

## **A Humean analysis of scientific realism <sup>1</sup>**

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### **Abstract:**

In their criticism of scientific realism, contemporary philosophers of science often assume that this position is incompatible with empiricism, the epistemological thesis according to which all factual knowledge is grounded on experience. Little attention is paid, however, to the roots of empiricism in modern philosophy. The present article aims to contribute to filling this gap, by examining the implications of Hume's version of empiricism to the issue of scientific realism. It is shown, first, how scientific realism is negatively affected by Hume's theories of ideas and causality. Secondly, the prospects of overcoming these difficulties by appealing to the method of hypotheses are examined, first through a survey of Hume's own stand concerning hypotheses, and then by direct philosophical analysis.

### **1. Introduction**

In contemporary philosophy of science, scientific realism is commonly thought of as being challenged either by “constructivism” or by “empiricism” (see e.g. Boyd 1984). However, the use of the word ‘empiricism’ in this context is somewhat misleading. The term has originally been coined to designate an epistemological thesis concerning the problem of the *sources* of knowledge, paradigmatically defended by philosophers such as Locke and Hume. In this

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classical and proper meaning, empiricism stands in opposition to *rationalism*, as found for example in certain works of Leibniz and Descartes. Realism, on the other hand, is a general position regarding the related, but distinct issue of the *extension* of knowledge. Scientific realism, in particular, is the thesis according to which our knowledge somewhat extends to the realm of the unobservable entities posited by theories of the natural sciences, such as viruses, atoms, and magnetic fields. Since philosophers of science generally no longer regard rationalism as a viable epistemological position, the description of the current debate concerning the extension of scientific knowledge in terms of a confrontation between scientific realism and “empiricism” introduces a bias against realism from the very beginning.

Putting aside this widespread terminological confusion, the fundamental epistemological problem that concerns us here is to determine the precise nature of the links (if any) between the classical doctrine of empiricism and several typical positions against scientific realism. Bas van Fraassen is one of the few contemporary philosophers who have explicitly considered this problem. In his influential criticism of scientific realism, he claims that this position is *incompatible* with empiricism, understood as “the epistemological thesis that experience is the sole legitimate source of information about the world” (van Fraassen 1985, p. 286). Accordingly, he regards himself as simply someone who is offering an interpretation of science in strict conformity with empiricism. Unfortunately, however, he has not developed the point fully.<sup>2</sup> The present paper aims to contribute to filling this gap, by investigating scientific realism in the light of Humean empiricism. This task is rendered particularly tentative by the fact that, unlike many other modern philosophers, Hume has not explicitly inquired into the issue of scientific realism. Given, however, the enormous influence of his theory of knowledge, it is worth trying to draw its implications to the current controversy over that issue.

## 2. Knowledge, “proofs” and probability

Roughly speaking, the problem of scientific realism is whether science can be considered capable of attaining genuine *knowledge* about the existence and properties of the unobservable entities postulated by scientific theories. One of the first difficulties in

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<sup>2</sup> Although the main goal of his recent book, *The Empirical Stance* (2002), is to expound his views on empiricism, little explicit attention is given to the specific issue we are examining in this article.

interpreting Hume’s epistemological writings concerns precisely the meaning of the word ‘knowledge’. When he adheres to the received view of his time, Hume takes the word as meaning *certain* knowledge. This happens, for instance, in the first two sections of the third part of book 1 of the *Treatise*, where knowledge is explicitly restricted to the relations of resemblance, contrariety, degrees in quality, and proportions in quantity or number. Hume is thereby led to conclude that the only truly “scientific” disciplines are algebra and arithmetic, the rest affording only “probabilities”. All propositions concerning matters of fact, with the exception of those expressing the immediate perceptions of the mind, would accordingly be regarded as strictly unknowable. Realizing perhaps that this consequence is at odds with common-sense, Hume introduces a middle-term epistemic category, or “kind of evidence”, to accommodate propositions like ‘The Sun will rise tomorrow’ and ‘All men are mortal’, which he says it is “ridiculous” to take as just probable. He misleadingly calls this third category “proofs” (T 1.3.11.2, E 6n).<sup>3</sup>

If we adhere strictly to this threefold epistemic partition, and understand scientific realism as a thesis about *knowledge* in the classical sense of the word, then the dispute is already decided in the negative: it concerns matters of fact, and according to Hume there is simply no *knowledge* in this domain, with the above-mentioned exception. It should be remarked, however, that this epistemological analysis would exclude from the realm of knowledge not only the existence and operations of the putative unobservable entities of science, but also the existence of ordinary material objects, such as cats and fleas, as well as any extension of the evidence of the senses based on the relation of cause and effect, as the proposition that a sound will be heard the next time someone knocks on a door.

