What is Metascientific Epistemology?

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Abstract—Metascientific epistemology differs from any philosophical epistemologies in its aims, objects and methods. Through an examination of Mario Bunge's epistemology, we will show that the main objective of metascientific epistemology is the development of a unified representation of the epistemic transformations of scientific knowledge through the study of the epistemic operations necessary for its acquisition, creation and validation, that its objects of study are scientific constructs, and that its methods do not differ from those expected to be found in any rational activity. Metascientific epistemology is therefore not transcendent, since it takes for granted that the sciences study concrete objects with the help of natural faculties, and that it itself studies scientific constructs with the help of natural faculties, and therefore does not resort to special faculties or methods to carry out its research.

Résumé—L'épistémologie métascientifique se distingue des épistémologies philosophiques par ses objectifs, ses objets et ses méthodes. Par un examen de l'épistémologie de Mario Bunge, nous montrerons d'abord que le principal objectif de l'épistémologie métascientifique est l'élaboration d'une représentation unifiée des transformations épistémiques de la connaissance scientifique par l'étude des opérations épistémiques nécessaires à son acquisition, sa création et sa validation, puis, en second lieu, que ses objets d'étude sont des construits scientifiques, et finalement que ses méthodes ne diffèrent pas de celles qu'on s'attend à trouver dans toute activité rationnelle. L'épistémologie métascientifique n'est donc pas transcendante puisqu'elle tient pour acquis que les sciences étudient des objets concrets à l'aide de facultés naturelles, qu'elle-même étudie les construits scientifiques à l'aide de facultés naturelles, et que, par conséquent, elle n'a pas recours à des facultés ou à des méthodes spéciales pour mener à bien ses recherches.

We undertook a characterization of metascience in general terms in our article "Metascience: for a scientific general discourse" (Maurice 2020), which appeared in the first issue of *Mɛtascience*. We

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pursued this characterization in more precise terms through the study of Mario Bunge's metascientific ontology in our article "What Is Metascientific Ontology?" (Maurice 2022a), which appeared in the second issue of *Mætascience*. Just as we identified a metascientific ontology in Bunge's work, it is also possible to extract from it a metascientific epistemology distinct from any philosophical epistemology[2].

We will therefore examine Bunge's epistemology as set out in volumes 5 and 6 of the *Treatise on Basic Philosophy*. This exposition will make clear the non-philosophical nature of Bunge's theories if we take the trouble to focus on what he does and not on what he says–that is, if we examine the way he proceeds and the results he achieves, without allowing ourselves to be distracted by what Bunge believes to be his epistemology. Note that the type of exposition employed by Bunge in these two volumes of the *Treatise* differs from that of the first four volumes devoted to semantics and ontology. Bunge has abandoned the use of mathematical formalism and the organization of these concepts in a protoaxiomatic format, even though, as with any argumentative text, the two works are sufficiently coherent and the exposition is epistemically progressive, almost didactic, Bunge favoring an order to facilitate understanding rather than a logical order from the most elementary to the most elaborate concepts. We shall also see that the exposition differs on another level, since Bunge puts forward, alongside his own metascientific results, scientific and therefore factual results. We'll explain this latter situation by exposing Bunge's inconsistency between his conception of epistemology and his practice of epistemology.

In this article, we focus on the objects of study of this epistemology. This examination of the referents of this discipline will enable us to expose a tension in Bunge, a tension already present in his ontology (Maurice 2022a): at times he seems to maintain that there is a strong link between, on the one hand, epistemology and, on the other, psychology, biology and neuroscience, while at other times he defends the idea that epistemological research is autonomous.

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[2] We have taken up the structure of our article "What Is Metascientific Ontology?" which appeared in the second issue of *Mætascience* published by Éditions Matériologiques. We have also reproduced several passages from that article, making the necessary changes to facilitate the reading of the present article.

As with his ontology, Bunge oscillates between a conception of epistemology as a factual science, a naturalized epistemology, and a conception of epistemology as a conceptual science. As we shall see, in practice, Bunge develops an "autonomous" epistemology of the factual sciences. The objects of study of epistemology are the constructs of the factual sciences, i.e., epistemological constructs refer to scientific constructs and not to concrete objects.

This muddled conception of epistemology does not, fortunately, affect Bunge's epistemological practice, which is mostly clear: Bunge clearly distinguishes epistemological from psychological, biological and neuroscientific propositions when elaborating his positions.

In addition to the referents of epistemological theories, we'll look at the methods, techniques and tools Bunge uses to construct these theories. We'll see that Bunge doesn't use any approaches associated with philosophical doctrines. In short, we follow Bunge's advice: "When in doubt about the authenticity of an intellectual endeavor, the right thing to do is to perform a candorous [*sic*] reexamination of its three components: subject matter, method and goal" (Bunge 1973, p. 1).

To help us in our characterization of metascientific epistemology, in the next section we will refer to Bunge's definition of science (Bunge 2003, see entry "Science, Basic")[3].

[3] The definition of science is based on the more general notion of epistemic or cognitive field. Using this notion, Bunge deals with several other notions, such as paradigm, epistemic revolution, field of research, research project, etc. (Bunge 1982, sections 2 and 3, 1983a, pp. 90-93, 1983b, chaps. 13 and 14, 1984, 1985a, pp. 21-28, 1985b, pp. 242-252, 1989, pp. 296-300, 1996, chaps. 7, 2001, sections 8.3 and 8.4, Bunge & Ardila 1987, sect. 3.5). Bunge's attempt to demarcate science from pseudoscience based on the notion of epistemic field would seem ineffective because it is impossible to identify sufficient and necessary conditions to distinguish what is scientific from what is not (Mahner 2021). This is the problem of finding one or more demarcation criteria. For an elaborate treatment of the demarcation problem and the Bungean notion of epistemic field, see "*Demarcating Science From Nonscience*" (Mahner 2007). Like Mahner, we believe that the notion of epistemic field is important because it nevertheless clarifies our representation of science, which in principle makes it easier to identify pseudoscience "so as not to surrender to relativism, arbitrariness, and irrationalism" (Mahner 2007, p. 571). This characterization of science also makes it easier to identify objects of study for the metasciences, and to raise issues that would otherwise go unnoticed.

