Organisms
Journal of Biological Sciences

Vol. 1, 1 (JUNE 2017)
ISSN: 2532-5876
DOI: 10.13133/2532-5876_1.7


ORIGINAL ARTICLE

# Metaphysics: the proverbial elephant in the room

*Nicole Perret,*[a b] *Carlos Sonnenschein,*[a b c] *Ana M. Soto* [a c]

[a] *Centre Cavaillès, République des Savoirs, CNRS,*
*Collège de France et Ecole Normale Supérieure, Paris, France*
[b] *Institut d'Études Avancées de Nantes*
[c] *Department of Integrative Physiology and Pathobiology,*
*Tufts University School of Medicine, Boston, MA USA*

**Corresponding author:** Ana M. Soto **ana.soto@tufts.edu**

**Abstract**

The increasing number of reports on the irreproducibility of epidemiological and experimental data has motivated explanations addressing its sociological and ethical implications. Regrettably, philosophical and theoretical issues such as the construction of objectivity or the role of theory have not been addressed in those reports. These issues are central to the practice of scientific research. The uncritical acceptance of ideas borrowed from mathematical theories of information and associated ideologies force interpretations of experimental results attributing a privileged causal role to molecules and to genes. In order to avoid these shortcomings, biologists should make explicit their metaphysical assumptions and the theoretical principles that guide their research.

**Keywords:** mathematical theories of information; causes in biology; metaphysics

**Citation:** Perret, N, Sonnenschein, C. & Soto, AM, 2011, "Metaphysics: the proverbial elephant in the room", *Organisms. Journal of Biological Sciences*, vol. 1, no. 1, pp. 17 - 21. DOI: 10.13133/2532-5876_1.7.

## 1. Introduction

Oftentimes biologists pronounce disparaging statements about the role of theory and philosophy on their practice, such as, "Yours is just a theory", or "Yours is just a philosophical question", or "Just give me the facts." Even when the role of theory is acknowledged, its relationship with philosophy is often neglected. We posit that this attitude is detrimental to the progress of knowledge and that the role of philosophy, and more specifically, metaphysics needs to be aired among biologists, rather than keeping it in the realm of philosophy. By metaphysics we mean ideas about the fundamental nature of being and the world that encompasses it to which a scientist implicitly adheres. For instance, in the Laplacean frame of thought, metaphysics is the idea that nature is intrinsically deterministic and predictable, because it is regulated by a strong and essential relation of linear causes and effects. As we will show later, this metaphysics is partially inherited by the framework of molecular biology, among other metaphysical assumptions. Nevertheless, these assumptions are often hidden or implicit.

Therefore, explanations offered for the irreproducibility of experimental data are relegated to sociological aspects for instance, the perpetrators seek prestige, money and/or career advancements. Alternative explanations, such as the adequacy of the theoretical and philosophical frames of the research programs that are prone to this irreproducibility problem are not being discussed. In this context, explanations offered for the irreproducibility of experimental data are relegated to sociological aspects (supposedly, the perpetrators seek prestige, money and/or career advancements). Alternative explanations, such as the adequacy of the theoretical and philosophical frames of the research programs that are prone to this irreproducibility have not been discussed. (Davies 2009)

The practice of science relies on explicit or implicit theoretical assumptions. Theories provide a framework for experimentation, determine which are the relevant observables and guide the establishment of objectivity. The configuration of scientific objects depends on the conceptual instruments used to understand them. More precisely, establishing objectivity means extracting stable regularities and structures that are invariant with respect to a class of transformations. Accordingly, an observable cannot be derived from a simple observation but depends on the class of conceptual instruments that allows for its detection. For example, if one adopts the notion of quiescence as the default state of metazoan cells, cells would be perceived as passive objects that require stimulation in order to proliferate or move; that is, they would require growth factors to proliferate and motility factors to move. If on the contrary, one adopts proliferation and motility as the default state, cells would become agents that constitutively proliferate and move. In order to regulate proliferation and motility, the participation of inhibitory factors and/or physical constraints would be required (Soto et al. 2016). Given that the interpretation of facts varies with changing theories, theories are not neutral; that is, they depend on the specific world views which generate them. If these assumptions are acknowledged up front, theories and results would be better understood. That is one of the reasons why philosophy of science is useful to the practice of science.

