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The Role of Metaphysical Naturalism in Science

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Abstract This paper defends the view that metaphysical naturalism is a constitutive ontological principle of science in that the general empirical methods of science, such as observation, measurement and experiment, and thus the very production of empirical evidence, presuppose a no-supernature principle. It examines the consequences of metaphysical naturalism for the testability of supernatural claims, and it argues that explanations involving supernatural entities are pseudo-explanatory due to the many semantic and ontological problems of supernatural concepts. The paper also addresses the controversy about metaphysical versus methodological naturalism.

1 Introduction

Metaphysical or ontological naturalism (henceforth: ON) is the view that all that exists is our lawful spatiotemporal world.[1] Its negation is of course supernaturalism: the view that our lawful spatiotemporal world is not all that exists because there is another non-spatiotemporal world transcending the natural one, whose inhabitants—usually considered to be intentional beings—are not subject to natural laws.[2] These are rough and simple definitions, which will be qualified later on, but for now they suffice to address a basic metaphysical antagonism that has pervaded the history of knowledge. On the one hand, one could argue that at least contemporary science need not bother with this traditional antagonism any more, because science has long eliminated supernaturalism from its

[1] If the currently fashionable multiverse scenario were true, this definition could easily be expanded to comprise the totality of all universes. The problem is of course that it seems impossible to ever gain empirical evidence for other spatiotemporal worlds.

[2] If supernaturalism were defined as the contrary of naturalism, everything would be supernatural, including that which appears to be natural. We may disregard this view here, because most supernaturalists admit that some things are natural, whereas some others are supernatural.

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theories and explanations and hence also from its metaphysics. For example, in biology the design argument has not been a serious contender since about 1730 (McLaughlin 2008).[3]

On the other hand, the situation is not that simple. Both scientists and science educators keep being challenged by creationists of all shades, who try hard to reintroduce supernaturalist explanations into biology and into all the areas of science that concern the origin of the world in general and of human beings in particular. A major aspect of this debate is the role of ON in science. Must science reject supernaturalist explanations as a matter of principle, or can it readmit them if there were sufficient evidence pointing to supernatural causes? Is ON then a necessary or constitutive philosophical principle of science, or only a regulative or methodological one?

In an earlier paper on science and religion published in this journal, Mario Bunge and I claimed that science *presupposes* metaphysical naturalism (Mahner and Bunge 1996). Many authors have since disagreed with our view: see, e.g., Lacey (1996), Gauch (2009), Glennan (2009), Fishman (2009). So I shall devote this contribution to a special issue of *Science & Education* appearing at the occasion of Mario Bunge's 90th birthday to taking a closer look at our earlier presupposition thesis and the role of ON in science.

A presupposition is often understood in the sense of a statement that is entailed by a set of premises, or in the sense of a necessary condition implied by some antecedent statement. Is ON entailed by science in one of these senses? No. ON is not part of a deductive argument in the sense that if we collected all the statements or theories of science and used them as premises, then ON would logically follow. After all, scientific theories do not explicitly talk about anything metaphysical such as the presence or absence of supernatural entities: they simply refer to natural entities and processes only. Therefore, ON rather is a tacit metaphysical *supposition* of science, an ontological *postulate*. It is part of a metascientific framework or, if preferred, of the metaparadigm of science that guides the construction and evaluation of theories, and that helps to explain why science works and succeeds in studying and explaining the world.

Now this can be interpreted in a weak and a strong sense. In the weak sense, ON is only part of the metaphysical background assumptions of contemporary science as a result of historical contingency; so much so that we could replace ON by its antithesis any time, and science would still work fine. This is the view of the creationists, and, curiously, even of some philosophers of science (e.g., Monton 2009). In the strong sense, ON is *essential* to science; that is, if it were removed from the metaphysics of science, what we would get would no longer be a science. Conversely, inasmuch as early science accepted supernatural entities as explainers, it was not proper science yet. It is of course this strong sense that I have in mind when I say that science presupposes ON. As we shall see, this view does not imply that ON is undefeasible: it only ties the fate and success of science to ON. Let me try to make a case for this in the following.

2 Naturalism and Scientific Methods

A popular view among scientists maintains that science need not bother with philosophy, let alone metaphysics, at all: scientists should just apply and follow the scientific method or, if preferred, the collection of scientific methods. Somewhat more sophisticatedly: if science is ultimately about finding the truth, all that counts is evidence. Whether it

[3] It is a popular historical myth that supernaturalism was a serious contender in biology until Darwin rendered the argument to design superfluous (McLaughlin 2008).

confirms the natural or points to the supernatural, we should follow the evidence wherever it leads (Fishman 2009; Monton 2009). Indeed, "… science differentiates only between known and unknown, or between explained and unexplained, not between natural and supernatural. Every phenomenon that can be studied using methods of inquiry based on evidence is legitimate in science" (Perakh and Young 2004, p. 189). I think this anti-metaphysical stance is importantly wrong because it rests on the assumption that both scientific methods and the evidence they produce are free of metaphysical presuppositions.

To show that there is quite a number of metaphysical postulates of science (Bunge 1983), we take a look at the three (overlapping) general empirical methods in science by means of which we gain data, which, in turn, may function as evidence: observation, measurement, and experiment. The question is whether these methods can work in a metaphysical vacuum, or whether their successful application rests upon certain metaphysical assumptions. In other words, could these methods work successfully in just any world, or can they work only in a world with a particular nature? A simple experiment chosen from a high school biology textbook will function as an example (Fig. 1, following Mahner 2007a, b).

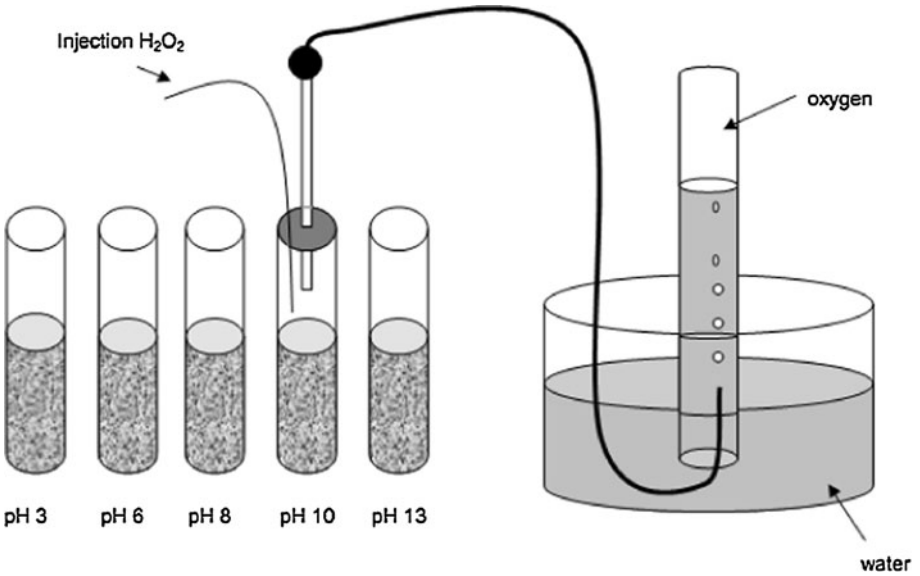

Fig. 1 By determining the pH-optimum of the enzyme catalase, this experiment is used to demonstrate that the functioning of enzymes is pH-dependent. The experimental set up is as follows. Five test tubes are halfway filled with water. We add a piece of yeast to each of them. By adding different amounts of hydrochloric acid (HCl) or caustic soda (NaOH), we arrange for a different acidity or alkalinity, respectively, in each tube, say, pH 3, pH 6, pH 8, pH 10, and pH 13. The yeast cells contain the enzyme catalase, which enables them to break down hydrogen peroxide into water and oxygen (i.e., $2\ H_2O_2 \rightarrow 2\ H_2O + O_2$). We inject a certain amount of hydrogen peroxide solution into the test tubes (by means of a syringe, for example). Each time we close the tube and measure the amount of gas produced after 2 min by collecting it in a measuring tube, which is connected to the given test tube by a thin rubber hose. We do not need to specify the precise amounts and conditions here, because the basic setup of this experiment will be clear anyway (redrawn and modified from Knodel 1985, p. 39). The result of this experiment: the oxygen production is highest at pH 8 (in fact at pH 8.5, which can only be discerned by refining the experiment)

Let us focus here on the question of how much metaphysics is hidden in this simple experiment, addressing possible objections mostly in footnotes so as not to interrupt the exposition.

