Metascientific Epistemology

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Science and Epistemology[2]

In French, the terms "epistemology" and "philosophy of science" are sometimes used interchangeably. However, most authors recognize that epistemology has a narrower scope than the philosophy of science. The latter is interested not only in epistemological questions, but also in a wide range of other philosophical questions related to science. These may include uncovering the true nature of reality through an adequate interpretation of scientific knowledge, accounting for the relationship between science and society, understanding the ethics of science, and studying the history of science.

Epistemology, on the other hand, would not be the study of science in all its aspects, but would be limited to the study of scientific knowledge. Dominique Lecourt summarizes the situation well in the following passage:

> While the term "epistemology" is often used loosely, it can be considered more modest than "philosophy of science." Epistemology focuses on the rigorous analysis of scientific discourse, examining the modes of reasoning employed and describing the formal structure of scientific theories. Epistemologists, concentrating on the process of knowledge acquisition, often exclude reflection on its meaning. They sometimes present their discipline as a scientific one that has broken away from philosophy. (Lecourt 2010)

In this strict sense, epistemology takes scientific discourse or scientific knowledge as its object of study and sometimes conceives of

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[2] This text was originally written for a French audience.

itself as a discipline independent of philosophy. This characterization of epistemology is therefore similar to our conception of metascience (Maurice 2020, 2022a, 2022b). Have we therefore chosen an expression to designate the same activity as that practiced within epistemology in the strict sense? This is not the case if we recognize that scientific knowledge is a construction of the mind, but that this particular construction takes several forms. Scientific constructs are for example concepts, statements, classifications, theories and scientific models. These types of constructs can themselves be divided into subtypes depending on whether one studies a construct from a semantic, ontological or epistemological angle. It is because scientific constructs have several conceptual properties that they are at the same time an object of study for metascientific semantics, ontology and epistemology[3].

While epistemology can be interested in various types of constructs, it pays particular attention to those that Mario Bunge calls epistemic operations, distinct from cognitive processes. Examples of epistemic operations include definition, reduction, description, subsumption, explanation, demonstration, prediction, questioning, problematization, observation, experimentation, classification, theorization, problem-solving, analysis, synthesis, planning, etc., operations that deal with concepts, propositions, theories, etc. These operations contribute to epistemic transformations, that is, to the acquisition, creation, and transformation of scientific knowledge.

Epistemic operations are constructs or abstractions or, in Bunge's terms, fictions. As constructs, epistemic operations possess no properties of a concrete object, notably that of energy. They cannot therefore be studied by factual sciences. The latter, notably cognitive neuroscience, studies the cognitive processes that enable us not only to create or abstract an epistemic operation, but also to transmit it to others, receive it from others, reactivate it with a view to studying or using it, and so on. Cognitive processes are facts of the world that occur in brains, while epistemic operations are constructs produced by these same brains. This is the position we defend in our article "What is Metascientific Epistemology?"

[3] The nature of metascientific ontology was addressed in our article "What is Metascientific Ontology?" published in the second issue of *Metascience*. Metascientific semantics will be treated in the fourth issue.

Metascience would be very poor without metascientific practice. We are fortunate to be able to draw on the work of Mario Bunge, the first accomplished metascientist, but a living discipline is one that discovers and invents. This same work has shown us that metascience is a varied activity that can be practiced in many different ways. Let's follow our common thread, Bungean or metascientific epistemology, and take a brief look at the few articles in this third issue of *Mεtascience* devoted in whole or in part to metascientific epistemology.

The links between epistemology, science education and science teaching are numerous. In an article with the explicit title, "Making Sense of Models and Modelling in Science Education: Atomic Models and Contributions from Mario Bunge's Epistemology", Juliana Machado explores some of these links. She takes as her starting point the fact that students encounter an obstacle in their learning of scientific models. The model is seen as a mere copy of reality. A better understanding by students of the notion of model and of modeling, an epistemic operation par excellence, could therefore prove useful in learning scientific models. The notion of model she explores is that of Mario Bunge. She puts this notion of model to the test by examining several models of the atom proposed at the beginning of the 20th century. She concludes that the notion of the Bungean model provides a good account of the development of models of the atom, or, more precisely, that the properties Bunge attributes to scientific models can be found in models of the atom and in the way the atom is modeled. Students could thus benefit from a coherent and relevant notion of models when learning about a scientific model.

In recent years, researchers have revealed the existence of a group of philosophers who contribute to the solution of scientific problems. These philosophers use classical tools, methods or epistemic operations from philosophy, such as conceptual clarification, critical evaluation of scientific hypotheses, analysis of the coherence of arguments, the formation of new concepts, theories or research programs, and the search for links between different disciplines. The researchers in question do not deny that these epistemic operations are also used by scientists, but maintain that this practice, which they call philosophy *in* science, is nevertheless a philosophical one, more precisely, a pragmatic one. François Maurice challenges this assertion in his article "What's Left of Philosophy?"

