Truth in Constructive Empiricism

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ABSTRACT

Jamin Asay: Truth in Constructive Empiricism
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Constructive empiricism, the scientific anti-realism championed by Bas van Fraassen, claims to offer an adequate reconstruction of the aim and practice of scientific inquiry without adopting the inflationary metaphysical excesses of scientific realism. In articulating the positions of the realist and the empiricist, van Fraassen freely makes use of the concept of truth. Theories of truth come in a variety of flavors, some more metaphysically stark than others. Deflationary theories of truth, for instance, boast of the ability to offer a full account of the nature of truth without having to succumb to the supposed metaphysical extravagances accompanying more substantive accounts. Constructive empiricism and deflationism about truth seem, then, to form a natural pair. My contention is that such a pairing is not possible—constructive empiricism requires a more substantive account of truth than can be offered by the deflationist.

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TABLE OF CONTENTS

Section | Page

1. Introduction

Constructive empiricism, a brand of scientific anti-realism authored and championed by Bas van Fraassen (1980), claims to offer an adequate reconstruction of the aim and practice of scientific inquiry, all without adopting the inflationary metaphysical excesses of scientific realism. The goal of scientific practice, so says the constructive empiricist, is not to produce true theories, but rather to produce empirically adequate theories. In articulating the positions of the realist and the empiricist, van Fraassen freely makes use of the concept of truth. Theories of truth, of course, come in a variety of flavors, some more metaphysically stark than others. Those who subscribe to deflationary theories of truth, for instance, boast of the ability to offer a full account of the nature of truth without having to succumb to the supposed metaphysical extravagances accompanying more substantive accounts. Constructive empiricism and deflationism about truth seem, then, to form a natural pair; both are motivated by the traditional empiricist inclination to make do with as little metaphysics as possible. My contention is that such a pairing is not possible—constructive empiricism requires a more substantive account of truth than can be offered by the deflationist. Consequently, constructive empiricists are committed to some inflationary metaphysics that they normally would rather avoid, while deflationists are unable to understand the aim of science in the way that constructive empiricists suggest.

2. Constructive Empiricism

Van Fraassen advocates constructive empiricism in hopes of offering a rational reconstruction of scientific practice that both improves upon the empiricist accounts offered by the logical positivists and also avoids the pitfalls associated with scientific realism. Constructive empiricism is the view that the aim of scientific inquiry is to generate empirically adequate theories, theories that are true to the observable phenomena. Accordingly, acceptance of a scientific theory involves the belief only that the theory is empirically adequate. Acceptance also involves a pragmatic commitment to a research program; in accepting a scientific theory, one chooses to adopt the ideology of the theory, to understand problems and offer explanations from the perspective and worldview that the theory offers. Scientific realism, by contrast, claims that the aim of science is to produce true theories, theories that are true not only to the observable facts, but to the unobservable facts as well. Hence, acceptance of a scientific theory, for the realist, involves the stronger belief that the theory is true.[1]

There are a number of important features that serve to distinguish constructive empiricism from its competitors. First, the constructive empiricist articulates the division between realists and empiricists *methodologically*, not metaphysically. In other words, what separates the two camps is not a bold metaphysical thesis (involving the nature of, say, truth[2]

[1] See van Fraassen 1980: 8-13 for his presentation of scientific realism and constructive empiricism.

[2] Arthur Fine (1984a and 1984b) argues that what separates scientific realists from scientific anti-realists has everything to do with the theory of truth to which they subscribe (a correspondence account in the case of the

or meaning[3]), but rather a thesis about what the aim of science is, and the epistemological and pragmatic commitments that accepting a scientific theory involves.[4] Accordingly, constructive empiricists are not compelled to endorse the instrumentalism inherent to positivist interpretations of scientific theories. Consider, for instance, the positivist thesis that scientific theories should be interpreted such that empirically equivalent theories have identical content, even if they appear to have contradictory theorems regarding unobservables (Schlick 1959; Ayer 1952). The constructive empiricist does not need to adopt such a controversial and problematic interpretation of scientific theories. Thus, the constructive empiricist and the realist can agree as to the content and interpretation of scientific theories.[5] Both can, in van Fraassen's phrase, accept the "literal interpretation" of scientific theories (1980: 10).

Constructive empiricism's second essential feature is its reliance on there being a genuine distinction between observable and unobservable entities.[6] Observability always is relative to an epistemic community and depends upon what the members of that community are able to detect with their unaided senses (van Fraassen 1980: 17-18). Jupiter, Jell-O, and the Japanese

former, a verificationist or pragmatic account in the latter). Those who, like Fine, see themselves as being "above" the debate choose to adopt no theory of truth.

[3] Michael Dummett (1978) famously argues that realism debates ought to be reformulated as debates about the nature of meaning: realists about a domain of discourse hold that the meanings of the statements in that domain are evidence-transcendent; anti-realists believe that the statements' meanings are not evidence-transcendent. Crispin Wright (1992) carries on Dummett's project in a similar vein. For van Fraassen's response to Dummett's approach, see his 1980: 37-38.

[4] Consequently, some (Musgrave 1985, for example) describe van Fraassen as an "epistemological" anti-realist.

[5] As a result, the constructive empiricist can agree with much of Maxwell's (1962) realist interpretation of scientific theories, and can second the criticisms he makes of instrumentalist accounts. There is still much in Maxwell's realism, however, that the constructive empiricist finds problematic (its demands for explanation and its stricter epistemological requirements, to name a couple).

[6] Van Fraassen's distinction here has generated enormous controversy; it is perhaps the least attractive feature of van Fraassen's philosophy of science, at least in the eyes of many of his critics. For a sampling of the criticism, see Churchland 1985 and Hacking 1985; for van Fraassen's response, see his 1985.

are all observable; germs, genes, and gravitational forces are not. Van Fraassen focuses his talk of the observable on objects, but it could be extended to features of objects as well. A table's being brown is one of its observable features; its being composed of atoms is not. We can also define the derivative notion of an observable fact (or putative fact): observable facts are just those that involve the observable features of observable objects (the fact that snow is white is an obvious candidate).[7] The distinction between observability and unobservability allows the constructive empiricist to draw the further vital distinction between truth and empirical adequacy. A theory is true just in case the world is exactly as the theory says it is. A theory is empirically adequate just in case everything the theory says about the observable is true. Theories, therefore, may be empirically adequate yet false (by entailing something that is not the case about the unobservable). Truth entails empirical adequacy, but not vice versa.

A third central feature of constructive empiricism is its account of the nature of scientific theories. To aid in distancing his own empiricism from that of the positivists, van Fraassen advocates a semantic interpretation of scientific theories, in contrast to the syntactic view adopted by the logical positivists and logical empiricists. On the traditional syntactic view, scientific theories are identified as sets of sentences. In order to separate the portions of the theory concerning only observable entities from the portions concerning unobservable entities, a distinction in vocabulary between observational and theoretical terms is adopted. From the original theory a subset of sentences can be formed that includes all and only the empirical consequences of the original theory. The subset is generated by formulating,

[7] Note that I am making no assumptions about the metaphysical nature of facts. Some deflationists are suspicious of the very notion of a fact, and my appeal to them is not intended to figure into my arguments against the consistency of constructive empiricism with deflationism.

wherever possible, the theorems of the theory using only the observational vocabulary. According to the syntactic view, a theory is true just in case every one of its component sentences is true; the theory is empirically adequate just in case each sentence of its empirical subset is true.