1] The Components of a Factual Science

A factual science is characterized in Bunge by ten criteria, to which we add an eleventh criterion, V. The set of these criteria can be represented by $\mathcal{R} = \langle C, S, V, D, G, F, B, P, K, A, M \rangle$, where each component is detailed as follows:

(1) C, the *research community* of $\mathcal{R}$, is a social system composed of persons who have received a specialized training, hold strong communication links among themselves, share their knowledge with anyone who wishes to learn, and initiate or continue a tradition of inquiry (not just of belief) aiming at finding true representations of facts;

(2) S is the *society* (complete with its culture, economy, and polity) that hosts C and encourages or at least tolerates the specific activities of the components of C;

(3) the *domain* or *universe of discourse* D of $\mathcal{R}$ is composed exclusively of (actual or possible) real entities (rather than, say, freely floating ideas) past, present, or future;

(4) The *values and norms* V adopted by the members of C, such as (a) rationality values (non-contradiction, non-circularity of arguments, etc.); (b) semantic values of precision, clarity and maximum truth; (c) methodological values of testability, explanatory power, predictability, reproducibility and fecundity; (d) moral values of universalism, objectivity, critical thinking, open-mindedness, sincerity, and recognition of the work of others (these moral values correspond roughly to Merton's notion of scientific ethos)[4, 5];

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[4] Our subcomponent V d) is in Bunge a subcomponent of *G*. Mahner (2007) adds three subcomponents to *G*, which we take up to make our subcomponents *V* a), b) and c). Thus, we separate the values from the general principles of *G* because, in Mahner's own words, "to stress the fact that science has an internal system of values and corresponding norms, it may be useful to treat them all together." (Mahner 2007, p. 532). The separation is important, as values and norms cannot be treated in the same way as *G*'s general principles or postulates. The latter are general hypotheses, whereas values and norms are not. General assumptions are abandoned if they are inconsistent with the results of science, while values and norms are abandoned if they do not lead to adequate results.

[5] Here's a clarification from Mahner that underlines the collective aspect of this value system:

> […] the system of logical, semantical, methodological, and attitudinal ideals constitutes the *institutional rationality* of science […], even though individual scientists may more or less often fail to behave rationally. (More

(5) The *general outlook*[6] G of $\mathcal{R}$ is made up of general principles or postulates, which are all metascientific hypotheses, such as (a) the ontological principle that the world is made up of concrete things subject to nomic change, things that exist independently of the researcher (rather than being unreal, imaginary or miraculous entities that undergo no change); (b) the epistemological principle that the world can be known objectively, at least in part and gradually; (c) the methodological principles of parsimony, fallibility and the improvability of knowledge; (d) the semantic principle of correspondence between our representations and the world[7];

(6) the *formal background* F of $\mathcal{R}$ is the collection of up-to-date logical and mathematical theories (rather than being empty or formed by obsolete formal theories);

(7) the *specific epistemic background* B of $\mathcal{R}$ is a collection of up-to-date and reasonably well confirmed (yet corrigible) data, hypotheses, and theories, and of reasonably effective research methods, obtained in other fields relevant to $\mathcal{R}$;

(8) the *problematics* P of $\mathcal{R}$ consists exclusively of cognitive problems concerning the nature (in particular the regularities) of the members of D, as well as problems concerning other components of $\mathcal{R}$;

(9) the *fund of knowledge* K of $\mathcal{R}$ is a collection of up-to-date and testable (though rarely final) theories, hypotheses, and data compatible with those in B, and obtained by members of C at previous times;

> on the problems of the rationality of science in [Kitcher, 1993].) And, however biased the individual scientist may be, the above values are also the basis for the *institutional objectivity* of science. As a consequence, basic science is value-free only in the sense that it does not make value judgments about its objects of study. In other words, basic science has no external value system. (Mahner 2007, p. 533)

[6] Bunge uses the expression "philosophical background" as a synonym, which we can dispense with since, for us, philosophy is not to be confused with a scientific general discourse or metascience.

[7] Philosophers have failed to develop a satisfactory correspondence theory of truth. Bunge has repeatedly returned to this problem without finding a solution that he considers adequate. We will be proposing such a theory in the next issue of *Mεtascience*, which will focus on metascientific semantics. Note that we will be moving away from approaches, such as Bunge's, which attempt to develop a notion of "approximate truth" or "partial truth".

(10) the *aims* A of the members of C include discovering or using the regularities (in particular laws) and circumstances of the Ds, systematizing (into theories) general hypotheses about Ds, and refining methods in M;

(11) The *methodics* M of $\mathcal{R}$ consist exclusively of procedures that are accessible (can be verified, analyzed or criticized) and justifiable (can be explained), starting with the general scientific method. According to Mahner (2007), procedures can be concrete (use of instruments), as in electron microscopy, or conceptual (formal), as in statistical methods. Other examples of conceptual procedures are epistemic procedures or *epistemic operations*, such as 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., and contribute to *epistemic transformations*, i.e., the acquisition, creation and transformation of scientific knowledge.

To these eleven criteria, Bunge adds two necessary conditions for a field of research to be scientific, which Mahner (2007) refers to as the systematicity condition and the progressiveness condition respectively:

(1) the *systemicity condition* stipulates that there is at least one other *contiguous* research domain in the same $\mathcal{R}$ system of factual research domains, such that (a) the two domains share certain items of their general perspective, formal context, specific epistemic context, fund of knowledge, aims and methodics; and (b) either the domain of one of the two domains is included in the domain of the other, or each member of one of the domains is a component of a concrete system of the domain of the other;

(2) the *progressiveness condition* stipulates that the elements of the D, G, F, B, P, K, A, M components of $\mathcal{R}$ undergo *changes*, sometimes quite slowly, as a *result of research* in the same field (rather than as a result of ideological or political pressure, or as a result of "negotiations" between researchers), as well as a result of research in the associated (formal or factual) scientific fields[8].

[8] The changes we are talking about does not concern changes in concrete objects due to their energetic activity, but rather conceptual changes, such as the abandonment of a concept or rule, the replacement of one concept or rule by another,

Based on this characterization, Bunge defines the *material framework* and the *conceptual framework* of a factual science. The material framework is made up of the first three components, C, S and D, while the conceptual framework is made up of the last seven components, G, F, B, P, K, A and M[9]. Between these two frameworks, we insert the values and norms framework, component V. If we reason in terms of objects of study, i.e., the referents of a discipline, the concrete objects of component D are the objects of study of a particular factual science, be it physics, chemistry, biology, psychology, sociology, etc., while the concrete objects of components C and S, i.e., scientists, scientific communities and the societies that host them, are the objects of study of the history, sociology and psychology of science.

Next, the conceptual objects or scientific constructs of the G, F, B, P, K, A and M components are the objects of study for metasciences, be they semantics, ontology, epistemology or metascientific methodology. Thus, some scientific constructs lend themselves to either semantic, ontological, epistemological or methodological research, and others, perhaps the majority, are studied using two or more of these metascientific disciplines. In other words, the same scientific construct can be studied from several angles, not to mention logically analyzed and mathematically synthesized if incorporated into a mathematized metascientific theory. Finally, component V deals with the values and norms, implicit or explicit, that are necessary for the proper functioning of scientific activity. Thus, the factual sciences study the material objects of components C, S and D, the metasciences study the conceptual objects of components G, F, B, P, K, A and M, and the convivence disciplines, essentially ethics and praxeology, study the values and norms of component V.