First, we assume that this experiment involves real entities in a real world, not just objects existing in our mind. That is, we work on the basis of ontological realism, which helps to explain not only the success but in particular the failure of scientific theories.[4]

Now that we are talking real test tubes with real yeast and real chemicals, we may ask why an experiment like this is found in a textbook. Obviously, we assume that we can repeat this experiment as many times as we see fit, and that we will obtain (roughly) the same results, provided we do not make any mistakes. The gas produced is always oxygen, neither nitrogen nor carbon dioxide. The test tubes remain test tubes, and do not spontaneously transform into chewing gum or thin air. It appears then that things and their properties remain the same under the same conditions. Certain properties of things seem to be constantly connected, so that they change together: they are covariant. In other words: certain properties of things are lawfully related.

Of course, ordinary experience already indicates that the world is lawful, but the thesis of a lawful world is not a piece of empirical knowledge: it is a necessary condition of cognition. Without things behaving regularly due to their lawful properties, no organism would be able to learn much about the world. Note that what I am referring to here are laws in an ontological sense of lawfully related properties, not general law statements as conceptual representations of such ontic laws (Bunge 1979, 1983, 2006; Ellis 2002). This must be emphasized because the view that laws of nature are nothing but universal statements is still popular.[5]

Imagine next that we fail to obtain oxygen in our measuring tube. In this case we would look for mistakes in the setup, like a leakage in the rubber tube. We would check whether

[4] A very general ontological realism is probably the least controversial metaphysical presupposition of science (Bunge 1983, 2006; Alters 1997; Gauch 2009), although there is an ongoing realism/antirealism debate in philosophy. However, this debate concerns mostly epistemological problems regarding the justification of more detailed realistic claims such as the status of unobservable entities, the truth of scientific theories, etc. Thus, someone who rejects more specific forms of realism, such as scientific realism, usually is still an ontological realist. I shall not defend ontological realism in more detail here (for such a defense see, e.g., Vollmer 1990), because I submit that both ontological naturalists and supernaturalists share a basic realist outlook anyway.

[5] I sbumit that the mainstream view of laws in the philosophy of science is inadequate. Science calls for a (neo-)essentialist view of laws, according to which "the laws of nature are immanent in the things that exist in nature, rather than imposed on them from without. Thus, […] things behave as they do, not because they are forced or constrained by God, or even by the laws of nature, but, rather, because of the intrinsic causal powers, capacities and propensities of their basic constituents and how they are arranged" (Ellis 2002, p. 1). Thus, "not even an omnipotent God could change the laws of nature without changing the things on which they are supposed to act. Therefore, the idea that the laws of physics are contingent, and superimposed on intrinsically passive things that have identities that are independent of the laws of their behavior, is one that lies very uneasily with modern science" (Ellis 2002, p. 5). The lawful behavior of things neither entails that we can always represent them as law statements nor that every scientific explanation is a subsumption under some law. For example, due to the enormous variation of organisms, many biologists believe that there are no laws (= law statements) in biology. But this does not entail that organisms do not behave lawfully: it is just that it often makes not much sense to try to find general, let alone universal, law statements because their reference class is rather small, holding only for some subspecies, variety or even smaller units, for example; that is, only for those organisms sharing the same lawful properties (more on laws in biology in Mahner and Bunge 1997, Ellis 2002). Finally, even some cases of randomness are lawful because they are based on stochastic propensities such as in quantum physics. That is, there are probabilistic laws. For the neo-essentialist approach to laws adopted here see Bunge (1977), Mahner and Bunge (1997), and Ellis (2002).

the yeast is still alive, whether we have correctly set the pH value of the water, or whether the substance we add is really a hydrogen peroxide solution. No scientist would seriously entertain the idea that somewhere in the experimental setup the gas has literally dissolved into nothing. Conversely, no scientist would assume that we can produce gas out of nothing. There is simply no point in doing experiments and "wiggling parameters" if things simply could pop out of or into nothing. Let's call this the *ex-nihilo-nihil-fit* principle.[6]

What initiates the production of oxygen? Oxygen does not originate spontaneously: it starts to emerge only after we add some hydrogen peroxide solution. Thus, by meddling with certain parts of the setup, we can produce a certain effect: we can (causally) interact with the setup. Moreover, the steps in this chain of events are ordered: their sequence is not arbitrary. That is, we must assume that causation is for real and hence an ontological category, as well as that there is a principle of antecedence: causes precede their effects in time, so that the present is determined causally or stochastically by the past, but not conversely. In other words, we need to assume not only that the experimental setup (or the world in general) is real, but also that we can interact with it and that our actions can trigger orderly chains of events. Otherwise, no deliberate effect could be produced, variables could not be controlled for, etc.[7]

If the results of our empirical methods are expected to be the results of real processes in a real world, we must exclude the possibility that the experimental setup can be causally influenced in a *direct* way solely by our thoughts or wishes (or more precisely our thinking and wishing); that is, without the interposition of motoric actions of our bodies (Broad 1949). Indeed, if the world were permeated by causally efficacious mental forces, we would have no reason to trust the reading of any measuring instrument or the results of any experiment. In other words, the data obtained through observation, measurement, or experiment could not function as evidence if they were literally the telepathic or psychokinetic product of wishful thinking. Worse, we could not even trust our own perceptions and conceptions, as they could be the result of telepathic manipulation. We may call the

[6] Note that "nothing" really means "nothing", not some form of radiation or some other massless form of matter. For example, what is called particle annihilation is just a transformation of a particle with mass into one or more massless particles, that is, into some form of radiation. However, it seems that the ex-nihilo-nihil-fit principle is being challenged by cosmologists, who keep entertaining the idea that the universe originated from nothing (see, e.g., Stenger 2011). In particular, according to multiverse cosmology some primordial "nothing" keeps randomly popping out universes. But since this "nothing" has at least one property, namely the propensity to pop out universes, it doesn't seem to be a genuine nothing which should have no properties at all and hence be unable to change. Anyway, a metaphysically more satisfying statement is this: "…if you can't grasp the notion of tunneling from nothing, just think of our universe as having tunneled from an earlier one, a process that is already well understood" (Stenger 2011, p. 146). Finally, even if we had to make an exception for the origin, if any, of the universe, the metaphysical principle of nothing-out-of-nothing would still hold within the universe, until further notice. It may also be objected that the ex-nihilo-nihil principle is not really metaphysical, but an intrascientific conservation principle. However, as it occurs in many different scientific disciplines which share no common conservation theory, such as physics, biology and economics, it is a metascientific principle concerning a basic feature of the world.

[7] Since this is not the place to review the many concepts of causality, I shall not commit myself to a specific variant. All we need here is an ontological concept of causation, for instance, in the sense of some energy transfer between things (see, e.g., Bunge 1979, 2000, 2006). A possible objection to the antecedence principle is the fact that some physicists have considered the possibility of backward causation. But this only shows that not every formal consequence derived from a mathematical model need have a real or factual application (Bunge 2001). In any case, unless we encounter such causation, we may regard such talk as metaphysically misguided.

assumption that no such mental forces exist the "no-psi principle" (Bunge 1983, p. 106).[8] This principle must hold not only for humans but for any organism anywhere that is able to think. Neither humans nor little green aliens from another galaxy must be able to meddle, just by thinking alone, with empirical methods or our perceptional and conceptual processing of their results.