The problems with the syntactic approach are numerous—the downfall of positivism was inextricably linked with the failure to produce a pure observational language. For van Fraassen's purposes, there is one criticism of the syntactic approach worth addressing specifically. That problem is that theorems clearly expressing unobservable facts can be explicitly stated using only observational vocabulary. As examples, van Fraassen cites Newton's theory, which entails that there exists something that occupies no volume and has no position in space, and the Copenhagen interpretation of quantum mechanics, which holds that there exist things which have a position in space at some times, but not at others (1980: 54). Such theorems can be stated without the use of any theoretical terms, yet clearly count as being unempirical consequences of their respective theories. The problem generalizes. All unobservable entities share one feature in common: they are not observable. Equipped with the observational vocabulary and the negation operator, van Fraassen argues, "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" (1980: 54). As a result, van Fraassen concludes that the distinction between truth and empirical adequacy, which is of central importance to the constructive empiricist, "reduces to triviality or absurdity" (1980: 55). If the empirical subset of a theory ends up being identical to the whole theory, the distinction is trivial and meaningless; if the empirical subset includes sentences involving unobservable entities, the distinction has absurd consequences (for it holds that certain unobservable facts are observable). The syntactic approach to theories, then, cannot be sustained by the constructive empiricist. A different interpretation is called for.

The syntactic approach offers an idyllic view of a scientific theory, casting it as a simple conjunction of two sets of sentences, the empirical and the theoretical. Were such a picture sustainable, the distinction between truth and empirical adequacy easily would be understood. So in order to make sense of the distinction, van Fraassen, following the lead of Patrick Suppes (1967), adopts the semantic account of scientific theories.[8] On that picture, a scientific theory is identified as a class of models, not as a set of sentences. Each model offers a putative representation of the world, a mathematical structure into which the relevant facts of the world may be embedded. Further, the theory's models have empirical substructures, which serve "as candidates for the direct representation of observable phenomena" (van Fraassen 1980: 64). A theory is true just in case one of its models is isomorphic to the actual world—just in case all the facts can be embedded into the structure offered by the model. A theory is empirically adequate just in case it has a model whose empirical substructure is isomorphic to all the observable phenomena. In addition to avoiding the need for postulating theoretical and observational vocabularies, the semantic approach, van Fraassen argues, also better describes the behavior of practicing scientists (1989: 224-225).

[8] For more on van Fraassen's semantic view of theories, see any of his entries in the bibliography, especially his 1970, 1972, and 1987. An extensive defense of the semantic approach can be found in Suppe 1974 and Suppe 1989 (Suppe defends the semantic conception alongside scientific realism). The view has been put to work recently in evolutionary and biological theory by Elisabeth Lloyd (1988) and Paul Thompson (1989), respectively. The notion of a model that is central to the semantic approach will be developed in much more detail later in the paper.

3. Truth

Theories of truth fall on a continuum of metaphysical robustness. At one extreme are substantive accounts—correspondence theories in particular—which claim that truth is a metaphysically substantive relation between a proposition (statement, sentence, or what have you) and the world. On the other side of the spectrum are the various deflationary theories, which range from the austere disquotationalism of W. V. Quine (1970) and Hartry Field (1994; see also the position developed in David 1994) to the minimalism of Paul Horwich (1990) and Wolfgang Künne (2003).[9] It is fairly clear that van Fraassen himself adopts a correspondence theory of truth. Particularly revealing are the following passages from *The Scientific Image*: "In the case of a statement, *truth* is the most important semantic property. A statement is true exactly if the actual world accords with this statement" (1980: 90; emphasis is in the original) and "I would still identify truth of a theory with the condition that there is an exact correspondence between reality and one of its models" (1980: 197).[10] Regardless of what van Fraassen himself might think about truth, the crucial question is whether

[9] Other prominent players in the philosophy of truth include figures like Dummett, whose verificationist-inspired understanding of truth is not obviously placed on the same continuum with deflationists and substantivists. Wright's view of truth, which is something of a mixture of verificationism and deflationism (he like Horwich and Künne calls his view "minimalism"), also evades easy categorization. Other traditional accounts of truth (coherence theories and pragmatic theories, to name a couple), though historically interesting, have fallen out of the debate in recent years, and will not be discussed here. Nor shall I discuss other deflationary accounts, such as prosententialism (Grover 1992) and the redundancy account (Ramsey 1927). My suspicion is that my conclusions will apply equally to those other deflationary accounts.

[10] I am not the only one who has made the observation that van Fraassen subscribes to a correspondence account. Richard Jennings writes that "Van Fraassen's version of instrumentalism accepts the realist concept of truth (correspondence) for all statements including theoretical ones" (1989: 236). Fine detects more ambiguity in van Fraassen's attitude toward truth than I do (though Fine produces textual evidence only of van Fraassen's substantivism, and not any that would suggest that van Fraassen rejects substantivism) (1986: 157).

constructive empiricism itself requires a substantive theory of truth, or whether it can make do with only a deflationary account.

In order to evaluate whether deflationism can be conjoined consistently with constructive empiricism, we must highlight two features common to most brands of deflationary truth. Following Dorit Bar-On and Keith Simmons (2006), we can identify two theses common to most accounts of deflationism.[11] First is the claim that the truth predicate primarily is a logical device for disquotation (call that thesis *linguistic deflationism*).[12] Appending the truth predicate to a sentence adds no cognitive content to the sentence. Field, for example, argues that the sentences ‘snow is white’ and ‘‘snow is white’ is true’ are *cognitively equivalent*: they mean the very same thing to the speaker who utters them (1994: 250-251). Accordingly, any sentence involving the truth predicate can be replaced, without change in truth-value or meaning, by another sentence not employing the predicate. To take a canonical kind of example, consider the sentence ‘Something Kant said is true’. The deflationist offers a translation of that sentence without using the truth predicate. The deflationist might offer a quantified statement: ‘There exists some x such that Kant said that x and x’. Or the deflationist might offer an infinitely long statement: ‘Kant said that snow is white, and snow is white, or Kant said that grass is green, and grass is green, or…’. The deflationist claims that any use of the truth predicate similarly can be circumvented. Nevertheless, the truth

[11] Bar-On and Simmons also identify a third deflationary thesis, *metaphysical deflationism*, which is the thesis that truth is not a genuine property. But as they point out, many deflationists (notably Horwich) do not accept the metaphysical thesis (2006: 1). Thus, metaphysical deflationism is not necessary for a standard deflationist account of truth (though it is probably sufficient, as it may entail the other two theses).

[12] Note that for a deflationist like Horwich, truth technically plays a denominalizing rather than a disquotational role. Horwich’s account adopts the notion of a proposition, so the axioms of his account (such as ‘the proposition that snow is white is true just in case snow is white’) involve no disquotation (unlike in sentential accounts like Quine’s).

predicate has an important role to play in our language, in that it allows us to make such infinitely long statements in a manageable, finite manner.