It is symptomatic of the unnaturalness of these conclusions that Hume frequently writes as if he has forgotten them. In the *Enquiry*, especially, he clearly concedes that we in fact *know* many propositions of the latter kind. In 5.6, for instance, after proposing that habit or custom is the foundation of all causal inferences, he adds that *without* its influence “we should be entirely *ignorant* of every matter of fact beyond what is immediately present to the memory and senses. We should never *know* how to adjust means to ends [...]” (italics mine). And in 5.21 we read: “Had not the presence of an object, instantly excited the idea of those

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<sup>3</sup> We follow the form of reference adopted in the new Oxford editions of Hume’s works: ‘T 1.3.11.2’ refers to the *Treatise of Human Nature*, book 1, part 3, section 11, paragraph 2, and ‘E 6n’ denotes the *Enquiry concerning Human Understanding*, section 6, footnote.

objects, commonly conjoined with it, all our *knowledge* must have been limited to the narrow sphere of our memory and senses” (emphasis added; see also E 5.2, 5.7 and 12.29).

If the extension of the word ‘knowledge’ is broadened along these lines, the problem of scientific realism is posed again in a fruitful way. The traditional epistemic criterion, which includes certainty as a necessary condition for knowledge, appears forbiddingly restrictive in the light of modern empiricism. The relevant question concerning scientific realism is not whether we can attain *certainty* about the existence of the unobservable entities of science. Hume has convincingly argued that, strictly, we are unsure even about the objective existence of ordinary bodies, and about the absolute regularity of their operations. What is more relevant from a Humean perspective is to determine whether the existence and properties of the unobservable scientific entities can be rationally admitted with an assurance *comparable* to that of causal inferences amounting to “proofs”. It is in this relative sense that we shall afterwards consider the problem of scientific realism.

### 3. Ideas of unobservable entities?

From a Humean point of view, a preliminary difficulty faced by scientific realism concerns the very *idea* of an unobservable material object. As is well known, Hume holds (effectively following Locke) that “all our ideas, or weak perceptions, are derived from our impressions, or strong perceptions, and that we can never think of any thing which we have not seen without us, or felt in our own minds” (*Abstract* 6; see also T 1.1.1.7 and E 2.5). This fundamental principle has a semantic counterpart: a word has no “distinct meaning” unless we can point out an impression capable of originating the associated idea (E 2.9). The application of this criterion of meaning to our problem apparently leads to the conclusion that the scientific terms putatively referring to unobservable entities are devoid of distinct meaning, since by hypothesis no impression could have yielded the corresponding ideas. This conclusion lends support to anti-realist positions such as instrumentalism and positivistic reductionism, which propose non-literal construals of such terms.

But the issue deserves closer scrutiny. Effectively following Locke once again, Hume distinguishes *simple* ideas (and impressions) from *complex* ideas (and impressions) (T 1.1.1.2, E 2.6), aiming at preserving experience as the *ultimate* source of the “materials” of knowledge. Thus, although we have never had the impression of a mountain of gold, we can form the idea of such an object by combining the simpler ideas of gold and mountain.

Wouldn't it be possible now for us analogously to form ideas of the unobservable objects out of certain simple ideas we do possess? In the case of the entities of classical theories we are prone to believe it would. The unobservable ontology postulated, for instance, by Descartes in *The Principles of Philosophy* consists of corpuscles with properties entirely similar to those we perceive in ordinary objects: tiny hard spheres, minute rotating screws, etc.

In contrast with Descartes and several other modern philosophers, Hume did not participate directly in the contemporary scientific discussions on the structure of matter; but there is no indication that he would have considered *inconceivable* the unobservable entities postulated by the scientific theories of his time. Thus, in discussing the ideas of space and time he acknowledged that “sound reason convinces us that there are bodies *vastly* more minute than those, which appear to the senses”.<sup>4</sup> Also, in order to defend that “chance is nothing real in itself” (T 1.3.11.4), that “there [is] no such thing as Chance in the world” (E 6.1), Hume held that natural philosophy was meeting with increasing success in discovering “secret causes” in the operation of bodies. The search for such causes was motivated precisely by the urge to explain why apparently random events happen. Rhubarb, for instance, does not always purge, nor opium make sleep (E 6.4). Once sufficiently deep causes are specified, however, complete regularity is recovered (T 1.3.12.5, E 8.13).

With respect to the specific *ideas* we can have of such microscopic bodies, Hume argues in T 1.2.1 that they are none but the very same ideas we have of similar macroscopic bodies. Considering the ideas of a grain of sand and of a mite a thousand times smaller than those we ordinarily see, he comments:

When you tell me of the thousandth and ten thousandth part of a grain of sand, I have a distinct idea of these numbers and of their different proportions; but the image, which I form in my mind to represent the things themselves, are nothing different from each other, nor inferior to that image, by which I represent the grain of sand itself, which is suppos'd so vastly to exceed them (T 1.2.1.3).