What holds for natural entities applies *a fortiori* to supernatural entities. We must stipulate, then, that no supernatural entity manipulates either the experimental setup or our mental (neuronal) processes or both.[9] We can even make the case that this holds not only for science, but for perception and cognition in general. Indeed, this "no-supernature principle" as we may call it, is also needed to avoid Cartesian skepticism. In his *Meditationes*, Descartes (1641) wrote:

> I will suppose, then, not that Deity, who is sovereignly good and the fountain of truth, but that some malignant demon, who is at once exceedingly potent and deceitful, has employed all his artifice to deceive me; I will suppose that the sky, the air, the earth, colors, figures, sounds, and all external things, are nothing better than the illusions of dreams, by means of which this being has laid snares for my credulity… (*Meditation* 1, §12).

Unlike Descartes, we no longer have reason to believe that the supernatural is dominated by an all-good God, who, by his very nature, would not only refrain from malicious manipulation, but even function as the guarantor of the truth of our cognition and thus our knowledge. Even in traditional Christianity there are many other supernatural entities than God, like devils, demons, and angels. Now add the many supernatural entities of other religions, and finally everything we can imagine. As the fantasy and horror movie genre shows, the possible inhabitants of supernature are only limited by our imagination. If we admit the supernatural, there is no reason to exclude a priori the existence of a malicious entity that could meddle with the world including our cognitive processes. So we need to start with the postulate that no such entities exist.

Let us summarize then the metaphysical—not methodological!—suppositions of the general empirical methods of science:

(a) ontological realism
(b) the (ontological) lawfulness principle
(c) the ex-nihilo-nihil principle
(d) the antecedence principle and an ontological conception of causation
(e) the no-psi principle
(f) the no-supernature principle.

I claim that whoever subscribes to empirical scientific methods and their function to generate evidence must also subscribe to these metaphysical principles. They are part of the ontology behind science's methodology. In a world that has these properties science is possible. But are these principles also necessary conditions, perhaps even a priori conditions? Or could the scope of at least some of these principles be somewhat restricted while science could still work successfully? In other words, are they just default principles? For example, the traditional metaphysical principle of strict causality (every event has a cause)

[8] The no-psi principle was one of Broad's (1949) so-called *basic limiting principles* of science. Being a strong believer in the paranormal, Broad maintained that this basic limiting principle had been refuted by parapsychology. However, Broad was fooled by the sloppy and partly even fraudulent parapsychological research of his time.

[9] This was already acknowledged by J.S.B. Haldane (1934), who stated that his "practice as a scientist is atheistic", that is, when he sets up an experiment he assumes "that no god, angel, or devil is going to interfere with its course" (p. vi).

has been shown by quantum physics to be false, because some events such as radioactive decay are spontaneous (uncaused). This is why a principle of strict causality is not part of the above list. And if the universe had popped out of nothing (however magical this would be), principle (c) would still hold within the universe. This suggests the possibility that some metaphysical principles could be revised. Similarly, it may be argued that even if the universe were initially created by a supernatural being, science would still be possible if there had been no further interventions since, or if the number of interventions were very small. As our focus here is ON, I shall not further address the principles (a)–(e), but turn right to this possible objection to the no-supernature principle.

3 Naturalism or Non-Interventionism?

I have just claimed that observation, measurement, and experiment must not be subject to supernatural manipulation because they would then lose their status as empirical methods for the generation of evidence. Does this really warrant a no-supernature principle? *Prima facie*, it does not, at least not without further ado: it seems to warrant at most a principle of non-intervention with respect to scientific research and cognitive processes. How, then, can we justify a no-supernature principle?

To see how, it will be helpful to take a closer look at the notion of non-interventionism. It may be tempting to analyze it as a conditional statement such as "If supernatural entities exist, they do not intervene in the course of the natural world". However, this would turn non-intervention into a necessary condition for the existence of the supernatural. Indeed, by contraposition, we would obtain the absurd statement, "If supernatural entities intervene in the course of the world, they do not exist". Therefore, we better analyze "non-interventionism" as the conjunction of two statements, namely "Supernatural entities exist & They do not intervene in the course of the natural world".

This analysis shows that while at first sight non-interventionism appears to be a reasonable minimal supposition, it is in fact not, because it presupposes the existence of supernatural entities. The first statement of the above conjunction, "Supernatural entities exist", cannot be a metaphysical supposition of science because there is no reason why science should postulate the existence of something that, by not intervening in the course of the natural world, plays no part in any scientific explanation of the world.[10]

Indeed, it is common practice in science to adopt the null hypothesis until there is evidence for an alternative substantive hypothesis. The null hypothesis usually negates that something is the case, such as that some thing exists or that two variables are related. Examples: "Junk food is not the cause of obesity", "Men and women do not perform differently in mathematical tests", or "The Loch Ness monster does not exist". In order to prove some substantive hypothesis, its corresponding null hypothesis must be refuted empirically. The null hypothesis approach is not restricted to science: it is also adopted in modern law where a defendant is presumed innocent until proven guilty. *Mutatis mutandis*,

[10] It may be argued that the principle of parsimony should be invoked here to distinguish between ON and supernaturalism. However, I submit that Ockham's razor must be combined with ON. Wouldn't a Berkeleyan world, in which there is but one infinite spirit (God) and some finite ones (humans) and where everything else is just appearances in these minds, be more parsimonious than a natural world with all its very complex things and processes? Or wouldn't occasionalism, according to which God is the cause of every event, be simpler than naturalism with all its manifold and complex causes? It seems that the application of the parsimony principle (a methodological principle) needs an ontological grounding, which should be ON. Only together do they make for a powerful tool.

the null hypothesis principle may—nay, should—be applied also in metaphysics, in particular when it comes to existential claims. For example, in the philosophy of religion, Antony Flew (1972) was the first to suggest defining "atheism" in this sense, although he did not use the scientific term "null hypothesis". An atheist, then, is not someone who positively and dogmatically denies the existence of gods, but someone who just adopts the "presumption of nonexistence" as a court of law adopts the presumption of innocence. Correspondingly, one way to conceive of ON is as a metaphysical null hypothesis, stating that a supernature does not exist.

Of course, there is an important difference between scientific and metaphysical null hypotheses. In contradistinction to scientific statements, metaphysical ones are usually regarded as unfalsifiable by direct empirical evidence. This distinction at least was the upshot of both the neopositivists' and Popper's demarcation efforts. If we disregard the neopositivist view that metaphysics is untestable because it is nonsense, and thus accept Popper's distinction for the time being, we can say that at least some metaphysical hypotheses can be refuted (or, more cautiously, disconfirmed) *indirectly*, for example, by turning out to be incompatible with scientific practice, or in being unable to explain it. For example, science could fail as a cognitive enterprise, either in its entirety or in some particular area, so that we might have to reconsider ON. But before we can examine the testability problem (Sect. 5), we must take another look at the metaphysics of the natural and supernatural.

4 The Metaphysics of the Natural and the Supernatural

In Sect. 2 I have summarized some general metaphysical principles of science. However, these general principles do not exhaust the metaphysics of science. In fact, a proper ontology of science should offer a theory of metaphysical categories such as substance, property, thing, event, process, kind, etc. (In this paper I use "metaphysics" and "ontology" synonymously.) In its attempt to clarify such concepts modern analytic ontology has come up with many different and, well, more or less useful answers and approaches. Let us take a quick look at one of the most promising ontological theories: the ontology of Mario Bunge (1977; for condensed versions see Mahner and Bunge 1997; Bunge and Mahner 2004). Whether or not one accepts this ontology, it serves as an example to help us understand the problems with a supernaturalist metaphysics.

Figure 2 illustrates the basic logical structure of Bunge's ontology. The central concept is that of a (material) thing, which, quite traditionally, is based on the notion of property and substance (the bearer of properties). What is considered real is neither a substance (or bare individual) nor properties in themselves: only the propertied substance, that is, a thing, is an autonomously real object. Properties can be intrinsic or relational, accidental or essential, absolute or relative, etc. Some of the essential properties of a thing are its laws. The set of properties of a thing (at a given time) determines the state of a thing (at that time), and the lawful properties of a thing determine its actually possible states (as opposed to its logically possible states), so that the behavior of material things is constrained by their lawful properties.