Although all deflationists accept linguistic deflationism, some substantivists do as well (see Frege 1956). Thus, deflationists are also marked by their adoption of a second thesis, *conceptual deflationism*. Bar-On and Simmons describe conceptual deflationism as follows: "On the one hand we have the concept of truth. On the other we have a family of concepts to which truth is traditionally tied: meaning, validity, belief, truth-aptness, assertion, verification, practical success, and so on. According to the deflationist, there are no rich conceptual connections between truth and these other concepts" (2006: 1-2). Conceptual deflationism is the view that truth does not play an indispensable role in the philosophical analysis of other concepts that goes beyond its function as a device for disquotation or denominalization. Were an analysis to regard truth either as a metaphysical primitive, or as an essential component of the analysis beyond its disquotational or denominalizing role, the analyst would be relying on truth in a robust, non-deflationary manner. Consider, for example, Gottlob Frege's analysis of assertion. Frege embraces linguistic deflationism: "it seems, then, that nothing is added to the thought by my ascribing to it the property of truth" (1956: 293). Yet he thinks that what separates assertions (my sincere expression of my belief that snow is white) from non-assertoric speech acts (an actor's saying that snow is white during a performance) is that assertions put forward a thought as being true. Substantivists about truth can analyze the concept of assertion by appealing to the notion of truth—they can allow that there is a rich conceptual connection between truth and assertion. Deflationists, however, must deny that there are any such connections. Both the linguistic and conceptual deflationary theses can be attributed to most deflationists. No substantivist would subscribe to conceptual deflationism, so the two theses in combination adequately define a standard deflationist position. The task now is to determine whether constructive empiricism can sustain each of the two components of deflationism.

4. Constructive Empiricism and Deflationary Truth: A First Pass

In order for constructive empiricism and deflationism about truth to form a consistent pair, the deflationist-cum-constructive empiricist must be able to offer a statement of his view that does not rely conceptually on truth in any way that goes beyond its disquotational or denominalizing role. Constructive empiricism, again, is the view that the aim of scientific inquiry is to produce empirically adequate theories, where a theory is empirically adequate just in case everything involving the observable features of observable objects to which the theory is committed is true. Since that position makes reference to the concept of truth, we must investigate whether it can be disquoted or denominalized away in typical deflationist fashion. What the accounts of truth and empirical adequacy for scientific theories that the deflationist needs to offer will look like depends on whether the syntactic (sentence-based) or semantic (model-based) view of theories is adopted. Now, earlier I rehearsed van Fraassen's main arguments against the syntactic view of theories. I shall assume alongside van Fraassen that those arguments are decisive, and that constructive empiricists should adopt the semantic account of theories. Nevertheless, it will be instructive to look at what truth and empirical adequacy would look like for the deflationist on the syntactic view, were we indeed able to think of theories as a set of sentences (for the syntactic view makes no use of models, which complicate matters significantly). As a first pass, then, consider the following disquotational account of empirical adequacy:

EA_1: Scientific theory *T* is empirically adequate if and only if, for all propositions (statements, sentences, or what have you) *p*, if *T* implies that *p*, and '*p*' expresses only observable (putative) facts, then *p*.[13]

On that account, what it is for a theory to be empirically adequate is for each of its implications about the observable to be true. The implications that qualify as observable are those involving the observable features of observable objects. Similarly, the deflationist-cum-constructive empiricist might define the truth of a scientific theory as follows:

T_1: Scientific theory *T* is true if and only if, for all propositions (statements, sentences, or what have you) *p*, if *T* implies that *p*, then *p*.

Notice that the deflationary accounts of truth and empirical adequacy at hand employ some kind of universal quantification. There is a rich literature exploring what the nature of that kind of quantification must be, and the consensus seems to be that some sort of substitutional quantification is required.[14] Though the topic of substitutional quantification is beyond the scope of this paper, it is worth mentioning at least one obstacle that the deflationist has to deal with: as Horwich puts it succinctly, "the notion of substitutional quantification is trivially interdefinable with that of truth and itself requires elucidation" (1990: 27). If the deflationist-cum-constructive empiricist hopes to adopt the above accounts of truth and empirical adequacy, he must also offer an account of substitutional quantification in which truth is wholly dispensable.[15]

[13] I make reference to "putative" facts so as to disallow theories that include false implications about the observable from being true. For example, consider the theory including only the proposition that snow is green. It is false that that proposition expresses only observable facts (for it expresses something false), but it is true that is expresses only observable (putative) facts. Were it not to mention putative facts, **EA_1** would hold that the theory that only says that snow is green is empirically adequate, which is false.

[14] See Horwich 1990: 26-31, David 1994: 78-93, and Künne 2003: 356-360.

[15] See Hill 2002 for one approach that constructive empiricists might consider following.

Perhaps the above quantification is optional. Horwich, for one, opts to avoid substitutional quantification by adopting an infinitary definition of truth—one that cannot be stated finitely (1990: 31).[16] Were we to follow his lead, we might define our core notions as follows:

> **T_2**: Scientific theory *T* is true if and only if, if *T* implies that there are electrons, then there are electrons, and if *T* implies that snow is white, then snow is white, and if *T* implies that all ravens are black, then all ravens are black, and…

In order to fill out the rest of **T_2**'s right-hand condition, of course, we would need to add every grammatically sound conditional of the form 'If *T* implies that *p*, then *p*'. Empirical adequacy would be defined like this:

> **EA_2**: Scientific theory *T* is empirically adequate if and only if, if *T* implies that there are electrons, and 'there are electrons' expresses only observable (putative) facts, then there are electrons, and if *T* implies that snow is white, and 'snow is white' expresses only observable (putative) facts, then snow is white, and if *T* implies that all ravens are black, and 'all ravens are black' expresses only (putative) observable facts, then all ravens are black, and…

Just as there are reasons to be dissatisfied with the quantified accounts of truth and empirical adequacy, there are reasons to be dissatisfied with the new infinitary accounts. First, the deflationist-cum-constructive empiricist would be unable to state in finite terms a central thesis of his position. Philosophers are divided as to the gravity of that objection: Horwich accepts it willingly (1990: 31); others see it as threatening the very intelligibility of the position (see David 1994: 107-110 for discussion). Second, since according to constructive empiricism acceptance of a scientific theory includes the belief that the theory is empirically adequate, we might question whether the infinitary statement of empirical adequacy is something that can serve as the content of a belief in a finite mind.

[16] Contrastingly, Künne (2003) takes on the burden of substitutional quantification in order to avoid Horwich's infinity of axioms.