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and so on. In the case of the D component, the abstract set of concrete objects that form the objects of study of a factual science, it is the elements of D that can change over time, i.e., be replaced by a simple, possibly arbitrary operation of the mind, whereas the objects themselves change naturally in a nomic way, i.e., according to the concrete links between the properties of these objects, and also because they are endowed with energy. For example, abandoning the idea that phlogiston exists in nature removes this concept from D components of all fields of factual research R that studied it as a concrete object. On the other hand, the concept can be an object of study in the history of science and in diachronic metascience.

[9] Bunge recognizes that the term "material framework" is a misnomer, since component D is made up of conceptual objects in the case of the formal sciences, but also, we add, in the case of the conceptual sciences, the metasciences.

As fields of research, the metasciences can be characterized in a similar way to the factual sciences. At this point, the constructs or conceptual objects of the G, F, B, P, K, A and M components of the factual sciences are found as D elements of the metasciences, i.e., the objects of study of a scientific general discourse. In this article, among the components D, G, F, B, P, K, A and M of a metascientific epistemology, we will therefore focus in the next section on component A, the aims of such an epistemology, then in section 3, we will examine component D, the objects of study of this epistemology, and, finally, in section 4, we will look at component M, the methodics of metascientific epistemology. In short, our purpose is meta-metascientific, that is, we discuss the nature of metascience, rather than practicing metascience, and we will use the Bungean epistemology to illustrate what a metascientific epistemology is.

2] Goals of Epistemology

Bunge's characterization of epistemology and the goals he assigns to it are ambiguous and inconsistent with the way he practices his epistemology. Bunge's tension concerning the role and objects of study of epistemology seems to stem from his desire to create a scientific epistemology, i.e., an epistemology in line with scientific findings, which often leads him to closely associate cognition, a concrete process, and knowledge, a construction of the mind:

> Many disciplines besides descriptive and normative epistemology[10] study cognition and its outcome, i.e., knowledge. (Bunge 1983a, p. 10)

The disciplines referred to in this passage are factual sciences such as psychology, sociology, neuroscience and so on. In this way, epistemology and certain factual sciences would have the same objectives and the same two objects of study (referents): the study of cognition and the study of knowledge. This close association between cognitive processes and knowledge stems from Bunge's error in believing that the referents of epistemology are the same as those of the cognitive sciences:

[10] To add to the confusion, Bunge sometimes identifies descriptive epistemology with psychology (for Bunge, normative epistemology is synonymous with methodology). In other words, descriptive epistemology is a naturalized epistemology.

> All the members of cognitology[11] have a *common referent*, namely the inquiring system (individual or group). Therefore there is-inevitably and happily-some overlap between the various sciences of cognition and knowledge. However*, a common reference does not ensure identity, for one and the same subject matter can be studied from different viewpoints-i.e., one can ask questions of different kinds about one and the same entity*. This holds, in particular, for the scientific and the philosophical approaches to cognition and knowledge. (Bunge 1983a, p. 11 ; italics ours)

It's true that the same object or concrete process can be studied by different disciplines, but here we're dealing, on the one hand, with a concrete process, cognition, and on the other, with an abstract result obtained through epistemic operations, knowledge. These are not two aspects of the same object. Scientific knowledge is made up of constructs, fictions in Bunge's terms, while cognition is a concrete process that takes place in our brains. The inconsistency of this passage becomes clear when we recall that Bunge supports the methodological postulate of the dichotomy between concrete and conceptual objects (Maurice 2020, 2022a). Postulate 3.4 of volume 3 of the *Treatise* states, "Every object is either a thing or a construct, no object is neither and none is both." (Bunge 1977, p. 117) Bunge makes the following clarification:

> Postulate 3.4 is an axiom of *methodological dualism*. It does not commit us to metaphysical dualism: we are not claiming that there are two kinds of thing, the *res extensa* and the *res cogitans*, or things proper and ideas. We take it that constructs, whether useful or idle, scientific or mythical, are fictions not entities. Hence they are not part of the real world even when they take part in our representations of the latter. (Bunge 1977, p. 118)

So, on the one hand, there are concrete objects, real objects, studied by the factual sciences; on the other hand, there are conceptual objects, constructs, or fictions in Bunge's terms, studied by the metasciences. We must emphasize that this methodological postulate is one of Bunge's most important ones, perhaps the most important of all. Bunge takes great pains to implement it rigorously, but when it comes to discussing the nature of his approach, he

[11] Bunge uses cognitology four times in *Exploring the World* as a quasi-synonym for cognitive science, in which epistemology is included (Bunge 1983a, pp. 10-12).

momentarily forgets that two objects of different natures—one real, the other fictional—require different disciplines to approach them. In short, the factual sciences study concrete objects endowed with energy and, among conceptual objects, logic and mathematics study formal objects, while the metasciences study the constructs of the factual sciences[12].

Thus, epistemology cannot have the same objects of study as the factual disciplines of cognitology in the second-to-last quotation, since these disciplines study "inquiring system (individuals or groups)". These systems are concrete, and therefore belong to the factual sciences. The fact that these systems can be approached from *different viewpoints* by different factual disciplines is possible because these disciplines study concrete objects. But since epistemology studies constructs, it cannot then study inquiring system from a different viewpoint, as Bunge asserts in this passage.

Bunge makes it clear that cognitive processes are concrete, and knowledge is a human-created abstraction. It cannot therefore be, as the passage suggests, a question of two approaches to the same object of study, as is the case with cognitive psychology and cognitive sociology, two ways of studying the same concrete objects. Cognitive science studies cognitive processes, while epistemology and other metascientific disciplines study knowledge and the epistemic operations involved in acquiring, creating and transforming that knowledge.

The inquiring systems referred to in the previous passage are concrete systems (scientists or scientific communities) that can only be studied by factual sciences such as psychology, neuropsychology, sociology and so on. In other words, the referents of the factual sciences are concrete objects, whereas knowledge is not a concrete object, but a set of constructs, i.e., concepts, propositions, classifications, models, theories, etc. Knowledge cannot therefore be studied by the factual sciences, but rather by the conceptual sciences that are the metasciences.

