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Descriptive imaginary morphology from mental imagery to scientific discourse*

Abstract: The present paper intends to emphasize the link between descriptive imaginary and mental imagery, which could contribute to a better understanding of the dynamics of descriptive representations` morphology throughout the history of scientific theories in natural sciences. There are several difficulties regarding this effort, most of them regarding the fact that mental imagery is an internal, subjective and sometimes unconscious process. In spite of this, starting from the fact that mental imagery is often involved in the development of mental experiments used within the process of shaping new scientific theories, we tried to analyze the two major components of descriptive imaginary: the private one and the public one. Our effort was aimed at emphasizing the specific gradual transition from the individual development of descriptive representations to the social negotiation of their morphology within scientific communities. This way, the context of discovery is combined with the context of justification in the development of new descriptive and explanatory scenarios in natural sciences, with characteristics that influence at the same time the profile of scientific discourse.

Keywords: scientific imagination, mental imagery, discourse, morphology descriptive representation.

1. Three stages of descriptive discourse

The present work intends to describe the specific dynamics of the morphology of descriptive imaginary, in order to underline the particularities of this concept, introduced in some of our previous works. Our endeavor is focused on the evolution of scientific concepts, from the

* **Acknowledgement:** This paper was made within The Knowledge Based Society Project supported by the Sectoral Operational Programme Human Resources Development (SOP HRD), financed from the European Social Fund and by the Romanian Government under the contract number POSDRU ID 56815.

moment of their birth up to the moment of their definitive consolidation within scientific discourse or, in some cases, up to the moment of their elimination from the category of useful descriptive tools.

The historical evolution of scientific concepts is a major aspect of the whole process we intend to analyze. However, we would be mainly interested, beyond historical circumstances, in a better understanding of the contribution of imaginative faculties of scientists to the development of scientific discourse whose main purpose is a better understanding of nature. In order to do that, we are going to introduce a distinction between the *physical real* and the *reality*, considering from the beginning that the human mind is capable of developing specific methodologies for acquiring knowledge about the *physical real* on which human beings could apply various experimental strategies able to identify, to isolate and to make visible different significant features of it. Furthermore, the human mind is capable to concatenate different types of acquired information into a coherent and approximately unitary description of the physical real, description which we are going to call *scientific reality*. Thus, the scientific reality could be considered as being nothing more than a product of the human mind, of its rational capabilities, being in fact a genuine image of the physical real, an image that reflects the way in which and the degree up to which the human mind was capable to penetrate, to unveil objectively and to express coherently the properties or the characteristics of the physical real (Cartwright 1994, 141).

As a consequence, scientific reality evolves together with scientific theories, paying tribute morphologically to their historical evolution. Of course, in periods of historical effervescence for the most influent historical theories, the boundaries of scientific reality are expanding, but become from time to time less defined, whereas in historical periods characterized by a long dominance of a single theory in natural sciences these boundaries become more stable and the coherence degree of scientific reality increases. A good example in this regard is the mechanistic period in physics, characterized by the authoritarian dominance of Galilean and Newtonian Mechanics. Of course, even in this particular case, we cannot speak about conceptual stagnation in the evolution of scientific reality, given that scientists such as Lagrange and Hamilton determined through their contributions the development of the very Classical Mechanics. But in those times the general view about the physical real was developed around a few principles of this theory, while mechanical phenomena were considered the starting point of the experimental investigation of natural characteristics.

However, things become more complicated in the cases when two or more theories which are up to a certain point incompatible dominate for quite a long period of time the manner in which the physical real is understood and investigated. For instance, the epistemological tensions between Quantum Mechanics and Relativity determine nowadays a relatively low congruence among the explanatory principles and models dedicated to different levels of reality. For some of the scientists and philosophers of science, these discrepancies determined even the introduction of ontological distinctions amongst different levels of reality or, if you prefer, different levels of organization of the physical real. It is a circumstantial solution which has somehow the advantage of a quite good consistency from an epistemological point of view, but its poor coherence involves the exposure of scientific discourse of contemporary natural sciences to a somehow fractured ontology with three different scales of matter organization: the quantum scale, the macroscopic scale and the cosmic scale.

One legitimate question in this context would be whether or not the physical real is fractured in its properties or the human mind is incapable of producing a unitary coherent description of it doubled by experimental results tributary to experimental refined strategies able to unveil unitarily this coherence of the physical real itself. And the same question could have become the starting point for all the scientists preoccupied with the development of a unification theory in contemporary physics.

