How to talk about unobservables

Dedicted to the memory of Peter Lipton (1954–2007), a spirited philosopher of science who left this world too early

F. A. Muller & B. C. van Fraassen

1. Challenges to the notion of empirical adequacy

In this journal, Dicken & Lipton (2006) argued, notably following Musgrave (1985), that a *constructive empiricist* cannot coherently draw the distinction between observable objects (events, processes, ...) and unobservable ones. We argue to the contrary: the distinction can be drawn coherently. Furthermore, we point to a flaw in these and similar criticisms: they proceed from the *syntactic view* of scientific theories whereas constructive empiricism is and has always been wedded to the *semantic view*, a fact that has consequences for the characterization of *empirical adequacy* and hence for the formulation that constructive empiricism favours.

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It was emphasized from the beginning that to say that a theory is empirically adequate just if all *it says* about observable things is true, is only a rough, informal way (van Fraassen 1980: 12). Rough and informal, but also immediately marked there as inadequate: it presents the notion of empirical adequacy for the conception of a theory as a set of sentences in a well delineated language. The main reason for rejecting that conception was precisely that it cannot give us an adequate notion of empirical adequacy: every way to do it seems to rely on the troublesome distinction between 'theoretical' and 'observational' predicates in the language of the theory. Further, you certainly cannot tell whether a sentence *is about*, or *is only about*, observable objects by looking at its syntactic form, or at the predicates in it:

> The empirical import of a theory cannot be isolated in this syntactical fashion, by drawing a distinction among theorems in terms of vocabulary. If that could be done, **T**/*E* would say exactly what **T** says about what is observable and what it is like, and nothing more.[1] But any unobservable entity will differ from the observable ones in the way it systematically lacks observable characteristics. As long as we do not abjure negation, therefore, we shall be able to state in the observational vocabulary (however conceived) that there are unobservable entities, and, to some extent, what they are like. ... Thus on the syntactic approach, the distinction between truth and empirical adequacy reduces to triviality or absurdity, it is hard to say which. (van Fraassen 1980: 54–55)

Hence the rejection of the syntactic 'Received View' in favour of the 'semantic' view of theories, which characterizes a theory through a class of models.[2] Nevertheless, that rough, informal version of empirical adequacy was taken as basis in some articles, and they come upon a predictable number of difficulties.

Musgrave (1985) raises this problem in a probative form and it was re-raised and elaborated by Dicken and Lipton (2006); cf. Muller 2004, 2005. Remarkably, Musgrave explicitly puts aside the semantic view when he raises his objection:

[1] **T**/*E* is the set of theorems of **T** in which no theoretical terms occur; this notion is defined relative to the ('Received View') conception of a theory as a set of sentences (theorems) and relative to a division of the vocabulary into theoretical and non-theoretical.

[2] Sober (1985) brings out another important reason not to take the 'rough and ready' formulation seriously: the term 'about' is beset by logical and semantic difficulties; in fact it is not clear that it can be understood within any familiar semantic framework so far. Cf. Goodman 1961.

> I ignore ... a central feature of van Fraassen's position, his preference for a semantic approach to scientific theories ...[3]

2. *The incoherence argument*

Musgrave's incoherence argument relied on the rough, informal account of empirical adequacy tied to the syntactic view of scientific theories (1985: 208). Van Fraassen's reply, in the same volume, did not satisfy Musgrave, nor did it later satisfy Muller, nor, most recently, Dicken & Lipton.[4]

Musgrave made his excuses for staying within the syntactic view. The discussion of the incoherence argument by Muller, Dicken & Lipton, as well as in a related paper by Sober (1985), followed Musgrave's lead: they rely on the informal rough characterization of empirical adequacy whose very deficiencies motivated the introduction of the semantic view (and a concomitant notion of empirical adequacy that does not suffer from these deficiencies) in *The Scientific Image*. We shall argue that it has no force when seen within the semantic view of theories. But the incoherence argument has an extension, due to Muller, which raises a further problem.