To make it clear that Bunge's confusion about the nature of his epistemology does not prevent him from distinguishing

[12] The constructs of logic and mathematics are studied by metalogic and metamathematics, respectively.

epistemological from scientific questions, let's complete the second-to-last quotation:

> […] whereas the scientist may study perception and perceptual illusion as sources of knowledge and error respectively, the philosopher may also study the scope of perception, the nature of perceptual knowledge and its differences from conceptual knowledge, as well as the contrast between appearances (as presented in perception) and reality (as conjectured by theory). Whereas the scientist may be interested in the way children come to know about objective constancies (e.g. conservation laws), *the philosopher may puzzle the nature of law statements, their relation to objective patterns, and the role of such statements in science and technology*. And whereas the scientist may investigate the origin-psychological or historical-of theories, *the philosopher may study the very nature and role of finished theories, as well as the conceptual (rather than psychological or cultural) differences between them*. (Bunge 1983a, p. 11; italics ours)

Despite this last passage, which is fairly clear as to which questions belong to the cognitive sciences and which to epistemology, Bunge asserts a few lines further on:

> […] there is no clear demarcation between scientific and philosophical epistemology, and none should be invented. (Bunge 1983a, p. 11)

Not only does Bunge argue that there is continuity between cognitive science and epistemology, he also uses "scientific epistemology" as a synonym for "cognitive science". Yet, fifteen years before the publication of volume 5 of the *Treatise*, Bunge had a clear idea of epistemology and even metascience:

> The *internal* approach to science has, since its inception, been a philosophical subject. It is philosophers—and occasionally scientists on holidays—who have studied the general pattern of scientific research, the logic of scientific discourse, and the philosophical implications of method and outcome. This internal study of science bears on scientific knowledge apart from its psychological origin, cultural setting and historical evolution, whereas the external approach is concerned with the activities of the men involved in the production, consumption, waste, and corruption of science: the external sciences of science are as many branches of the sciences of

> culture. The internal study of science on the other hand, steps above its object, in the semantical sense that it is a discourse on a discourse. Just as a statement about a statement is called a metastatement, so the internal study of science may be called *metascience*, itself part of the theory of knowledge (*epistemology*)[13]. (Bunge [1967] 1998, p. 35-36 ; italics in original)

Similarly, twenty years after the publication of volume 5 of the *Treatise*, Bunge clearly distinguishes cognition, a concrete process[14], from knowledge, an abstract result, as well as the disciplines that study both:

> [A cognition is a] process leading to knowledge. Perception, exploration, imagination, reasoning, criticism, and testing are cognitive processes. Cognition is studied by cognitive psychology, and cognitive neuroscience, whereas knowledge is studied primarily by epistemology and knowledge engineering. (Bunge 2003, p. 43)

Thus, Bunge's discourse on his own epistemology suggests that he will develop a naturalized epistemology: "In this work epistemology is conceived as a merger of philosophy, psychology, and sociology: it describes and analyzes the various facets of human cognitive processes […]." (Bunge 1983a, p. xiv) A few lines later, he returns to a conception of epistemology as metascience: "Epistemology is concerned with inquiry in general."

Bunge sometimes identifies his epistemology with a theory of knowledge, a practice that is widespread in English and somewhat less so in French. Yet Bunge's epistemological practice has not produced a theory of knowledge, at least not a philosophical theory of knowledge, nor a theory that embraces all types of knowledge. In

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[13] Here, Bunge makes metascience a branch of epistemology, the latter being a theory of knowledge in general or a gnoseology. However, we have argued that Bunge's "philosophy" is concerned *only* with science, which implies that there is no semantics, ontology or epistemology of common knowledge in Bunge's work, for example, which implies that there is no theory of knowledge in Bunge's work, as we shall see later in the article. Similarly, philosophy of science as a discipline distinct from semantics, ontology and epistemology is redundant in Bunge, since the latter disciplines are concerned only with science, in particular scientific constructs (Maurice 2020, 2022a). In short, Bunge has developed a metascience, a science of science, by studying the semantic, ontological, epistemological and methodological constructs of scientific conceptual knowledge, without concern for ordinary language or common sense.

[14] A pleonasm since a process is concrete by nature.

the first place, if the theory of knowledge is the study of the relationship between subject and object in the act of knowing (Lalande [1926] 1997a, [1926] 1997b), then Bunge has not conceived a theory of knowledge, since he does not problematize this relationship philosophically. Bunge takes for granted the concrete existence of both objects in cognitive relationship, but since they are concrete objects, then their relationship can only be studied by the factual sciences. Secondly, if the theory of knowledge is an inquiry into the *origins*, *nature*, *value* and *limits* of knowledge or the faculty of knowing (Lalande [1926] 1997a, [1926] 1997b), and even if we restrict this inquiry to scientific knowledge, then, once again, Bunge has not conceived a theory of knowledge, since the *origins* or "sources of knowledge" are for Bunge a problem of cognitive mechanisms (Bunge 1983a, pp. 1-2), and therefore a problem studied by the factual sciences such as cognitive psychology, cognitive sociology, cognitive neuroscience, etc.

The study of the *nature* of knowledge can fall within either the factual sciences or epistemology, depending on what we mean by "nature". If it is the "concrete nature" of knowledge that interests us, then we need to study cognitive mechanisms; if it is rather the "conceptual nature" of knowledge that interests us, then we need to study epistemic operations. It is the latter task that Bunge tackles in volumes 5 and 6 of the *Treatise*, because he is essentially, if not exclusively, interested in *scientific conceptual knowledge*.

The *value* of knowledge, whether scientific or not, can be evaluated internally or externally. External evaluation is part of a general discourse on convivence or togetherness. For a society, this involves firstly assessing the possible consequences, beneficial or otherwise, of some kind of research, and secondly, when scientific results are available, evaluating the consequences of basing decisions and actions on these results, particularly with regard to technological development. Internal evaluation, in the case of science, is a task for the metasciences, most often implicit among scientists. These values may be logical, semantic, methodological or attitudinal (moral), adopted because they constitute the way members of scientific communities consider appropriate to acquire and manage knowledge (Mahner 2007, p. 524).

As for the *limits* of knowledge, they can be studied from a scientific point of view (physical and biological limits of knowledge), but

they can also be imposed following an ethical evaluation of knowledge, i.e., of the consequences of the ways in which knowledge is acquired and used, which comes under a discourse of convivence. In any case, neither philosophy nor metascience has anything to add on this subject. Thinkers engaged in "philosophical reflection" on the limits of knowledge, particularly scientific knowledge, are, for the most part, ethicists without a philosophical doctrine to guide them, from which they could deduce the limits of scientific knowledge from an ethical and therefore external point of view. These ethicists are therefore no longer philosophers, since they do not adhere to any philosophical doctrine, they do not use any particular faculty to "see" their object of study, these objects of study are not those of philosophical ethics, and they do not use any approach, technique or method specific to philosophical ethics. In short, contemporary ethics is gradually becoming autonomous from traditional philosophical ethics, to form a general discourse of convivence.

We discuss the notions of "general discourse", "scientific general discourse" and "general discourse of convivence" in our article "Metascience: for a scientific general discourse", which appeared in the first issue of *Mɛtascience*. In it, we defend the idea that philosophy is only one general discourse among others, and that it is possible to develop general discourses that are neither philosophical, nor religious, nor mystical; the non-philosophical, non-religious and non-mystical character of these general discourses has the consequence that they cannot be total, hence the existence over the last few decades of an ethics independent of philosophical ethics, of a metascience independent of the philosophy of science, but, above all, independent of each other.