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<sup>4</sup> T 1.2.4.24. Notice incidentally that this statement is at odds with the opinion that Hume adopted a phenomenalist interpretation of bodies. Rosenberg 1993, for instance, explicitly holds this view (pp. 68, 70), concluding from thence that Hume was, a fortiori, an anti-scientific realist (p. 68). Rosenberg's analysis, however, is vitiated by the identification of Hume's criterion of empirical significance with the stricter criterion advocated in our century by logical positivists (p. 66). This identification is severely criticized in Wright 1983, Craig 1987 and Strawson 1989; Wright and Strawson also argue directly against the claim that Hume was a phenomenalist (see Wright 1983, p. 42, and Strawson 1989, p. 58).

Things become more complicated when it comes to the ideas of the unobservable entities postulated by *present-day* scientific theories, or even by certain earlier theories, such as nineteenth century electromagnetism, which are much more “abstract” than the theories known to Hume. It is far from clear how such ideas could be formed out of sense impressions, even if worked out by the mental processes of composition, decomposition and “diminution”. It is *prima facie* unlikely that ‘magnetic field’, ‘wave function’, ‘neutrino’ and ‘quark’, for instance, are expressions denoting ideas reducible to perceptions. Notwithstanding, the theories in which they occur are fairly clear and precise, at least from the point of view of their applications. Also, effective communication between scientists is not impaired to any great extent by the lack of direct sensorial content of these concepts. The Humean theory of ideas and meaning seems therefore to be too narrow to accommodate a realist interpretation of contemporary scientific theories.

At this point one is reminded of Edward Craig’s unorthodox claim that the theory of ideas was actually of secondary concern to Hume, and that on several occasions he sacrificed it in favor of his central epistemological theses (1987, chapter 2). Following this cue, it is worth examining briefly how Hume tried to overcome a related limitation of his theory of ideas. When discussing the hypothesis of the existence of ordinary bodies, he came across a problem similar to the one we are discussing. In the short section closing the second part of book 1 of the *Treatise*, Hume argues that it is “impossible for us so much as to conceive or form an idea of any thing specifically different from ideas and impressions”, as real bodies are supposed to be (T 1.2.6.9). “The farthest we can go towards a conception of external objects, when suppos’d *specifically* different from our perceptions, is to form a *relative* idea of them, without pretending to comprehend the related objects” (T 1.2.6.9; last italics mine). Hume returns to this subject in T 1.4.2, where he claims that “we may well suppose in general, but ‘tis impossible for us distinctly to conceive, objects to be in their nature any thing but exactly the same with perceptions” (T 1.4.2.56).

Couldn’t we now allege analogously that we are somehow provided with *relative* ideas of the unobservable scientific entities, and that we can legitimately *suppose* them to exist? But there is a problem with this suggestion: What kind of relations would be involved in the formation of such ideas? Once again, in the case of many theories of classical physics there are better prospects of overcoming this difficulty, since the entities they postulate seem to be describable in terms of ordinary relations such as ‘similar to a screw’, ‘a thousand times

smaller than a grain of sand', etc. But apparently no such simple characterizations are possible for the notions involved in the highly abstract theories of contemporary physics.

Be this as it may, one thing deserves to be considered here. In the formation of the relative ideas of both ordinary and "scientific" bodies, the central component seems to be the *causal relation*. Our fundamental idea of a body, of whatever kind, is that of something *causing* the sensorial impressions. But Hume's analysis of the idea of cause implies that we can have no positive idea whatsoever of unobservable causes. This point will be reviewed in the following section.

#### **4. Realism and causal inferences**

Being a matter of fact beyond the testimony of senses or memory, the existence and properties of unobservable entities could only be known, according to Hume, by causal inferences from phenomena describable as their causes or effects (T 1.3.2.3, E 4.4). Examining the role these entities play in scientific theories, we see indeed that they are typically postulated as causes of certain phenomena, thus affording an explanation for their occurrence. The heat we feel in bodies, for instance, is taken as the effect of the movements of their constituent microscopic corpuscles, and the attraction of iron by loadstone as the effect of its magnetic field.

If Hume is right, however, any knowledge of causal relations derives from the experience of the regular conjunction of phenomena (T 1.3.6, E 4.6). A serious difficulty for scientific realism therefore arises: By supposition, the existence and operation of unobservable bodies is not a *phenomenon*, and so could never be established as being the cause or effect of anything whatsoever. We cannot *observe* the constant conjunction of atomic vibration and heat, or of magnetic field and the attraction of iron. It is remarkable that nowadays realist philosophers, the vast majority of whom profess to belong to the tradition of classical empiricism, disregard this crucial problem, assuming, without further justification, that causal links involving unobservable objects can legitimately be defined, and even known.

