Horia-Costin CHIRIAC
”Gheorghe Asachi” Technical University of Iasi (Romania)

Scientific Progress in Terms of Descriptive Imaginary Evolution*

Abstract: The present paper aims to underline the use of imaginative faculty within the process of acquiring scientific knowledge, especially in the case of the natural sciences. Moreover, we are interested to investigate the way in which scientific progress takes place. Such a problem was one of wide interest for a quite long time, a problem that triggered the development of some of the most influential theories in the philosophy of science. Our proposal involves the introduction of a new concept, the descriptive imaginary, which plays an important part in our effort to clarify the specific use of the imaginative faculty within the development of new scientific theories. We will try to develop a pragmatic theory about scientific progress able to combine a moderate fictionalist point of view about the genesis of scientific representations with the idea that scientific progress is happening in terms of progressive grasping of the features of nature.

Keywords: descriptive imaginary, scientific representation, scientific progress

1. Introduction

The present paper aims to emphasize the use of the imaginative faculty within the process of acquiring scientific knowledge, especially in the case of natural sciences. Moreover, we are interested to investigate the way in which scientific progress takes place. Such a problem was one of wide interest for a quite long time, a problem that triggered the development of some of the most influential theories in the philosophy of science. One could remember, in this respect, at least two famous

* **ACKNOWLEDGEMENT**: This paper was presented as communication at the EIGHTH EUROPEAN CONGRESS OF ANALYTIC PHILOSOPHY, BUCHAREST AUGUST 28 – SEPTEMBER 2, 2014, in the section dedicated to Philosophy of Science.

personalities: Karl Popper and Thomas Kuhn. The former understood scientific progress as a continuous competition among theories in which error itself played a constructive role and the so-called falsification test was crucial for the theory selection. The latter understood the dynamics of science in terms of paradigm change. He also had a quite difficult time with the problem of evaluating scientific progress, if we take into account the concept of incommensurability he introduced and advocated with respect to the so-called historical turn in the theory of science. Since that time, the variety of positions advocated by different authors regarding this problem increased substantially. Despite the fact that such a subject was of major concern quite a long time ago, we think it is important to revitalize it in a new context.

2. The descriptive imaginary

As we are going to see, the understanding of scientific progress depends on various factors, including the general philosophical positioning and the conceptual tools used in debating the subject. In this respect, the present endeavor involves the introduction of the concept of *descriptive imaginary* (Chiriac 2011), which plays an important part in our effort to clarify the specific use of imaginative faculty within the development of new scientific theories. The roots of the mentioned concept could be linked to the concept of *imaginary* used in a more general way by authors like Gaston Bachelard, Gilbert Durand or Jean Jacques Wunenburger, on one hand, and the concept of *state description* mentioned in the philosophy of Rudolf Carnap (1966) (somehow equivalent to the notion of *state of affairs* used by Ludwig Wittgenstein), on the other hand. By introducing the concept of descriptive imaginary, we are trying to underline the fact that, beyond abstract thinking, scientific theories benefit in their development by some conceptual products we can call descriptive representations, which in their turn allow the link between sensory data and abstract notions. In fact, as authors like Max Turner and Gilles Fauconnier account, it seems that at the origin of many abstract concepts lay a consistent amount of sensory information (Fauconnier and Turner 2002). In spite of the fact that imagination was regarded with reluctance by many philosophers who often avoided its association with scientific knowledge, we believe that productive imagination plays a special role in the development of scientific theories, provided some rules regarding the morphology and concatenation of its products are obeyed.

As one can see from the above, the descriptive imaginary represents a conceptual tool for investigating the dynamics of scientific discourse. In the same time, it can be used for evaluating the scientific progress at least in two respects. First, the analysis could regard the link between scientific advancement and practical steps realised at the technological level. In this respect, the descriptive imaginary embeded into a specific physical theory is deeply linked to the evolution of the technology emerged from certain successes of the mentioned physical theory, due to the descriptive scenario that oriented the experiments and the technological applications of the theory as well. One could talk, for example, about Newtonian mechanistic imaginary, about relativistic imaginary or about descriptive imaginary specific for Quantum Mechanics in its different stages of development and its different interpretations (Bohr, Bohm, Everett etc.). Second, the analysis could regard the intrinsic syntactic progress of the scientific discourse from an epistemological and ontological point of view; descriptive imaginary could be partially responsible for the degree of refinement of the descriptive representations that connect the genuine mathematical concepts (Mario 2012, 224) used within a scientific theory with the studied phenomena.