We have thus deconstructed the philosophical conception of the theory of knowledge as an inquiry into the *origins*, *nature*, *value* and *limits* of the faculty of knowing or knowledge. Each component of this conception of the theory of knowledge finds a place in either science, metascience or a discourse of convivence. This analysis is an example of the possibility of constructing non-philosophical, non-religious and non-mystical general discourses. The results of the analysis only make sense if we adopt a number of general postulates, logically unprovable, empirically unverifiable, but obtained as a result of reflection on our experience of the world, including our scientific experience of the world (Maurice 2020, 2022a). The

adoption of general postulates is not a defect, since it is a necessity for any discourse. Bunge has therefore not conceived a philosophical theory of knowledge for his epistemology, just as he has not conceived a philosophical theory of matter for his ontology (Maurice 2022a, 2022b)[15, 16]. Just as he takes for granted the existence of concrete objects, especially those studied by science, Bunge does not question the existence of concrete cognitive processes involved in the acquisition, creation and validation of knowledge.

What, then, are the objects of study of metascientific epistemology? As with his ontology, Bunge is much more consistent and clear about his practice. If we rely on the epistemology Bunge has produced and not on what he says about it, we find that it studies scientific constructs, notably epistemic operations, and not concrete objects or concrete processes, such as neurons and cognitive processes, which are a type of neural processes[17]. We might be tempted to hastily conclude that epistemology studies scientific knowledge, in one of the traditional senses sometimes retained by Bunge in the passages quoted, but in fact all metascientific disciplines study scientific knowledge. However, each of them focuses on certain scientific constructs rather than others, since scientific constructs possess semantic, ontological and epistemological properties. For example, ontology is concerned with scientific constructs such as general postulates, e.g., the world is independent of us and is knowable, but it is also concerned with constructs explicitly used by scientists

[15] With regard to the differences in nature between philosophical and scientific theories of matter, we refer the reader to Stephen Gaukroger (2006, 2010, 2016) and Alan Chalmers (2009). In particular, Chalmers argues that scientific atomic theories owe nothing to philosophical atomic theories. More generally, Chalmers argues that philosophy and science are two distinct activities. While science is independent of philosophy, the latter must accommodate or adapt to the results of science on all subjects where the latter excels, such as atoms and perception. But, for Chalmers, a philosophical theory that adapts to science is still a philosophical theory, because it explores its subject beyond what science allows (Chalmers 2009, p. 9). For us, Chalmers is a good example of a historian and philosopher of science who is no longer interested in philosophy, but who nonetheless tries to create an epistemic nook for it, because there are nonetheless questions that science cannot answer.

[16] Note that a philosophical theory of knowledge is often linked to a philosophical theory of sensation and perception, which we do not find in Bunge. Bunge takes for granted the scientific results of disciplines that study sensation and perception.

[17] Note that the same linguistic sign, here “neuron”, is used to name both the object and the concept that represents it.

without them defining them or studying their conceptual nature, such as the notion of an object's property (Maurice 2022a).

Metascientific epistemology, on the other hand, is concerned with the scientific constructs that enable us to produce a unified representation of the *epistemic transformations* of scientific knowledge through the study of the *epistemic operations* required for its acquisition, creation and validation, as opposed to psychological, sociological or neurological research into *cognitive processes* at all levels. If we return to the definition of a factual science set out in Part 1, these constructs (epistemic operations are constructs; they do not exist in nature) are to be found mainly among the constructs that make up component M of the conceptual framework of factual sciences, i.e., methodics. Other constructs also belong to metascientific epistemology, such as the postulates, principles, values and epistemic norms of the G component.

Finally, there are other conceptions of epistemology close to the one we defend:

> Although it has to be admitted that usage remains rather vague, it can be said that the term "epistemology" is intended to be more modest than "philosophy of science". Epistemology applies itself to the rigorous analysis of *scientific discourse*, examining the modes of reasoning it employs and describing the formal structure of its theories. By concentrating on the process of knowledge, epistemologists often exclude reflection on its meaning. *They sometimes present their discipline as a scientific one that has broken with philosophy* (Lecourt 2010; italics ours).

Similarly, Romero, a long-standing Bungean, and even if his terminology is ambiguous, since he distinguishes a "general epistemology" from a "philosophical epistemology", he attributes to the latter the role of the internal study of science, i.e., the study of scientific knowledge:

> Epistemology is the general study of cognitive processes and their outcome, i.e., knowledge. Specific mechanisms of knowledge acquisition are investigated by neurosciences and psychology. Philosophical epistemology, instead, has a general problematics that includes the nature of knowledge and understanding, the characterization of science, theories and models, the ways of explanation,

> interpretation problems of specific sciences and theories, and so forth. (Romero 2018, p. 51)

On the other hand, Paty, a reader of Bunge, proposes an epistemology centered on the internal study of the sciences, i.e., a "critical examination of their concepts and propositions":

> I'll confine myself to mentioning, albeit very briefly, an idea that I've called an "epistemological program", and which, while taking into account certain elements such as those mentioned (a certain degree of falsifiability, the notion of a rational research program, the solidarity of propositions, even representations, etc.), inserts them into a complex whole that includes instances as heterogeneous (but ordered in relation to each other in a chain of connections) as concepts, theoretical models, principles, categories of thought, epistemological presuppositions and general conceptions […]. (Paty 1990, p. 54)

This epistemological program proposed by Paty is similar to the Bungean program as found in volumes 5 and 6 of the *Treatise on Basic Philosophy*. Notably, in both cases, "scientific knowledge is taken as a fact" (Paty 1990, p. 52), just as the progress of theories and the possibility of comparing theories are taken as a given (Paty 1990, p. 25). Paty, like Bunge, takes a set of general postulates associated with science for granted (Maurice 2020).

3] Objects of Epistemology

We have pointed out an inconsistency in Bunge's conception of his epistemology. At times, it is conceived as a scientific discipline, as a naturalized epistemology, forming a single body with psychology, sociology, and cognitive neuroscience, sharing with them the same objects of study. At other times, it is seen as an autonomous discipline with its own objects of study.

> […] we recognize the need for studying the "product" of the cognitive process regardless of the idiosyncrasies of the learning subject and her environment-i.e. the need for the study of knowledge. (Bunge 1983a, p. 72)

We have eliminated the inconsistency by appealing to principles or postulates supported by Bunge himself, notably the methodological postulate that states the dichotomy between concrete objects (things) and constructs, one of the fundamental postulates of

Bunge's thought. In other words, Bunge cannot both support this postulate and defend a conception of naturalized epistemology. Since this postulate lies at the heart of the Bungean system, the inconsistency can be eliminated in favor of a conception of epistemology whose objects of study are constructs, not concrete objects.