However self-evident these concepts may seem to philosophers and historians of science, they are seldom discussed among experimental biologists. This is a common attitude, particularly among those researchers who consider facts to be theory-free, or theory to be philosophy-free. As the philosopher Daniel Dennett said "There is no such thing as philosophy-free science; there is only science whose philosophical baggage is taken on board without examination" (Dennett 1995). Facts are inseparable from assumptions stemming from the dominant metaphysics. Indeed, metaphysics becomes implicit and is then perceived as common sense. Thus, it becomes difficult to identify the metaphysical components in the everyday scientific practice. For example, in the middle of the 19th century, a significant effort was made to understand optical, magnetic, electrical and thermal phenomena within the framework of Newtonian laws. This effort went so far as to introduce hidden mechanical entities (like corpuscles or aether) to make phenomena fit into the classical mechanical laws. According to the French philosopher Gaston Bachelard, this effort was evidence of physicists' strong attachment to an intuitive notion of solids in the early historical and psychological formation of physics (Bachelard 2002).

## Theory, facts and observation

The relationship between theories and empirical facts can be conceived in different ways. The simplest way is to think that facts exist on their own, and that the role of theories is to describe them in an accurate way. This interpretation seems to fit within the simple and common idea that the world is in front of the subject ready and available to be discovered. This is not a neutral statement. On the contrary, once adopted, a theory determines which are the observables and at what level they ought to be described. For example, a rigid genetic theory is based on the hypotheses of the completeness of the genetic description. The genetic theory of development states that genes are not only involved in embryogenesis, but that they also regulate it in a specific way (Davies 2009). Necessarily, this premise ascribes a primary and causal role to the genetic level. Any successive stage of development of embryos is interpreted as produced by the expression of specific genes. For decades, this rigid commitment has prevented scientists from seeing and conceptualizing non-genetic events happening during embryogenesis. For example, research has shown that some mechanical movements initiate endoderm differentiation during the development of the embryo (Farge 2011). This means that morphogenetic movements affect and regulate gene expression. Now, these outcomes are frequently explained by the idea that gene expression is *mechanosensitive.* Instead of discussing the primary role of movements and the mechanical forces they create in the causation process, causal priority is again allocated to the gene level. This misperception results from assigning the primary level of observable facts to genes.

The differential method is a good example of the way facts are produced by the method. From the point of view of genetic determinism, a developmental gene is specific if its activation is directly related to one or several functions necessary for the next stage of embryogenesis. The differential method consists of producing a change in the genotype in order to observe a change in the phenotype. To achieve this, the phenotype of the unaltered "wild type" animal is compared to the one of the "mutant" animal. From this perspective, it is claimed that certain genes are specific to certain embryogenic functions if the latter are altered after a mutation is produced in a DNA segment. It is possible to stand back and look at the epistemic process by which the object of the developmental gene is constructed. In this way, it becomes clear that the differential method is associated with a certain view of the nature of objects. In this case, the specificity of the phenotype has been attributed to the genotype. This is only possible if a strong causal priority is previously accorded to the genetic level. The differential method does not prove this causal priority, it merely presumes/assumes it. Without this strong prior commitment, the method is logically wrong. By observing a change in B after a change in A does not allow us to deduce that normal A causes normal B (Longo and Tendero 2007). Gene knockout experiments are, in this regard, a case in point, whereby it would be unwarranted to conclude that a set of molecules has a regulatory role without a previous choice of priority of the molecular level (Davies 2009). In other words, what the differential method and results from knockout experiments allow us to conclude is that there is merely a strong correlation between these two levels of organization. It can also be claimed that some specific set of molecules is necessary for some processes to occur (Davies 2009). Nevertheless, the linear and bottom-up causal relationship from genotype to phenotype established by the genetic approach to embryogenesis does not derive from these experiments. On the contrary, it is the theoretical supposition that guides these experimental practices. In order to point out the inconsistency of the differential method applied to genotype and phenotype, we will quote an amusing example extracted from Denis Noble's book entitled "The Music of Life" (Noble 2006):