The complexity of the concept of imaginary and the wide range of its use, starting from the contributions of Gaston Bachelard, Jacques Le Goff, and Gilbert Durand and up to those of Cornelius Castoriadis or Jean Jacques Wunenburger are remarkable. However, we felt that many authors did not pay enough attention to the specific prophile of scientific imaginary in contrast to other types of imaginary. One particular aspect that differentiates scientific imaginary involved in the development of natural science theories from other types of imaginary refers to the censorship criteria involved in the selection of the products of human imaginative faculty. Censorship is a process that occurs in the case of different types of imaginary, representing in this respect a common feature of their dynamics. For instance, Ioan Petru Culianu (1994, 19) speaks about the censorship of Renaissance religious and social imaginary as a process which favored unexpectedly the rise of modern science. Artistic imaginary encounters also a type of censorship on the road from the free fantasy of an artist and up to the final stage of the elaborated work of art. But the censorship of scientific imaginary, mathematical and physical, is a complex process guided by specific rules that differentiate it from other types. This happens because the products of scientific imaginary are aimed to describe the physical real or, at least, some of its features. At the same time, they are designed to be integrated into a complex and coherent scientific theory, which forces them to obey several syntactic and semantic rules. For instance, the introduction of a new concept in physics involves the effort of making its definition compatible with that of other forces, a process that may take time, as it is the case with the notion of acceleration in times of Galileo Galilei, Simon Stevin and Isaac Newton.

3. A few perspectives on scientific progress

As we already mentioned from the beginning, this paper aims to examine the problem of scientific progress from a perspective built around the concept of descriptive imaginary, which in our case refers to the scientific imaginary involved in the development of natural sciences. As we are going to see, the link between these two elements is quite a complex and not at all accidental one. At first, it is important to clarify what we understand by scientific progress. From its beginning, modern science claimed to be not an ordinary type of discourse about nature, but rather a privileged one, in terms of descriptive success. The authority of scientific conclusions regarding the fundamental properties of nature and its main features was not to be limited, ignored or minimized in favor of other types of discourse about nature. As far as the modern science is concerned, this claim regarding the epistemic authority of the scientist was founded on two distinctive elements: the mathematical demonstrability and the experimental verifiability of scientific knowledge.

Given these facts, the idea that modern scientific discourse manages somehow to reflect important and technologically exploitable characteristics of nature was generally accepted, not only by the scientists, but also by the general public. Only recently some post-modern authors claimed that science might be just a type of discourse among others, but still, the above mentioned characteristics of this discourse and the strong link between scientific theories and technological applications place modern science on a privileged position. However, the understanding of scientific progress depends a lot on the philosophical positioning in what concerns the problem of scientific realism.

For a genuine realist the scientific progress could be understood as a step forward in unveiling new properties of physical structures using scientific theories, while maintaining at the same time a direct correspondence between different types of explanatory notions and the physical entities. What is difficult for a sheer realist to justify is the fact that scientific progress is a continuous process that never ends, exactly because each step on its path is always an incomplete one. At the same time, the fact that representational and descriptive strategies of science are changing, from a historical period of time to another, poses obvious difficulties for a realist. Nevertheless, for a realist, the variety of scientific concepts has a more or less direct correspondent in the real world. For the sake of simplicity, we are going to introduce the distinction between the physical real and the scientific reality as a world of descriptions, as an explanatory image of the physical real. In fact, the physical real might not be fully accessible to the human mind, conceptually and experimentally, at least not in one finite period of time. So each age of scientific development poses new challenges to the structural matrix of logical categories embedded in the human mind. Scientific progress arises quite often from the capacity of the human mind to reinvent itself in respect to its conceptual tools used for investigating and expressing intelligibly those features of the physical real considered for the moment as being fundamental, namely as having priority in the causalistic scenario applied to the nature for making it understandable for Human Being. One good example is the introduction of quantum logic for explaining the awkwardness of quantum phenomena revealed experimentally at the beginning of the last century. On one hand, scientific reality and its boundaries influence the direction of development for designing new phenomena, on the other hand, some surprising results of various experiments are challenging the minds of scientists to come up with new explanatory solutions for making intelligible the new picture of nature, the new scientific reality. And obviously, the basic ingredients in this effort are the mathematical concepts and the descriptive representations used to approximate the phenomena and to make possible the process of signifying their characteristics in a measurable and mathematically articulated way. In such a context, a realist will connect, for example, more or less directly the ever-changing level of scientific reality with the level of the physical real.