The set of scientific constructs is what Bunge calls *conceptual* scientific knowledge (propositional, ideational, fictional). Even in science, however, there are other forms of knowledge, notably *perceptual* knowledge (Bunge 1983, p. 72, Romero 2018, p. 52). Although the various types of knowledge complement each other, Bunge supports, more discreetly, another methodological postulate, that of the dichotomy between conceptual and perceptual knowledge:

> Perception gives us only perceptual knowledge, which is egocentric and limited to appearances. *Only conceptual knowledge can be objective and deep*: only conceptual maps give us a glimpse of things in themselves. (Bunge 1983a, p. 196-97; italics ours)[18]

Since conceptual knowledge is the only kind that can be objectified, it is the only kind that can be the subject of a discipline independent of the factual sciences, metascience. However, this conceptual knowledge does not exist in itself:

> Just as there is no motion apart from moving things, so there are no ideas in themselves but, instead, ideating brains. To be sure we may *feign* that there are ideas in themselves and in fact we must often make such pretense. We do so whenever we abstract from the real people who think up such ideas as well as from the personal and social circumstances under which they ideate. (Bunge 1983a, p. 23 ; italics in original)

On the other hand, it is not possible to proceed *as if* perceptual knowledge existed in its own right, since it is limited to

[18] The two dichotomies are intimately linked. The first dichotomy emphasizes the ontological nature of real objects (concrete objects in Bunge's case) and conceptual representations of them (fictions in Bunge's case). The second dichotomy focuses on the epistemological nature of the perceptual knowledge and conceptual knowledge we have of these concrete objects. Only conceptual knowledge is objective, or enables an objective, albeit incomplete, representation of concrete objects. In fact, a philosophical doctrine can be characterized by its conception of these three poles and the links between them: reality, perception (appearance) and representation.

appearances. These types of knowledge can only be studied by factual sciences, although the latter can also study the cognitive processes of conceptual knowledge. Only conceptual knowledge can be the subject of metadiscourse. This possibility depends not only on the possibility of objectifying conceptual knowledge, but also on accepting the postulate of the dichotomy between reality and its representation, and thus not attributing existence to ideas, concepts and conceptual knowledge. Although conceptual knowledge is not limited to science, since it can be found in practically all human activities, even the most common ones, it is *scientific conceptual knowledge* that Bunge is most interested in. Moreover, because it is easier to study, notably because it is more precise, more systematic and better validated, a better knowledge of scientific conceptual knowledge should enable us to access a better knowledge of conceptual knowledge produced by other human activities.

The way Bunge does and practices epistemology gives meaning to the above. Thus, another way of eliminating inconsistency in Bunge's conception of his own epistemology is to examine what he does, i.e., how he proceeds, or, alternatively, determine the objects he studies. Examining the aims of epistemology gave us a first opportunity to specify the objects of study of metascientific epistemology. Thus, in order to study epistemic transformations in science, epistemology must focus on the epistemic operations that lead to these transformations. These operations, however, do not take place in an epistemic vacuum, which is why epistemology is also interested in epistemic postulates, principles, values and norms. Is this what we find in volumes 5 and 6 of the *Treatise*?

The oscillation in Bunge's thinking on the nature of epistemology structures the presentation of volumes 5 and 6. Volume 5, *Exploring the World*, consists of Chapters 1 to 9, while Volume 6, *Understanding the World*, comprises Chapters 10 to 15. Chapters 1, 2, 3 and 4 describe the cognitive processes of perception, learning, communication, sensation, observation, cognitive development and evolution, etc., from the perspective of the cognitive sciences (psychology, sociology, neurology, etc.). However, the introduction to Chapter 2 reminds us that knowledge can be studied independently of cognitive processes:

> […] although we cannot detach the outcome (knowledge) from the corresponding process (cognition), we may distinguish them.

> Moreover for some purposes we may *feign* that cognitive processes have a "content" that can be communicated to other brains or externalized as artifacts such as inscriptions and tapes. To be sure actually there is no such content and, a fortiori, no such transfer. Acquiring knowledge is learning something, i.e. going through a certain brain process, hence not the same as acquiring a book or some other commodity. Likewise exchanging information is not like trading things but is interacting with another animal in such a way that each party elicits certain learning processes in the other's brain. Yet from a methodological point of view it is convenient to feign that cognitive processes do have a transferable content, so that we may think of the latter separately from the former. This convenient fiction amounts to supposing that, for certain purposes—such as checking validity or usefulness—it does not matter what or who went through the cognitive process in question. (Bunge 1983a, p. 61; italics in original)

Bunge appeals here to the dichotomy between concrete and constructed objects, or fact and fiction (postulate 3.4, mentioned earlier). Right from the start of chapter 2, Bunge reaffirms the autonomy of epistemology, a position already advanced in the introduction to volume 5 and in the first chapter. This position is constantly reiterated, despite Bunge's idea of developing a naturalized epistemology.

From Chapter 5 onwards, epistemology as a discipline that studies constructs gradually asserts itself, without Bunge abandoning psychological or neuropsychological considerations. Thus, epistemological notions are often preceded by an account of the psychological, sociological or neurobiological aspects associated with the constructs and epistemic operations examined by Bunge. This organization of Bunge's presentation is apparent in the titles of certain sections of Chapters 5 to 8. Thus, sections 1.1 and 2.1 of chapter 5 are entitled "From Percept to Concept" and "From Thought to Proposition" respectively, since percepts and thoughts (or judgments) are cognitive processes, while concepts and propositions are constructs. Similarly, section 1.1 of chapter 6 is entitled "Natural Reasoning", and section 1.2 "Formal Reasoning", since natural reasoning is a psychobiological field, while formal reasoning is a logical one. The titles of sections 1.1 of chapters 7 and 8 are even more eloquent: "Psychobiology of Problems" and "Psychobiology of

Conjecturing". Even when epistemological research dominates, and no section is devoted to the psychobiology of a construct or epistemic operation, Bunge peppers his discussion with findings from cognitive neuroscience, notably in chapters 9 to 14.

Bunge tells us that his epistemology "is conceived as a merger of philosophy, psychology, and sociology" (Bunge 1983a, p. xiv). This is not what we find in volumes 5 and 6 of the *Treatise*. We're dealing with two presentations that are always distinct from one another, although they may be intertwined in the same chapter or paragraph. In other words, there are two distinct discourses and a confused metadiscourse. There is a psychological, sociological and neurological discourse, and then an epistemological discourse. The statements of these two discourses may intermingle, but they never merge. In particular, there is no single psycho-epistemological, socio-epistemological or neuro-epistemological statement, i.e., one and the same statement that refers to both concrete objects and epistemological constructs. The inconsistency or confusion is thus to be found in Bunge's metadiscourse when he discusses the nature of his epistemology. So, even though his metadiscourse asserts that epistemology is naturalized, the two parallel discourses, one scientific, the other metascientific, prove that this is not the case. It's impossible to interweave two discourses of different natures and magically create a new discipline. Naturalized epistemology is a chimera.

