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CONSTRUCTIVE EMPIRICISM:
Observability, Instrumentation, and the Epistemic Community

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Bas C. van Fraassen's 1980 publication, *The Scientific Image*, plunged him and the constructive empiricism he advocates into the midst of a long-standing debate about the nature of scientific theory. Through the vehicle of constructive empiricism (the word "constructive" emphasizing van Fraassen's view of science as a model building activity rather than a discovery process), van Fraassen applies anti-realism to science, seeking to offer a strong and cogent response to scientific realism. Understanding constructive empiricism in this context, one must ask whether he is successful: Does van Fraassen's formulation of constructive empiricism offer a cogent response to scientific realism, a response strong enough to stand on its own merits?

To explore this question, I will begin with a discussion of van Fraassen's formulation of constructive empiricism (CE), and contrast it with scientific realism (SR), showing how one may differentiate CE from SR's more well-known challengers, logical positivism and instrumentalism. Second, I will explore the difficulties that van Fraassen's formulation engenders with a special focus upon his view of observability. Third, I will propose a way in which these obstacles might be surmounted while retaining the basic principles of CE intact.

To clarify the characteristics of CE, one should evaluate CE and SR side by side. To answer the question "What does the constructive empiricist believe?" we must concurrently ask, "What does the scientific realist believe?" It is important to begin by understanding which positions constructive empiricists and scientific realists have in common. Both interpret theories literally and recognize language as being theory-laden by nature. This position differentiates their views from those of the logical positivists and the instrumentalists. For the realist or empiricist, if a theory refers to an entity as existent, the concept of its existence can be added to or explained, but the implication that it does in fact exist cannot be withdrawn. In the words of van Fraassen:

> To insist on a literal construal of the language of science is to rule out the construal of a theory as a metaphor or simile, or as intelligible only after it is 'demythologized' or subjected to some other sort of 'translation' that does not preserve logical form. (*Scientific Image* 11)

Because scientific realists support a literal construal of the language

in scientific theories, SR is opposed to both logical positivism and instrumentalism. One should not, however, confuse CE with either of these earlier movements merely because they also are at odds with SR. Although CE shares certain characteristics of logical positivism and instrumentalism (most obviously that it also opposes SR), it is a mistake to assume that it is merely a species of either of them. CE is a new animal with some familiar parts.

Van Fraassen explains the relation of CE to earlier views which opposed SR by suggesting that there are two types of anti-realists. The first type believes that the goal of science (properly, as opposed to literally, construed) is truth, while the second type (that of the constructive empiricist) believes that theories should be construed literally, although those theories *need not be true* when taken literally to be good (*Scientific Image* 10).

One reason for carefully differentiating CE from instrumentalism is that instrumentalism has long been viewed as the losing side in the battle against SR; it has lost support. If CE can benefit from some of instrumentalism's insights, yet avoid its weaknesses, its position in the battle against SR becomes more strategic. In considering unobservable entities, just such an advantage becomes clear. Wesley Salmon notes that "the instrumentalist cannot appeal to unobservables for purposes of explaining observed fact, for he or she denies that any such things exist" (134). By contrast, the scientific realist asserts the existence of unobservable entities postulated in accepted theories as literally true. CE aligns itself with neither of these positions. Van Fraassen defends his right to be agnostic towards the existence of unobservable entities. He does not accept theories which postulate unobservable entities on the belief that they are true, but limits his acceptance of any theory to a claim for that theory's empirical adequacy. Van Fraassen does not deny that the unobservable entities postulated by some theories exist, but he does not affirm it either. One of van Fraassen's central aims is to defend the rationality of suspending belief regarding unobservable entities. Van Fraassen understands rationality as a permission term. That is, if a possible course of action is rational, this does not necessitate the performance of the action for all rational people, but it does mean that the action would not be irrational. Van Fraassen thus defends his rationality in not siding with either the instrumentalist or the scientific realist.