Things can be either simple or complex (consisting of parts). Unlike elementary particles, most things are of course complex: they are systems. Things can undergo changes of state (events) or sequences of events (processes) or entire trajectories (histories). Things interact by causing changes of state in each other, which involves a property that every material thing possesses: energy (Bunge 2000). Changes can be quantitative (only the

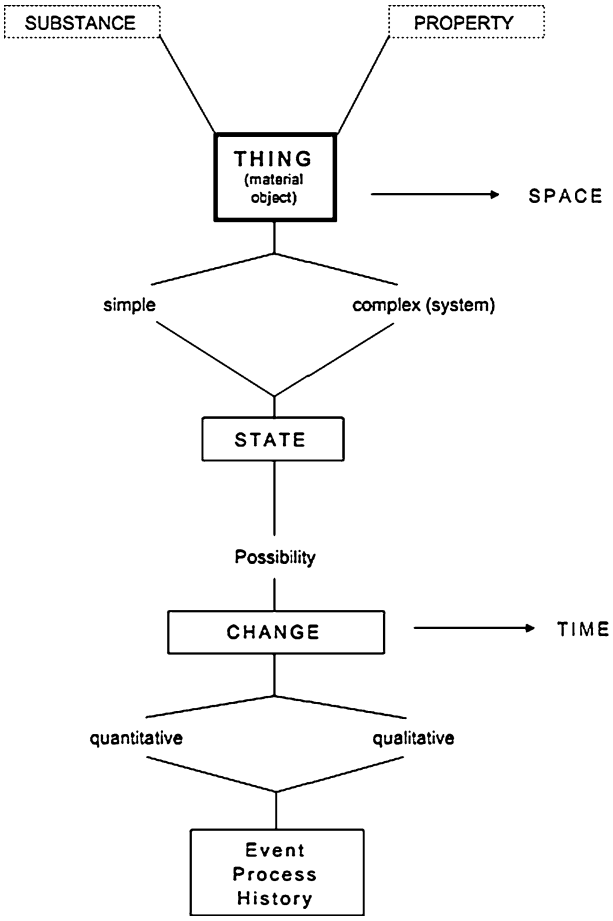

Fig. 2 The basic structure of Mario Bunge's ontology (modified from Bunge and Mahner 2004). The figure is to be read from *top* to *bottom*, and the nodes are to be understood in the sense of a logical or definitional precedence, that is, a given concept at a certain level is defined with the help of the preceding concept(s). For example, the concept of a state is logically prior to the concept of an event

value of the property changes) or qualitative (new properties are acquired, or existing properties are lost). Space and time are neither things nor containers of things: spacetime is the relational structure of separated and changing things.

Of course this is not the place to expound and examine the reasons for this ontological conception, or to defend it against alternative ontologies (for example, ontologies which consider things as bundles of properties and thus dispense with the concept of substance, or which claim that processes are more fundamental than things, and so on). The point is to show that a modern metaphysics involves more than just a collection of general principles: it should come as a comprehensive theory of ontological concepts, compatible with the results of science.

Bunge's ontology exemplifies what has been called "the new essentialism" (Ellis 2002). In fact, in my view it provides a full-fledged ontological foundation of neo-essentialism, which may be better called *nomological* or *scientific essentialism*.

Whereas the general features of the material world can be described by an ontological theory proper, the question arises whether this is also possible for the supernatural. Now, one may be tempted to point to the elaborate efforts of Scholastic metaphysics at coming to terms with the supernatural. However, even Scholastic metaphysics was far from being a

rigorous ontological theory, and it has become obsolete long time ago for being incompatible with modern science (see, e.g., Matthews 2009).

There are several reasons why it is doubtful that there ever will be a proper ontological theory of the supernatural. Recall the metaphysical principles of science listed in Sect. 2. It seems the supernatural can be characterized by simply negating most of these principles. Thus, a supernatural entity would be one that:

- may be able to create things out of nothing or annihilate them;
- may not be subject to the antecedence principle in that it could make past events undone or change the natural sequence of events;
- may not be subject to the lawfulness principle because it may be able to change the lawful properties of (natural) things or the lawful course of (natural) events; in particular,
- may be able to influence (or to manipulate, if not fully control) natural things, including thinking entities and their perceptions and conceptions.

This is essentially what is behind the common characterization of a supernatural entity as one that has magical abilities and can thus perform miracles. Whether or not supernatural entities are subject to any supernatural laws (whatever these may be) is irrelevant here. All that matters is that, in principle, they could be able to interfere with the lawful course of natural events, hence also with our brain functions. This is why a supernaturalist ontology invites (and maybe even entails) a non-naturalist epistemology and methodology in which special forms of cognition, such as revelation, religious experience, a *sensus divinitatis* or whatever non-natural ways of communication with the supernatural may obtain, are accepted as legitimate sources of knowledge and means of justification. For example, Plantinga (2001) defends the view that there is no reason why a Christian should not make use of such religious methods in science. Plantinga's example illustrates that methodology is not free of metaphysics. It comes as no surprise therefore that accommodationist scientists and philosophers, who reject ON to make room for religion yet at the same time want to keep supernaturalism out of science, struggle hard to make a consistent case (see Sect. 7).

That the supernatural is characterized mostly, if not exclusively, in negative terms has been shown in more detail by Spiegelberg (1951). Even *prima facie* positive attributes turn out to be negative ones in that they are just denials of known natural characteristics. For example, "transcendence" is the negation of "immanence", that is, *not* being "located" within the confines of our spatiotemporal world. Or, being a first cause is nothing but being an *uncaused* cause. And the few positive attributes such as omnipotence or omniscience are actually natural properties raised to an absolute degree. In this regard they are not fully supernatural—a statement that may require some elaboration.

Spiegelberg distinguishes two conceptions of the supernatural, quantitative and qualitative. In the former case supernatural entities are ascribed properties that differ from the natural only in degree, though often to an absolute degree. For example, a supernatural entity is more powerful than a natural entity, perhaps even all-powerful; or more knowledgeable, perhaps even omniscient.[11] The attributes of supernatural entities are then still conceived of on the basis of familiar natural properties. Thus, such conceptions are more or less anthropomorphic, which suggests that the quantitatively supernatural, if any, would still have to be spatiotemporal. By contrast, according to qualitative

[11] Despite many theological defenses, the notions of omnipotence and omniscience are incoherent (Martin 1990), so that we have reason to reject characterizations of the supernatural that employ them.

supernaturalism, supernatural entities are *categorically* different from natural ones, so much so that their properties are essentially mysterious, ineffable, incomprehensible. God, then, is the *Wholly Other*, not someone or something to be understood even by the faintest analogy with anything known natural. Spiegelberg called these two types of the supernatural *overnatural* and *transnatural*, respectively (1951, p. 343). Whereas the overnatural seems to be somewhat intelligible by analogy with known natural properties, the transnatural is incomprehensible. To obtain or retain a modicum of intelligibility, conceptions of the supernatural usually combine overnatural and transnatural features. This allows the believer to oscillate between these two conceptions, depending on his argumentative needs. Modern theology tends to reject a merely overnatural conception of the supernatural as being too anthropomorphic, and seems to prefer a more "sophisticated" conception of the supernatural in terms of the transnatural. Yet the transnatural is defined but negatively.