Notwithstanding, scientists have been able to produce predictively and explanatorily successful theories involving what they take to be unobservable causal mechanisms. Scientific realists typically regard this fact as indicating that these mechanisms are real (see sections 6 and 7, below). If their position is to be sustained, the preceding analysis shows that they must seek either: 1) to devise a non-Humean epistemological theory in which knowledge of unobservable matters of fact can be achieved independently of causal inferences; or 2) to

show, again contrary to Hume, that at least certain causal relations can be established without the experience of the constant conjunction of phenomena. Undoubtedly, these are formidable tasks. Before proceeding to tentatively examine them, it is instructive to see how Hume himself stumbled on an analogous difficulty in his treatment of our knowledge of the existence of the external world.

Acknowledging that we in fact believe in the existence of an objective, external reality, Hume sets out to explain, in T 1.4.2, *how* this belief arises. In the case of the man in the street, the explanation is, roughly, that he fails to distinguish the external objects from the mental items that supposedly represent them. Hume claims, however, that from a philosophical point of view this identification is erroneous: “The table, which we see, seems to diminish, as we remove farther from it: But the real table, which exists independent of us, suffers no alteration: It was, therefore, nothing but its image, which was present to the mind” (E 12.9; see also E 12.10 and T 1.4.2).

Hume turns then his attention to the “more rational opinion” (E 12.14) of the “double existence” (T 1.4.2) of objects and perceptions. But how, he asks, can we be *assured* of this double existence? Not by the senses, certainly, since all they afford to the mind are interrupted and dependent perceptions. And not by reason either: Being a matter of fact beyond the reach of the senses, the existence of material objects could only be known by causal inferences. In its turn, knowledge of causal relations results exclusively from the experience of the regular conjunction of causes and effects. But by hypothesis the real bodies (the putative ultimate causes of perceptions) are not the proper object of any experience. “The mind has never any thing present to it but the perceptions, and cannot possibly reach any experience of their connexion with objects. The supposition of such a connexion is, therefore, without any foundation in reasoning” (E 12.12).

Although in the *Enquiry* Hume concludes that in this topic of realism the skeptic will always triumph (12.14), in the *Treatise* he tries to show how another faculty of the mind, the *imagination*, leads us to believe in the continuous and independent existence of bodies (T 1.4.2.14ff). Such a belief, Hume argues, must arise from the peculiar qualities of the imaginative faculty and of certain groups of perceptions. The involuntary character and “superior force and violence” of certain impressions, commonly taken as marks of objectivity, are rejected as such by Hume on the basis of counter-examples (1.4.2.16). He defends the view that only the conjunction of the *constancy* and the *coherence* of certain impressions can

afford the imagination the materials for the formation of that belief. It is not necessary to enter into the details of this complex explanation to see that it cannot be adapted to the case of scientific realism. Even if we (controversially) concede epistemic force to the imaginative faculty we still won't be able to justify along similar lines the belief in the existence of the unobservable entities of scientific theories, since by hypothesis we have no impression of them whatsoever.

### **5. The role of hypotheses in Hume's "science of man".**

The preceding analysis shows that there are serious difficulties in getting access to unobservable entities by means of the causal relation. Hence, it is worth investigating whether there are alternative epistemic routes open to realism. We could, for instance, try to introduce unobservable entities and the theories about them as *hypotheses*, to be justified *a posteriori*, according to certain criteria. Would this proposal be compatible with Humean epistemology? In this section we shall review Hume's own statements concerning the epistemic status of hypotheses; in the rest of the paper, the prospects for the further development of this proposal will be briefly examined.

The remark in the *Abstract* that the author of the *Treatise* "talks with contempt of hypotheses" (2) should be taken *cum grano salis*, since in his "science of man", or "moral philosophy", Hume freely appeals to hypotheses, which, on most occasions, are *not* treated contemptuously. Here are the most important cases:

1. *The function of general terms.* Hume begins his analysis of abstract ideas (T 1.1.7) by agreeing with Berkeley that "all general ideas are nothing but particular ones, annexed to a certain term, which gives them a more extensive signification, and makes them recall upon occasion other individuals, which are similar to them" (1). He then proceeds to reinforce Berkeley's proof of the impossibility of conceiving ideas that are not in themselves particular. Finally, Hume sets out to offer an *explanation* for the process of generalization, which he implies Berkeley has not provided. This rather complex explanation is explicitly presented as a "hypothesis" (16).