Both the infinitary and quantified accounts of empirical adequacy include the requirement that the sentences implied by the theory "express only observable (putative) facts". A complete defense of those accounts should include an explanation of what it is for a sentence to express only observable (putative) facts. As we have already seen, the syntactic view falters because of its inability to adequately specify which of a theory's theorems belong to its empirical subset. Do the above examples from Newtonian theory and quantum mechanics, when they appear in the definition of empirical adequacy, express only observable (putative) facts? Both examples clearly express facts involving unobservables, though they make no explicit mention of unobservable entities or features. Since the appeal to an observation language is unlikely to provide a satisfying method for distinguishing a theory's empirical and unempirical consequences, the advocate of the syntactic view must offer some other explanation of when sentences express only observable (putative) facts. The legacy of the syntactic account of scientific theories suggests that no such project will be successful. I have no argument for the conclusion that no adequate defense of the syntactic view is forthcoming. Instead, I shall continue to assume with van Fraassen that the semantic view of theories is preferable to the syntactic view, and that constructive empiricists ought not to take on the burden of defending the latter.[17]

So much for the syntactic view of scientific theories. While the view offers a fairly clean deflationary reconstruction of truth and empirical adequacy, the analyses rely on an outdated

[17] Similarly, I am assuming with van Fraassen that just as sentences are essential to the syntactic view, models are essential to the semantic view (though van Fraassen is sometimes ambiguous on the matter (see Thompson 1989: 77)). I have not argued, then, that one could not offer a sentence-based yet semantic account of theories (in other words, a semantic approach to theories that did not utilize models). I suspect that the hurdles I raise below for the semantic approach will apply equally to a semantic approach that relied only on sentences. In my discussion of the semantic approach to theories, I shall employ the model-theoretic version that proponents of the semantic approach in fact advocate.

and much-maligned view of theories. Let us now examine whether the model-theoretic approach already favored by constructive empiricists lends itself adequately to disquotation or denominalization.

5. The Game of Life

On the model-theoretic or semantic view of scientific theories, a theory is identified with a set of models. Unlike propositions, statements, and sentences, models are not the sort of thing for which truth naturally can be predicated. A traditional disquotational or denominalizing approach, therefore, is not obviously available to the deflationist-cum-constructive empiricist who adopts the semantic account. On the model-theoretic view, a theory is true just in case one of its models is isomorphic to the actual world, and empirically adequate just in case the empirical substructure of one of its models is isomorphic to the observable world. The constructive empiricist's invocation of isomorphism here offers some preliminary suggestion that the view might presuppose a substantive account of truth.[18] Attributing the theory to Bertrand Russell (1912), Richard Kirkham defines one kind of classical correspondence account as the view "that there is a structural isomorphism between truth bearers and the facts to which they correspond when the truth bearer is true" (1992: 119). In order to critically evaluate whether the suspicion of substantivism lurking in the notion of isomorphism survives closer scrutiny, let us examine what exactly a model is on the semantic conception of scientific theories.

[18] Again, see van Fraassen's own correspondence-laden words: "I already made clear one important point in the empiricist view of scientific models. They may, without detriment to their function, contain much structure which corresponds to no elements of reality. The part of the model which represents reality includes the representation of actual observable phenomena, and *perhaps* something more, but is explicitly allowed to be only a proper part of the whole model" (1987: 122). Van Fraassen also says that what it is for a model to be isomorphic to the actual world is for it to be "an exact copy of reality: each part or element of the model represents something real, and those real things are related in just the way that the model represents" (1991: 242).

We can understand better the model-theoretic account of scientific theories by examining a very simple example that utilizes John Horton Conway’s game *Life* (see Gardner 1970 and Dennett 1991). Life provides a simple deterministic system such that its future states systematically can be deduced from its earlier states. A Life world consists of a two-dimensional grid of cells. At any given time, each cell is in one of two possible states (ON or OFF). Any non-initial configuration of the grid is a direct result of the previous configuration and the “laws” that govern the transformations of the grid over time.[19] Whether a cell is ON or OFF at a particular time depends entirely on whether its neighboring cells (including diagonals) were ON or OFF during the previous time. Life operates according to three simple rules:

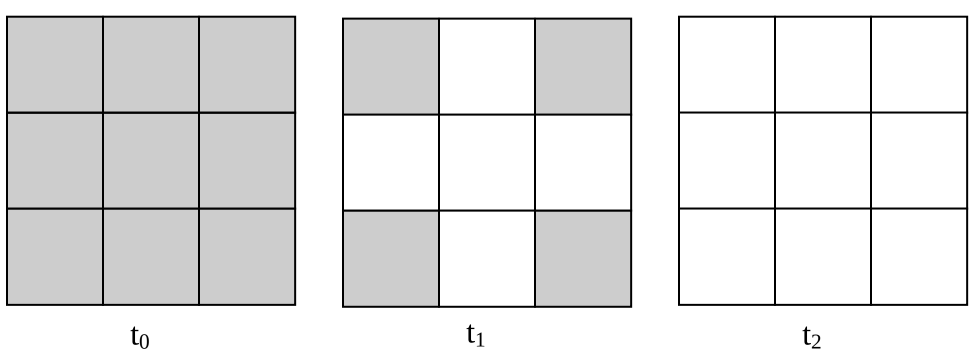
A_1: If at time t_n any cell has exactly two neighboring ON cells, then that cell remains in the same state at t_{n+1}.

A_2: If at time t_n any cell has exactly three neighboring ON cells, then that cell is ON at t_{n+1}.

A_3: If at time t_n a cell is under any other condition, then that cell is OFF at t_{n+1}.

Here is a simple three-stage Life transformation on a nine-celled grid (gray squares denote the ON position, white squares the OFF position):

Figure 1



[19] Note that the “laws” here are not assumed to be anything that might be distasteful to a constructive empiricist.

Were this pattern to be continued, all subsequent configurations (at t_3 and beyond) would be identical to the entirely OFF configuration at t_2 (for a “dead” grid cannot be “resuscitated”).

We can use the game of Life to give an example of what a model-based scientific theory looks like. Imagine a universe that consisted of nothing more than what we find in the Life universe, a universe that could be described exhaustively by specifying at every time whether each of its cells was in the ON or OFF state. Suppose we wanted to construct a scientific theory that modeled such a universe. To do so, we would need to define the mathematical structures that will serve as representations of the various components of the universe. The first thing to be defined would be a set of nine ordered pairs, each representing a cell on the grid: {<1, 1>, <1, 2>, …, <3, 3>}. We would also need to define the symmetrical *neighbor* relation, which specifies the cells that are neighbors to each other (cells are neighbors just in case they have different coordinates, which differ by no more than a magnitude of one). Also included would be the axioms $\mathbf{A_1}$, $\mathbf{A_2}$, and $\mathbf{A_3}$, which serve as the laws, or just fundamental regularities, of the theory. Given that minimal structure and apparatus, the theory can be defined in terms of a set of models that are consistent with the given structure. Distinguishing each model of the Life theory would be a function that assigned to each ordered pair an initial value from the set {0, 1}, representing the features OFF and ON, respectively. The individual moments of time in the Life universe are assigned natural numbers. Since our universe has nine cells, there are 2^9 or 512 unique initial configurations.[20] Because the Life universe operates deterministically, each initial configuration leads to one particular future.

[20] Note that one could define the Life theory without building into the structure that there are nine cells. One might instead offer a more general version of the theory that left it open to the individual models to specify how many cells were in the universe. Such a theory would have infinitely many models, 512 of which are the ones included in the narrower theory I am offering.

Now suppose that the history of the universe began as in the example above, with each cell initially in the ON position, and in fact is a Life universe. Because the universe is a Life universe, it behaves according to the axioms of the theory. Thus, the Life theory offers an accurate representation of the universe, for one of its models (namely, the one whose initializing function assigns '1' to each ordered pair) correctly describes the actual state of each cell at every time of its history.