The incoherence argument begins by asking us to imagine a theory that describes the world as having some observable and some unobservable parts, and marks a difference between them:

> suppose some theory **T** *does* distinguish 'the observable which it postulates from the whole it postulates' ... **T** *might* even be van Fraassen's 'final physics and biology', if such a theory is possible. **T** will say, among other things, that *A* is observable by humans, while *B* is not. Of course, if we are to use **T** to delineate the observable, we must *accept* it. (Musgrave 1985: 208)

Then Musgrave offers his objection:

> But van Fraassen cannot have us accept it as true, since it concerns in part the unobservable *B*. The constructive empiricist can accept **T** only as empirically adequate, that is, believe to be true only what **T** says about the observable. But '*B* is not observable by humans' cannot, on pain of contradiction, be a statement about something

[3] Musgrave (1985: 208) offers his excuses with reference to a passage in van Fraassen's (1970) paper on the semantic view which did misleadingly downplay some differences or advantages that the semantic approach could bring.

[4] As reported in Muller 2004, which e.g. cites Musgrave as agreeing that the reply was not satisfactory – in fact, as indicating that Musgrave did not understand it.

> observable by humans. And, in general, the consistent constructive empiricist cannot believe it to be true that *anything* is unobservable by humans. And, if this is so, the consistent constructive empiricist cannot draw a workable observable/unobservable dichotomy at all. (Musgrave 1985: 208)

The reply offered in the same volume was given in terms of the semantic view of theories, although Musgrave explicitly eschewed that view. But since the aspect of acceptance of **T** that enters Musgrave's argument is the belief that **T** is empirically adequate, and that notion can only be properly understood on the semantic view, and not on the older syntactic view of theories, we *have to* examine the case in the light of the semantic view. Indeed, the only proper response, and the one that turns the tables on Musgrave and his followers, is to argue that his incoherence argument does not work in the context of the semantic view as here elaborated, while the bad consequence he draws is an inevitable corollary to the older view within which he presents it.

3. *The incoherence argument revisited*

There are many theories and sorts of theories abroad in the scientific world, often able to combine coherently, though sometimes not. Most of them do not provide a taxonomy with an observable/unobservable division; that we can find only in scientific studies of vision, hearing, and so forth. But those studies draw on other more general accepted theories as background to mark their distinctions, and can be combined with those background theories.

Suppose that with Musgrave we consider such a combined theory, in which the classifications available include such categories as 'emitting *X*-rays' and 'visible', even 'observable' *tout court*. Suppose we accept the theory, but only believe that it is empirically adequate. Let us suppose that in the theoretical taxonomy the categories '*X*-ray' and 'observable' are disjoint. Do we now believe that *X*-rays are not observable?

To say that the two categories are disjoint means that the theory provides us with no models which could even logically have the role of representing a process classifiable as involving observable *X*-rays. So we cannot consistently assert the conjunction of 'There are phenomena involving observable *X*-rays' and 'The theory is such that all observable phenomena are correctly represented in some model of that theory'. To put it conversely: *the belief that the theory is empirically adequate brings along with it, on pain of logical inconsistency, the belief that there are no processes involving observable X-rays*. And *mutatis mutandis* for other examples of theories about the unobservable.

At this point we can see that **T** could not be empirically adequate if there were real observable *X*-rays, and also that the acceptor's thinking about **T**'s domain is within a classification scheme that does not allow for the contemplated overlap. Recall Musgrave's conclusion, divided into two parts:

(i) '*B* is not observable by humans' cannot, on pain of contradiction, be a statement about something observable by humans.
(ii) And, in general, the consistent constructive empiricist cannot believe it to be true that *anything* is unobservable by humans.