In sum, CE differs from instrumentalism by maintaining agnosticism with respect to unobservable entities and differs from both logical positivism and instrumentalism by construing theories literally. It cannot and should not be identified as a re-interpretation of the views that have opposed SR in the past. When one apprehends CE's shared attitude with SR towards the necessity of construing theories literally, and perceives that it is more closely aligned with SR on this issue than either logical

positivism or instrumentalism are, it is natural to ask next how CE differs from SR. As I noted above, one of the most significant distinctions between CE and SR is that the scientific realist is willing to accept theories postulating unobservable entities as literally true, while the strongest claim the constructive empiricist will make is for a theory's empirical adequacy.

It is difficult to neatly quantify the realist position because it has many adherents, each of whom has a personal and divergent interpretation of what it is to be a scientific realist. However, surveying realist literature from many different sources, including Churchland and Boyd, Maxwell and Sellars, McMullin and Hacking, it is possible to make some viable generalizations. In the introduction to his anthology, *Scientific Realism*, Jarrett Leplin accomplishes this goal, although he is careful to qualify his project of stating characteristic realist theses with the proviso that no majority of them "even subjected to reasonable qualification" would be accepted by all who name themselves realists (1). Leplin's characterization of these theses is especially helpful because it was published in 1984, four years after van Fraassen published his seminal work, *The Scientific Image*. Under the intense critical scrutiny kindled by CE, SR was forced to re-evaluate itself, no longer able to remain complacent in the face of logical positivism and instrumentalism alone. This re-evaluation resulted in the proliferation of carefully formulated and better supported realist positions.

Although van Fraassen does not refer to Leplin's characterization of realist theses specifically, he does address versions of most of them, first in *The Scientific Image* and then in more detail in "Empiricism in the Philosophy of Science," his 1985 *Images of Science* response to the new realists' defense of realism. Most of his effort centers around the ideas undergirding the Leplin theses 2, 7, and 10.

The remaining theses are also important if one is to understand possible variations on the realist position, but for the purpose of this paper, I will constrain my discussion to theses 2, 7, and 10. Utilizing Leplin's conception of characteristic realist theses, we can contrast CE and SR more easily. Considering Thesis 7 first, that "the theoretical claims of scientific theories are to be read literally, and so read are definitively true or false" (Leplin 2), we find SR and CE in agreement. As discussed above, the literal construal of theories is an important characteristic SR and CE share. However, the second part of Thesis 7, that the theoretical claims of theories are "definitively true or false," runs counter to the constructive empiricist's agnosticism if interpreted to obligate taking a position on a theory's truth or falsity. Because the constructive empiricist construes theories literally, he will be comfortable with the notion that the theory's theoretical claims are capable of being either true or false, but believes suspension of belief towards both options to be more appropriate. For the constructive empiricist, the relevant question is not, "Is the theory, literally construed, true or false?" but, "Is it empirically adequate?"

Thesis 2 is related to Thesis 7, stating that "the central terms of the best current theories are genuinely referential" (Leplin 1). Designating the central terms of theories (when unobservable) as "genuinely referential" is again counter to the constructive empiricist's agnosticism. Thesis 2 also introduces the new element that "the best current theory" is genuinely referential. This is a very strong claim for realism to make, too strong for the satisfaction of a large number of realists. Many realists would recognize a weaker claim, as such exemplified by Elliot Sober's statement, "Realists may refuse to assert that this or that current theory is true" (394) as the stronger and more sophisticated stance.

Although inessential to the realist position, the claim that modern science is approaching maturity in many areas, or that today's scientific theory is (approximately) true, remains an important part of many realist positions (See Leplin Theses 1, 3, 4, 6, 8; and *Scientific Realism* 1-2). However, the thesis that modern science can now be considered genuinely referential, while past science could not, is open to criticism from the constructive empiricist who utilizes history to note that the theories which have been believed to be genuinely referential in the past are many, but most of those theories are now in disfavor.

One is justified in asking what it is that differentiates today's scientific theories from the mistaken ones of the past. One reason that might be given is that we have proven many of our past theories wrong and our present theories seem supported by better reasoning than ever before. However, the attitude of science of one hundred years ago towards its theories was much the same and we might ask how many of those theories we have altered or discarded altogether. That we feel we have good reason to be certain of our results means little when we realize that most of the theories generally accepted by the scientific community, both those already proven false and those not yet (and possibly never to be) proven false, have been historically greeted with the same open arms and certainty of belief. This argument from historical generalization is naturally not a deciding or incontrovertible one, but it certainly opens claims of "genuine referentiality" to some doubt. They were wrong about epicycles five hundred years ago, might we not be wrong about X today?

