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Bas C. Van Fraassen's Objection to Unobservable Entities: A Studied Rebuttal with the Case of Mycobacterium Tuberculosis

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ABSTRACT

Bas C. van Fraassen holds an anti-realist position that directs a damaging attack against entity realism. As it stands, the question of limits of experience is crucial to van Fraassen's constructive empiricism and has an intricate link with his negation of the ontological status of unobservable entities. This paper essentially rebuts van Fraassen's position with the case of drug resistant Mycobacterium tuberculosis. It queries the sort of experiential limits placed on science by van Fraassen and argues that his epistemological or constructive empiricist dimension of discourse does not fit or tie-in properly with the question of existence of unobservable entities. Most of his critics somewhat fail to recognize differences in dimensions of discourse. To be sure, this un-appreciated difference in discourse dimension is what brings a shimmering freshness to this paper. Now, using the qualitative tool of critical analysis, the paper fronts the pragmatic and ontological dimensions as much better thresholds of argumentation in the realm of existence of unobservable entities.

Introduction

The controversy over Bas C. van Fraassen's discourse on the limits of experience revolves on his view that the existence of unobservable entities talked about in scientific theories cannot be epistemologically guaranteed. His agnostic attitude makes van Fraassen think that unobservable entities are mere *hidden variables* that cannot be genuinely considered as part of the explanatory demands of empirical science. Granting this position, van Fraassen automatically dissociates with hardcore entity realists, who forever believe that both sense-extending and philosophical instruments are all resolving the so-called *hidden variables* or tiny bits of reality to us. In other words, van Fraassen's constructive empiricism is antithetical to the realist posture and poses somewhat as a viable alternative. This is more evident in the opening prefatory statement of *The Scientific Image*, which reads: "The aim of this book is to develop a constructive alternative to scientific realism…" (van Fraassen, 1980, p. vii).

The chief aim of this paper is, therefore, to challenge the proponent of constructive empiricism on one special aspect of his alternate position, namely, the claim that un-aided sense experience should stand as limit to what we can *believe* (not just *accept*) in any genuine empirical scientific inquiry. As far as we are concerned, scientific instruments ought to provide some pragmatic evidence for what we refer to as unobservable entities. Based on this, we argue that the existence of unobservable entities can actually be guaranteed from two solid dimensions of discourse, say, pragmatic and ontological. Having read the celebrated quip of van Fraassen that we cannot shrink to the size of a paramecium to prove its existence, we now deploy some experimental techniques in microbiology – especially, the case of *Mycobacterium tuberculosis* – to bring about the empirical conviction that microbes actually exist. More intriguing is the fact that the microbiologist, in the strict sense, is not interested in proving the existence of microbes, but his business is to stop their harmful activities on mankind.

Unfortunately, a good number of critics that responded to the position of van Fraassen, as we shall presently see, clearly ignore the fact that he argues more from the epistemological dimension of discourse, which we consider not too suitable for solid analysis of the question of existence of unobservable entities. What constitutes novelty here is the insistence that scholars should down-play epistemological, linguistic, logical, and sociological dimensions of discourse and play-up the ontological and pragmatic dimensions of discourse in any genuine debate on entity realism in science.

We are particularly interested in where constructive empiricism undercuts the entity strand of scientific realism. It is really not part of our concern to look at van Fraassen's general analysis of scientific theory, whether it aims at truth, explanation, or empirical adequacy and all-what-not. In our stride, too, we shall make limited reference to the platform provided by Paul M. Churchland and Clifford A. Hooker in their edited *Images of Science*, wherein both van Fraassen and his realist critics such as Richard Boyd (1985), Brian Ellis (1985), Gary Gutting (1985), Mark Wilson (1985), and Alan Musgrave (1985), and Ian Hacking, among others, argue back and forth in defence of their respective positions regarding the ontological status of unobservable entities.

In what follows, then, we shall start with a highlight on the difference between observable/unobservable distinction and theoretical/nontheoretical distinction. Then, we shall treat van Fraassen's hard-line position on un-observable entities in science. We shall also look at some critical comments on the

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tenets of constructive empiricism as it appertains, especially, to van Fraassen's objection to unobservable entities. From here, then, we shall look at the main reason we think of van Fraassen's epistemological argument as wrong-headed and ultimately buttress the existence of unobservable entities, using the case of drug resistant *Mycobacterium tuberculosis*. We shall end with a re-statement of our position.