2. *The "system of the double existence".* In the *Treatise* Hume says that the system of the double existence of objects and perceptions is a "hypothesis" or "fiction" (see e.g. 1.4.2.52) devised to *explain* certain facts about our perceptions and tendencies, thereby resolving the conflict between imagination and reason (continuity and independence versus

discontinuity and dependence of perceptions). The relevance of this case to our topic lies in the fact that the hypothesis is about the existence of unobservable entities (the real bodies).

3. *Custom as the determinant of the causal inferences.* The third occasion Hume appeals to hypotheses is important for another reason, since it is the very kernel of his epistemological doctrine that is explicitly classified by him as a hypothesis, whose aim is to explain a certain crucial fact about the operations of the mind. In a nutshell, when first presented with an object (or event) the mind is utterly unable to form any conclusion about its causes or effects; it is only after being exposed to the constant conjunction of objects of this kind with objects of another kind that any inference at all can be drawn by the mind as to causal relations among these objects. Hume's well-known explanation for this fact is that the mind is "determined by custom alone to expect the one from the appearance of the other. This *hypothesis* seems even the only one which explains the difficulty, why we draw, from a thousand instances, an inference, which we are not able to draw from one instance, that is, in no respect, different from them" (E 5.5; italics mine). The hypothetical character of Hume's explanation is emphasized when Hume resumes the issue in the section dedicated to the study of the reason of animals (section 9). In its first paragraph we read: "We shall make *trial* of this, with regard to the *hypothesis*, by which we have, in the foregoing discourse, endeavored to *account for* all experimental reasonings; and it is hoped, that this new point of view will serve to *confirm* all our former observations" (my italics). Now, experience clearly shows that "the animal infers some fact beyond what immediately strikes his senses; and that this inference is altogether founded on past experience", it being "impossible that this inference of the animal can be founded on any process of argument or reasoning". Hume concludes that his epistemological hypothesis has passed the test, adding that, being "firmly established" in this case, there is a "strong presupposition, from all the rules of analogy, that it ought be universally admitted" (E 9.5).

4. *The reason of animals.* In contrast with Descartes, Hume believed that it is ridiculous to regard the superior animals as entirely destitute of thought and reason. Although the animals' thoughts are, *qua* mental events, unobservable, Hume maintained that we can legitimately infer their existence from the observation of animal behavior: "When therefore we see other creatures, in millions of instances, perform like actions, and direct them to like ends, all our principles of reason and probability carry us with an invincible force to believe the existence of a like cause" (T 1.3.16.2). Presumably Hume is appealing here to his fourth

rule “by which to judge of causes and effects”: “The same cause always produces the same effect, and the same effect never arises but from the same cause.” (T 1.3.15.6). This rule allows him to infer that something unobservable, the animals’ reasoning faculty, does indeed exist, and causes certain phenomena, namely, the animals’ bodily actions. Notice the similarity between this argument and a typical argument supporting scientific realism. By mere analogy with certain impressions of reflection, we form the idea of an unobservable process (animal thought); this process is then postulated as the cause of certain phenomena (animal behavior), in spite of the fact that we can never observe the constant conjunction of one and the other; finally, the explanatory power of this hypothesis is taken as evidence for its truth, and therefore for the reality of the postulated unobservable process.

5. *The nature of belief.* When Hume asks, in T 1.3.7.3, “Wherein consists the difference betwixt believing and disbelieving a proposition”, his famous answer, framed in terms of the vivacity of perceptions, is referred to by him as “my hypothesis” (5n). In the *Abstract* Hume returns to the point, confronting explicitly his hypothesis with a rival hypothesis: “that belief joins some new idea to those which we may conceive without assenting to them” (*Abstract* 19). This is, he confesses, the only alternative he is able to think of. But he proceeds to an immediate criticism of this rival hypothesis, leaving only his as a viable explanation of the notion of belief. This case has, thus, a distinguishing feature: by a process of *conclusive* rejection of alternatives, a hypothesis becomes, in the end, established beyond reasonable doubt (A 21). Hume goes as far as saying that his arguments “*prove* that belief consists merely in a peculiar feeling or sentiment” (A 24; my emphasis).

6. *Personal identity.* In the final paragraphs of the Appendix to the *Treatise* Hume candidly acknowledges his failure at giving a satisfactory account of personal identity: “But all my hopes vanish, when I come to *explain* the principles, that unite our successive perceptions in our thought and consciousness. I cannot discover any *theory* which gives me satisfaction on this head” (20). After recalling the rejected explanations – the substantial self and the perception of a “real connexion among distinct existences” –, Hume adds these striking words: “I pretend not, however, to pronounce [the difficulty] absolutely insuperable. Others, perhaps, or myself, upon more mature reflection, may discover some *hypothesis*, that will reconcile those contradictions” (21; my emphasis). It seems that Hume is here treating hypotheses as respectable epistemic tools for the elucidation of a fundamental philosophical problem.