One solution for diminishing some of the mentioned difficulties is that of assuming the position of a moderate realist. A moderate realist will admit the limits of ontological correspondence between the set of scientific concepts and the real physical entities and structures, but will firmly account for the fact that at least *some* of the features of the physical real are well-represented by the conceptual structures used in the physical theories. The obvious difficulty in this case is the precision and criteria of demarcation between those scientific concepts with real epistemic authority and ontological consistency on one hand, and those discursive entities characterized by a weaker or totally missing link towards real physical entities and structures on the other hand.

In our view, to draw this line of demarcation implies in this case the need for specific pragmatic and methodological criteria for selecting descriptive representations with epistemic authority and ontological consistency. And, given the continuity of scientific progress, the activity of defending such a position of moderate scientific realism implies the continuous change of the set of examples used within the effort of tracing the demarcation line again and again.

From the point of view of an anti-realist, however, the very possibility of scientific progress poses a difficult question. This happens, due to the fact that an anti-realist perspective implies a very weak link between the level of physical reality and the level of the physical real. In this respect, scientific concepts are mere socially constructed labels of real physical entities whose existence is partially emphasized experimentally and whose manifestation as parts of physical phenomena is partially measurable. Thus, for a genuine anti-realist is quite difficult to conceive the scientific progress as having an ontological component. As a matter of fact, scientific progress is understood in terms of increased coherence and simplicity of the conceptual structures labeled to the real phenomena. Scientists could evolve in restructuring the set of notions associated to the real physical entities, while the ontological consistency of these notions would always remain for an anti-realist a problematic one.

There is, also, a third position that could be taken into account, as far as the problem of actual scientific progress is concerned: that of a structuralist who embraces the perspective of mathematical realism. For such a person, inspired partially by the position of Plato regarding the reality of mathematical structures, the link between a physical theory and the real world is not grounded on the similarities between the characteristics of the descriptive representations used within the theory and the characteristics of the real physical entities, but rather on some sort of isomorphism between conceptual mathematical structures of the theory and the existence of underneath mathematical structures in the real world. It is not very clear, however, what kind of existence can be attributed to those underneath mathematical structures. Is it an abstract, ideal level of existence, or rather the presence of calculable and mathematically describable patterns within the array of properties, characteristics and behavior of physical entities that interact one to each other and populate the physical systems studied in the laboratory? Beyond the awkwardness of these aspects, many mathematicians give credit to such a possibility when claim that their effort is to *discover* new mathematical structures and entities rather than to *invent* them.

On his side, the physicist with such an implicit philosophical positioning could feel that mathematical structures represent the core element of a physical theory not only in terms of internal precision and coherence, but also in terms of inner ontologic consistency. Examples like that of Electromagnetism could be considered revelatory in this respect, especially if one takes into account that only the famous equations of the electromagnetic field survived to these days, while the ontology they were grounded on changed dramatically in time, losing one of its main ingredients: the concept of ether. Consequently, for such a physicist the function of descriptive representations within the theory is more an auxiliary one, analogies playing an important part in this context mostly for humanizing or making more accessible the scientific discourse by bringing it in the proximity of human sensorial perception of the world.

We can conclude that there is a strong link between the philosophical positioning regarding scientific realism and the perspective upon the very possibility of scientific progress. In this context, the use of human imaginative faculty has its importance, especially if we think about its contribution within the effort of improving the knowledge about the physical real. The importance of descriptive representations with respect to the entire scientific endeavor may vary depending on the philosophical perspective adopted by different authors, but what matters the most is the understanding of their participation within the effort of explaining and investigating the diverse properties of the physical real. Generally speaking, the presence of analogies of various kinds within the specific descriptive discourse of physical theories is acknowledged by many analysts of the process of scientific development. What triggers still controversial positioning seems to be, most of all, the understanding of their role within the scientific discourse.

4. A possible fictionalist perspective on scientific realism

Knowing that fictionalism is a philosophical position that was criticized for its relation with experience (both in its classical form adopted by Hans Vaihinger or in some of its later forms), we need to specify the sense of our claim that descriptive representations have a fictional nature within the scientific discourse. They have in many respects the same genesis as the pure fictions, being essentially the product of the imaginative faculty. But beyond this aspect, which is usually admitted even by moderate realists like Ronald Giere, their function within scientific discourse involves also a fictional aspect. They are provisionally invested with epistemic authority, namely with ontologic-descriptive veracity, for the sake of syntactical coherence of the discourse. Depending on the confirmation or infirmation of the predictions derived from the developed theory, the initial and provisional status of descriptive representations within scientific discourse would change dramatically. Some of them will become well-trusted descriptive tools within scientific discourse, while others will become pure fictions without any correspondence to the real world. For this second category the transformation of the ontological status is quite remarkable, in the sense that at the end of their carreer they become pure fictions in a much more radical manner than in the moment of their genesis, given the fact that their birth was partially influenced by pragmatic censorship criteria applied to the human imaginative faculty that generates them with an explicit descriptive purpose.