Without positive predicates, however, we have neither a concept of a supernatural thing, nor of a supernatural state, nor of a supernatural change. Nor do we know whether the behavior of supernatural entities is constrained by lawful properties. For example, if a supernatural entity could be omnipotent, it seems there are no such constraints. Without the concept of change, in turn, we have no concept of supernatural causation. We do not know what it means to say that a supernatural entity thinks or decides something, let alone *does* something, because all this presupposes some form of change, if only in some immaterial mind. But then again, we have no formal ontological (as opposed to an ordinary language) concept of change in immaterial, if natural, entities either, which is one of the reasons that an ontology of science is actually restricted to material objects. In other words, science is based not just on ON, but on ontological materialism (Bunge 1977). However, this thesis is not subject of this paper.[12]

I suggest that, in the sense of an axiomatic definition, the natural can be characterized positively as anything that is analyzable or describable in terms of the metaphysical theory sketched in this section.[13] If the quantitatively supernatural could be analyzed thus too, it would ultimately be incorporated into (or be reduced to) the natural. But such prospects are rather doubtful because, as we just saw, lawfulness and superpowers do not seem to go well together. What is doubtful in the case of the overnatural appears to be insurmountable in the case of the transnatural, so much so that any metaphysics of the transnatural is just handwaving and speculation. There neither is an ontological theory proper of the transnatural nor could there be, because there can be no theory of the unintelligible. And if the supernatural has both overnatural and transnatural features, it will also remain beyond the scope of any metaphysical theory proper.

The extraordinary, if not insoluble, ontological problems of the supernatural have consequences for the testability and the explanatory power of the supernatural.

[12] I submit that the difference between naturalism and materialism concerns the status of abstract objects. If abstract objects really existed as immaterial things, perhaps somehow interacting with our mind, then they would be part of the natural world. By contrast, according to Bunge's materialism, abstract objects do not exist independently of thinking organisms: they are at best constructs or fictions, and thus part of the real world only via their tokens in thinking brains (see, e.g., Bunge 2006; Bunge and Mahner 2004).

[13] This makes room for abstract objects as the contents of thinking brains, and for the mental as being an emergent or, if preferred, supervenient property of highly complex neuronal systems.

5 Testability and the Supernatural

> There is no way of making any valid deductions from supernatural principles to their natural consequences as long as we have only negative concepts of the former. (Spiegelberg 1951, p. 356)

If ON is a metaphysical presupposition of science, science should be unable to deal with anything supernatural. By contrast, if one believes that science is free of metaphysical presuppositions, the answer to the question of whether the supernatural is testable is quite simply affirmative. For example, if angels descended from the sky and raised the dead, or if studies on the effects of intercessory prayer yielded significant positive results, we would have empirical evidence for the supernatural, and hence a valid test. (In the first case, we would have *direct* evidence, in the second case *indirect* evidence.) While many authors agree with this view (e.g., Augustine 2001; Stenger 2007; Fishman 2009; Monton 2009; Boudry et al. 2010), others maintain that the supernatural is untestable as a matter of principle (e.g., Spiegelberg 1951; Pennock 2000, 2001; Forrest 2000). I submit that this disagreement can be explained by the distinction between the overnatural and the transnatural.

Those who maintain that the supernatural is testable seem to conceive of the supernatural as merely overnatural. That is, the supernatural is intelligible to a certain degree because its properties are not actually categorically different from natural properties: overnatural entities are more or less superpowered entities with quasi-natural properties. By contrast, those who believe that the supernatural is untestable seem to regard the supernatural as transnatural and hence as categorically different from anything known natural—which makes it both inaccessible and unintelligible, and thus untestable.

But let us first take a look at the two central concepts of this debate, testability and evidence. In the broad sense, a statement, a hypothesis, a model, or a theory is empirically testable if there is empirical evidence for or against it (Bunge 1983), whereby the evidence e is another statement—a datum—that is relevant to the hypothesis h (or model or theory) in that e either confirms or disconfirms h. Now both e and h must be semantically meaningful (nonsense is untestable), and they must not be logical truths or falsities. For some evidential statement e to be relevant to some hypothesis h, e and h must share at least one referent or, if preferred, one predicate. For example, data about the crime rate in Australia in 2011 are irrelevant to quantum theory, because the data and the theory are not (partially) coreferential. Last but not least, we must demand that e has been acquired with the help of empirical operations that are accessible to public scrutiny, and—here enters metaphysics—both the empirical operations and our cognitive processes involved in the perception and processing (interpretation and evaluation) of the data gained by these operations must involve only natural processes—that is, they must not be the result of supernatural manipulation.

So for there to be some evidence e about the supernatural, e would have to share at least one predicate with the respective hypothesis h referring to some supernatural entity. This, in turn, would require that the supernatural referred to in h possesses at least one property that can be represented by a meaningful (positive) predicate—which could only be a natural or quasi-natural property. But this is possible only if the supernatural is conceived of as *not* qualitatively or categorically different from the natural. For example, if we found reproducible significant positive effects of intercessory prayer, and if these empirical data were supposed to function as evidence for a hypothesis involving a supernatural being as the cause of this effect, the supernatural entity referred to would have to be able to "listen" to prayers, if only telepathically (however this would work), and understand and consider

them in a way that is analogous to a human person listening to the requests of others and considering them on the basis of his or her background knowledge including a code of ethics. It is not intelligible how some solely negatively characterized transnatural entity should be able to do any of that; worse, we would not even know or understand what it means that any such entity *does* anything. For this reason, I submit that there could be evidence at most for the more or less anthropomorphically defined overnatural, so that only the overnatural may be testable in the broad sense.

Therefore, Pennock (2000, 2009) is right when he says that for the supernatural to be testable it would have to be understood in a naturalized way, and the supernatural would have to be able to partly naturalize itself (or simply be natural to begin with) so as to interact with the natural world. If some process were actually transnatural, we could not observe it, however indirectly. Think of transsubstantiation. Or think of the theological concept of continuous creation, according to which everything is constantly recreated *ex nihilo* by God, from moment to moment, and thus sustained in its existence. Continuity of existence is therefore just an appearance, whereas the reality behind it is a continuos transnatural intervention.

However, we still have to consider the last condition of evidence mentioned above, namely the one that prohibits supernatural manipulation. Even if some empirical data fulfilled the formal conditions of evidence—provided the supernatural is construed as overnatural—we are still faced with the paradoxical situation that the empirical operations employed to produce such evidence presuppose the nonexistence of the very entities whose existence is supposed to be confirmed by this evidence. It may be tempting then to retreat to a principle of non-intervention with regard to our cognitive processes. But on what grounds could we defend non-interventionism? Of course, we could come up with various ad hoc assumptions. For example, the powers of the supernatural entities involved could somehow be limited, God could guarantee local non-interventionism with regard to our cognition, or God could even be the ultimate cause of our cognition and thus guarantee its correct functioning. But would it be epistemically warranted to accept any of these ad hoc contrivances, unless they are independently testable, that is, unless they are more than just logical possibilities? I don't think so.

For this reason it may be better to reconsider whether it would be legitimate to even accept such evidence as genuine rather than just as a *prima facie*. To see why, let us take a look at the usual inference patterns of confirmation and disconfirmation, using the example of a supernatural creator. If a supernatural creator x has property P, the world y should have (a somehow detectable) property Q. Now Q is either observed or not. If Q is not observed, we conclude by *modus tollens* that x does not have P. If P is considered a necessary property of x, we can further conclude that x does not exist. For example, if God is by definition all-good and there is evil in the world, he is not only not all-good but he cannot even exist. But note that all we do here so far is to draw conclusions about what the supernatural is *not*, which adds to the fact that it is mostly characterized in negative terms. Needless to say, it is the sole purpose of theological apologetics to come up with protective ad hoc hypotheses to obviate such falsifications. One of them is the assumption that God's goodness is not to be understood in quasi-natural terms, which would make him a merely overnatural entity that we can still somehow comprehend, but in terms of a completely different "goodness", which accommodates what normal human beings would consider atrocities. This turns God into a transnatural entity, so that claims referring to such an entity become untestable.