Van Fraassen devotes most of his arguments against realism to a discussion of the formulation of realism which closely resembles that suggested by Leplin's Thesis 10: "Science aims at a literally true account of the physical world, and its success is to be reckoned by its progress toward achieving this aim" (2). It contrasts nicely with van Fraassen's formulation of CE: "Science aims to give us theories which are empirically adequate; and acceptance of a theory involves as belief only that it is empirically adequate" (*Scientific Image* 12).

To contrast the constructive empiricist and scientific realist, I have matched each van Fraassen (CE) or Leplin (SR) statement with its

complement, making inferences where necessary (as indicated by parentheses).

SR-Science aims at a literally true account of the physical world
CE-Science aims to give us theories which are empirically adequate

SR-its success is to be reckoned by its progress towards achieving this aim [a true account of the world]
CE-(its success is to be reckoned by its progress towards achieving this aim) [an empirically adequate (description of the world)]

SR-(Acceptance of a theory involves belief that it is true).
CE-Acceptance of a theory involves as belief only that it is empirically adequate.

The scientific realist believes that the aim of science is truth: A good theory is a true one; to propose a theory is to assert that it is true. Thus, it is important to make the distinction that the debate over the tenets of CE is, for sophisticated scientific realists, not a debate concerning whether the unobservable entities postulated today actually exist, but more importantly, what is the ultimate goal of science, truth or empirical adequacy?

Van Fraassen argues that science has no reason to make claims extending beyond empirical adequacy; the aim of science is not truth, but to offer a true explanation of observable phenomena. "As far as the enterprise of science is concerned, belief in the truth of its theories is supererogatory" (*Images* 255). As twentieth-century humans, we strive, like our ancestors did, to explain the world we see around us, although science is our method where myth was theirs. Gutting captures this idea well when his fictitious constructive empiricist observes, "The further assertion of the theory's truth is a gratuitous addition, entirely unnecessary for the fulfillment of science's fundamental aim; namely, an exact account of observable phenomena" (125).

For the realist, to accept a theory is to believe it to be true. To assert a theory is to assert its truth. In contrast, for the constructive empiricist, acceptance is recognition of a theory's empirical adequacy. The constructive empiricist "displays" his theories, evincing the theory's empirical adequacy, its ability to "save the phenomena" rather than asserting its truth (van Fraassen, *Scientific Image* 10).

The discussion of all facets of CE is beyond the scope of this paper. However, in noting that the scientific realist considers truth to be the aim of science, while the constructive empiricist champions empirical adequacy, the importance of understanding what van Fraassen means by the term empirical adequacy becomes manifest. What is empirical adequacy, and how does it differ from the truth the scientific realist speaks of? Adequacy

is not a difficult concept, but its meaning in this context is contingent upon what is meant by the term empirical. To understand empirical adequacy an understanding of observability must be gained as well. I will focus on the issue of observability in the remainder of this paper. There are three aspects to consider when reviewing van Fraassen's notion of the observable: what is it to be observable (or unobservable) *in principle;* what is the epistemic community, how is it to be determined, and who are its members; and what is the role of scientific instrumentation in determining what is observable?

Attempting an initial definition of empirical adequacy it seems reasonable to suggest, "a theory is empirically adequate when it offers a true explanation of the phenomena observable by us." But this explanation is too simple, for the scientific realist will ask, "How are you defining the term observable phenomena?" In raising this question he is joined by Grover Maxwell who argues that an "observable-theoretical" distinction cannot be maintained. In explicating the anti-realist positions that he argues against, Maxwell refers to the concept unobservable "in principle" (9) which van Fraassen does not hesitate to accept, although he formulates the same idea positively as "observable *tout court*" (*Scientific Image* 17). What this means is that van Fraassen's empirical adequacy deals not only with *observed* phenomena, but also with *observable* phenomena. Van Fraassen recognizes this distinction explicitly in *Images of Science* (254, 296). For van Fraassen, observable phenomena are things previously observed, things presently observed, and things that might be observed in the future. "X is observable if there are circumstances which are such that, if X is present to us under those circumstances, then we observe it" (*Scientific Image* 16). It is the possibility of future observance as a determiner of observability being left open, that causes van Fraassen his most serious problems. The difficulties such an "in principle" or "under appropriate circumstances" guideline for observability encounters will become more clear in conjunction with discussion of scientific instrumentation and the epistemic community.