Apart from this aspect, we have to justify the use of the term *descriptive imaginary* and to emphasize the way in which its morphology could be a useful indicator for a better understanding of the historical evolution of scientific discourse in natural sciences.

The use of the imaginative faculty in acquiring knowledge, all kinds of knowledge, was always a controversial or, at least, a problematic subject. In the case of scientific knowledge acquiring things became even more complicated and the debates even more heated, due to the long history of interference between imaginary explanatory entities and empirically originated explanatory entities in natural sciences.

The rise of modern science triggered the process of gradual change in the morphology and the function of human fantasy. A brief look at the history of science reveals a few interesting aspects in this regard. First of all, it seems that the rise of modern science in the world depended not only on the effective empirical progress in investigating the structure of the world or on the sheer conceptual progress in developing new mathematical concepts, but most of all on the capacity of a culture to

make the distinction between the real properties of nature and the imaginary ones. There are remarkable civilizations like the Chinese, the Indian and the Mesopotamian that made significant progress in one or another of the directions mentioned above without registering in the same time any important advancement towards the development of a veritable modern natural science. Of course, the steps mentioned above can furnish the criteria for enforcing the distinction between real and imaginary in building a descriptive reality about the physical real, but the distinction itself depends primarily on the way in which human imaginative faculty is involved in the complex process of designing descriptive scenarios whose coherence can be demonstrated mathematically and whose adequacy to the physical real can be tested experimentally.

The process of involving human imaginative faculty in the struggle of acquiring knowledge about the surrounding world registered different stages of evolution, from the mythological age to the philosophical age and finally the scientific age. Throughout these stages, the implementation of different criteria involved in the selection of conceptual components of descriptions highly influenced the relation between human imaginative faculty and the effort of expanding knowledge about external world.

The mythological age was dominated by the substitutive role of fantasy in what regards the direct experience of the world. On this occasion, whenever the human mind encountered a surprising phenomenon, imagination introduced explanatory entities designed to fill the gap in knowledge at that time and to build an explanation centered on plausibility combined with the feeling of mystery. The more extraordinary the substitutive imaginary explanation, the more excitement in favor of accepting it as plausible.

The philosophical age was characterized by a very subtle mixture of imaginative explanatory conceptual entities with observational data about the surrounding world gathered for inductive purposes and logical deductions that made possible the building of a rational image about the world. The philosophical reality was in fact the product of human mind using its imaginative faculty within the limits of rationality which guided the philosophical speculative endeavor of creating a beautiful and coherent explanation of the way in which the surrounding physical real appeared to human consciousness. Due to the lack of a very effective and rigorous experimental method, quite often the substitutive character of philosophical concepts in describing reality became noticeable.

However, there were some important differences in comparison to the previous period, as far as the limits and functions of human imaginative

faculty are concerned. The imaginative effort was assumed within the limits of rationality for the first time, the logical coherence and plausibility becoming two guiding principles in developing the descriptive discourse regarding nature. Underneath this logical infrastructure of the discourse laid a veritable aesthetics of the philosophical concepts used to depict the features of the real and to integrate them into a harmoniously shaped philosophical reality as image of universe. But the lack of a rigorous experimental method for acquiring data about the surrounding world prevented the philosophical discourse about nature to achieve a level of accuracy comparable to that of the later developed natural sciences. Moreover, no practical method of direct verification could certify the status of knowledge for the philosophical assumptions about the features of the physical real, apart from their logical coherence. Hence, in this case, which could be very well exemplified by the Physics of Aristotle, the substitutive role of those explanatory discursive entities originated exclusively in the human imaginative faculty in comparison with empirical data was still present.

The third period is that of remarkable methodological achievements for the natural sciences. The complex character of the mutations involved required terminological innovations to cope with the paradigm shift. The new manner of describing the nature and its features in an objective and technologically potent way required a different conceptual apparatus. This time the shift involved not the transition from mythological thinking towards a rational and causally centered one, but rather a transition between rational plausibility towards experimental verifiability in certifying knowledge. Such phenomenon was possible due to another significant change regarding the role of imaginary originated products of the human mind within scientific discourse: a transition from the substitutive role of such products towards a complementary role of their informative contribution, alongside with empirically originated products of the human mind, aimed at configuring the *descriptive reality* as a coherent image of the physical real.