In section 2 of our article, we ruled out the idea that Bunge's epistemology is a philosophical theory of knowledge. We have just ruled out the idea that his epistemology is a naturalized epistemology. We have quoted extensively from volumes 5 and 6 to show that Bunge consistently supports the idea that constructs can be studied in themselves, objectively. We can now answer our previously formulated question: like volumes 1-4 of the *Treatise*, volumes 5 and 6 study constructs, be they epistemic operations, postulates, principles, values, norms or rules. These are the constructs that enable epistemic transformations in science, i.e., the acquisition, creation and validation of scientific knowledge. The number of these epistemic constructs is unknown, and it may be impossible to draw up an exhaustive inventory:

> […] there are as many mechanisms of epistemic change as there are types of epistemic operation. Some workers go out into the field

> whereas others stay at the laboratory; some make observations and others experiment; some classify and others calculate; some draw blueprints whereas others build theories; some solve problems with the help of existing theories, and others criticize the latter; some delight in specificity, others in pattern; some split and others lump- and so on. The growth of knowledge requires that all of these and more epistemic operations be carried out concurrently in the scientific and technological communities. (Bunge 1983b, p. 170-71)

With regard to epistemic postulates, principles, values, norms and rules, Bunge takes care to draw up two lists in Chapter 15, Section 3, "Maxims of Scientific Realism", one devoted to descriptive epistemology or epistemology proper, the other to prescriptive epistemology or methodology. But since these lists each contains fifty items, Bunge has taken care to summarize his scientific realism in sixteen isms in the conclusion to the same chapter 15. We will not examine these principles further, although a major task of analysis and synthesis remains to be done, as much for epistemic principles as for semantic and ontological principles–in short, for all metascientific principles. Do certain principles derive from others? Can they be classified under more general principles? Can they be incorporated into metascientific theories? Bunge stresses the importance of studying epistemic postulates, principles, values and norms:

> […] if we care for science, technology, and the humanities, we should also care for their epistemological presuppositions–such as that there is an independent reality and that it can be known if only in part. We should dig up, cleanse, analyze, and systematize such principles. […] It would seem obvious that, the better we know how we can get to know, the better we can improve (or block) the learning process, particularly in science, technology, and the humanities. So, a study of the epistemological presuppositions of research, as well as of any other tacit assumptions of scientific and technological research, should payoff in practical results[19]. (Bunge 1983a, p. 14)

However, in chapters 5 to 14 of volumes 5 and 6 of the *Treatise*, Bunge's effort is directed essentially towards the study of *epistemic operations*, operations which relate to concepts, propositions, classifications, models, theories, etc., and which contribute to *epistemic*

[19] Translating the results of metascientific research into useful results for science is what we call the Bungean wager.

transformations, that is to say to the acquisition, creation and transformation of scientific knowledge from a conceptual point of view, that is to say independently of any particularities of the learner subject and his environment, and consequently without taking into account the cognitive processes studied by cognitive neuroscience.

These operations are definition, reduction, description, subsumption, explanation, demonstration, prediction, questioning, problematization, observation, experimentation, classification, theorization, problem solving, analysis, synthesis, planning, hypothetization, validation and so on. These constructs form an important part of the methodics of a factual science, i.e., the M component of the characterization of a factual science.

Thus, these operations are the objects of study of metascientific epistemology. They are treated *as if* they existed in themselves, in the same way that metascientific ontology studies constructs in themselves (Maurice 2022a). This practice is possible because conceptual knowledge can be abstracted from its contexts in order to make it objective. Naturalized epistemology is therefore non-existent in Bunge's work, just as naturalized ontology is non-existent in his work (Maurice 2022a). Despite his metadiscourse on his own ontology and epistemology, Bunge did not attempt to naturalize them, in the sense of transforming them into disciplines of the factual sciences, i.e., disciplines that study concrete objects. On the contrary, both his ontology and epistemology study the constructs of science, making them radically different from the factual sciences, turning them into conceptual sciences or metasciences. Bunge's naturalization is therefore not to be found in the object of study of his ontology and epistemology, but rather in the methods and cognitive faculties required to study scientific conceptual knowledge. We first dealt with this naturalization of general discourse in Bunge in our articles "What Is Metascientific Ontology?" (Maurice 2022a) and "Bunge's Metascience and the Naturalization of the General Discourse" (Maurice 2022b). We return to this subject here in the specific context of metascientific epistemology.

4] Methods of Epistemology

Bunge has said little about his method of constructing semantic, ontological and epistemological theories, perhaps because for the

author of the *Treatise* it is obvious that his approach, methods and techniques of analysis and synthesis fit naturally into the way things are done in science, logic and mathematics. Bunge's method is not philosophical. Thus, he does not favor a logic or mathematical formalism a priori on the basis of a philosophical doctrine, but rather on the basis of what scientists commonly use. And since scientists use predicate logic and standard mathematics, Bunge will use predicate logic and standard mathematics. Nor does Bunge suggest that special skills are needed to explore the world. He calls on the whole arsenal of cognitive faculties, starting with reflection[20].

Discussing the nature of philosophy of science (metascience), Bunge clarifies what its object, method and purpose are:

> The object should be real science (both natural and social), and the method should be essentially the same as the method of science– since in either case one tries to know *something given*. The goal should be to dismount and then to reassemble the mechanism of science in order to expose its structure, content, and functions. (Bunge 1973, p. 21 ; italics ours)

In the case of science, what is given are the concrete objects of the world; in the case of metascience, what is given are the constructs of science. For his ontology, Bunge made the following clarification:

> Any means should be permitted in constructing a metaphysical theory as long as it leads to a good theory: pinching from another field, analogizing, extrapolating, looking for models of abstract theories, and of course inventing radically new ones. Here, as in science and in mathematics, there is no royal road, and theories are judged by their works not by their scaffoldings. (Bunge 1971, p. 509)

This is also true of the metascientific epistemology we were able to extract from volumes 5 and 6 of the *Treatise*. Thus, in terms of methods and techniques of analysis, metascience, like Bunge, claims a methodological conservatism and opportunism. Many philosophers, including Bunge, make little or no use of the tools or methods of reflection and analysis recognized by philosophers. These methods seem to cause more problems than they solve, which

[20] Ordinary or natural thinking, which we all have, not philosophical thinking. Thinking, even in a general way, does not prove that we are philosophers. Philosophers do not have a monopoly on general reflection (Maurice 2020).

may explain why they are not used in the formal and factual sciences. Here, then, is a non-exhaustive list of tools, methods and approaches, essentially associated with philosophy and not used by Bunge[21]: transcendental argument, *philosophical* counterfactuality, *philosophical* thought experiment, *philosophical* logical analysis, *philosophical* conceptual analysis, *philosophical* linguistic analysis, *philosophical* necessity and possibility, *philosophical* conceivability, *philosophical* intuition, dialectics, epoché, as well as analyses using possible worlds (modal techniques), and so on[22]. Nor did Bunge seek to develop a doctrinal method, a method associated with a philosophical doctrine, as is the case with many philosophers: Plato developed dialectics, Aristotle syllogistic, Descartes wrote the *Discourse on the Method*, Husserl proposed phenomenological reduction, and the Vienna Circle, logical analysis. That said, there is a Bungean style to metascience, just as there is an Einsteinian style to physics. Bunge also developed methods for analyzing scientific theories, such as the double axiomatization, made up of a syntactic axiomatization, and therefore more conventional, and a semantic axiomatization, Bunge's original contribution to this method (Bunge 1967).