Between Observable/Unobservable Distinction and Theoretical/Nontheoretical Distinction

Before plodding our way, it is good to settle the issue of van Fraassen's discountenance of what he calls a common tendency in many philosophers of science to run the "observable/unobservable distinction" together with theoretical/nontheoretical distinction as if they bear the same semantic import. He argues that, "…the assertion of an important difference… between theoretical and non-theoretical entities is crucial to foiling the anti-realist counterargument…" (1980, pp. 214-215). Now, the difference in semantic import between the "theoretical" and the "unobservable" is evident in Churchland who compares his position with van Fraassen's when he asserts: "we agree that the observable/unobservable distinction is entirely distinct from the nontheoretical/theoretical distinction" (Churchland,1985, p. 36). Contrary to the deposition of van Fraassen and his willing ally, say, Churchland, what scholars oftentimes refer to as *theoretical entities* are the *unobservable entities* embedded in scientific theories. As a matter of fact, the *theoretical* often meshes with the *unobservable* in entity realism discourse.

Perhaps, there may not be any serious need, after all, to wrangle over false semantic problems; for one may argue that within the confines of realm/level 1 theory what could be tagged "theoretical entities" are largely the observable aspects of a physical theory. In that singular case, then, the *theoretical* parts company with the *unobservable*. Precisely as entity realists, we seem to think that van Fraassen, a prototypical realm 1 fellow, possesses a mindset that differs from those of the scientific realists who are given to extending science beyond the observable limits.

In point of fact, the distinction between the *theoretical* and the *non-theoretical* and that between the *observable* and *unobservable* is even worse in the eliminative instrumentalist's account. The eliminative instrumentalist strongly maintains that "the theoretical terms of our scientific theories do not refer to the unobservable entities…"; they are literally meaningless or empty terms "…and have no more semantic content than any other of the grammatical devices we might use, such as brackets, commas and full-stops" (Dicken, 2016, p. 44). What we can deduce from here is that the eliminative instrumentalist is merely talking-past or at cross purposes with the entity realist. Unfortunately, Rudolf Carnap increases the load of confusion when he argues that we should not be asking if theoretical entities are real, but rather we should be asking whether "we prefer a language of physics [and of science in general] that contains theoretical terms, or a language without such terms?" (Dicken, 2016, p.55). Beyond what Carnap has said, we believe that, theoretical terms are always very vital in the understanding of any scientific theory, even if the eliminativist thinks those terms are empty or mere place-holders. Or, if they are not so important, then why talk about them at all? Now, the term "non-theoretical" actually makes sense if it is generally applied to less significant terms in any scientific theory.

In fact, Putnam is the one that tries to mediate between the extremities of theoretical terms and unobservable entities when he claims that the former (theoretical terms) is introduced to illuminate the latter (unobservable entities). Putnam argues that without theoretical terms, "we could not speak of radio stars, viruses, and elementary particles, for example – and we wish to speak of them, to learn more about them and to explain their behavior and properties better" (qtd. Dicken, 2016, p. 51). Therefore, we seem to think that the dichotomy initiated by van Fraassen and his allies remains, for us, a mere linguistic and epistemological distraction that should not merit any extensive treatment here.

Our ultimate concern or interest is specifically on the ontological or reality status of the unobservable or what we tag in the present context as "theoretical" entity. There is no gainsaying the fact that everything is totally dependent on the leaning or persuasion of any particular philosopher of science, hence we feel at ease to use both terms ("theoretical" and "unobservable") interchangeably even if anyone considers them as incommensurable or semantically far-afield from each other. To our mind, any attempt at decoupling the two terms trivializes the very essence of what we intend to achieve in this paper.

Van Fraassen's Hard-line Position on un-observable Entities in Science

Nine years before the appearance of van Fraassen's *The Scientific Image* (1980), Hilary Putnam had categorized all those who reject unobservable entities as fiction mongers. These mongers merely argue that certain posits or "concepts… are indispensable", but strongly maintain that their realist counterparts have "…no tendency to show that entities corresponding to those concepts actually exist". At best, some such posits or entities could serve as "useful *fiction*'" (Putnam, 1971, p.63).

To be sure, van Fraassen clearly falls within this class of scholars that is drawn more to "fiction" than to "faction" with particular reference to the question of existence of unobservable entities. For van Fraassen, going beyond the observable is equivalent to believing that science predominantly seeks explanation. He insists that, "the true demand on science is not for explanation *as such*, but for imaginative pictures which have a hope of suggesting new statements of observable regularities and of correcting old ones" (van Fraassen, 1980, p. 34). Van Fraassen encapsulates his empiricist orientation in the following words: "I use the adjective 'constructive' to indicate my view that scientific activity is one of construction rather than discovery: construction of models that must be adequate to the phenomena, and not discovery of truth concerning the unobservable" (1980, p. 5). This gives us a clear insight to the hardnosed position of van Fraassen against the ontological/reality status of unobservable entities. As such, science is all about the creation of world pictures and models that do not strictly depict any underlying reality.