7. *The “religious hypothesis”*. In contrast with all the cases thus far considered, this is a hypothesis about which Hume adopts a robust *negative* stand. From the order he observes in the universe, the religious believer frames the hypothesis of the existence of a supremely wise and good Creator. Reasoning then in the reverse direction, he infers from this ultimate cause that there must be aspects of the world beyond the reach of our present experience, such as a “future state” in which the apparent injustices observed in this world are duly compensated. Notice once again the similarity with the inferential practice of natural scientists, which scientific realists take at face value. From certain phenomena, the hypothesis of certain (generally) unobservable causes is formulated, aiming at their explanation; from these causes new effects are predicted; their subsequent observation lends further support to the hypothesis. (In the particular case of the religious hypothesis, this last step actually is only presumed – and this is one of its main weaknesses.) Despite having been defended by illustrious scientists and philosophers,<sup>5</sup> this pattern of inference is expressly criticized by Hume in the *Enquiry*:

When we infer any particular cause from an effect, we must proportion the one to the other, and can never be allowed to ascribe to the cause any qualities, but what are exactly sufficient to produce the effect. [...] If the cause be known only by the effect, we never ought to ascribe to it any qualities, beyond what are precisely requisite to produce the effect: Nor can we, by any rules of just reasoning, return back from the cause, and infer other effects from it, beyond those by which alone it is known to us (E 11.12).

That this judgment is fatal to scientific realism no one can doubt. What is less clear is whether Hume himself doesn't fall prey to it when he defends his philosophical hypotheses (especially the hypothesis concerning the role of habit in causal inferences, which is explicitly defended by

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<sup>5</sup> Descartes, for instance, presents and defends this reasoning in a noteworthy passage of *The Principles of Philosophy* (part 3, paragraph 42). To know the true nature of the visible world, he says, “je croy qu’il n’est pas besoin pour cela que nous ... considerions toutes [les Phainomenes] d’abord, & qu’il sera mieux que nous taschions de trouver les causes de ces plus generales *que j’ay ici proposées*, afin de voir par apres si des mesmes causes nous pourrons aussi déduire toutes les autres plus particulieres, auxquelles nous n’aurons point pris garde en cherchant ces causes. Car si nous trouuons que cela soit, ce sera vn tres fort argument pour nous assuerer que nous sommes dans le vray chemin.” It is important to remark that the specific causes Descartes refers to here are unobservable, being explicitly introduced by him *as hypotheses*. Also, they should not be confused with the generic, ultimate metaphysical causes of phenomena (matter, God).

a similar argument, as we pointed out).<sup>6</sup> Whatever the case may be, let us consider now the philosophical question of what kind of justification, compatible with the tenets of Humean epistemology, *could* be given to hypotheses not capable of direct, inductive empirical confirmation.

## 6. Causes and explanatory power

Scientific realists typically argue that among the theoretical virtues capable of lending support to the literal truth of a hypothesis – and therefore to the reality of the entities it postulates – *explanatory power* is of paramount importance. In science, explanations are typically regarded as involving the specification of causes; it is by pointing out a cause that we ordinarily explain a phenomenon or phenomenological law (see e.g. Salmon 1984). Indeed, most of the unobservable entities of scientific theories are supposed to play the role of causes. But, as we have seen, in a strictly Humean epistemological framework the very concept of an unobservable cause is rather problematic. Therefore, explanatory power does not seem to afford an independent epistemic route for justifying scientific hypotheses transcending the phenomenological level.

This blockage of most scientific explanations of natural phenomena is at odds with the conception of science favored for centuries by scientists and philosophers, and lends support to the few dissenters who, like Berkeley and Mach, held that the sole aim of science is to systematically describe phenomena.<sup>7</sup> One way of avoiding this conclusion is to reject the ordinary association of explanation and truth, and to propose that genuine scientific explanation is possible independently of the truth of the explanans. Van Fraassen's "pragmatic" theory of scientific explanation expounded in *The Scientific Image* is in line with this suggestion, although it has not been explicitly introduced in response to the present difficulty. Van Fraassen's proposal raises its own philosophical problems, and will not be

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<sup>6</sup> We should not disregard here the fact that Hume's criticism of the religious hypothesis had motivations that were not exclusively epistemological, as the *Dialogues concerning Natural Religion* make clear.

<sup>7</sup> Rosenberg 1993 explicitly includes Hume in this team (p. 73). However, his analysis depends crucially on taking Hume as a regularity theorist about causation (pp. 71-4), a thesis that has been criticized as resting on a confusion of epistemological with ontological issues (see e.g. Wright 1983 and Strawson 1989).

discussed further here.<sup>8</sup> It is important to notice, however, that by severely emasculating the concept of explanation it undermines the project of appealing to explanatory power to extend our knowledge beyond the observational level. (And this is just well for van Fraassen, of course.)