This way of defending philosophy, by severely restricting its nature to be of any use to science is a widespread strategy. It suffices to limit epistemic operations to those shared by science and to pragmatically redefined philosophy. In his article "On Philosophical Heuristics", Andrés Pereyra Rabanal adopts such a conception of philosophy as "a type of conceptual research subjected to the usual standards of rationality and capable of raising questions considering the best available knowledge with the help of formal tools such as mathematics and logic". This strategy makes it possible to conceive of philosophy on an epistemic continuum that also includes common knowledge and scientific knowledge. There is no difference in nature, only in kind, between the various types of knowledge.

Language is the subject of bitter debate about what it is and how to study it. The epistemic status of linguistics is also under debate. Can linguistics be an empirical science on a par with the natural sciences? Dorota Zielińska answers in the affirmative in her article "In Defence of Linguistics as an Empirical Science in Light of Mario Bunge's Defence of the Scientific Treatment of Biology". She argues that a right conception of science, such as Mario Bunge's, makes it possible to conceive of linguistics as an empirical science on a par with biology. To achieve this, she debunks a number of myths about the nature of linguistics.

These articles all have an epistemological component, but we mustn't lose sight of the fact that metascientific disciplines, like scientific disciplines, don't operate in a vacuum, that metascientific epistemology, ontology and semantics study the same conceptual object—scientific knowledge—and not the concrete world, which is the preserve of science, nor a metaphysical world, which is the preserve of philosophy.

Contributions

The ten contributions to this issue come from authors of different backgrounds, as befits a general thought that aims to be useful to all fields of knowledge. It should be noted, however, that the contributors to this issue of *Mεtascience* do not necessarily support the research program of Society for the Progress of Metascience, nor the editorial policy of the journal. They are authors interested in various aspects of Bunge's thought. Although epistemology is a common thread linking some of the articles in this issue, we distinguish four

types of contribution: 1) Studies on Bunge's System; 2) Metascientific Contributions; 3) Applications of Bungean Thought; 4) Around Metascience.

1] Studies on Bunge's System

François Maurice in "What is Metascientific Epistemology?" pursues the characterization of metascience begun in his articles in the first and second issues of *Mεtascience*. Metascientific epistemology differs from philosophical epistemologies in its aims, objects and methods. Its general aim is to build conceptual knowledge about science through the study of scientific constructs. More precisely, metascientific epistemology studies the *epistemic operations* necessary for scientists to acquire factual knowledge. Consequently, it does not study *cognitive processes*, which are the domain of cognitive neuroscience. Notably, this epistemology does not propose a theory of knowledge, as is common in philosophy. Metascientific epistemology is therefore not a naturalized epistemology; it distinguishes the concrete objects studied by the sciences from the constructs used to represent these objects. Metascience and its constituent disciplines, such metascientific semantics, metascientific ontology and metascientific epistemology, are concerned only with scientific constructs.

Martín Orensanz examines in "Difference Between the Existential Quantifier and the Existence Predicate According to Mario Bunge" the contradictions and paradoxes that arise when philosophers grant an ontological scope to logic, more specifically to the "existential quantifier" ∃. Orensanz reviews the solutions proposed by Frege, Russell and Quine as part of this ontological interpretation of logic. The contradictions or paradoxes that arise from this interpretation of the "existential quantifier" are avoided if ∃ is read "for some…" and not "there exists…" and if the quantifier is named "particular quantifier" following Mario Bunge. In this way, the quantifier remains a logical concept. To account for the property of existence, it is then sufficient to introduce two existence predicates to account for real existence, E_R, and conceptual existence, E_C, so that contradictions and paradoxes vanish.

2] Metascientific Contributions

Martín Orensanz and François Maurice, in "Advancing the Metascientific Program. First Dialogue", propose an initial dialogue on the possibility of a metascientific research program. This dialogue is an opportunity for two Bungeans of different orientations to exchange views on

several notions and problems found in Mario Bunge's work: is it possible to prove that the external world exists? What is matter? Is the part-whole relation transitive? What's the difference between systems and assortments? Do fictitious objects have a function in ontology? While Maurice defends his metascientific interpretation of Bunge's thought, notably by refusing to use philosophy to examine the problems addressed, Orensanz does not hesitate to call on analytic metaphysics to solve a number of these problems.

3] Applications of Bungean Thought

Juliana Machado, in "Making Sense of Models and Modelling in Science Education: Atomic Models and Contributions from Mario Bunge's Epistemology", addresses the problem of teaching scientific models, as these are often perceived as mere copies of reality. Machado draws on Mario Bunge's epistemology and model theory to solve this problem. Bunge distinguishes several types of models, each with its own characteristics and its relationship to reality, to general theories and to other types of models. Bunge also emphasizes the role of abstraction and idealization in modeling reality. Machado uses the history of atomic models to illustrate the application of Bunge's epistemology and model theory, demonstrating that scientific models are abstract, idealized constructs that evolve over time to better explain and predict phenomena. In this way, the joint use of Bunge's model theory and the history of science makes it possible to achieve pedagogical objectives in science education. Machado also argues that Bunge's model theory can be used directly for modeling activities in the classroom, without the need for historical examples.