A reading of van Fraassen's essay on "Empiricism in Philosophy of Science", especially the second section of it, treating "empiricism and the limits of experience", affords one the opportunity of encountering his contention that "*experience can give us information only about what is both observable and actual*" (van Fraassen, 1985, p.253). But, then, where van Fraassen's instrumentalist or fiction posture glistens most is in the following declaration:

> Not long ago, I refused to believe in the existence of the theoretical entities postulated by science. I agreed, of course, that science postulates subatomic particles, forces, fields, and what have you, in order to describe the regularities found in nature…

> However, I regarded the theoretical entities as fictions facilitating systematic account, not as providing true explanation (1980, p. 204).

Anyone who truly understands the above passage can never be in doubt as to where van Fraassen stands on the issue of ontological status of theoretical or unobservable entities. At the moment, we must try to admit that, van Fraassen's cynical attitude towards any physical theory that goes beyond observational level seems to have stemmed from the very fact of proliferation of atomic theories or models that successively replaced one another over centuries of scientific tinkering with atom. No doubt, these recurrent changes or persistent revolutions began from the gentle rise of modern empirical science (wherein Robert Boyle modeled atoms as mere little "bouncy balls", to borrow David Hume's phrase) through its maturation in the twentieth century quantum physics with the entire floury saga surrounding the Copenhagen interpretation of quantum phenomenon and so on. For van Fraassen, science is all about interpretation. It remains an "open text" (van Fraassen, 1991, p. 8), so much so that scientists can bring up different interpretations of the world in a physical theory. Hence, van fraassen posits:

> What is the world depicted by science? That is exactly the question we answer with an interpretation, and the answer is not unique. Perhaps no interpretation ever finishes the task of answering all questions about the depicted world it displays as the theory content (1991, p. 481).

In fact, the most celebrated question posed by van Fraassen remains: Whose electron did Millikan observe? He argues that the way scientists and realists interpreted the results of oil-drop experiment and some other experiments make it appear "as if by carefully designed experiment we can discover facts about the unobservable entities behind the phenomena" (van Fraassen, 2008, p. 112). The foregoing van Fraassenian position notwithstanding, there are perennial scathing criticisms of atomic theories in the successive constructions of atomic models. In his wake, for instance, John Dalton gave no structure to his atoms; J.J. Thomson's model afforded some scattered or random positive and negative particles; Ernest Rutherford and Niels Bohr offered the spherical shell model; Summerfeld postulated the relativity atomic model to take care of the lapses of Rutherford-Bohr's model; and eventually Ulenbeck and Goldsmith coined the elliptical vector model to modify the preceding theory. The fact that experiments enabled scientists to notice some of the errors or defects of those proposed atomic models matters little to van Fraassen. For him, experimentation remains a way of filling out a blank in a theory, or "the continuation of theory construction by other means" (2008, p. 112). To be sure, in an earlier work, van Fraassen flatly argues: "Experiment cannot establish much" (1991, p. 94).

Now, from all indications, van Fraassen may be quick to declare his willingness to ***accept*** any and every theory about the so-called unobservable entities, but will certainly discountenance any attempt to make it appear that he ***believes*** in the actual existence of any such entities. As a proof of this: van Fraassen tries, willy-nilly, to make reparation to scientific realism in the last part of *The Scientific Image*, entitled "Gentle Polemics". He deploys the Five-Way (Existence-of-God-Defence) arguments of St. Thomas Aquinas to defend theoretical entities. Van Fraassen's lips-deep *mea culpa* reads: "And so we must accept, as a literally true representation, the picture disclosed by our best available scientific theories" (1980, 212). But more particularly, we are inclined to think that trying to make a distinction between *acceptance* and *belief* is epistemologically catastrophic for van Fraassen. To be sure, a theory that is seen to contain some truth in it does not beg for acceptance. What a true theory yearns for is pragmatic application to some technological ends, which its sponsors or underwriters are ever willing to pursue.

Ironically, van Fraassen accepts scientific practice on a very pragmatic ground, for he admits that science answer our questions regarding the empirical world. It is just obvious that explanation is not the end of science in van Fraassen's view. Control or domination of the empirical world is undoubtedly one of the obvious reasons that have kept science afloat. In fact, that we reap the benefits of laser jets (which work on the basis of exciting electrons or some other particles with photons of equal mass) is part of the practical control in the search for authentic technological transformation of the world. Moreover, photons equally transmit television signals to our home receivers and open doors in hotels and banks. This is certainly one practical control that can only be achieved through adequate knowledge of the behavior of any theoretical entity; which knowledge is, of course, deployable in any advanced technological recipe. In fact, there are myriads of other technological feats that have been achieved through experimental manipulation of entities; even in computer simulation of models, experiments often pull some heuristic stunts that are of technological benefit. In the thick of this stricture, let's then consider some reactions from van Fraassen's critics.