Now if property Q is in fact observed in y, the statement that x has P (or that x exists) is confirmed, but as is well known, this is not a valid conclusion: it is the fallacy of affirming

the consequent. As the antecedent is not necessary for the consequent, the observation of *Q* is compatible with alternative causes or explanations, respectively. For example, if there were reproducible evidence that intercessory prayer works, there would be several alternative natural hypotheses compatible with the evidence, such as a telepathic mechanism causing the healing or a superior alien civilization playing a prank on us. In the philosophy of science this is known as the problem of underdetermination. Whereas in science underdetermination is an overrated problem because it can often be overcome in practice (Devitt 2011), it remains a problem for supernatural hypotheses. After all, in science it is metaphysically innocuous that for some evidence *e* there are several alternative hypotheses consistent with *e*, because due to ON all these alternative hypotheses refer to natural entities or processes. In the case of a hypothesis referring to a supernatural entity, however, there are also alternative *natural* hypotheses compatible with *e*, even if they are as outlandish as the alien prank hypothesis. So would *e* ever be good enough to make us opt for something that is even more outlandish for involving a supernatural entity, including the scientific and metaphysical revolution that would come in its wake?[14]

The answer depends on the question of whether hypotheses involving supernatural entities are acceptable as scientific explanations. After all, if there were evidence for a supernatural hypothesis *h*, *h* would have to be able to explain the data at hand. Which brings us to the next section.

6 Naturalism and Scientific Explanation

Scientific theories are assessed (amongst others) with respect to their explanatory power. A scientific theory is expected to explain a certain fact or domain of facts. That is, it is supposed to tell us how something came about or how something works. In so doing it employs law statements or reference to mechanisms (Bunge 1983, 2006; Mahner and Bunge 1997). For example, a theory of photosynthesis informs us about the physiological processes (mechanisms) by means of which plants use light to transform carbon dioxide and water into carbohydrates and oxygen. These mechanisms are specific enough to explain what they are supposed to explain. Thus, they cannot be used to explain, for example, how birds fly or how earthquakes occur, because the respective laws and mechanisms are quite different. Do theories referring to supernatural causes or entities comply with this requirement?

They do not—even if we focus on the supernatural in the sense of the overnatural because transnatural entities devoid of positive properties are incomprehensible and hence non-explanatory anyway. At first sight, invoking an overnatural cause to account for some fact does seem to have explanatory power. For example, intelligent design creationists

[14] To answer this question, some readers may expect that we turn to confirmation theories such as Bayesianism, which is widely believed to allow us to assess the "probabilities" of the hypotheses involved. However, as an objectivist, I am ignoring these methods here because they operate with subjective probabilities. I concur with Bunge's criticism of Bayesianism that the probability calculus is not the correct means for formalizing concepts such as plausibility, credence, degree of confirmation, or approximate truth, or whatever the "probability" of a hypothesis is supposed to be (Bunge 2006). Moreover, even if Bayesian methods and their like were legitimate, they could only be applied if we had admissible evidence in the first place, and it is exactly the (in)admissibility of alleged evidence for the supernatural what is at issue here. However, this is not the place to go deeper into this matter. See Fishman (2009) for a defense of Bayesianism as a means of evaluation of supernatual hypotheses, and Sober (2009) for likelihood considerations concerning the argument form design. For a criticism of Sober's approach, see McLaughlin (2008) as well as Boudry and Leuridan (2011).

claim that the theory of evolution cannot explain how certain complex organs have originated. So they invoke a supernatural entity, an intelligent designer (who allegedly need not be, but is in fact considered to be God himself) who either created the organ or at least helped to accrue the given complexity. This answer appears to have explanatory power because, by analogy with human handicraft, we all understand what creating or developing artifacts is about. Yet in fact it explains nothing because it explains too much. The problem is that an answer like "God made it the way it is" can be applied to all facts.[15] Whatever exists and whatever happens can be explained thus by reference to the will and actions of some supernatural entity. But an explanation that explains everything explains nothing.[16] Thus, supernatural explanations explain nothing because they are omni-explanatory. Moreover, they put an end to further inquiry because they are ultimate: "For example, even if one believes that science explains how life came about in terms of physical–chemical process Z, inquiry would be closed by saying that God directly created Z" (Martin 2002).

The all-purpose God-did-it explanation is not something naturalists have come up with to ridicule supernaturalism. As a matter of fact, the philosophical doctrine of *occasionalism* seriously held that God is the cause of each and every event because matter is passive and cannot change or bring about anything on its own.[17] If occasionalism, assuming 100% supernatural causation, were true, there would be no need for natural explanations at all: a single supernatural cause would explain everything. So why do supernaturalists not adopt occasionalism? Why is science allowed to come up with natural explanations in some cases, but not in others? It seems that since the naturalist approach of science has been so successful, many supernaturalists have conceded its explanatory power and retreated to a god-of-the-gaps approach.[18]

Even some philosophers defend this view (e.g., Monton 2009), claiming that it is legitimate *in some cases* to fill an explanatory gap with a supernatural explainer, and that this would refute the charge that supernaturalist explanations are omni-explanatory. However, it is doubtful that this rejoinder works. After all, supernaturalist explanations come with two proliferation problems. First, if we admit one supernatural entity into the explanatory realm of science, we are on a slippery slope to admitting as many as we fancy (Kanitscheider 1996). Christian creationists, for example, will of course tell us that the number of supernatural entities is limited by scripture. But if science admits entities from the biblical cosmos, nothing prevents it from admitting entities from other religions as well. There is no a priori reason why a Christian supernatural entity is a better explainer than a Hindu one, for example. The more supernatural explainers we get, however, the closer we get to omni-explanation again. Second, even if science were able to incorporate the overnatural into its explanations, how do we know that reference to such entities

[15] More on the problems of supernaturalist explanations in Pennock (2000), who also explores the consequences of supernaturalism for the legal system, which would have to reconsider the-devil-made-me-do-it arguments including historically superseded forms of evidence based on "higher insights" and revelations.

[16] Note that the famous "theory of everything" in theoretical physics is a misnomer, because it would not explain everything. It would just offer a unified theory of the fundamental forces of physics. But this would not even begin to explain all the emergent properties of higher-level systems.

[17] This is the broad sense of occasionalism. In its narrow construal God only causes the bodily reactions of our mind, which was assumed to be immaterial. And even back then it was known that the immaterial cannot interact with the material. So an intermediate entity was needed to causally bridge the material (body) and the immaterial (mind).

[18] Those supernaturalists who dislike the god-of-the-gaps approach for theological reasons, have retreated to a transnatural conception of the supernatural, which is immune to any empirical refutation.

provides final explanations? If science could study the overnatural (so that reference to the supernatural would not be a science stopper), what would happen if we encountered explanatory gaps in the overnatural world too? The analogous procedure would be to resort to super-supernatural entities to fill these gaps in the first-order supernatural world—and so on, possibly *ad infinitum*. Just think of the famous question, "Who created the creator?".

In any case, there is another and perhaps better reason for rejecting supernatural explanantia than their omni-explanatory power. As we know nothing about the laws and mechanisms, if any, of the supernatural, we better argue that supernatural explanations explain nothing, not because they are omni-explanatory but because they are pseudo-explanatory. Indeed, to explain the unknown by means of something even more unknown and, worse, something magic and occult, is an argumentative flaw known as *ignotum per ignotius* or *obscurum per obscurius*. Of course, believers in the supernatural may object that they do know something about the supernatural, for example, by reading sacred texts, by revelation or by some special form of experience. However, all these "methods" do not meet epistemological standards for something to count as a source of knowledge (Mackie 1982; Martin 1990; Forrest 2000). For this reason, appealing to the supernatural for explanatory purposes is tantamount to saying that we do not know how a certain fact works or has come about. Supernatural explanations are therefore *argumenta ad ignorantiam*: appeals to ignorance (see also Smith 2001). Thus, they cannot, as Clarke (2009) claims, function as inferences to the best explanation: proposing a pseudo-explanation is an inference to the worst explanation.

For those who believe that filling explanatory gaps with supernatural entities is a legitimate instance of an inference to the best explanation, hypothesizing supernatural entities is analogous to postulating unobservable (or theoretical) entities in science. However, this idea faces several semantic, methodological, and ontological problems.