To support his argument that no observability-theoretical distinction can be established Maxwell asks where the line between observability and unobservability would be drawn in the following series: "Looking through a vacuum . . . , looking through a windowpane, looking through glasses, looking through binoculars, looking through a low-power microscope, looking through a high-power microscope . . ." (7). He concludes that no non-arbitrary line can be drawn.

Van Fraassen responds by endeavoring to bind the observability-

unobservability[1] distinction to human capabilities (we know which things are observable, because they are observable *to us*):

> I have a mortar and pestle made of copper and weighing about a kilo. Should I call it breakable because a giant could break it? Should I call the Empire State Building portable? Is there no distinction between a portable and a console record player? The human organism is, from the point of view of physics, a certain kind of measuring apparatus. It has certain inherent limitations—which will be described in detail in the final physics and biology. It is these limitations to which the 'able' in 'observable' refers—our limitations, *qua* human beings. (*Scientific Image* 17)

Phrasing the observability-unobservability distinction in this manner results in serious consequences for van Fraassen. Most problematic is the inconsistency it engenders when evaluated in conjunction with his subsequent statements regarding the epistemic community. The constitution of the "epistemic community" is for van Fraassen part of what determines observability: "What the anti-realist decides to believe about the world will depend in part on what he believes to be his, or rather *the epistemic community's* accessible range of evidence" (*Scientific Image* 18, my emphasis). Van Fraassen explains the composition of the epistemic community in this manner:

> At present, we count the human race as the epistemic community to which we belong; but this race may mutate, or that community may be increased by adding other animals (terrestrial or extra-terrestrial) through relevant ideological or moral decisions ('to count them as persons'). (*Scientific Image* 18)

If the epistemic community is integral in determining what is observable, we cannot stipulate that the *homo sapiens* species is the sole and final determiner of what is and is not observable. If we could know that the epistemic community will always and forever be solely of human composition, no difficulty would arise from a "man as measuring apparatus" guideline, but we cannot know that the composition of our epistemic community will not change. We must acknowledge the possibility that in the future we will find grounds for admitting other, non-

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[1]He rejects Grover's term "observable-theoretical dichotomy," calling it a category mistake: "Terms or concepts are theoretical . . . [while] entities are observable or unobservable" (14).

human members to our community.

Stipulating that it is the capabilities of the *epistemic community*, rather than human abilities, which determine what it is to be observable, and recognizing the possibility that we will in the future add new members to our community, the possibility that these creatures might have electron-microscope eyes or some other enhanced sense organ or capability, means that the realm of what we could "in principle" observe is greatly expanded. Paul Churchland raises a similar concern, terming his creatures with biologically constituted electron microscope capabilities "humanoid" (43-44). In response, van Fraassen seizes upon the word "humanoid" and declares that what other creatures are able to observe is irrelevant unless they are part of our epistemic community. He then criticizes Churchland's argument as a modal one of the form:

> We could be, or could become, X. If we were X, we could observe Y. In fact, we are, under certain realizable conditions, like X in all relevant respects. But what we could under realizable conditions observe is observable. Therefore, Y is observable. (*Images* 257)

Van Fraassen criticizes this argument by noting, "the crucial third premise, however, is justified by appeal to science (at best)" (*Images* 257). He goes on to suggest that because, as constructive empiricists, we claim only empirical adequacy for our science, the only premise we are justified in making is that we are "empirically indistinguishable from beings like X in all relevant aspects" (257). Consequently, the only thing we are justified in concluding is that "under certain realizable conditions, all the observable phenomena are as if we are observing Y" (258), which leaves open the possibility that Y is unobservable.