Critics on van Fraassen's Denigration of Unobservable Entities

It is proper here to address critics' attempts at debunking van Fraassen's thesis or his disenchantment with unobservable entities in scientific theorization. This is done with a view to present something not merely fathered on him out of a gross misinterpretation of his actual position on the question of ontological status of unobservable entities. Straightaway, we must begin with Churchland who compares his own realist position with that of van Fraassen's constructive empiricism:

> I assert that global excellence of theory is the ultimate measure of truth and ontology at all levels of cognition, even at the observational level. Van Fraassen asserts that descriptive excellence at the observational level is the only genuine measure of any theory's truth and that one's acceptance of a theory should create no ontological commitments whatever beyond the observational level (1985, p. 35).

Here, what Churchland says truly lies at the very source of van Fraassen's rejection of the existence of unobservable entities. But bringing in the issue of "global excellence" to counter van Fraassen's "descriptive excellence" of a theory does not establish anything regarding the ontological status of both observable and unobservable entities. In other words, Churchland's so-called global (or what-you-will) excellence of a theory cannot clearly be seen as undermining van Fraassen's rejection of the existence of atom, electron, paramecium, and other microscopic entities that appear in most scientific theories.

Apparently, van Fraassen cares little about the deliverances of any sense-extending scientific instruments on the basis of which the scientific community always celebrate the discovery or detection of some strange tiny particles (say,

Higgs or electron) or force fields (say, electromagnetic or Higgs force). Ian Hacking (1985) in his response to van Fraassen reveals that the latter does at least trust the deliverances of some scientific instruments. As Hacking writes: "Van Fraassen concludes that we do not see through a microscope. Yet we see through some telescopes… But you can point ahead of the trail and spot the jet, or at least wait for it to land, but you can never wait for the electron to land and be seen" (1985, p. 135). As it stands, van Fraassen would always give critics a run for their money on this issue of taking whatever is received from scientific instruments as real; hence, he maintains: "Even if 'observation with instrument' had the same justification status as observation pure and simple, many hypotheses go far beyond the deliverances of experience so far" (van Fraassen, 1985, p. 251). Contrary to van Fraassen's supposition, Hacking argues that we do not just observe or detect unobservable entities; we also manipulate them to different ends by acquiring some home truths about them and deploying assorted instruments and, of course, using different techniques to corroborate the results of scientific investigations. Hacking strongly believes that, "The 'direct' proof of electrons and the like is our ability to manipulate them using well-understood low-level causal properties" (1983, p. 274). At any rate, this does not imply that Hacking is making a round claim that existence or "reality is constituted by human manipulability" (Hacking, 1983, p. 274). Pretty clearly, we should understand Hacking as enunciating the fact that, in the special case of electrons, manipulability is one of the best possible ways of establishing or guaranteeing their existence besides observing them in the cloud chamber and so on. Hence, one may truly echo with Hacking, that "Long-lived theoretical entities, which don't end up being manipulated, commonly turn out to have been wonderful mistakes" (1983, p. 275). In fact, this is a well-directed kind of response that flows from the pragmatic through the ontological establishment of the existence of a physical (not an abstract) object.

Now, Alan Musgrave points out that the term "*observable* is a vague predicate," and that actually van Fraassen "concedes the familiar realist point that there is a continuous spectrum between directly observing an object and 'indirectly detecting' it using instruments" (1985, p. 204). Allan Franklin, following Hacking and Musgrave, has tried in *The Neglect of Scientific Experiment* (1989) to practically demonstrate this continuum of observation from the natural human eye to hand lens and to other more sophisticated optical instruments. However, Musgrave takes van Fraassen to task when he submits:

> But to indicate how difficult it is to avoid realist ways of thinking and talking, let us see how van Fraassen thinks and talks. He talks of *detecting* an electron in a cloud chamber. Can one say truly that one has detected an object without also believing it to be true that the object really exists? Later he describes how Millikan measured the charge of electron … Did not Millikan think it true, and does not anyone who accepts Millikan's results think it true, that electrons exist and carry a certain charge? Can one say truly that one has *measured* some feature of an object without also believing that the object really exists? (1985, pp. 206-207).

Perhaps, if one should correctly judge the merit of Musgrave's barrage of questions, one would perceive that his argument tends toward "thinking" and "belief". That is to say, it does not transcend the epistemological threshold. Say what one may, belief and thinking cannot answer any question regarding existence. We suppose that it is a wrong epistemological move to traverse, as it were, the logical bridge between thinking and existence.