In science we must be willing to endow theoretical entities with a definitive set of properties. We cannot infer a best-explaining entity whose properties vary arbitrarily (Kanitscheider 1996). Yet this is exactly the case with concepts of supernatural entities, in particular the concept of God, which is of course the most employed concept in supernaturalist explanations. Indeed, the properties of "God" vary from theologian to theologian, from tradition to tradition, even from believer to believer, so much so that "God" in theology *A* may have properties contradictory to the ones of "God" in theology *B*. A historical example is the God of Leibniz and Newton (Kanitscheider l.c.). Whereas Leibniz's God has set up the laws of nature at the beginning so that the world has been functioning without intervention ever since, Newton's God had to intervene more or less often in the natural world in order to adjust some imperfections. Thus, both a perfectly lawful and an imperfectly lawful world can be explained by reference to God. Whatever the factual evidence, then, some concept of God can always be applied.[19]

This is not to say that "God" is meaningless in the ordinary language of a certain group, because everyone has a rough idea of what "God" means in his or her religious tradition, in

[19] It may be argued that the variation in the meaning of "God" is not problematic, because scientific concepts often start out with fuzzy and variable meanings too. Think of terms like "gene" or "atom". However, the variations in the precise meanings of these concepts are adjustments guided by empirical research and theory development. These concepts could be made precise enough to even get hold of their referents: today genes can be sequenced, and atoms can be photographed. The various concepts of God, by contrast, are not constricted and guided by empirical research, so there is no improvement in the sense of an approximation to reality. The conceptual "development" in theology is purely apologetic in that the traditional overnatural concepts of God have been transformed into transnatural ones, so that they can no longer conflict with science, or anything factual for that matter.

particular since these traditions employ rather anthropomorphic and thus overnatural conceptions of God. But this meaning is very restricted, as it is well known that religious sects have fought each other to death over the proper meaning of "God". However, being possibly meaningful locally and in ordinary language terms is not enough to qualify as a legitimate scientific concept, and not even as a philosophical one. As Flew (1972) put it:

> Where the question of existence concerns, for instance, a Loch Ness Monster or an Abominable Snowman, [the introduction and defense of the proposed concept] may perhaps reasonably be deemed to be more or less complete before the argument begins. But in the controversy about the existence of God this is certainly not so: not only for the quite familiar reason that the word 'God' is used—or misused—in many different ways, but also […] because it cannot be taken for granted that even the would-be mainstream theist is operating with a legitimate concept which theoretically could have an application to an actual being.

This is important to remember because some scientists and oddly enough even some philosophers (like Monton 2009) seem to be so naive to think that the very use of the word "God" already amounts to postulating a legitimate theoretical entity with explanatory power. But it must first be ascertained that a sentence like "God caused some *x*" is more informative than "Tok caused some *x*" (Nielsen 1985). Assuming for the sake of the argument that it is possible to make "God" more informative than "Tok" and thus turn it into a meaningful theoretical concept and also into one whose meaning does not vary arbitrarily, an explanation referring to this God would still be arbitrary. For example, the origin of a complex organ such as the vertebrate eye may be explained by reference to some creative intervention by God. But in fact reference to any other supernatural entity would do the same explanatory work, be it a devil, an angel, a demon, or whatever. After all, we know nothing about the possible powers and intentions of such entities. So we have no empirical means for deciding among competing supernaturalist explanations (Augustine 2001). The only commonality supernatural explanantia for some fact *x* seem to share is this: some supernatural entity chose to do *x* for unknown reasons. This is hardly superior to "we do not know what caused *x*".

For all these reasons, postulating supernatural entities is *not* analogous to postulating theoretical entities in science. The semantic fuzziness, if not arbitrariness, of supernaturalist terms makes them useless as scientific concepts.

In sum, the semantic and ontological problems of supernatural concepts and statements affect both the concepts of evidence and explanation. Even if there were highly anomalous data, they would not constitute evidence for the supernatural unless there were scientifically meaningful statements about the supernatural in the first place. Until then, such anomalous data could not be explained as the results of some supernatural intervention. For example, a sentence such as "Due to its complexity, the human eye was intelligently designed by a supernatural creator" is at first sight meaningful by analogy to human design and creation. But even when applied to the merely overnatural, it is no longer clear what "intelligence", "design" and "creation" actually mean. Indeed, as Sarkar (2011) has shown, Intelligent Design "theorists" are unable to offer coherent and positive specifications of these concepts. This does not preclude that some overnatural concepts could be made more precise, but it shows that the road to evidence for the supernatural and the supposed benefits of its explanatory power are much rockier than the accommodationists believe.

In this and the preceding section we have examined several semantic and methodological reasons for adopting ON. It is perhaps the many methodological reasons which lead to the popular view that science is not based on ON but only on *methodological* naturalism. Let us see how this thesis fares in the light of our preceding analysis.

7 Metaphysical Versus Methodological Naturalism

In the philosophical context of the evolutionism/creationism controversy as well as in science education, which is concerned with *nature of science* issues, it has become common practice to distinguish methodological naturalism (henceforth: MN) from ON, and to claim that the former, not the latter, is a philosophical assumption of science. Regrettably, however, the characterizations of MN that we encounter in this debate are less than clear, so much so that we must guess what exactly MN is and how it differs from ON. Before I substantiate this charge by taking a look at some of the most common definitions, it is important to realize that in this context "MN" is used in a non-standard way.

In philosophy, the standard meaning of "MN" is that philosophy ought to embrace the results of science and use some of its methods (weak MN), or that there is no unique philosophical method at all because only the methods of the natural sciences produce genuine knowledge (strong MN or strong scientism). In other words, weak MN states that science and philosophy are essentially continuous in that they pursue similar tasks with similar means, whereas strong MN leaves not much to do for philosophy. (For further varieties of naturalism see, e.g., De Caro and Macarthur 2008) By contrast,

> [i]n some philosophy of religion circles, 'methodological naturalism' is understood differently, as a thesis about natural scientific method itself, not about philosophical method. In this sense, 'methodological naturalism' asserts that religious commitments have no relevance within science: natural science itself requires no specific attitude to religion, and can be practised just as well by adherents of religious faiths as by atheists or agnostics (Papineau 2007).

It is only this second meaning of "MN" that is relevant here, and it is this conception that in my view is ill-understood. The main problem is that it is unclear whether this MN actually is about scientific method rather than the metaphysics of science; in other words, whether it is a methodological (and hence an epistemological) view proper, or whether it is just a covert metaphysical position, that is, a disguised form of ON. To illustrate this problem, let us take a look at some common definitions.

Pennock (2001) characterizes ON thus: "The Ontological Naturalist makes a commitment to substantive claims about what exists in nature, and then adds a closure clause stating 'and that is all there is'."(p. 84). By contrast:

> [t]he Methodological Naturalist does not make a commitment directly to a picture of what exists in the world, but rather to a set of methods as a reliable way to find out about the world—typically the methods of the natural sciences, and perhaps extensions that are continuous with them—and indirectly to what these methods discover. (Pennock, 2001, p. 84).

A commitment to method indicates that MN is epistemological. This is seconded by Forrest (2000), who tells us that MN is "an epistemology as well as a procedural protocol". Michael Ruse, by contrast, includes also ontological assumptions (lawfulness):

> On the one hand, one has what one might call 'metaphysical naturalism': this indeed is a materialistic, atheistic view, for it argues that the world is as we see it and that there is nothing more. On the other hand, one has a notion or a practice that can properly be called 'methodological naturalism': although this is the working philosophy of the scientist, it is in no way atheistic as such. The methodological naturalist is the person who assumes that the world runs according to unbroken law; that humans can understand the world in terms of this law; and that science involves just such understanding without any reference to extra or supernatural forces like God. Whether there are such forces or beings is another matter entirely and simply not addressed by methodological naturalism. Hence… in no sense is the methodological naturalist… committed to the denial of God's existence. It is simply that the methodological naturalist insists that, inasmuch as one is doing science, one avoid all theological or other religious references. (Ruse 2001, p. 365).

