structural elements in reality, and therefore, had the same and identical reference through their intention.

8.3. Determinism and Free Will

The case of determinism involves very complicated technical details that are available elsewhere [20]. Only so much shall be given here: If determinism is a philosophical problem, this is because of an overgeneralization to infinite situations of intuitions acquired on finitude. Once the real infinite variety in the world is accepted, determinism cannot be distinguished from indeterminism [36]. The paradox disappears as soon as infinity plays a role as it does for the different forms of incommensurability mentioned in this text, for example in bifurcations.

We have the impression that determinism is in contradiction with free will, because we apply understanding of finitude, of commensurability, of simplistic push-pull or two-body causality, of logics instead of mathematics, of mechanical systems instead of chaotic structures allowing bifurcations. It is possible to do an explicit analysis of what mechanical systems are and how mathematics can go beyond them [20], precisely because they include infinity.

In any case, a clear notion of determinism in infinity exists that is perfectly able to give a noncontradictory understanding of free will, creativity and intelligence. All these notions can be explained by using the view of perception as completion in an open brain that is part of an infinite world. Indeed, they all need a capacity to go out of a given system, which results

[33] Reference to an example by Putnam [47].

[34] In any case, talking of wholeness in this context makes no sense, as some significant information always exists obligatorily outside of such a given whole, theoretically in an infinite world but in most cases also practically in the highly complex world we live in.

[35] Being of good faith, we agree with Kant that these questions cannot be decided (see the conclusions)

[36] This conclusion is also made by Bohm [49].

naturally from completion.

However, as it must now be clear to the reader, according to the point of view suggested here, it is not at all sure that in an infinitely big world the global determined formalism exists, which was pointed out in the exposure of the problem. But even if it did exist, to make possible the above-mentioned cognitive features, even inside such a global formalism including the infinitely big, the existence of chaotic systems is sufficient (under the condition that for each such chaotic system, something exists outside that can induce true bifurcations). Such systems are in fact well-recognized by existing science and according to any generally accepted formalism the world must incidentally be full of them. For instance, any nonlinear multi-body system with three or more bodies is chaotic and generates enough incommensurability. This is the case, for example, for all interaction between any particles in the simple case of any atomistic particle model. Accordingly, any other more complex formalism or, as we have to suppose, multitudes of formalisms, generate even more complex forms of incommensurability and therefore, must also allow the elimination of this paradox.

9. Conclusions

After accounting for all difficulties for reliable finite knowledge that have been shown over the centuries, it is possible, thanks to the above ideas, to take an optimistic attitude and see the constructive possibilities for taking advantage of infinity. We do not claim this to be an epistemological theory. In our eyes, as mentioned at the beginning, it is no more than just pointing out that through an adapted utilization of infinity, a logically sound possibility can be given that avoids the paradoxical impregnation and allows a clear and understandable form of truth and objectivity.

With Kant, we claim that the question of whether the world is ultimately infinitely big cannot be decided. The same can be said about the existence of elementary particles that are really elementary.

So what? Is everything that has been presented in this paper philosophical fiction? Not really. There is a central part of "hard science philosophy." This solid core of the miracle of completion is all that is related to the incommensurability of bifurcations; that is, sensitivity to infinitesimal fluctuations, strange attractor-like behavior, the ability to deal with forms, openness of the brain, as well as the discussion about intentionality, truth, and objectivity. All we need for that is continuity of space and time. Although for complete intellectual satisfaction it is nicer, and at least for some points, like the ontological equivalence of all levels of description, necessary to have the complete infinities downwards and upwards in scale; this core part has the doubtless advantage of being just there. Nonlinear dynamic systems are accepted science. With that, a new view is insistently knocking on our doors. We can hardly do anything other than to open ourselves, at least epistemologically and metaphysically, to the open brain.

Acknowledgments

The author thanks Professor Marie-Jeanne Borel at Lausanne University for financial and scientific support.

References

[1] F. Varela, E. Thompson, and E. Rosch, The Embodied Mind: Cognitive Science and Human Experience, Cambridge MA: MIT Press, 1991

[2] P. K. Feyerabend, Against Method, London: New Left Books, 1975.

[3] I. Prigogine and I. Stengers, Order Out of Chaos: Man's New Dialogue with Nature, London: Flamingo, 1984. French original: La nouvelle alliance, Paris: Gallimard, 1979.

[4] H.-O. Peitgen, H. Jürgens, and D. Saupe, Chaos and Fractals: New Frontiers of Science, New York: Springer Verlag, 1992.

[5] D. Ruelle, Chaotic Evolution and Strange Attractors, Cambridge, MA: Cambridge University Press, 1989.

[6] B. Mandelbrot, Fractals and Chaos, Berlin: Springer, 2004. French original: Les objets fractals, Paris: Flammarion, 1975.

[7] H.-O. Peitgen and P. H. Richter, The Beauty of Fractals, Berlin: Springer, 1986.

[8] L. Nottale, Fractal Space-time and Microphysics: Towards a Theory of Scale Relativity, London: World Scientific, 1993.