Part (i) is easily granted. The statement that *X*-rays, for example, are not observable, is not about things that are observable. Part (ii) requires a conflation between 'constructive empiricist' (denoting a sort of philosopher) and 'acceptor of science' (could be anyone). But even on that ground, (ii) does not follow on its most obvious reading, as we have just shown: the acceptor of **T**

(a) believes that there are no observable phenomena that **T**'s models won't fit,
(b) knows that **T**'s models have no room for observable *X*-rays,

and hence

(c) believes that there are no such phenomena.

It is at first blush correct to express this last belief (c) with '*X*-rays are unobservable'. We'll see in a moment that this conclusion encounters an unexpected challenge.

4. *The incoherence argument extended*

In the semantic approach, we pride ourselves on not being so language-bound as one was during the hegemony of the syntactic view. Here a theory is not identified with or through its formulation in a specific language, nor with a class of formulations in specific languages, but through or by a class of models. Yet in a context characterized by acceptance of given scientific theories, those theories will shape or constrain the use of words and the description of the phenomena under study. One of us has drawn attention to this (Muller 2004; 2005); in effect this brings us face to face with a further problem engendered by such objections as Musgrave's, even after they are shown to be powerless within the semantic approach.

Specifically, one of us has argued that the above response to Musgrave is *not* enough, and that there 'remains in the end an unsolved problem that constructive empiricism cannot afford to leave unsolved' (Muller 2004, Abstract). This problem is at the heart of Muller's (2004) analysis, and

vulnerability to this problem is in retrospect clearly signalled in the words in which van Fraassen answered Musgrave originally:

> Suppose theory **L** entails that statement ('electrons are unobservable'). Then **L** has no model in which electrons occur in the empirical substructures. Hence, *if electrons are real* and observable, not all observable phenomena fit into a model of **L** in the right way, and then **L** is not empirically adequate. So, if I believe **L** to be empirically adequate, then I also believe that electrons are unobservable *if they are real*. I think that is enough. (van Fraassen 1985: 256; emphasis inserted)

Is this indeed enough to conclude that if we accept (rather than believe) this theory, we believe that *electrons are unobservable*?

Not enough for everyone. For the last sentence concerns a belief about the actual, real, existent observable entities in the world, to the effect that none of them are electrons. So – as the insertion of 'if they are real' signals – it could equivalently be expressed as: *All existent electrons – if any – are unobservable*. But the English statement *Electrons are unobservable* allows for and suggests a stronger interpretation, something we could express as: *All possible electrons are unobservable*. A non-existing electron surely is not an *observable* object.

This cannot be formulated with the usual extensional ('referential', 'restricted', 'actualized') understanding of the quantifier 'for all'. But that should not stand in our way with respect to the English language actually in use, the language of science included. How exactly we should understand the 'unrestricted' universal quantifier is a topic in philosophy of logic and language, where there are various proposals to consider. We only need to stipulate here that, in this context, we cannot agree to understand it in a sense in which it is intelligible only if possible non-existents, e.g. inhabitants of 'other worlds', are real.

As Muller recalls from van Fraassen 1980: 15, 18, 197, the 'observable/unobservable' classification is quite independent, logically, of the 'existent/non-existent' distinction. Before we know whether Pegasus exists or not, we classify it as observable; it is in part because flying horses *are observable* that we are so sure there aren't any. This suggests strongly that we need some such 'unrestricted' sense of the quantifier for the discussion of theories postulating unobservables.

So this is the *extended incoherence problem*: belief in a theory's empirical adequacy is only a belief about the real, actual observable phenomena, but acceptance of a theory seems to bring in a train of stronger beliefs than that, even if we grant that it does not bring in the belief that the theory is true.