To summarize, then, our Life theory *L* of the nine-celled universe is to be identified with a set of 512 models. Each model of *L* itself can be identified with a single function. That function takes two inputs, ordered pairs defined over {1, 2, 3} and members of the set of natural numbers, and maps them to a member from the set {0, 1}. What makes each of the 512 models models of *L* is the fact that it is consistent with the above axioms of the Life game.[21] Models that are not consistent with those axioms are not models of *L*. For example, if there were a function that assigned '1' to each ordered pair at t_0, and yet assigned '1' to each ordered pair at t_1, that function would not be a model of *L*, but perhaps of some other non-Life theory. The axioms need not be understood as part of the *content* of the models or the theory. They are essential in offering an analysis of what makes the models belong to the Life theory, and for specifying why other models do not belong to the theory. Further, they are useful for making predictions about Life universes. But they nevertheless can be

[21] Note that I presented the axioms using the non-mathematical language of cells, times, ON, and OFF. To demonstrate that the models of *L* are consistent with the axioms, the axioms would need to be reformulated using just the mathematical language of *L*.

understood as statements merely consistent with the models; they are not in any important sense statements *of* the models (for the models are identified merely with the functions).[22]

Another feature of the game of Life is that it easily can be modified to make sense of the distinction between observables and unobservables, making it an especially helpful example for the constructive empiricist. One way one might introduce the distinction is simply by demarcating some of the Life matrix as being unobservable. For example, suppose that the top row of the Life world depicted above is unobservable. Statements involving the features of the top row would not count as expressing observable phenomena, whereas statements involving only the lower two rows would.[23] Constructive empiricists can find that picture of the unobservable appealing, for it suggests that the unobservable and observable are "metaphysically continuous": the unobservable regions of the universe are just as real as the observable regions, and have the same features. The regions differ only in their epistemic accessibility (for whatever reason that might be). Further, the empirical substructures of a theory easily could be defined. The empirical substructures in the case of a Life world would be identical to partial functions that map only the observable regions of the cell matrix paired with times to the relevant values.

The game of Life is helpful in elucidating what constitutes a model of a scientific theory. But there is more to the semantic view of theories than just models. The view is *semantic*

[22] Note that van Fraassen's own presentation of the model-theoretic view of theories differs slightly from my own, given his choice of examples (he also presents his view using the technical vocabulary of state spaces, elementary statements, and satisfaction functions). The picture provided using the Life game, I think, better helps elucidate the potentially confounding notion of a model. For full exposition of van Fraassen's description of models, see van Fraassen 1970: 328-329, van Fraassen 1972: 311-312, Suppe 1989, and Thompson 1989: 77-81.

[23] Here is another equally adequate way of differentiating the observable and unobservable facts: set a time which demarcates the two. For example, suppose that the only observable phenomena take place at t_{1000} and before. All states of the Life universe following that time are unobservable.

because it stresses that scientific theories always involve an intended interpretation. In the Life universe depicted above, *L* provides an accurate model of the universe—one of its models is perfectly isomorphic to every state of that universe's history. Consider, however, a different universe. In that universe, there is one object, Bob. Bob can have one of two features. He is either happy or angry. At each moment in time, the universe is described entirely by specifying whether Bob is happy or angry. As it turns out, the universe unfolds as follows: Bob begins life as a happy entity. However, ever since that first moment, Bob has been angry. Bob continues to be angry for the rest of time. Perhaps surprisingly, we can use the same mathematical structure provided by *L* to offer a successful account of Bob's universe. The new theory—the Bob theory—employs the same mathematical structure as the Life theory. The theory incorporates the same set of nine ordered pairs, and each model is a function that assigns a value from {0, 1} to ordered pairs at times. Future configurations of the system in the model are determined according to the same three axioms. Where the two theories differ is in their intended interpretation. For the Life theory, the nine ordered pairs represent the nine Life cells. For the Bob theory, the set of nine ordered pairs represents Bob. Further, since the Bob universe does not involve the real features ON and OFF, the values 0 and 1 are interpreted as follows: Bob is *happy* at t_n just in case at t_n there are at least five ordered pairs bearing the value '1'. Bob is *angry* at t_n just in case at t_n there are fewer than five ordered pairs bearing the value '1'. Several models of our theory satisfy the condition that the grid has at least five '1' cells only at t_1. Thus the structure from the Life theory can be used in a theory that correctly represents the very different Bob universe.

We must understand *L*, then, as the conjunction of its models and an interpretation. The Life theory and the Bob theory share models employing the same mathematical structure, but they accompany different intended interpretations and thus are distinct theories. The theory's interpretation plays the role of pairing the mathematical structure of the theory's models with the real features of the world. To define the intended interpretation J of L, we need to define three one-one functions. The first (j_1) takes ordered pairs to cells. In the Life world, the cells are the real objects. Hence J includes a function taking ordered pairs defined over {1, 2, 3} to the set of cells, each named with a letter {A, B, …, I}. Next there is a function (j_2) that assigns to members of the set {0, 1} the real features OFF and ON, respectively. Finally, a third function (j_3) maps the set of natural numbers with actual times: 0 with t_0, 1 with t_1, and so on. J now provides a semantics for L. L, again, includes 512 models, which constitute the set of functions $\{M_1, M_2, \ldots, M_{512}\}$. Let Φ be a variable ranging over the class of cells, φ a variable ranging over the class of features, and t a variable ranging over the class of times. Any statement of the form 'Φ is φ at t' is true-in-M_n if and only if $M_n\,(j_1^{-1}(\Phi), j_3^{-1}(t)) = j_2^{-1}(\varphi)$. Hence, all "ordinary statements" that would be used to describe the Life universe ('A is ON at t_0'; 'E is OFF at t_2') can be evaluated from the perspective of each model of the theory.[24] Such statements often will be true in some models, but not in others. For example, consider the sentence 'A is ON at t_0'. From the perspective of M_1, the model where every cell begins in the OFF position, the sentence is false (not true-in-M_1). M_1 says that the first cell in the grid is OFF at the initial time: $M_1\,(\langle 1, 1\rangle, 0) = 0$. From the perspective of M_{512}, the model where every cell begins in the ON position, the sentence is true (true-in-M_{512}): $M_{512}\,(\langle 1, 1\rangle, 0) = 1$.

[24] We could also treat the class of "ordinary statements" as the base of a recursively defined class of logically more complex statements. Then we could easily define the semantics for such complex statements like 'A is either ON or OFF at t_0' or 'All cells are OFF at t_5'. The base would also need to include other true statements about the Life world, such as basic existential statements ('There are nine cells').

