<published in *Analysis* 68 (2008), 197–205. The definitive version is available at www.blackwell-synergy.com>

How to talk about unobservables

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January 2007

Dedicated to the memory of Peter Lipton (1954 − 2007),
An immersed philosopher of science who left this world too early.

In this journal, Dicken & Lipton [2006] argued, 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, but add a qualification to deal with an associated problem concerning the language of science.

1. Challenges to the Notion of Empirical Adequacy

The flaw in those and similar criticisms is that they proceed from the *syntactic view* of a scientific theory as a set of sentences in a well delineated language. In consequence they take literally the 'rough and ready' characterisation of *empirical adequacy* of a theory as 'truth of all that the theory says about observable things'. Constructive empiricism is and has always been wedded to the semantic rather than the syntactic view, precisely because the latter affords no non-trivial concept of empirical adequacy (van Fraassen 1980: 12, 54-55).

Musgrave's argument relied on the account of empirical adequacy tied to the syntactic view of scientific theories (1985: 208). The reply offered in (van Fraassen 1985) did not satisfy Musgrave, nor did it later satisfy Muller (2004, 2005), nor, most recently, Dicken and Lipton (2006).

Musgrave's original argument begins by asking us to imagine a theory **T** that describes the world as having some observable and some unobservable parts, and marks a difference between them. As Musgrave points out, "if we are to use **T** to delineate the observable, we must *accept* it." (Musgrave 1985: 208). But to accept **T** involves as belief only that it is empirically adequate. Dicken and Lipton, going as Musgrave did with the same syntactic view's characterization of empirical adequacy, present the ensuing objection as follows:

> When he accepts a theory, the constructive empiricist [...] only believes the statements of his theory of observability **T** that are about observable entities. Therefore, in order to know which statements of **T** he can believe, the constructive empiricist needs to know which statements of **T** are about observable entities. However, it is **T** that tells the constructive empiricist what counts as an observable entity: the constructive empiricist therefore needs to use **T** to tell him which statements of **T** he can believe. (Dicken and Lipton: 226-227, replacing their "**T***" with Musgrave's "**T**")

The salient difficulty is then that such a statement as "X-rays are not observable" is not about observable objects and hence, even if T implies it, it is not among what is believed by someone who merely accepts **T**.

The only proper response, and the one that turns the tables on Musgrave, to Dicken and Lipton is to argue that the argument does not work if empirical adequacy is understood -- as it must be -- within the semantic view of theories.

Consider a theory in which the classifications available include such categories as 'emitting *X*-rays' and 'visible', or even 'observable' *tout court*. Suppose we accept the theory, but only believe that it is empirically adequate. Suppose further 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”. Equivalently: *the belief that this theory is empirically adequate brings along with it, on pain of logical inconsistency, the belief that there are no processes involving observable X-rays.* 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 observable *X*-rays.

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.

2. The Objection Extended

In the semantic approach 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. There are nevertheless significant connections between theories and language (van Fraassen 1970; 1980: 196-203; 1987). Specifically, in a context characterised 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 draws attention to this (Muller 2004, 2005), and in effect brings us face to face with a further problem engendered by such objections as those of Musgrave, Dicken and Lipton, *even after they are shown 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). Vulnerability to that problem is in retrospect clearly signaled 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*.

This cannot be formulated with the usual extensional ('referential', 'restricted', 'actualised') 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 are real, such as inhabitants of 'other worlds'.

The ‘observable/unobservable’ classification is logically quite independent of the ‘existent/non-existent’ distinction (van Fraassen 1980: 15, 18, 197; Muller 2004, 2005). 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.

This we call the *extended Musgrave’s 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 one of us (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 can be broken in 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, one us proposes (end of Muller 2004, 2005) an *extended epistemic policy*, to answer the crucial question:

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

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

3. 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** advices a neutral (or agnostic) propositional attitude towards *A,* whereas **2'** advices no propositional attitude whatsoever towards *A* but passes over it 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 comes:

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 take **1** and **2** or **2'** to be your epistemic policy, but no longer apply these rules to propositions *A* stating '*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 **L**. This *is* enough to solve the extended Musgrave problem.

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