A more conservative option for preserving the usual view that science explains, or aims to explain facts, would be to resort to the nomological-deductive account of explanation, which was part of the logical positivist conception of science (see e.g. Hempel 1965). However, this does not seem to be of great help to the realist. By bypassing altogether the issue of the reality of the causal explanatory mechanisms – to explain is just to deduce from general laws, whatever their contents – this account of explanation *eludes, ipso facto*, the problem of seeking an alternative epistemic access to unobservable entities. (And this is just well for logical positivists too.)

Furthermore, a strictly Humean epistemological framework does not appear, contrary to what is commonly assumed, to accommodate easily the nomological-deductive account. As is well known, Hume has shown that the full universality of natural laws cannot be assured neither by *a priori* reasonings nor empirically. Now, the deductive-nomological theory of explanation requires truly *general* propositions, capable of providing the basis for deductions of particular statements about phenomena or other general statements expressing phenomenological laws. If we also assume, following the leading proponent of this theory, Hempel, that in any *actual* (as confronted with merely *potential*) explanation the explanans must be true,<sup>9</sup> we get a conflict with the above-mentioned Humean conclusion. For how do we know, in any particular case, that the explanans is true? Notice that this conflict is independent of whether or not the explanans includes propositions involving unobservable items; what matters is that it includes synthetic general propositions.

To illustrate this point, let us consider one of Hempel's own examples. Hempel holds that the general law  $T = 2\pi\sqrt{L/g}$  explains why a 1 meter-long pendulum has a period of

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<sup>8</sup> Examples of other contemporary works which propose to sever the link between truth and explanation are Laudan 1977, Fine 1986a and chaps. 7 and 8 of Fine 1986b. Rebuttals can be found in Salmon 1984 and Leplin 1997.

<sup>9</sup> For an independent defense of this condition, see, for instance, Leplin 1997 (chap. 1) and Salmon 1984 (pp. 107-8, 133-4).

approximately 2 seconds (Hempel 1965, p. 352). But *if*, according to Hume, the cognitive content of the law reduces to the statement that all pendulums so far observed have behaved in conformity with it, Hempel's claim effectively amounts to saying that our 1 m pendulum completes a full swing in 2 seconds because the other 1 m pendulums have been observed to behave similarly. But the first fact can in no way be *deduced* from the second, and therefore cannot, according to the deductive-nomological account, be explained by it.

This criticism is at odds with an analysis found in Boyd 1985. Boyd claims that the deductive-nomological account of explanation "derives" from the Humean account of causation (p. 55), and even that it "*just is* the Humean definition of causation" (p. 61, Boyd's emphasis; see also p. 63). As the only explicit justification of this view, Boyd quotes Hume's "philosophical" definition of cause, "An object precedent and contiguous to another, and where all the objects resembling the former are plac'd in like relations of precedency and contiguity to those objects, that resemble the latter" (T 1.3.14.31), adding that according to it "the cognitive content of a causal statement is a *simple generalization* of the cognitive content of the observation statements that are seen as providing evidence for it" (p. 56, my italics). However, this conclusion does not seem to be justified. Closer scrutiny of Hume's text shows that the terms in which he frames his definition are somewhat misleading. The generalization implied by the word *all* and by the use of the simple present ("*are* plac'd") finds no support in his detailed analysis of the notion of cause. It is interesting, in this respect, to notice that although when the definition is presented in the *Enquiry* the same word and the same tense appear again (see E 1.3.7.29), the example given at the end of the paragraph corrects the undue generalization, through the use of the appropriate tense, the present perfect: "We say, for instance, that the vibration of this string is the cause of this particular sound. But what do we mean by that affirmation? We either mean that this vibration is followed by this sound, and that all similar vibrations *have been* followed by similar sounds: Or ...".<sup>10</sup>

Thus far in this section we indicated that the hope of justifying hypotheses involving unobservable entities *a posteriori*, on the basis of their explanatory power, runs into serious difficulties, according to Hume's epistemological theory. Yet another problem should be now

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<sup>10</sup> Although Boyd's specific claim about the links between the Humean notion of cause and the deductive-nomological view on explanation appears to be untenable, his far-reaching criticism of this view stands on its own, and is very important in a general realist strategy. Leplin 1997 also takes a resolute stand against nomological-deductivism (see, for instance, pp. 23-4), as part of his defense of scientific realism.

pointed out: even granting that it is legitimate to introduce the concept of unobservable causes, and that the theories of explanation which do not require reference to causes are unacceptable for one reason or another, the very ascription of epistemic weight to explanatory power is open to criticism. In other words, what the realist typically tries to do here is to *infer* the (literal) truth of a hypothesis on the basis of its explanatory power. This form of inference, which obviously is not logically sound, has been discussed in the literature under the names of *abduction* (Peirce 1934-35) and, in a more recent version, *inference to the best explanation* (Harman 1965, 1968). As applied to the issue of the unobservable entities, the reasoning is: *if* there *were* such and such entities, such and such phenomena *would* be naturally explained; therefore there are sound reasons for believing that the entities really exist.