Nevertheless, Brian Ellis, who experimented with internal realism and is noted for his "famous flight…to entity realism" (Emedolu, 2017, p. 213) affords a major and brilliant clarification in the dispute between van Fraassen and his critics on the issue of ontological status of unobservable entities. He argues that both van Fraassen and his critics in their epistemological tracks neglect the fact that there are different forms of explanation in science, which include the following: causal explanation, model theoretic explanation, functional explanation, and systemic explanation. Whereas scientific or entity realists focus more on causal explanation as the baseline prototype of scientific theorization, van Fraassen takes "model and systemic theories as typical" (Ellis, 1985, p. 56). Ellis declares: van Fraassen "adds to his troubles by construing all theories on the model of model theories, for he is now committed to saying that the postulated entities of causal process theories have no more claim to be considered real existents than the theoretical constructs of model theories" (1985, p. 57). Ellis is of the view that there is no way an entity postulated as causing certain phenomena cannot be "supposed to exist if the theory is to be accepted as doing what it purports to do; and normally we should expect to be able to find independent confirmation of their existence from various sources" (1985, p. 57). But, then, Ellis insists that there is no way to guarantee the existence of "theoretical entities of abstract model theories. Since they are not postulated as causes, they are not supposed to have any effects" (1985, p. 58). Following from this, Ellis ultimately maintains that "if the theories we are talking about are special relativity and 'possible world's semantics, van Fraassen's position is at least plausible" (1985, p. 57). This mediation of Ellis is remarkable if one is to avoid talking past or at cross purposes with van Fraassen. In a way, it suggests that loose ends should be tightened in any serious engagement with van Fraassen – critics should either use examples from his own scale-end of "model and systemic theories" or bring him over to their scale-end of "causal theories".

Next, Richard Boyd surmises that "our knowledge about scientific theories that they are empirically adequate is typically parasitic on our knowledge of 'theoretical entities'" (1985, p. 30). Whether this goes down well with van Fraassen is something one needs to rethink. Be that as it may, the nature and level of this parasitism is difficult to glean. Moreover, this Boydian line of argument does not eventually act as a buffer against the epistemological onslaught of van Fraassen.

In the mock dialogue between Scientific Realism and Constructive Empiricism, Gary Gutting testifies that the constructive empiricist of the van Fraassenian persuasion is ever ready to concede that there is "reason to think" that all the "observable consequences" of the atomic theory are true. However, Gutting maintains that, the constructive empiricist's own point is that there is as well "no evidence that makes it irrational to withhold judgment about their [i.e., atoms' or electrons'] existence" (1985, pp. 118-119). This spells out the essence of van Fraassen's agnosticism. To be sure, the proponent of constructive empiricism has this liberal attitude toward what one should believe. He thinks that one is free to believe anything one wish to believe. Churchland simply refers to him as a *selective* skeptic; for he simply

stands "in favour of observable ontologies over unobservable ontologies" (1985, p. 35). Given our concern, we perceive a whiff of mere platitude when van Fraassen writes, for instance: "It is not irrational to 'go beyond the evidence,' and belief in…electrons or the truth of theories in molecular biology does not *ipso facto* make it irrational" (1985, p. 248). We do not have any truck here with the issue of rationality or irrationality of any given stance in science. Much as all this might sound meaningful to Gutting, Churchland or anyone else, the brand of agnosticism and/or skepticism purveyed by van Fraassen has nothing, at the moment, to do with the matter at issue.

Mark Wilson, for his part, points out that van Fraassen seems to have stuttered in some of his arguments. Wilson instantiates a damaging inconsistency in van Fraassen's doctrine of scientific observation when he argues that, van Fraassen (1980), on page 65, allows "…such properties as the spin projection of a single electron count as observable". But earlier on page 60 van Fraassen "…claims that even macroscopic mass, force, momentum, and kinetic energy are not observable properties in classical mechanics" (1985, p. 223).