The change was dramatic and it involved a remarkable shift within the functioning conditions of the human imagination that we are going to investigate. Therefore, we chose to name the kind of scientific imaginary involved in the development of modern natural sciences` discourse - *descriptive imaginary*. As the denomination suggests, this type of imaginary is involved in a rational act of description: the description of the physical real, in order to create a coherent perspective on nature using a detailed image of it, called *scientific reality.*

2. The features of descriptive imaginary

Of course, the scientific reality is a type of descriptive reality, or a kind of descriptive image of the physical real, but it is not the only one possible. Since we are going to compare different historical periods in the evolution of the coherent view on nature, up to the moment of full maturity of modern scientific paradigm in natural sciences' discourse, it is preferable to talk about the different stages of evolution of the *descriptive reality*, from the mythological and then philosophical stages up to the genuine scientific ones, instead of talking directly about different phases in the evolution of *scientific reality*. As Ioan Petru Culianu suggests, particular cultural conditions favored at a certain moment in time the crystallization of what we call today *scientific spirit* in understanding the characteristics of nature (Culianu 1994, 19).

Those circumstances were, as Culianu seems to imply, not only special, but also, up to a certain point, could have happened later in the history of European cultural space than they actually did. Therefore, the process of acquiring those methods able to assure the rigorous selection of knowledge in natural modern sciences can be considered as deeply linked to some subtle mutations involving the way in which human imaginative function has been used within scientific descriptive effort regarding the surrounding world.

Descriptive imaginary can be seen as a special and distinct kind of imaginary in this regard, with particular features, among which we could mention the specific pragmatic criteria for selecting its products with explicit descriptive purpose. The two major components of descriptive imaginary deserve also some attention, one of them being placed in the context of discovery, while the other one can be placed in the context of justification of the new scientific theories.

The first component, which regards the private part of descriptive representations, is closer linked to mental imagery at the level of individual inquiry, while the second component, which regards the public part of descriptive representations, is closer linked to the negotiation process of descriptive representations' morphology among the members of the scientific community. The first component is rather intuitive, sometimes subconscious in its manifestations and rich in a visual way that is quite independent from direct verbalization or from the transposition of images into natural or formal language, while the second component is rational, inter-subjective and dependent on linguistic transpositions that make it more verifiable by different members of the scientific community.

But the problem of mental imagery in itself is quite a controversial one, due to various reasons, among which two seem to be more important. First, not everybody becomes aware of the fact that mental imagery is an actual part of one's mental processes of thinking, in spite of numerous claims in this sense made by various personalities like Faraday, Maxwell, Einstein and others, which used quite often in their scientific work not only genuine mental images, but also adopted several times a strategy that is called *mental experiment* or *Gedankenexperiment.* This way, they succeeded in discovering many of the conceptual weak points of their theories before any real experiments were proceeded in order to test their predictions. In fact, mental imagery seems to be strongly linked to creativity in science or art, but the capacity of visualizing various solutions to different problems seems to be a privilege for only a fraction of individuals. In mathematics, for example, the ability of geometrizing various problems used to be more important until the Bourbaky group increased the level of abstraction for mathematical discourse. The problem with mental imagery seems to be the genuine individual character of it, which cannot be entirely verbalized (David 2004, 63).

For example, the Russian physicist A. Migdal considered significant the visual hallucinations that accompanied Albert Einstein's efforts in developing Theory of Relativity (Migdal 1989, 84). As Einstein himself admitted, in order to be able to work with mental images, the physicist has to take them as being *real* (Einstein 1992, 62). This way, the mental realities become a heuristic tool essential within the development of a set of descriptive specific for a certain scientific theory. Of course, conscious and unconscious cognitive processes involving the use of mental images represent by themselves another important subject, still fueling heated debates (Montangero 2003, 157).

In this regard, classical science appears as more visual and individualistic, while the contemporary one seems to be more collective and abstract, dependent on formal languages and strategies, including the coexistence nowadays of digital images and informatics codes behind them, which involves a linguistic option (meaning in this context the adoption of a formalism) and a strategy of representing the visual aspects of mental imagery as a perceptual reality within a formal linguistic code which transposes it. Classical science was tributary to mental imagery, rich in private unconscious components of descriptive imaginary, while the more recent science was tributary to the conscious exchange of information with analytical content, more abstract, which involves the adoption of a common language.