> Before writing this page, I relaxed by listening for the first time for a long time to one of my favourite pieces of music: The piano trio in E-flat major by Schubert. I put the CD into my player and lay down on the sofa.As the music entered the slow movement, I cried.
>
> The emotional effect of this piece of music, which I first heard live in a concert, is always very strong… The effect does not always depend on the music itself. It can also depend on the context, the people we were with, and the significance of the event in our lives. So, what caused me to cry?
>
> Imagine some space travellers watching this scene… They have some of the characteristics associated in Science Fiction with 'androids.' They notice the crying. They record the sound waves in the room. As scientists, they trace the sequence of cause and effect, back through the loudspeakers, the amplifiers, the laser disc reader, right down to the CD itself.
>
> One of them …explains to his colleagues that the whole effect is caused by some highly specific digital information on the CD. Another … is nevertheless sceptical. "How, he says, could just a bunch of numbers have this effect?"
>
> The discoverer counters the scepticism by pointing out that this is the lowest level of the chain of cause and effect. Without the digital information, there would be no music, no emotion. Moreover, if you play around with that information, 'mutate' it as it were, by playing it too fast or too slow, or playing it backwards, transposing sections, or even transposing bits from another CD, then the person in the room no longer cries. In fact he may angrily turn the machine off and even throw the disc away.
>
> There is an inevitable and mechanical chain of cause and effect here. … Different amplifiers, speakers and other gadgetry can replace everything except the highly specific digital information on the CD. Surely, then, they conclude that this is the cause of me crying.
>
> Of course, we know better. We would say that the causes of my crying include:
>
> Schubert because he wrote the music;
>
> the piano trio because they played it with such heart-tugging inspiration;
>
> and the beautiful context in which I first heard the music and first cried as a result of it. This, we would say, is in my memory and forms the emotional context
>
> We would say that the digital information on the CD is just a way of capturing the moment, as accurately as possible, and making it possible for me to recreate, partially at least, the original moment. We know also that the information could be coded in many different ways, including analogue encoding in the form of a vinyl disc. It is just a database that enables the music to be stored and recreated.
>
> In short, we would have no difficulty at all in laughing at the stupidity of our Silman visitors from another planet. They saw a simple explanation, we would say, and grabbed at it. How stupid! Well, we should be careful whom we laugh at. For we too get trapped in simplistic explanations.

A historical perspective provides multiple examples whereby alleged empirical facts disappear by changing theoretical assumptions. The philosopher Larry Laudan indexed a remarkable list of historical examples of slipping between data and facts on one side, and theoretical assumptions on the other (Laudan 1977). For example spontaneous generation was considered as an empirical problem by early nineteenth century biologists. It was considered as a *fact to explain* how meat left in the sun could transmute into maggots. This example reveals the instability of empirical facts when confronted with alternative theoretical assumptions. It is wrong to recognize facts as external from theory because theory provides a conceptual framework for experimental programs while establishing and determining the observables. In physics, for example, it is necessary to make explicit the scale at which a phenomenon is observed and thus the theoretical framework to study it (for large scale relativity, for intermediate scale classical mechanics, for microscopic scale quantum mechanics). We posit that, in biology, it should also be required that the researcher explicitly announces at what level a given phenomenon is happening.

## The illusion of theory - and philosophy-free facts

Facts are inseparable from the assumptions stemming from the dominant metaphysics. At a certain point in the history of science, a number of theories on explicit metaphysical assumptions are proposed. Then, one particular theory becomes hegemonic and its metaphysical assumptions are assimilated in a way that becomes reality in the mind of practitioners while their theoretical nature is forgotten. At that point, research emanating from this hegemonic theory struggles to put "all the facts" within the same frame. It is through this permutation that empirical facts are believed to be theory-free. This uncontested frame of reference constitutes an epistemological obstacle. As stated by Gaston Bachelard, "There comes a time when the mind's preference is for what confirms its knowledge rather than what contradicts it, for answers rather than questions. The conservative instinct then dominates and intellectual growth stops" (Bachelard 2002).

A classic example of this circumstance is the case of epicycles in astronomy. Epicycles were geometrical models that allowed for the explanation of the apparent motion of the sun, the moon and the planets within the frame of the Ptolemaic system of astronomy. The theoretical geocentric model derived from a strong metaphysical assumption of anthropocentrism and became hegemonic, to the extent that it became a perceived reality to which every fact had to be referred.

Recent biology offers another example of this dynamic. The dominant frame of genetics and molecular biology has been imposed onto a massive amount of facts. For decades, every biological fact had to fit within this framework which is not neutral. Indeed, the notions of program and genetic code largely influenced the beginning of molecular biology (Moss 2003;Fox-Keller 2000; Pichot 1999). Moreover, the informational theory framework came from the explicit metaphysical assumption of determinism made by Schrödinger who associated the idea of a code to Laplace's eye. "In calling the structure of the chromosome fibers a code-script we mean that the all-penetrating mind, once conceived by Laplace, to which every causal connection lay immediately open, could tell from their structure whether the egg would develop, under suitable conditions, into a black cock or into a speckled hen, into a fly or a maize plant, a rhododendron, a beetle, a mouse or a woman" (Schrödinger 1945).

All this ensemble of metaphysical elements became a world-view of genetic reductionism, which implies the idea that the genetic level determines all the rest. In this way, the living became the sum of its molecular components, and it would have always been possible to interpret it by an analysis of those discrete components. While the practice of decomposition of complexity is reasonable as a methodological reductionism, a reconstruction of meaning starting from this discrete decomposition is no longer methodological; this form of reconstruction becomes metaphysical reductionism. The main problem with this world-view was that it became hegemonic and as a consequence was accepted as common sense.