To all intents and purposes, Wilson's worry that van Fraassen rejected macroscopic *mass, force, momentum* and *kinetic energy* is unfounded because van Fraassen believes and accepts these phenomena on pragmatic and ontological grounds. Of course, van Fraassen is completely right, they are not physically visible, but their effects can be felt and measured through the use of instruments. To say, following van Fraassen's recalcitrance that, he does not know what *force* entails is simply to insult his native intelligence and sensibility. We do think he accepts the devastating experience of the hurricane Harvey, for instance, as the effect of the force of an evil wind – especially, if he reasons from both the ontological and pragmatic standpoints. Even W.V.O. Quine's own inference or claim that *force* (or *cause*) is a product of animism (Magee, 1978, pp.145-146) does not detract from the fact that *force* is a real entity, though it cannot be seen with any human eye. Quine is only talking here in terms of abstract linguistic conception of it. We equally maintain that van Fraassen accepts kinetic energy as the force of motion, and much else. To be sure, in *A World of Propensities*, Popper defines forces as "propensities for setting bodies in motion" (1990, p. 12). Generalizing further, Popper declares: "Forces are propensities to accelerate, and fields of forces are propensities distributed over some region of space and perhaps changing continuously over this region (like distances from some given origin). Fields of forces are fields of propensities" (1990, p.12). Furthermore, we do know that van Fraassen operationally accepts mass as the quantity of matter contained in an object – even though in contemporary quantum physics some sub-nucleic entities are conceived as massless, or rather that their mass cannot be measured (whether they have negative or positive mass). But, then, we might not readily intuit van Fraassen's preference regarding whether this mass is constant or invariant as classical or Newtonian mechanics suggested or whether this mass varies with velocity as Albert Einstein conceives it. Nonetheless, van Fraassen may downrightly reject the results of instrumental calculations of these physical features or quantities as unreal. Van Fraassen could be right in one sense, but could be completely wrong in an important sense: Since humans reserve the right to set standards and rules in all spheres of interactions with the world, denying them of such a right is equivalent to denying them the right to fix the price of a canary or a barrel of crude oil.

Having looked at the direct reactions from the foregoing critics, we seem to believe that none of the representative critics, with the exception of Hacking and Ellis, is able to understand how to defend entity realism against the epistemic attack of van Fraassen's. This leads us then to re-examine and pin-down van Fraassen's claim as an inappropriate epistemological move.

Van Fraassen's Rejection of Unobservable Entities as a Wrong-headed Epistemic Move

Van Fraassen's fixing of observable experiential limits to what is believable in science needs to be properly re-examined. If van Fraassen insists that the reality of all things that are beyond ordinary human sense perception be put under the ban of perpetual doubt, then he should also note the now hackneyed view that even the so-called deliverances of our natural sense organs are not so perfect and can be misleading sometimes. Of course, our only guarantee remains the agreement of community of perceivers. Isaac Newton, in all his glory, was even not unaware of the fact that conclusions reached via inductive empirical experiences cannot yield conclusive ***proof*** in the field of science, or anywhere else. This simply implies that if we drag the issue to absurdity, then van Fraassen cannot even escape from his constructivist snare. Making appeal or reference to agnosticism may not be capable of also saving van Fraassen from his commitment to the so-called physical/observable limits of experience. If one endorses the view that we do not possess any certain, practical or promethean knowledge of the world from modern-day scientific and technological investigations, then we feel that epistemology should rethink itself.

We seem to think that the existence of so many recognizable micro-organisms, atomic and sub-atomic entities is no longer in doubt. Following the ancient reasoning found in some of the Eleatic Zeno's paradoxes and in the Lampsacusan Strato's teachings, anyone would have known the fact that in principle, at least, we can keep splitting any particle to a point where it can no longer be seen with the ordinary human eye, even though matter still subsists in it. To be sure, the application of tiny atomic and sub-atomic entities in furtherance of technology bears eloquent testimony to their ontological status or existence. Merely arguing that there are no electrons and photons or arguing that we do not have any knowledge of these entities on the grounds of some modalities or counterfactual arguments (decked out with some degree of epistemological sophistication) smacks of impropriety of thought. Moreover, trying to reduce our argument to a brand of success of science or No-Miracles argument is baseless on the grounds that if any theory succeeds at all, then something *alethic* (or objectively true) must be going for it.

Granting what we have said so far, we submit that van Fraassen's acceptance of spin projection or ionization track of an electron in a cloud chamber is more or less a short step to saying that electrons are real or that they exist. The logic is that whatever spins or moves on the track or causes the trail is what we choose to call electron. Van Fraassen's argument, say, that we cannot wait for an electron to land in order to verify its existence is merely for the purposes of satisfying a verificationist urge. He is completely aware of the pragmatic essence and power of experimentation when he agrees that at some point in the history of any theory experiment guides or directs its *articulation*. Van Fraassen did declare that

"experimentation has a twofold significance" in matters of "theory construction". In the first place, experiment is involved in testing the "empirical adequacy of the theory as developed". In the second place, experiment helps towards "filling in the blanks, that is guiding the continuation of the construction or completion of the theory" (van Fraassen, 1980, p.74). Indeed, the powers of experiment could also be seen as both ontological and pragmatic; this is the reason why arguments for or against the existence of unobservable entities must essentially lie between those two thresholds.