5. Our proposal

Our proposal regarding a philosophical understanding of scientific progress lays on the concept of descriptive imaginary and could be considered a form of moderate fictionalism suitable to be called "pragmatic fictionalism". The main idea is that scientists use their imaginative faculty to build more and more efficient descriptions of natural phenomena, and these descriptions are composed of concatenated descriptive representations. The position we defend can be called a fictionalist one especially because it refers to descriptive representations as having a fictional origin, namely as being the products of the imaginative faculty. They are not pure fictions, given the fact that they are created with a descriptive purpose. In this respect, their use differentiates them from pure fictions, due to the fact that some pragmatic criteria concerning the selection and structuring of representations are taken into account from the beginning of their introduction into a descriptive and explanatory scientific theory. For some authors, like Ronald Giere for example, these aspects would not qualify these conceptual ingredients of the scientific discourse as genuine fictions, especially if we take into account that their adequacy to the physical real is tested by specially devised experiments. But for us their nature remains basically fictional, not only because they are products of human imaginative faculty, but because they *are ontologically invested with provisory epistemic* *authority within scientific theories.* Their investiture happens for the sake of scientific syntactic coherence of the theory in accordance with a pattern we are going to explain briefly.

At first, descriptive representations are necessary for building an entire conceptual system able to create a provisional picture of a phenomenon or a set of phenomena. The very discursive integrity and coherence of the scientific theory depends sometimes on their introduction into the explanatory system. Moreover, they also have a significant contribution in creating a mathematically intelligible description of a real phenomenon. In this respect, they connect the products of mathematical imaginary with some features of the physical real which can be measured and expressed through mathematical laws mainly because their image, obtained by the use of descriptive representations based more or less on analogies, is directly oriented towards some causal chains that trigger the real phenomenon. Of course, the causal chain is never completely understood and reflected within the image of the phenomenon in this stage of theoretical development, but at least scientists have a hypothetical and valuable starting point.

On the basis of the hypothetical descriptive scenario, the scientific theory evolves mathematically and makes quantitative predictions that can be tested on the basis of a few experiments. The experiments themselves are based also on experimental scenarios embedding the descriptive representations used initially for depicting the phenomenon in the first stages of the scientific theory development. In case the predictions made by the theory are confirmed, theory in its entire gains momentary credibility and consequently the descriptive representations within it are provisionally invested with supplementary epistemic authority and ontologic consistency. For the moment, they are considered the best discursive entities for replacing the features of the real phenomenon in the “scientific reality”, built as a workable but approximate image of the phenomenon. However, in case predictions are not confirmed, the descriptive representations used within the theory lose their credibility and their ontological status is that of dispensable fictions. This was the case with the *ether* as descriptive representation embedded in the theory of electromagnetic field. It played an impotant role in the ontology of electromagnetism in the time of Maxwell, but later was discarded as a pure fictional element once the Theory of Relativity introduced a wholly new descriptive scenario for an entire class of phenomena (Einstein 1992, 62).

The investing of descriptive representations with epistemic authotity is *provisional* and *conventional* in our view, for the sake of methodological development of the theory, whose predictions could be confirmed or infirmed experimentally, indirectly influencing the status of descriptive representations of the phenomena that formed initially the theory as a provisional description of the properties of a specific part of the physical real. But the provisional ontological status of descriptive representations influences the way the discursive schematization is conceived within each scientific theory and the associated ontology of the theory determines in the same time the argumentative foundation of the theory. As a result, what Thomas Kuhn called the incommensurability of scientific theories can be defined as a fundamental difference in terms of argumentative foundation and discursive schematization of them. Each theory has its own pattern of evolution regarding the epistemic authority of its own descriptive representations.