The specific stronger beliefs to which Muller is pointing encompass implications of the theory's taxonomy (its logical space) rather than e.g. its laws of co-existence and of succession. 'Electrons have negative charge' and 'Electrons are unobservable' seem to be plausible examples of something we can believe without restricting the quantifier to what is real. But not all such implications can be taken on, given the danger of arriving at the existence of unobservable entities among the real. For example, it might be part of the theory's taxonomy that the concepts of *water* and of H_2O coincide. In that case the taxonomy underwrites 'All possible water samples are ensembles of H_2O-molecules', from which it follows that if there are any real water samples, then there are H_2O-molecules. Given that we have also theory-independent criteria to identify water samples, on the basis of observation, the engendered belief about what is real would outstrip belief in the theory's empirical adequacy.

So one rule of thumb: whatever we let trickle down from the accepted theory's taxonomy, into our own language, should not have new consequences for what real things there are. But obviously we have a larger question here, which is precisely Muller's larger concern, which can be broken into two parts.

(1) Musgrave's argument rests in part on a presupposition: 'Judgments about the observability of every (actual or non-actual) object must be based on some accepted scientific theory.' (Muller 2004: 651)

If we are to arrive at the belief that all electrons, *tout court*, are unobservable we will have to arrive there in some other way than by appeal to the empirical adequacy of a theory. But that we can do so is, in itself, in no way contrary to anything in constructive empiricism. The judgment 'I see a mountain' implies that the mountain is visible, hence that it is observable – *voilà*! But such examples are not relevant, and not enough, to show how we can arrive at 'Electrons are unobservable' understood in its strong sense. Hence, although rejecting this presupposition stops Musgrave's argument in its tracks, it does not remove all of the problem that it raises. Here comes the other part.

(2) If asked what a theory says, we must answer in the language in which the question is asked, or perhaps in a suitable extension of that language. And if we are asked what an acceptor of a given theory believes, someone who believes the theory to be empirically adequate, we must also answer that question in the language in which it is asked.

This point stands although scientific theories are here not conceived as identified with or through their formulation in any specific language. Accordingly, Muller proposes at the end of (2004), and elaborates in his (2005) an extended epistemic policy, to answer the crucial question:

If you accept the theory **T**, then what do you believe?

The answer can be given wholly on the basis of the semantic view of **T**.

5. Amended epistemic policy

As Muller (2004, 2005) depicts it, constructive empiricism came with an epistemic policy, that tells what to believe and what to remain neutral about:

1. If you accept **T**, and 'T is empirically adequate' implies *A*, then believe *A*,

and

2. If you accept **T**, and 'T is empirically adequate' does not imply *A*, then remain neutral with respect to *A*;

or as an alternative to 2:

2′. If you accept **T**, and 'T is empirically adequate' does not imply *A*, then nothing.

So 2 and 2′ share their antecedents, 2 advises a neutral (or agnostic) propositional attitude towards *A*, whereas 2′ advises no propositional attitude whatsoever towards *A* but passes over in silence.

This policy to handle beliefs does not, as we have seen, lead to such a belief as 'Electrons are unobservable'. In order to make it lead to such beliefs, an emendation of the epistemic policy seems needed. Here is one proposal, perfectly compatible with the spirit of constructive empiricism. First follow:

0. If you accept **T**, and *Y* is (un)observable according to **T**, then believe so.

Here variable *Y* extends beyond what is actual. Next follow rules 1 and 2 or 2′, but no longer apply these rules to propositions *A* stating that *Y* is (un)observable or including such (un)observability statements. Application of rule 0 will now readily give us the belief that *electrons are unobservable* and that *flying horses are observable* whenever we accept a physical theory that deems them so, such as the wave theory of light.

This *is* enough to solve the extended incoherence problem.

Erasmus University Rotterdam,
Burg. Oudlaan 51, H5–16,
3062 PA Rotterdam, The Netherlands
f.a.muller@fwb.eur.nl
and
Dept. of Physics & Astronomy,
Utrecht University, The Netherlands
f.a.muller@phys.uu.nl

Princeton University, Princeton,
New Jersey, NJ 08544, USA
fraassen@princeton.edu

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