The epistemological stance of van Fraassen, in contradistinction to other dimensions of discourse, is what makes his arguments appear so scary to anyone who does not understand the impact this could bring about. As we have already muted, standing on different dimensions of discourse without establishing a common ground often makes scholars argue at cross-purposes with one another. This remains one of the crucial but unappreciated problems thinkers and critics in this field of discourse face when they unwittingly engage themselves from disparate dimensions of discourse. As a consequence, they often fall prey to some whimsical epistemological and linguistic arguments. We can illustrate this with David Hume's argument against causality. Hume was actually arguing from a logical point of view, which demands the possibility of establishing a connection between an effect and its supposed cause. Anyone who challenges Hume from another dimension of discourse (*viz.* ontological or pragmatic) will certainly run into serious difficulties. Obviously, Hume will never at least deny agent-causation from an ontological or pragmatic point of view. Asking Hume, for instance, not to take water when he is thirsty or run when pursued by a gun-wielding assailant in the pretext that water does no actually quench thirst or that bullet does not kill, and that all come as a result of custom and habit will never convince him not to have the water or run for his dear life. Such spontaneous actions of Hume show that he believes in causation or whatever name he chooses to call it.

The above reasoning inevitably applies in the case of van Fraassen who merely uses epistemological arguments to discuss issues relating to existence. To us, the unobservable entities-talk in empirical science is not just like God-talk, wherein Immanuel Kant's antinomies of reason might pop up to become a stumbling block. In point of fact, there are pragmatic and instrumental ways of establishing the validity of the existence of unobservable entities. Without mincing words, we assert that the existence of the now familiar entities like electrons, neutrinos, hadrons etc., has been amply demonstrated by Hacking (1983 and 1985), Franklin (1989) and other experimental or entity realists, not to mention the professional experimental scientists themselves.

Standing on the right ontological and pragmatic thresholds is what can dispel the wrong-headed epistemic move of van Fraassen's. Reality is forever larger than the material observable world into which van Fraassen strives to pigeonhole contemporary science. The revelations and revolutions sponsored by quantum-relativity physics show that science has gone beyond the question of existence of matter of all sizes, for science is neck-deep into the question of convertibility of matter to energy. We are now in the new quantum physical kingdom of fields of forces, wherein minute particles are created from energy in a vast "Sea of Potential". The teleportation machine technology that uses the principle of quantum entanglement, which Albert Einstein had earlier claimed leads to spooky action at a distance (cancelling locality or distance) is mind-blowing and will certainly dumbfound van Fraassen in his constructive empiricism. Moreso, quantum chemistry and quantum biology are still revealing a lot about the so-called unobservable entities. This takes us now to a practical or experimentally demonstrable proof of the existence an un-observable entity in microbiology, using the technical tale of the resistant strain of *Mycobacterium tuberculosis*.

On the Pragmatic Existence of Drug Resistant *Mycobacterium tuberculosis*

Tuberculosis (TB) is an age long disease which causative organism in some quarters have been referred to as the ancient bug. In our time Tuberculosis (TB) has been associated with the micro-organism, *Mycobacterium tuberculosis*. It is a non-motile, acid fast, rod shaped bacilli that is about 2-4*um* in length and have a very slow generation time. It appears red when stained with Ziehl Neelsen staining technique. It is difficult to differentiate microscopically a resistant strain of *Mycobacterium tuberculosis* from a susceptible strain.

There are two categories of TB, namely, active disease and latent infections. The most common form of active TB is pulmonary tuberculosis (PTB) which affects the lungs. There is also extra pulmonary tuberculosis (EPTB) which affects other parts of the body, e.g., the bone, the lymph node, the spinal cord etc. Pulmonary tuberculosis is transmitted through inhalation of aerosols that are released into the air when an infected person coughs, sneezes and sings. Some of the symptoms of pulmonary TB include: cough that have lasted for two weeks or more; but for people living with HIV, current cough is very significant; fever, night sweats, and weight loss are the basic symptoms.

As a matter of fact, TB is one of the most ancient diseases of mankind and has co-evolved with humans for many thousands of years. According to Gursimrat K.S. (2011), it was established by Dr. Richard Morton that the pulmonary form of TB was associated with "tubercle", owing to the variety of its symptoms. *Mycobacterium tuberculosis* was discovered by Robert Koch and he was awarded Nobel Prize in physiology or medicine in 1905. For close to two decades, one of us has been working in TB space; the disease has emerged in different forms/strains that defile the usual treatment that takes care of susceptible strain. We may not comfortably contest the existence of *Mycobacterium tuberculosis* because its molecular evidence dates back to over 17,000 years. The very fact that resistant strains are gaining ground is what is more frightening.