We have now defined the notion of truth-in-a-Life model, which will be useful in offering the accounts of truth and empirical adequacy that the deflationist-cum-constructive empiricist must offer. A true theory, again, is one that has a model that is isomorphic to the actual world. An empirically adequate theory is one that has a model whose empirical substructure is isomorphic to all phenomena. The deflationist, of course, must offer analyses of the truth and empirical adequacy of scientific theories that do not presuppose a substantive notion of truth, and that must appeal instead to truth-in-a-model, as rigorously defined above. They will also need to employ the derivative notion of truth-in-an-empirical substructure. That notion could be defined similarly, for the empirical substructure of a model is just a partial function of the model's function, a function whose domain is a subset of the model's domain (in our case, the partial function operates over just the ordered pairs representing the two lower rows of cells). The following accounts naturally suggest themselves:[25]

T_3: Scientific theory T is true if and only if there is a model M_n of T such that 'there are electrons' is true-in-M_n if and only if there are electrons, and 'snow is white' is true-in-M_n if and only if snow is white, and 'all ravens are black' is true-in-M_n if and only if all ravens are black, and…

EA_3: Scientific theory T is empirically adequate if and only if there is a model M_n of T and an empirical substructure E_n of M_n such that if 'there are electrons' is decided by E_n, then 'there are electrons' is true-in-E_n if and only if there are electrons, and if 'snow is white' is decided by E_n, then 'snow is white' is true-in-E_n if and only if snow is white, and if 'all ravens are black' is decided by E_n, then 'all ravens are black' is true-in-E_n if and only if all ravens are black, and…

The new offerings merit some comment. First, observe that that the right-hand side conjuncts in the definition of truth are now biconditionals. When speaking of models, van Fraassen routinely observes that they must be isomorphic to *all* the phenomena in order for

[25] For considerations raised earlier, I am offering the model-theoretic accounts of truth and empirical adequacy in their infinitary rendering, not the quantified version. If one wanted to adopt the quantified approach, analogous formulations easily could be made.

their theories to be empirically adequate, and to the *entire* world in order to be true. Without the biconditionals, any theory with a null model—one in which no statement is true—would count as true. Second, note that the biconditionals appearing in the definition of empirical adequacy are now nested as the consequents of conditional statements, with the antecedent making use of the notion of decidability. The empirical substructures of models fall silent on matters concerning the unobservable. For example, if the sentence ‘A is ON at t_0’ expresses an unobservable fact, then it will fail to be true in the empirical substructures of the models of L (even if it is true in the corresponding models), since the functions used to define the notion of truth-in-E_n are undefined with respect to cell A. Hence, ‘A is ON at t_0’ fails to be decided by E_1, E_2, and all the others. Only statements concerning exclusively the observable will be decided by empirical substructures; **EA₃** is thus defined so as to make statements involving the unobservable irrelevant to the evaluation of a theory’s empirical adequacy.

6. Why Constructive Empiricists Cannot be Deflationists

We have now seen what kind of account of truth and empirical adequacy the constructive empiricist must offer if he hopes to demonstrate that his notions are acceptable on deflationary grounds. Our task now is to explore why even those accounts are inadequate, and cannot be sustained by deflationists. What the new offerings of truth and empirical adequacy lack are definientia that are obviously acceptable to the deflationist, for they include the notion of truth-in-a-model. Now, above we saw what truth-in-a-Life model is. Equipped with that understanding, we can fully specify what it is for a Life theory to be true. What, however, of other theories? What is it for the theory of Newtonian mechanics, or the theory of evolution by natural selection, to be true? Presumably, any adequately developed scientific theory includes an adequately developed interpretation. Theories are tested against the world, and thus interpretations are needed in order to connect the theory's mathematical structures with the phenomena observed in the world. Giving an account of what those interpretations are is a very difficult task. For the simple and contrived Life theory, formulating the interpretation is fairly uncomplicated. Real scientific theories involve far more complicated mathematical structure; furthermore, the phenomena of our own universe are incomprehensibly vast and diverse—the complexity of the Life phenomena pales in comparison. In our world, it is true that snow is white. But what is it for 'snow is white' to be true in the models of general relativity, or quantum mechanics? If we lack an understanding of the interpretation of a scientific theory, and thus lack an understanding of what truth-in-a-model is for that theory, then our understanding of truth and empirical adequacy is also incomplete on the deflationist's account.

There is a far greater difficulty, however, for the above accounts of truth and empirical adequacy. The crux of the problem for the deflationist lies in the fact that the definientia they offer for truth and empirical adequacy involve the semantic notion of truth-in-a-model, which cannot (by the deflationist's lights) be taken primitively. Instead, the notion must always be understood relative to the theory whose truth or empirical adequacy is at stake. Because there is no general notion of truth-in-a-model, the deflationist is left without a way of articulating, in general, in what the truth or empirical adequacy of a theory consists. Recall that for the typical deflationist, the truth predicate exists solely for its disquotational or denominalizing functions. The truth predicate allows us to say things like 'Something Kant said is true', things that would be impossible to say without the truth predicate on account of their infinite length. Nevertheless, the deflationist can show what those infinite statements look like, and note how they do not presuppose any further semantic notions. The truth predicate, for the deflationist, is conceptually isolated, unsupported by further semantic notions. It can be done away with. That kind of deflationism about truth is simply not possible for the deflationist-cum-constructive empiricist who advocates $\mathbf{T_3}$ and $\mathbf{EA_3}$. The deflationist, of course, is always free to make use of the truth predicate. He can say, for example, that the aim of science, according to the realist, is to produce true theories. But to demonstrate that truth, in his understanding of the realist aim of science, is functioning only as a device for disquotation or denominalization, the deflationist must be able to offer an account devoid of any further mention of semantic concepts (just as the deflationist account of 'Something Kant said is true' makes no use of any such concept). What the deflationist-cum-constructive empiricist appears to have to do, however, is make reference not to just one further semantic concept, but to indefinitely many semantic concepts—one for each model of every possible scientific theory. Consequently, the deflationist-cum-constructive empiricist has not yet offered an account of his position that is acceptable on deflationary grounds. His analysis of truth (and empirical adequacy also) must rely on indefinitely many semantic concepts, most of which are concepts for which he has no understanding.

The deflationist may offer the following reply: When it comes to interpretations of our best current scientific theories, we of course do not have a fully worked out account, but neither does anyone else. Further, our account does indeed reduce truth to the notion of truth-in-a-model. We admit that there is no generalized account of truth—but that is exactly what we have always been stressing: truth is a thin concept, one that does not require a general account. There is nothing, in fact, that true theories have in common. Further, we have reduced truth to truth-in-a-model, but there is nothing metaphysically substantive about truth-in-a-model. In fact, we have seen an example (the Life theory) that defines explicitly what truth-in-a-model is. Truth-in-a-model is merely a technical mathematical notion, stipulatively defined, and thus devoid of metaphysical substance. Finally, as $\mathbf{T_3}$ and $\mathbf{EA_3}$ clearly show, truth-in-a-model still functions as a device for disquotation. Hence, they are after all acceptable to the deflationist.

The deflationist's reply, however, is lacking. The deflationist is correct to point out that no one, even those who adopt the most robust account of truth available, has an adequate grasp of what the interpretations for our best scientific theories are. Still, it seems that deflationists carry an extra burden as a result of the missing interpretations. If the deflationist-cum-constructive empiricist wishes to appeal to the concept of truth when articulating his position, he must be prepared to demonstrate that the notion presupposes nothing more substantive than a deflationist can allow. Since his account of truth rests on numerous other concepts (all varieties of truth-in-a-model), the deflationist is at pains to show that those concepts are themselves acceptable to the deflationist. To the extent that the deflationist-cum-constructive empiricist leaves unanalyzed the constituents of his notion of truth, he cannot claim justifiably that his account is genuinely deflationary.