As is well known, the legitimacy of this kind of inference has been strongly questioned by anti-realists in the contemporary literature on the philosophy of science. We shall not enter into this controversy here. It should be remarked, however, that even such a stern empiricist such as Hume appears to freely appeal to abductive inferences at several points of his work. Hume's defense of most, if not all, of his philosophical hypothesis, mentioned in the preceding section, depend crucially on abductive reasonings.

## **7. Realism and predictive power**

It is undeniable that many scientific theories, especially of contemporary physics, chemistry and biology, exhibit an impressive *predictive* power. Most of these theories postulate unobservable entities and processes. Since the laws purporting to regulate the behavior of these entities typically play an essential part in the prediction of phenomena, scientific realists argue that the predictive success of theories lends indirect support to the reality of those entities and processes. The advantage of this line of defense of realism over the one examined in the preceding section is that, contrary to explanatory power, predictive power is, to a large extent, objective. Hopefully, then, we can avoid some of the above difficulties relating to the concept of explanation.

But here the anti-realist may object that the postulation of unobservable entities is justified just to the extent in which theories deductively lead to true statements about phenomena, it being irrelevant whether the entities actually exist in the world. It is entirely possible that even an entirely "artificial" or "fictitious" theoretical system correctly *predicts*

the phenomena, if it has been tailored for that. Predictive power apparently does not require any realist construal of the causal unobservable mechanisms postulated by scientific theories.

However, the realist can retort that if sufficient attention is paid to the *specific ways* in which science (specially contemporary science) makes its predictions this interpretation loses its plausibility. What, above all, would confer epistemic weight to the predictive success of our best theories is their ability to predict *kinds of facts not taken into account when they were first proposed*. Arguments of this sort can be found in the writings of many prominent philosophers and scientists from the past, such as Descartes, Whewell and Darwin, but became popular nowadays mainly through the works of Smart and Putnam.<sup>11</sup> These philosophers argue that unless “cosmic coincidences” and “miracles” are countenanced, our best scientific theories could not be predictively successful *in the particular way* in which they are if their theoretical mechanisms did not correspond at least approximately to reality.

Although this argument bypasses some of the problems concerning the notions of explanation and causation, the question of the epistemic validity of abductive inferences cannot be altogether avoided, since it still involves abductive reasonings, although at the meta-level of *philosophical* theories. It is the explanatory power of scientific realism (and not of certain physical theories) that is taken as a reason for its truth. But we are here at the verge of several difficult questions going beyond the limits of the present paper.

## 8. Conclusions

The aim of this article was to identify the main challenges to the attempt to accommodate scientific realism on a Humean empiricist framework. We began by pointing out, in section 2, that a preliminary condition would be the extension of the notion of knowledge to cover cases of beliefs falling short of perfect certainty. In the same vein, we indicated in section 3 that scientific realism requires the development of a theory of ideas broader than the one put forward by Locke and Hume. Another major epistemological obstacle for scientific realism was identified in section 4: the epistemic tool of causal inferences is powerless to generate any knowledge about unobservable items. We remarked that Hume himself noticed that an analogous difficulty hampered realism about ordinary material objects. Thus, the realist is left

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<sup>11</sup> Smart 1968 and Putnam 1975, 1978; see also Leplin 1997 for a recent systematic defense of this form of argument.

with only two alternatives: either to devise a non-Humean epistemological theory in which knowledge of unobservable matters of fact could be achieved independently of causal inferences, or to show, again contrary to Hume, that at least certain causal relations can be established without the experience of the constant conjunction of phenomena. We proceeded then to examine the possibility of introducing unobservable entities in science by way of hypotheses. Hume's own use of hypotheses in his "science of man" was surveyed in section 5. The analytical task of justifying hypotheses from a Humean perspective was tentatively undertaken in the remaining two sections. The essential role of abductive arguments at several stages of this enterprise was underscored. Despite the criticisms to which this form of inference has been subjected in recent decades, we remarked that the refusal to attribute epistemic value to abductive inferences would leave the Humean philosopher with the bare flux of perceptions, from which nothing can be explained, or inferred to exist. As everybody will remember, Hume himself acknowledged that this sort of skepticism was "excessive" (E 12.23-24).

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