Throughout his work, Bunge constantly criticized these philosophical approaches or methods, and always denied the existence of any particular cognitive faculties required for philosophical practice. It would be futile to look for *the* Bungean method, linked to a philosophical doctrine, as we are wont to do in the case of great philosophers, the method then coming to characterize the philosopher. In this way, a Platonist cannot surpass Plato, a Cartesian cannot surpass Descartes and a Kantian cannot surpass Kant. The method is inseparable from the philosopher. If you modify the method too much, you develop another philosophical doctrine. In Bunge's case,

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[21] We have to qualify the majority of the approaches listed here as *philosophical*, because some of them also have meanings and utilities outside philosophy, but without being used philosophically.

[22] For an account of a number of philosophical methods, see the *Oxford Handbook of Philosophical Methodology* (Cappelen, Gendler & Hawthorne 2016) and the *Cambridge Companion to Philosophical Methodology* (Overgaard & D'Oro 2017). Both books, like similar works, appropriately use an encyclopedic style that fails to capture the scope of philosophical methods. Only by reading a few philosophical works is it possible to understand that philosophical discourses differ radically from rational discourses, scientific or otherwise, and that they are designed to differ radically since the aim is to know a reality that would escape the sciences.

a general discourse on science does not require a particular approach that is different from what is practiced in any rational activity, be it science, management, law, education, health, etc. It is therefore possible to continue Bunge's research in the same way as it was possible to continue Newton's research. This is an important, even essential, quality of the Bungean approach to the discourse on science, which distinguishes it, once again, from the philosophical approach.

The fundamental aspect of the Bungean approach has been clearly noted by Cordero: all rational activity makes use of experience, reason, imagination and criticism (Cordero 2019, pp. 94-96). It should be pointed out that the experience, reason and imagination in question have no transcendent scope. In other words, we are talking about the experience of the concrete world, including and especially the concrete world revealed by the factual sciences, and the use of reason and imagination as natural faculties and not as faculties that would give us access to a philosophical reality. Both the cognitive psychology of science and the cognitive neuroscience of science, which study cognition and cognitive processes in scientists, take it for granted that these processes are of the same nature for all humans: "[…] scientific thinking involves the same general-purpose cognitive processes—such as induction, deduction, analogy, problem solving, and causal reasoning—that humans apply in non-scientific domains" (Dunbar & Klahr 2013). The same applies to metascientific thinking.

Bunge differentiates himself from philosophers because the latter believe that there are special faculties to bridge the "gap" between reality and appearances, or if these faculties don't exist, then reality is unknowable. But from the outset, this is a false problem[23].

5] Conclusion

To understand the distinction between metascience and philosophy, it's useful to remember that we don't have direct access to reality, that there is no general proof or demonstration of the existence of things, that we must then take for granted the existence of the "external world", that there is no possible answer to the

[23] The dichotomy established by philosophers between appearance and reality is discussed in section 3 of our article "Bunge's Metascience and the Naturalization of the General Discourse" in the second issue of *Metascience*.

question of the existence of one property rather than another. It is through reflection and our experience of the world that we come to this conclusion. We have argued that our representation of the world comes through the study of scientific constructs, which is the task of metascientific ontology (Maurice 2020). If we also believe that a general discourse on science is valuable, useful for the advancement of knowledge, then we can study science itself, which is the task of epistemology, but also of metascientific semantics and methodology.

Bungean epistemology is essentially concerned with scientific conceptual knowledge, despite Bunge's desire to be part of the philosophical tradition. For Bunge, doing does not follow saying. And if a discipline is characterized by its objects and methods, then Bunge's metascientific epistemology bears little resemblance to any philosophical epistemologies. Bunge does not problematize science in the same way that philosophers of science do, and he excludes from epistemology certain traditional problems such as belief:

> The vulgar definition of knowledge as "justified belief" provides a useful albeit ephemeral starting point. To start off, it involves the reduction of epistemology to psychology, since beliefs are mental states, whereas knowledge, unlike cognition, is tacitly assumed to be impersonal–that is, valid for everyone […]. (Bunge 2018, p. 136)

Or the problem of perception:

> Adequate models of perception can be produced only by neuropsychology (or physiological psychology): they will not come from pure psychology, let alone from philosophical psychology, which has been at it for over two millennia without ever getting hold of that which does the perceiving, namely the central nervous system. (Bunge 1983a, p. 137)

In philosophical jargon, Bunge is a materialist, but his materialism is reduced to accepting the existence of concrete objects studied by the sciences, notably those studied by cognitive neuroscience. He therefore relies on science to determine the "furniture of the world", but especially on cognitive neuroscience to determine the furniture of the world involved in cognitive processes. It would be a mistake, then, to reduce Bunge's thinking to a materialist doctrine, since even such doctrines, because they are philosophical, postulate the existence of objects and processes foreign to science, and use

methods unknown to scientists. And because they are philosophers, materialists have to argue for the existence of matter and develop a sophisticated philosophical concept of it to counter critics from idealism, empiricism, phenomenalism, etc., whereas scientists have long since lost interest in a general or philosophical theory of matter, of which, incidentally, there is no trace in Bunge's work. We don't need materialist doctrines, we just need to adopt the same general postulates as the sciences, analyze and interpret their constructs, then abstract and generalize, all using our natural faculties. The role of Bungean epistemology, but also of semantics, ontology and methodology, is similar to that of metalogic and metamathematics. And since the scientific beast is just as complex as the logical or mathematical beast, it's not surprising that Bunge had to compose a treatise of almost 2,400 pages to lay the foundations of metascience[24].

An object of study like science cannot be dealt with in a single *Treatise*. And even if we add the hundreds of articles and books in Bunge's oeuvre, it's not enough. There is an enormous amount of work to be done in clarifying metascientific categories (semantic, ontological, epistemological and methodological), as well as a better understanding of the nature of scientific constructs, such as the various types of general postulates, concepts, propositions, classifications, models, theories, rules, norms. This is what we call the Bungean challenge.

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[24] We exclude here volume 8 of the *Treatise* on ethics because for us metascience, a scientific general discourse, is dissociated from a general discourse of convivence or togetherness. There is no such thing as metascientific imperialism as there is philosophical imperialism (Maurice 2020).

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