Further, while it is true that the deflationist usually (and justifiably) claims not to be obligated to offering a general account of truth (though some of course do), the deflationist-cum-constructive empiricist is so obliged. Constructive empiricists employ the concept of truth for a use that goes beyond truth's typical disquotational and denominalizing role, for they use it in formulating both their and their opponent's position. According to the constructive empiricist, the aim of science is to construct empirically adequate theories, regardless of what kind of theory is being considered. The deflationist-cum-constructive empiricist's statement about his very own position appeals to the notion of empirical adequacy *simpliciter*; yet he has no recourse to a similar, general notion of truth-in-an-empirical substructure for his deflationist reduction.

Given the formalized definition of truth-in-a-Life model I offered above, it may appear that the notion is metaphysically innocuous. The notion was defined mathematically, with no reference to a suspicious "correspondence relation" or anything else typically distasteful to the deflationist. Notice, though, that we could have defined several other relations as well. Let us define the notion of *waarheid-in-a-model*. Suppose we add another one-one function, j_4, to our interpretation J of the Life theory. The new function, like j_2, assigns features to the members of {0, 1}, but does so conversely. Thus, $j_4(0)$ = ON and $j_4(1)$ = OFF. Now call Life sentences of the form 'Φ is φ at t' waar-in-M_n if and only if $M_n\,(j_1^{-1}(\Phi), j_3^{-1}(t)) = j_4^{-1}(\varphi)$. As the two semantic notions are defined, no basic Life sentence can be both true-in-M_n and waar-in-M_n. Now, clearly the deflationist must opt for using true-in-M_n rather than waar-in-M_n in his definition of truth for a Life theory. But what rationale can the deflationist offer to explain why the former concept belongs in his notion of truth rather than the latter? Further, even supposing we define a true theory as in $\mathbf{T_3}$, and a waar theory analogously (by substituting 'waar' everywhere 'true' appears), what explanation could we offer for why the realist thinks the aim of science is to produce true theories, rather than waar theories? And why should the constructive empiricist think that the aim of science is produce theories that are true to the phenomena, rather than waar to the phenomena?

The appropriate response to those questions, it seems to me, involves some reasoning like the following: Of all the semantic notions of which we can conceive, one in particular stands out. For our Life theory, defining what it is for a sentence to be true-in-M_n is essential for understanding what it is for a Life theory to be true. Other notions, like waar-in-M_n and indefinitely many others we could define at our leisure, simply do not suffice. Truth-in-M_n is the privileged semantic notion, and not simply because of its arbitrarily chosen name (I could very well swap 'true' and 'waar' throughout this section, in which case 'waar-in-M_n' would denote the privileged semantic notion). Regardless of the theory we are considering, there will be one crucial semantic notion, one relevant to the truth-evaluability of that theory, that must be distinguished from all other notions we may wish to define. When interpreting evolutionary theory, for example, we must offer an interpretation of the models of the theory, and pinpoint the specific relation that is constitutive of truth for evolutionary theory. That relation is the *correct* one for defining truth in evolutionary theory, just as truth-in-M_n is the correct one for defining truth in the Life theory. The deflationist has no explanation for why those notions, rather than any other one, are the correct notions for understanding truth, and cannot say what it is that those notions have in common that separates them from their contenders. For deflationists, truth is merely a device for disquotation or denominalization: it is not to be understood as a metaphysically privileged semantic notion, as the constructive empiricist must take it to be.

Finally, consider the deflationist's claim that the various kinds of truth-in-a-model function as disquotational devices, and thus are acceptable on deflationary grounds. Granted, truth-in-M_n appears to be disquotational in $\mathbf{T_3}$ (as does truth-in-E_n in $\mathbf{EA_3}$), which includes biconditionals like ''snow is white' is true-in-M_n if and only if snow is white'. Those biconditionals resemble the classic "T-Sentences" like ''snow is white' is true if and only if snow is white'. For deflationists, T-Sentences are necessarily true, for their left and right conditions are cognitively equivalent. However, the biconditionals forming $\mathbf{T_3}$ are importantly different. Consider again the Life sentence 'A is ON at t_0', and suppose the world is as M_{512} depicts it (with all cells initially ON, as shown in Figure 1 above). Now, *ex hypothesi*, our Life theory L is true because one of its models (namely, M_{512}) is isomorphic to the actual world. Let us then instantiate $\mathbf{T_3}$ with L and M_{512}. Doing so generates the biconditional ''A is ON at t_0' is true-in-M_{512} if and only if A is ON at t_0'. It seems, then, that we have defined truth in terms of truth-in-M_{512}, and have then employed truth-in-M_{512} merely as a device for disquotation. There appears to be nothing here that is unsavory to the deflationist. However, appearances are here deceiving. The biconditional I have isolated, while true, is only contingently true. Its left condition is essentially a mathematical truth; regardless of whether the actual world is accurately described by M_1, M_2, or some other M_n, the sentence ‘‘A is ON at t_0’ is true-in-M_{512}’ is true, and necessarily so. However, the right-hand condition expresses a contingent matter of fact. In some worlds, A is OFF at t_0, and in some worlds it is ON at t_0. Hence the biconditionals constituting $\mathbf{T_3}$ are only contingently true. That the biconditionals forming $\mathbf{T_3}$ are contingent is important because such a conclusion is at odds with the traditional deflationist understanding of T-sentences. Deflationists typically take T-Sentences to be necessarily true (Horwich 1990 is a prime example). Since truth, on their view, is a deflated notion, predicating it of something adds no substance to it. As a result, classic T-Sentences are necessarily true, for their left-hand conditions bear no cognitive content not already possessed by their right-hand conditions. For deflationists, T-Sentences are vacuous. As a result, deflationists and substantivists disagree on the modal status of T-Sentences: substantivists typically argue that T-Sentences, while true, are contingent. Whether certain T-sentences are true depends on contingent matters of fact including, among others, facts involving the meanings of certain words. Deflationists should thus hesitate to embrace a view that requires T-Sentences to be metaphysically contingent.