Globally, we are experiencing decline in the incidence of drug susceptible TB and an increasing incidence of drug resistant TB, be it Mono resistance, Multi drug resistance (MDR), preXDR, Extremely drug resistance (XDR), and Total drug resistance TB. It is gradually building to climax and it is becoming worrisome. According to WHO 2017 report, in 2016 there were 600,000 new cases with resistance to Rifampicine (RR-TB) out of which 490,000 had multi-drug resistant TB (MDR-TB). There are still large gaps in TB detection and treatment. A total of 129,689 were started on treatment for drug resistant TB and treatment success rate remains low globally (WHO 2017 report). The treatment success rate for XDR-TB for 2014 was 30%, hence the higher the organism evolves the more difficult it can be treated.

Now, scientists have come with a novel technology in TB diagnosis that detects resistant strain in less than 2 hours. Specifically, the machine detects Rifampicine resistant TB. Another technology although working with the same principle goes a step further to detect TB that are resistant to

Isoniazide and that is called the Line Probe Assay (LPA). Rifampicine and Isoniazide are the two major drugs in the treatment of Tuberculosis. The two diagnostic technology work with the principle of polymerase chain reaction (PCR) whereby a portion of the bacterial DNA that is responsible for drug resistant is amplified to several copies to enable the machine to detect the presence of resistant strain of *Mycobacterium tuberculosis*.

Nonetheless, the gold standard for diagnosing TB is culture, which means growing the organism using sputum sample from the patient. This can be done using liquid or solid culture. Liquid culture takes a period of 14 days while solid culture takes up to 4 to 8 weeks. This is quite time consuming but that is the gold standard. The confirmatory test for Multi Drug Resistant TB is first line DST where the organism is subjected to growth media with minimum inhibitory concentration of the first line drugs which include: Rifampicine,Isoniazide,Ethanbuthol,Streptomycine/Parazina mide. The first line DST can be grown in either solid or liquid culture. The confirmatory test for pre XDR is second line DST whereby the sputum sample from the patient is subjected to the minimum inhibitory concentration of second line drugs used for the treatment of multi-drug resistant TB which include: Rifampicine; a second line injectable which could be either kanamycine, Amikacine or capromycine; a fluoroquinolone which could be levofloxacine, ofloxacine or moxifluoxacine, etc. The resistant organism will grow in the presence of the drugs.

Treatment of susceptible tuberculosis takes a period of 6 months with the following drugs: Rifampicine, Isoniazide, Ethambuthol and Parazinamide which is a four fixed combination. On the other hand, the current treatment of drug resistant TB using shorter regimen is for a period of 9 months, depending on the results from DST profile of the patient's sputum. New drugs have been added to the treatment of drug resistant TB and they are Bedaquiline and Delamanide. In time past the treatment of MDR-TB is 20 months and some country programmes are still using the conventional long regimen.

From what we have presented so far, it is evident that there are varieties of scientific instruments and techniques that could be used to detect and interact with TB causative organism, *Mycobacterium tuberculosis*. There are also clear ways of identifying its level of susceptibility or resistance to drugs. Now, if this cannot serve as proof of existence for van Fraassen, then the term "existence" needs to be redefined to capture whatever else he has in mind while rejecting the ontological status of unobservable entities in science. But this will turn the whole issue into a semantic gambit and this paper is ill-prepared for that!

Conclusion

Towards ending this paper appropriately: We suggest that scientific realism debate should be repositioned by making sure that the different dimensions of discourse, ranging from the epistemological to the ontological; from the sociological to the logical; and from the pragmatic to the linguistic, are well-comprehended to such an extent that disputants will no longer talk past each other. Van Fraassen needed to have whittled his broad-brush epistemological discourse down to bare-bone ontology in his efforts at rejecting or denigrate unobservable entities. The unfortunate thing is that some of his critics do not just understand what it means to delineate or separate dimensions of discourse; hence they produce unsound arguments in their attempts at responding to van Fraassen's fiery efforts at undermining the ontological status of unobservable entities.

Be that as it may, it is important to observe at this point that, despite all we have said so far about van Fraassen as an accomplished anti-realist who finds the existence of electrons and paramecia very repugnant, we do have a confirmation that he is also in some subtle way a realist. This somewhat explains why E. McMullin announces that van Fraassen's realism is "of a selective kind" (2003, p. 464). Whether he is a selective (particular/retail) or global (complete/wholesale) realist, our worry remains the inadvertent way van Fraassen tries to use his well-crafted epistemological reasoning to undermine the existence of unobservable entities. Beyond any complicated logical or epistemological devices we believe that the rebuttal presented so far in this paper has adequately uncovered van Fraassen's epistemic misdemeanour, especially, in terms of his dogmatic disposition to defend empiricism at all cost.

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