6. Conclusion

Analyzing the ontology of scientific imagery throughout the main stages of natural science development, we can observe interesting mutations regarding the visual component of scientific reprezentations (Cushing 2000). For example, a turning point was represented by the translation from pre-scientific Aristotelian qualitative representations of nature to quantitative interpretations of visual data in Galileo and Kepler`s Astronomy. Another turning point could be the transition from Faraday`s visual analogies in representing the magnetic field to Maxwell`s mechanical analogies of ether replaced finally by the famous field equations. Of course, any other important revolution in natural science, like the Relativistic one and the Quantum Mechanics one, involved also important mutations in the morphology of descriptive representations (Cao 1997).

What seems important for us in what regards the understanding of scientific progress is the evolution of scientific representations at the level of scientific communities, but also at the level of individuals. However, the continuous process of negotiation that influences the morphology of the private part and also of the public part of descriptive representations seems for us quite specific for the case of natural sciences. It is worth remembering in this context that the aim of our endeavor was to emphasize that many scientific concepts have in fact a fictional origin, an aspect which is somehow neglected or ignored at the peak of their influence within scientific discourse, but can be rediscovered at the end of their career as useful descriptive elements within scientific theories (Chiriac 2012). The case of *ether* is emblematic, but not at all singular in this respect, if we remember about the ontological Odissey of the concept of *atom* in Physics (Bohr 2012, 128). However, given the specific features of descriptive imaginary, which involve the use of the human imaginative faculty within the limits of rationality, our position should not be reduced to that of Hans Vaihinger`s fictionalism (Vaihinger 2001). What is crucial for us is the presence of commonly accepted criteria for selecting and shaping descriptive representations by scientific communities in such a way, that the progress in science can be real, at least intentionally, and not simply an apparent one. More exactly, in our view, it is possible to develop a pragmatic theory about scientific progress able to combine a moderate fictionalist point of view about the genesis of scientific representations with the idea that scientific progress is happening in terms of progressive grasping of the features of nature (Cartwright 1994, 141). In doing that, one has to make a distinction between metaphysically originated scientific concepts and empirically originated scientific concepts, like physical fundamental constants, which seem to be among the few stable elements within the scientific discourse for long periods of time. In this respect, they are at the opposite side of the scale in comparison to metaphysically originated concepts like *ether.*

The specificity of scientific imaginary comes from the fact that modern scientific discourse has some particularities that individualize it among other types of discourse with comparable ambitions in building knowledge. To understand better these particularities, which have a lot to do with the relation between scientific concepts and the physical real they intend to describe, the dynamics of scientific representations in natural sciences can be analyzed using the concept of descriptive imaginary as a methodological tool. In this context, one of the characteristics of the scientific discourse that becomes a rich soil for further investigations is the alternation between natural language and symbolic mathematical language, in which the semiotic relation between mathematical symbols and the physical world is characterized sometimes by intermittence. This intermittence regards the ontological independence of mathematical concepts within the discourse of scientific theories in natural sciences. One open subject for further analysis refers to the consequences of such intermittence for the ontological consistency of scientific discourse, especially as regards the relation between the physical world, the symbolic mathematical language and the image of the physical world reflected by the scientific theories using descriptive representations.

References

BOHR, Niels. 2012. *Teoria Atomică și descrierea naturii.* București: Editura Humanitas.

CAO, Tian Yu. 1997. *Conceptual developments of 20th Century Field Theories*. New York: Cambridge University Press.

CARNAP, Rudolf. 1966. *Philosophical Foundations of Physics*. New York: Basic Books Inc.

CARTWRIGHT, Nancy. 1994. *Nature's Capacities and Their Measurement*. Oxford: Oxford University Press.

CHIRIAC, Horia Costin. 2011. "The Interaction between Social Imaginary and Descriptive Imaginary". *Argumentum* 9 (2).

CHIRIAC, Horia Costin. 2012. "Scientific mythology and the dynamics of scientific concepts*". Argumentum* 10 (1).

CULIANU, Ioan-Petru. 1994. *Eros şi magie în Renaştere – 1484*. Bucureşti: Editura Nemira.

CUSHING, T. James. 2000. *Concepte filosofice în fizică: relaţia istorică dintre filosofie şi teoriile ştiinţifice.* Bucureşti: Editura Tehnică.

EINSTEIN, Albert. 1992. *Cum văd eu lumea.* Bucureşti: Editura Humanitas.

FAUCONNIER, Gilles and Turner, Mark. 2002. *The Way We Think: Conceptual Blending and the Mind´s Hidden Complexities*. New York: Perseus books Group.

LIVIO, Mario. 2012. *Este Dumnezeu mathematician?*. București: Editura Humanitas.

VAIHINGER, Hans. 2001. *Filosofia lui "Ca şi cum"*. Bucureşti: Editura Nemira.