[9] L. Nottale, Scale Relativity Theory and Fractal Space-Time: A New Approach to Unifying Relativity and Quantum Mechanics, London: Imperial College Press, 2011.

[10] H. Guillemot, "Voyage au centre du proton," Science & Vie, (908), 1993, p. 60–65.

[11] Entry "Preon" on Wikipedia.

[12] B. Greene, The Elegant Universe, New York: W. W. Norton & Company, 2003, p. 142.

[13] G. Cantor, Gesammelte Abhandlungen mathematischen und philosophischen Inhalts, E. Zermolo, Ed. Berlin: Springer, 1932. Different texts published from 1872 on.

[14] R. Dedekind, Was sind und was sollen die Zahlen. Braunschweig: Friedrich Vieweg und Sohn, 1888

[15] L. Nottale, 1993, p. 286.

[16] E. B. Norman, "Are fundamental constants really constant?" American Journal of Physics, (54), 1986, p. 317ff.

[17] B. Greene, 2003, p. 130.

[18] C. Sparrow, The Lorenz Equations: Bifurcations, Chaos, and Strange Attractors, New York: Springer-Verlag, 1982.

[19] YouTube, https://www.youtube.com/watch?v=FYE4JKAXSfY entitled "Simple Model of the Lorenz Attractor."

[20] A. Abächerli, Beyond the paradoxes of knowledge. Au-delà des paradoxes de la connaissance, only in French, unpublished preprint, University of Lausanne, 1998. Available by email from the author.

[21] R. Laughlin, A Different Universe: Reinventing Physics from the Bottom Down, New York: Basic Books, 2005.

[22] Entry "Emergent Properties" in the Stanford Encyclopedia of Philosophy: http://plato.stanford.edu/entries/properties-emergent/.

[23] M. Gu, C. Weedbrook, A. Perales and M. A. Nielsen, "More really is different," Physica D: Nonlinear Phenomena, vol. 238 (9–10), 2009, p. 835–930.

[24] W. V. O. Quine, From a Logical Point of View, Cambridge, MA: Harvard University Press, 1964, p. 20ff.

[25] J. W. Scott, "Idealism as Tautology or Paradox", Philosophical Review, (22), 5, 1913, p. 470.

[26] Entry "Kant's antinomies" on Wikipedia.

[27] L. Wittgenstein, Philosophische Untersuchungen/ Philosophical Investigations, Oxford: Blackwell, 1953.

[28] R. M. Rorty, Philosophy and the Mirror of Nature, Princeton, NJ: University Press, 1980.

[29] R. Carnap, Der logische Syntax der Sprache, Wien: Springer, 1934.

[30] R. Carnap, Introduction to Semantics, Cambridge, MA: Harvard University Press, 1942.

[31] W. V. O. Quine, "Two dogmas of empiricism," Philosophical Review, (60), 1951, pp. 20–43, collected in Quine, From a Logical Point of View, Cambridge, MA: Harvard University Press, 1953.

[32] S. Kripke, "Naming and necessity," in Semantics of Natural Language, G. Harman and D. Davidson, Eds. Boston: D. Reidel Publishing Co., 1972, p. 119-121.

[33] P. Ziff, Semantic Analysis. Ithaca, NY: Cornell University Press, 1960, p. 183-184.

[34] W. V. O. Quine, Word and Object, Cambridge, MA: MIT, 1960, § 12.

[35] W. V. O. Quine, Ontological Relativity, New York: Columbia University Press, 1969, p. 26ff.

[36] W. V. O. Quine, 1969, p. 38.

[37] P. Ziff, 1960, p. 102ff.

[38] S. Kripke, 1972, p. 121.

[39] J. R. Searle, Expression and Meaning. Cambridge, MA: Cambridge University Press, 1979, p. 1-29.

[40] Corresponding entry in the Stanford Encyclopedia of Philosophy: http://plato.stanford.edu/entries/scientific-underdetermination.

[41] W. V. O. Quine, "Identity, ostentation and hypostasis," Journal of Philosophy, (47), 1950, pp. 621-632, collected in Quine, From a logical point of view, Cambridge, MA: Harvard University Press., 1953.

[42] Entry "Gestalt psychology," chapter "Critics" on Wikipedia.

[43] D. Bohm, Causality and Chance in Modern Physics, London: Routledge & Kegan Paul, 1957.

[44] D. Bohm, Wholeness and the Implicate Order, London: ARK Edition, 1980.

[45] D. Bohm and F. D. Peat, Science, Order and Creativity, New York, Bantam Books, 1987.

[46] C. A. Skarda and W. J. Freeman, "Chaos and the new science of the brain," Concepts in Neuroscience, 1(2), World Scientific Publishing Company, 1990, pp. 275–285

[47] H. Putnam, Reason, Truth and History, Cambridge, MA: Cambridge University Press, 1981, p. 34

[48] I. Hacking, Representing and Intervening, Cambridge, MA: Cambridge University Press, 1983, p. 81

[49] D. Bohm and F. D. Peat, Science, Order and Creativity, New York, Bantam Books, 1987. French translation: La conscience et l'univers. Monaco: Ed. du Rocher. 1990, p. 126