Mental imagery is one aspect of human consciousness that can be linked to the dynamics of scientific representations, given that mental imagery involves the capacity of individuals "to see" within their own mind, "to visualize", but also "to hear" internally (Nagel 2005). The considerable variety of representations types involved in Physics and the high degree of abstractization characteristics for some of them prevents us from generalizing the link towards mental imagery for all of them. But at least an important part of descriptive representations is tributary to mental imagery, especially those with an obvious visual component. Others seem to be more dependent on formalization. For example, what we call today an electromagnetic wave can be hardly reduced to a visual representation. Richard Feynman himself admits it is almost impossible to attribute six distinct evolutive parameters to any point in space (Feynman 1966, 62).

In spite of this, important personalities in Physics, from Newton, Faraday, Maxwell to Einstein admitted the importance of mental imagery for geometrical modeling of physical phenomena. Even today, when sophisticated formalism and computers are largely used, the intuitive understanding of physical processes plays an essential part in the educational process (Fischbein 1958, 24).

But mental imagery is a private process in that of being a genuine personal and subjective experience, of which in fact only a fraction of individuals become aware (Montangero 2003, 157). So the real question in this regard, beyond the inherent difficulties in studying it, is whether or not the scientific representations used by scientific communities can benefit of mental imagery in what concerns their morphological evolution. That is why we are going to present the descriptive imaginary as involving the connection of two different levels of representation processing: a personal level and an interpersonal level. We are going to call the first one the private level of elaborating descriptive representations and the second one the public level of elaborating descriptive representations, since it involves a negotiation effort within the scientific community whose purpose is that of shaping a coherent descriptive discourse about the capacities of nature.

As to mental imagery as a psychological phenomenon, the long tradition of reluctances in Western culture towards the positive role of imagination in science also influenced, collaterally, this subject. A good proof in this regard is the wide variety of interpretations associated to the experiments concerning the mental turning of a three-dimensional object.

One of the most interesting theories is developed on the assumption that mental images which can be consciously manipulated in a well

determined time interval really exist. Another theory is dealing with experimental data assuming that the human brain operates as a data base, associating a specific list of attributes to each object on the mental space, which has a physical correspondent in the real world. Such a list could be numerically manipulated, without having in mind a specific visual component of it (Kosslyn 1995, 379). Anyway, we could mention also the fact that later on mental imagery was distinguished from perception and the link between it and human imagination became clearer. Nonetheless, it is also interesting how difficult became these days to integrate mental imagery and mental representations into the dynamic theory of mind, which tends to underline the continuous change of associations in human brain (Ungureanu 2012, 489-502).

Some authors considered that mental imagery should be linked mostly to reproductive imagination and neglected the possibility for it to obtain new information in comparison to those introduced already by the person that imagines an object, but later on its relation to productive imagination became clearer. In this regard, we can consider it as being an excellent support for descriptive reasoning, for example in the case of mental experiments involved in Relativistic Physics or Quantum Physics.

3. Instead of conclusions

Quite often, the set of descriptive images became indispensable for many physicists who were trying to develop a coherent theory about the true causes and the real configuration of the causes that give rise to a certain class of phenomena in the world. But not many discussed about the relation of an individual with a group of scientists in what regards the adoption of the various criteria for the selection of images used to describe the world. What seems for us quite intriguing is the relation between the private part of descriptive representation and the public part, which is more tributary to linguistic effort for transposing the description into a more verifiable form, conscious and rigorous, being in fact the result of a negotiation process regarding the morphology of descriptive representation, which has to be validated at the level of the scientific community on the basis of communitarian accepted criteria. In this context one can notice the particular succession between mental representation and abstract conceptualization in the cases of different remarkable scientists. For some of them, the abstract concept preceded the representation, while for many others things happened the other way around. In any case, starting from Archimedes, Galileo, Newton, Faraday,

Maxwell up to Einstein, Bohr or Heisenberg this relation between abstract thinking and descriptive representation on the physical world involved mental imagery at different levels.

Finally, we can remark the two limits for scientific imaginary in natural sciences: mental imagery and the private part of scientific representations on one hand, the scientific discourse, in which the public part of scientific representations is usually present, on the other hand. The last limit or the last level of manifestation for descriptive imaginary is highly influenced by three specific criteria we already talked about in some of our previous works: the correspondence criterion, the concatenation criterion and the simplicity criterion.

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