Ruse's characterization reveals the main motivation behind MN: to assure the religious believer that science and religion are compatible. Thus, the nonexistence of the supernatural (or rather its positive complement, ON) is not among the metaphysical presuppositions of science, it is just prohibited to refer to it. MN, then, boils down to the methodological rule, "Do not refer to anything supernatural!". The assumption of lawfulness, by contrast, is an ontological postulate. So Ruse's MN combines ontological and methodological aspects.

Even more ontological is another characterization of MN by Pennock:

> MN holds that as a principle of research we should regard the universe as a structured place that is ordered by uniform natural processes, and that scientists may not appeal to miracles or other supernatural interventions that break this presumed order. Science does not hold to MN dogmatically, but because of reasons having to do with the nature of empirical evidence (Pennock 2009, p. 8)

Now, assumptions about the nature, structure and workings of the world are metaphysical, not epistemological, even if most of the reasons for them are based on methodology. Moreover, Pennock's emphasis on MN as being nondogmatic, indicates that in "MN" the adjective "methodological" could have a different meaning than the standard one, which is in the sense of methodology as normative epistemology, that is, the branch of epistemology which is concerned with the justification of beliefs and knowledge, the evaluation of methods, etc. The standard adjective "methodological", then, classifies a position as epistemological—in contradistinction to adjectives describing some other philosophical category, such as a logical, semantical, ontological, or ethical. Another usage of "methodological", however, is in the sense of "provisional", "tentative", or "hypothetical". In this sense "methodological" (sometimes also just "methodical") indicates either that the position in question is not regarded as an a priori truth, or that it is not held dogmatically. Just think of the view that science exhibits *methodological conservatism*, that is, scientists stick to their theories even if there is some falsifying evidence against them (Bunge 1983). In other words, they do not behave like strict falsificationists. However, this is not a form of dogmatic conservatism but only a provisional strategy to go with the best we have as long as there is no better alternative available.

Consequently, there are at least two interpretations of MN:

1. MN is a genuine methodological/epistemological view, not an ontological one.
2. MN is an ontological position, namley ON, but it is held provisionally rather than dogmatically.[20]

In the light of what I have said about ON in this paper, only the second interpretation of MN is acceptable, although it would turn the name "MN" into a misnomer.[21] The preference of "MN" over "provisional ON" could be due to the prejudice that everything metaphysical is dogmatic. While traditional, and in particular religious, metaphysics often was dogmatic indeed, this is no longer true of a modern science-oriented metaphysics, which is fallible (Bunge 1977). And even if modern metaphysics still were an a priori discipline, as some authors maintain (e.g., Lowe 2011), its rationalist claims would not be

[20] MN in the first sense can be held either dogmatically or provisionally. In the latter case we may provocatively propose the name "methodological methodological naturalism", so as to point out the double meaning of "methodological". Note also that Boudry et al. (2010) distinguish intrinsic MN (in the sense of a defining feature of science) from provisional MN. The latter would be what I have just called methodological MN. Here I defend provisional ON as an intrinsic feature of science.

[21] Scott (1998) is one of the few who seem to share this view, as she speaks of "methodological materialism" rather than MN. Since materialism is obviously metaphysical, "methodological" in this case can only mean "provisional".

dogmas. (Analogy: That $2 + 2 = 4$ is not dogmatic.) This needs to be emphasized because some authors seem to confuse "a priori" with "dogmatic" (e.g., Fishman 2009, p. 814). The same would of course be true if *some* claims of metaphysics were fallible, whereas *others* would be a priori.[22]

If MN were indeed an epistemology, a procedural protocol, or a set of purely methodological rules, it would be a rather arbitrary choice of a protocol or of a set of rules, because it would not be backed up by a metaphysics. In a realist philosophy, being is prior to knowing. That is, the furniture and structure of the world must make cognition possible in the first place, and they must allow for the successful application of scientific methods. Hence, for a methodology to make any sense and to work successfully, there must be a metaphysics that helps to explain the functioning of this methodology. The methodology of science is therefore based on ON, just as the methodology of Plantinga's "theistic science" is based on supernaturalism (Sect. 4).

However, if methodology cannot be separated from metaphysics, science is not religiously neutral—at least inasmuch as religion involves supernaturalism. If science adopts ON in the sense of a metaphysical null hypothesis, it is not true that science is neutral on the existence of God, as most defenders of MN maintain (e.g., Scott 1998; Ruse 2001; Pennock 2009). After all, the null hypothesis about the existence of some x states that x does not exist. Thus, science is committed to the "presumption of nonexistence" also with regard to God's existence.

8 Conclusion

> … what Kant and Hume show, I think, is that limiting oneself to seeking natural causes for natural effects is not […] a metaphysical principle with no inherent grounding in science but rather a disciplinary condition of doing science, the only way to get the particular kinds of answers that science seeks within the terms of the evidentiary warrants it demands. (Loesberg 2007, p. 96f.)

In this paper, I have argued that:

- ON is a constitutive metaphysical principle (postulate) of science (if not of any form of cognition)
- ON is not a dogmatic principle, but a metaphysical null hypothesis (or, if preferred a null principle)
- ON serves as a presupposition of scientific methodology in that it helps to explain why scientific methods work
- the concept of evidence is not free of metaphysical assumptions but in fact presupposes ON
- ON can be formulated as a comprehensive ontological theory, whereas conceptions of the supernatural suffer from serious, if not insoluble, semantic and ontological problems
- the supernatural cannot function as an explanans in scientific explanations unless these semantic and ontological problems have been solved (for example, by conceiving the supernatural in rather anthropomorphic and hence quasi-natural terms)
- the idea that there could be evidence for the supernatural involves a paradox: the empirical methods used to gain the data that are supposed to function as evidence for

[22] Note that fallibilism with regard to metaphysics does not preclude that the latter has some a priori aspects. As Warenski (2009) argues, certain forms of apriorism are compatible with fallibilism.

some supernatural intervention, must themselves be free from any supernatural intervention—as must be our cognitive processes involved
- provided there is a solution to this paradox, the supernatural is testable (in a limited way) only if it is conceived of as overnatural, that is, in quasi-natural terms
- the transnatural remains untestable
- the success of science supports ON, whereas the failure of science could undermine ON.

It may seem as if we are faced with a contradiction in this summary. The claim that ON is a constitutive (and thus necessary) metaphysical principle of science, and the concession that ON is fallible appear to be mutually exclusive. Yet they are not, because they concern different contexts, namely ON as a metaphysics in general, and ON as a presupposition of science. If ON in general were refuted by whatever means, it would no longer be a correct ontological theory, in the sense that such a theory should be able to correctly describe *all* of the most general aspects of existence. However, depending on the relationship of the natural and the supernatural, ON could still correctly describe the natural part of the world. Thus, even though ON would be known to be incomplete for having lost its universal scope, ON would remain a necessary condition of science in order for its methodology to work properly. In this sense science keeps being tied to ON. If it turned out that the world is natural only very locally, where "local" is to be understood spatially or temporally as needed, science could operate only within this local realm of lawful natural things and processes, that is, with entities that are describable by an ontological theory of the kind introduced in Sect. 4. And if, contrary to our current knowledge of the universe, the whole world were permeated by supernatural interventions, that is, "if we were stuck in this universe with a whimsical and meddlesome creator, we would simply have no other option than to resign to the possibility of reliable natural knowledge about the world" (Boudry et al. 2010, p. 235).[23] ON is therefore provisional as a metaphysical principle, but it is not provisional as an essential feature (an ontological presupposition) of science.

I strongly doubt that the ontology of science could be expanded to include supernatural entities, for whatever theoretical and empirical approach would result from this would no longer be a science. Remember that a supernaturalist metaphysics would endorse and encourage a methodology comprising revelation, mystical experiences and other such subjective "methods". As a consequence, the evidential warrants demanded by science would change as well. Those who believe that science could accommodate supernaturalism must explain to us how much science could be modified to be still considered science rather than its opposite, namely magic, occultism, or religion.

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[23] Boudry et al. (2010) actually argue against the thesis that MN is an intrinsic feature of science, but it seems this quote presupposes exactly the opposite.

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