Equally disturbing is the notion of "gene" because it is not univocal (Fox-Keller 2000;Moss 2003). For example, Lenny Moss pointed out that there are, at least, two different senses of the notion of gene which are usually conflated in scientific narratives: there is the gene of epigenesis and the gene of preformationism. The former means a developmental resource that codes for proteins, while the latter relies on the prediction of a phenotype. Nevertheless, the notion of gene, in both of these senses, comes from a metaphysical reductionism which is the simple but strong idea that living beings can be reduced to their elementary and discrete parts. The gene as a functional unit of recombination was not implied in Gregor Mendel' s writings but appeared after 1900 when Hugo de Vries, Erich von Taschermark, and Carl Correns "rediscovered" Mendel (Pichot 1999). Indeed, Mendel expressed an interest in phenotypic traits that are simplified in order to consider their statistical behavior. However, when Mendel's laws were rediscovered, there was already a theoretical shift towards a convergence of phenotypic changes with discrete and specific units located deep inside the matter of life. In sum, a dispassionate analysis of the gene concept reveals that it is not more "factual" than the "corpuscle" concept mentioned above when discussing 19th century physics and the introduction of hidden mechanical entities in order to make phenomena fit into Newtonian laws.

## Conclusion: The importance of philosophy

Philosophy provides the tools that make metaphysical assumptions explicit, especially when they are disguised as common sense. A scientist in her laboratory can risk forgetting "the philosophical baggage" of the hegemonic theories that she is using. However, this baggage is the theoretical determinant of the facts she is trying to describe. The role of philosophy of science is precisely to make explicit, question and systematically challenge metaphysical assumptions. This philosophical reflection prevents hegemonic metaphysics from becoming common sense and uncritically dominating scientific practice. As the philosopher Alfred North Whitehead said, "We are apt to fall into the error of thinking that the facts are simple because simplicity is the goal of our quest. The guiding motto in the life of every natural philosopher should be, Seek simplicity and distrust it" (Whitehead 1957). While adopting a comparable philosophical inclination, we would like to suggest "seek common sense and distrust it".

## Acknowledgements

This work was conducted as part of the research project "Addressing biological organization in the post-genomic era" which was supported by the International Blaise Pascal Chairs, Region Ile de France. AMS was the 2013-15 Blaise Pascal Chair of Biology at the École Normale Supérieure. Additional support was provided by grants from the Avon Foundation, and the National Institute of Environmental Health Sciences of the NIH (ES08314 and U01-ES020888). The content does not necessarily represent the official views of the funding agencies including the National Institute of Environmental Health Sciences or the National Institutes of Health. The authors are grateful to Cheryl Schaeberle her critical input. The authors have no competing financial interests to declare.

## References

Bachelard, G, 2002, *The Formation of the Scientific Mind*, Clinamen Press Ltd, Manchester UK.

Davies J, 2009, Regulation, necessity, and the misinterpretation of knockouts, *BioEssays* vol. 31, pag. 826-830.

Dennett, DC, 1995, *Darwin's Dangerous Idea*, Simon & Schuster, New York, NY.

Farge, E, 2011, Mechanotransduction in development, *Curr. Top. Dev. Biol*., vol. 95, pag. 243-265.

Fox-Keller, E, 2000, *The Century of the Gene*, Harvard University Press, Cambridge.

Laudan, L, 1977, *Progress and its problems: toward a theory of scientific growth*. University of California Press, Berkeley.

Longo G, Tendero P-E, 2007 *The differential method and the causal incompleteness of programming theory in molecular biology*, Foundations of Science vol. 12, pag. 337-366.

Moss, L, 2003, *What Genes Can't Do*, MIT Press, Cambridge, MA.

Noble, D, 2006, *The Music of Life: Biology beyond the Genome*, Oxford University Press, Oxford.

Pichot, A, 1999, *Histoire de la notion de gene*, Flammarion, Paris.

Schrödinger, E, 1945, *What is Life? The physical aspect of the living cell*, The University Press, Cambridge [Eng].

Soto AM, Longo G, Montévil M, Sonnenschein C, 2016, The biological default state of cell proliferation with variation and motility, a fundamental principle for a theory of organisms, *Prog. Biophys. Mol. Biol.* vol. 122, pag. 16-23.

Whitehead, A, 1957, *The Concept of Nature*, University of Michigan Press, Ann Arbor.