Further, we must recognize that when deflationists claim that, say, truth-in-M_{512} is operating only as a device for disquotation, they are ignoring the element of interpretation that makes the T-sentences that feature it true. Indeed, assuming the world to be as M_{512} describes it, the biconditional ‘‘A is ON at t_0’ is true-in-M_{512} if and only if A is ON at t_0’ is true. It is misleading, however, to think of that biconditional as being partially constitutive of the deflationist-cum-constructive empiricist’s definition of truth. The kind of biconditional that is really constitutive of truth for the deflationist-cum-constructive empiricist is far more complicated, and not at all disquotational: ‘‘A is ON at t_0’ is true-in-M_{512} if and only if M_{512}

$(j_1^{-1}(A), j_3^{-1}(0)) = j_2^{-1}(ON)$'. That kind of biconditional satisfies the condition of being necessarily true (for each of its conditions are mathematical truths), but it clearly shows that truth-in-M_{512} is *not* a device for disquotation. As we saw above, the biconditionals forming $\mathbf{T_3}$ are only contingently true, and thus the inference from ''A is ON at t_0' is true-in-M_{512}' to 'A is ON at t_0' is not logically secure. If truth-in-M_{512} were a genuine device for disquotation, that inference would be of the highest triviality. The biconditionals that are constitutive of truth-in-M_{512} are formed from conditions that are clearly not cognitively equivalent; the left-hand side involves sentences from normal English, and the right-hand side involves only complicated mathematical symbolizations. Consequently, we arrive at the appearance of a disquotable sentence only through a detour involving a complicated translation between ordinary English and the mathematical language of the Life theory's interpretation. What we have in the notion of truth-in-a-Life model is not something that resembles straightforward disquotation. On a typical deflationist program, truth is immediately disquotable: no translation or further premise is required to fuel the inference between ''snow is white' is true' and 'snow is white'. For the notion of truth-in-a-model, no such immediate disquotation is possible, since the theoretical interpretation is playing a necessary, mediating role. Truth-in-a-model, regardless of the version being considered, cannot function as a simple device for disquotation, as the deflationist would have it.

To summarize, then, the deflationist-cum-constructive-empiricist characterizes the aim of science as pursuing empirical adequacy, which is defined in terms of truth. Since the deflationist must show that his appeal to truth is acceptable on deflationary grounds, he must show that his reliance on truth does not go beyond its disquotational or denominalizing features. Further, as a constructive empiricist, he must understand theories as sets of models paired with an interpretation. The attempts at offering a deflationary analysis of the truth and empirical adequacy of scientific theories end up relying on further semantic notions, which is already a strike against the deflationist (for deflationist reductions tend to include no further semantic notions, as in the breakdown of ‘Something Kant said is true’). Further, those additional semantic notions—in most cases notions that are likely never to be defined explicitly—raise the question of why they are crucial to the notion of theory truth and theory empirical adequacy, rather than other semantic notions, a question that deflationists are at pains to answer. As a result, the deflationist lacks a rationale for saying what it is that the various semantic notions all share such that they are relevant to evaluating a theory’s empirical adequacy and truth. Finally, deflationists are faced with the problem that the notion of truth-in-a-model on which they rely does not serve as a disquotational device at all, contrary to what might appear to be the case: $\mathbf{T_3}$ and $\mathbf{EA_3}$ are simply not disquotational accounts of truth and empirical adequacy. In short, without relying on the resources of a substantive account of truth, the deflationist suffers the inability of offering accounts of truth and empirical adequacy that are required to make sense of constructive empiricism.

7. Conclusion

If my diagnosis is correct, constructive empiricists require a more substantive account of truth than that offered by deflationists. Deflationists, recall, subscribe to the thesis of conceptual deflationism, the claim that truth is not richly connected with other philosophical concepts—that its conceptual contributions are limited to its disquotational and denominalizing functions. My aim has been to show that mere deflationary truth does not suffice for the constructive empiricist's account of several notions that are important in the philosophy of science: the truth and empirical adequacy of scientific theories, scientific realism, and even constructive empiricism itself.

What conclusion is to be drawn? Should constructive empiricism be rejected as an untenable philosophy of science, given the many merits of deflationism? Should constructive empiricism be rejected as unmotivated—or even incoherent—since its major motivation (metaphysical asepticism) is undermined by its commitment to a metaphysically robust theory of truth?[26] Should constructive empiricism's construal of the nature of realism and empiricism be rejected, paving the way for novel ways of articulating the realism debate in the philosophy of science?[27] Or, alternatively, should deflationism about truth be rejected, given its failure to adequately account for what the constructive empiricist claims to be the aim of science? I have not argued in defense of one of those conclusions rather than another;

[26] James Ladyman, in an argument not dissimilar to my own, takes that option after accusing constructive empiricists of being committed to a substantive account of modality (2000). See Monton and van Fraassen 2003 and Ladyman 2004 for further discussion.

[27] I take Wright (1992) to adopt that option.

I have merely tried to identify an inconsistency between two philosophical views that otherwise would seem to form a natural pair. Constructive empiricists and deflationists both share the desire to offer their theories with as little recourse to metaphysics as is necessary. My own suspicion is that the constructive empiricist's account of empiricism and realism has much to recommend it; traditionally, truth has played a prominent role in discussions of realism, and I see no reason to dispute that centrality (see Sayre-McCord 1988). Van Fraassen's characterization of realism and empiricism is natural and convincing: the realist argues that the aim of science is to discover the truth about the world, while the empiricist argues that science aims to achieve empirical adequacy, to discover the truth about the phenomenal world. If truth and realism are indeed inextricably linked, then we have reason to be suspicious of conceptual deflationism—we appear to have an area of ripe philosophical inquiry where truth seems to be put to use beyond its role as a device for disquotation and denominalization. Hence, I am inclined to think that truth is not merely a tool for disquoting and denominalizing. Deflationists were correct to identify those functions of the truth predicate, but there is more to truth than its basic linguistic functions. Truth is a rich concept, essential to our understanding of the aim of science.

Accordingly, it is worth noting an important corollary to my conclusion. Just as the constructive empiricist requires a substantive account of truth in order to make sense of what he thinks is the aim of science, so too does the realist (at least as construed by the constructive empiricist) require a substantive account of truth in order to make sense of what he thinks is the aim of science. That conclusion may not be so startling, given that scientific realists do not typically share the empiricist distaste for metaphysically substantive commitments. There is no inherent tension between the already metaphysically substantive realism and a substantive account of truth. Further, it is not uncommon to find scientific realists happily admit a substantive view of truth (see Devitt 1984, for instance). Still, I do believe there are important morals to be drawn from the inability of deflationism to make sense of much of the philosophical debate over realism. Although I have reserved my focus in this paper solely for the implications that deflationism has for constructive empiricism, the broader implications that deflationism about truth has for debates concerning realism in the philosophy of science and elsewhere are deserving of continued exploration.

What, to conclude, of constructive empiricism's call for metaphysical austerity? Does my contention that it requires a substantive account of truth undermine the spirit of empiricism that drives and motivates van Fraassen's preferred philosophy of science? One response available to the constructive empiricist, though not a particularly interesting one, is that he never claimed to offer a philosophy of science with *no* metaphysical commitment, just one with as little metaphysics as possible. As it turns out, it is just not possible to make do without a substantive theory of truth. However, there is another more fruitful response, one that points toward future possible research. I have not argued for exactly what kind of truth the constructive empiricist requires; rather, I have argued only that a deflationary account is insufficient. The constructive empiricist needs an account that is more robust than that offered by the deflationist, but it does not follow from my argument that a constructive empiricist requires, say, a classical correspondence theory of truth. Traditional correspondence theories are well-known for their problematic extravagances, and constructive empiricists might do well to share along with deflationists the worries that motivated deflationism in the first place. Still, there may be another option. Perhaps there is a theory of truth that, while more substantive than a bare deflationary account, nevertheless avoids the excesses of traditional correspondence theories. Such a theory would be acceptable to the empiricist, and could figure into his account of the nature of scientific inquiry. Constructive empiricists would be wise to search for such a theory.

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