In "System: A Core Conceptual Modeling Construct for Capturing Complexity", Roman Lukyanenko, Veda C. Storey and Oscar Pastor continue their research into the development of an ontology suited to information technology and conceptual modeling. In a previous article, "Foundations of Information Technology Based on Bunge's Systemist Philosophy of Reality", which appeared in the second issue of *Metascience*, they introduced us to Bunge's Systemist Ontology (BSO), inspired by Bunge-Wand-Weber (BWW) ontology, widely used for nearly four decades for conceptual systems modeling. Whereas BWW is based on the notion of thing or concrete object, BSO puts forward the notion of system. BSO uses Bunge's CESM schema to analyze any system in terms of *components*, *environments*, *structures* and *mechanisms*. For the authors, the CESM schema is too restrictive. They therefore propose

a CESM+ schema, which they see as a checklist "to help designers describe and model the essential aspects of a system". Thus, at the start of a project, in addition to considering a system's components, environments, structures and mechanisms, the CESM+ schema reminds the designer to consider other essential aspects of a system, including emergent properties and the history of the system. The authors examine a practical case of conceptual modeling using the CESM+ schema.

Dorota Zielińska, in "In Defence of Linguistics as an Empirical Science in Light of Mario Bunge's Defence of the Scientific Treatment of Biology", defends a conception of linguistics that makes it an empirical science on a par with the natural sciences insofar as one adopts an adequate conception of science along the lines of that proposed by Mario Bunge. The author had offered a defense of this conception of linguistics in a first article, "Linguistic Research in the Empirical Paradigm as Outlined by Mario Bunge", which appeared in the second issue of *Mɛtascience*. In the latter article, Zielińska, after outlining Bunge's scientific methodology and asserting the self-regulating and self-organizing nature of language, presented a linguistic law she established as part of this approach. In the present article, the defense of the empirical nature of linguistics begins with a brief overview of the history of laws in linguistics in order to show that the failure of linguists to establish *deterministic laws* led them to deny the possibility of conducting empirical research in linguistics that would be akin to research in the natural sciences. Zielińska argues, on the contrary, that linguistics is an empirical science whose *probabilistic laws* can be subjected to testing. The author then tackles eight myths about the nature of linguistics, appealing both to Bunge's conception of science and to examples of empirical laws in linguistics, including his own quantitative law on the order of adjectives in a sentence.

4] Around Metascience

Andrés Pereyra Rabanal, in "On Philosophical Heuristics", argues that science and philosophy form a continuum of concepts, from the most general to the most specific. There is therefore a difference in degree, not kind, between philosophical and scientific statements. From a heuristic point of view, philosophy is seen as a second-order reflection whose specific presuppositions in the science it studies must be evaluated in terms of their informativeness, appropriateness, relevance, generality and originality. In the same way,

philosophical theories must be subjected to Bungean evaluation criteria according to the way in which they contribute to knowledge, and help us to learn, ask and resolve new questions.

Martín Orensanz in "Object-Oriented Ontology and Materialism" challenges the idea that matter does not exist according to Graham Harman's object-oriented ontology (OOO). Orensanz argues that matter can be conceptualized both as a sensual object and as a real object within the framework of object-oriented ontology. He also argues that matter is not a fiction, against Mario Bunge and Gustavo Romero, and that the term "matter" can be understood as grammatically singular but referentially plural, i.e., as a disguised plural, borrowing the latter notions from Daniel Z. Korman. Orensanz conceives matter as a plurality of real things, each of which possesses energy.

Graham Harman responds to Martín Orensanz's criticisms and suggestions in his article "Matter and Society. Response to Orensanz". Harman immediately accepts that matter can be conceived as a sensual object within the framework of his object-oriented ontology, because in OOO's sensual domain everything is permissible, since sensual objects must be in relation to other objects in order to exist, which is not the case with real objects, which exist independently of any other entity that may encounter them. However, he denies that matter is a real object if by matter we mean the prime matter of the philosophers. But since sensual objects have real qualities in the context of OOO, he concedes to Orensanz that matter also has real qualities as a sensual object, although the concept of "matter" is a fiction, but a fiction conceived differently from Bunge and Romero. Harman rejects Orensanz's proposal to consider the term "matter" as a disguised plural whose referent would be a plurality of things, i.e., in the case of matter, the plurality of all things.

In "What's Left of Philosophy?" François Maurice takes another look at the idea of philosophy *in* science. This philosophical discipline would provide solutions to scientific problems using philosophical tools. While in a first article "Philosophy in Science: Can Philosophers of Science Permeate through Science and Produce Scientific Knowledge?" Pradeu, Lemoine, Khelfaoui and Gingras define philosophy *in* science and identify several philosophers who practice it, in a second article, "Reuniting Philosophy and Science to Advance Cancer Research", Pradeu and thirty-six collaborators demonstrate

the usefulness of philosophy *in* science using cases drawn from cancer research. Maurice reiterates that thinkers of philosophy *in* science practice a metascience unrelated to philosophy.

References

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