However, van Fraassen's response to Churchland is inconsistent with his earlier writings on epistemic community. In *The Scientific Image* he stated that we might increase our epistemic community, adding new animals to it, "through relevant ideological or moral decisions" (18), not through science as he suggests in his *Images of Science* response to Churchland. His initial explanation of the manner in which we add members to our epistemic community seems more accurate. Referring to U.S. racial tensions as an example, one can argue that Blacks were historically excluded from our epistemic community, not due to what our science informed us, but due to what we perceived. We act upon our perceptions of how things are, rather than the world independent of our perceptions. Science may aid in determining these perceptions, but past experience suggests that we often manipulate scientific data to support our perceptions rather than to aid in informing them. Moral and ideological decisions are the ultimate determiners of group acceptance, while science

is but one criterion by which such decisions are made.

Van Fraassen also assumes that we will make epistemic community membership decisions on the basis of how similar the other creatures are to us. In day-to-day life decisions, we do tend to admit those who are like us to our groups. However, when deciding the membership of our epistemic community, our epistemic community being the group by which we decide what is and is not observable, it seems that operating on a purely pragmatic basis, we might find ourselves motivated to admit members to our community who are radically unlike us. If we admit such creatures to our community and their capabilities extend beyond our own, then we are able to extend our science beyond its formerly human-bound limitations. Naturally, in order to be members of the same community, we would have to share some similarities. For example, something such as the ability to communicate would be a very important criterion. However, such necessary similarities would vary widely and be necessary, rather than sufficient conditions. Consequently, even if our empirically adequate science was mistaken and the creatures were "as if" they were like us, but in reality were not, it would not make a difference, because degree of actual similarity to ourselves would likely not be the determining criterion for membership.

Applying the principle of charity, we should assume that van Fraassen considers the role of science in determining the epistemic community to be that of judging whether the candidates share the necessary similarities (such as the ability to communicate) with us. However, even if we allow van Fraassen to assume that science is the method that we would use to determine membership in our community, and that such possible new membership would be based on whether they share necessary similarities with us, his criticism still founders. If in utilizing our science, we find that we are "empirically indistinguishable" from X (dolphin, Martian, etc.) in "all relevant respects" (necessary similarities), do we advance to our conclusion retaining the "observable phenomena are *as if* we are observing" qualification? We do not, because during the interim a choice is made. We must decide whether X, the creature(s) under consideration, should receive membership in our epistemic community. We cannot not decide. To delay the decision is to delay admitting the creatures to our community, that is, we have not admitted them. It is also difficult to imagine how we could provisionally accept them. ("Today your evidence is relevant to what this community can observe, but we haven't decided about tomorrow yet" and "We almost accept what you have observed as being observable" are equally ludicrous). We either admit the creatures or we do not, but qualifications accompanying our decision are unlikely if not impossible. Circumstances are not *as if* we have admitted them or have not, either we have admitted them, or we have not. If we accept them as members of our epistemic

community, what is observable to them is now observable to us, because we are all now the one "us" of our epistemic community. Circumstances are such that these things are observable *to us*.

Van Fraassen does not claim to know what the limits of our epistemic community might be, although he does assert that there are limits. He states merely that it is an empirical matter he is willing to leave to science (*Images* 253). He admits that "Significant encounters with dolphins, extraterrestrials, or the products of our own genetic engineering may lead us to widen the epistemic community" (*Images* 256). While creatures with electron microscope eyes may seem far-fetched, consider what would happen if we chose to admit dogs or dolphins to our epistemic community. What if we decided to admit the common housefly with its compound eyes? In many ways the sense organs of these other terrestrial beings are highly developed compared to ours. One could object that to admit such creatures would be to extend our epistemic community beyond its limits. However, we are unsure of what those limits are. Even when we propose possible criteria such as "the creature must be able to communicate with us" it is clear that with an advancing science we cannot be sure that our candidates will not meet our criteria tomorrow. For example, evidence has been forwarded that a dolphin language exists. If understanding the dolphin turns out to be merely a question of learning the dolphin language, we cannot say that science will not sometime in the future accomplish the task, making communication with dolphins possible. It can be conceived that other necessary similarity criteria we might devise could be met in the future as well.

Even when considering creatures we know to exist, the range of phenomena we would be forced to admit to our system if we accepted them as members of our epistemic community is significant. It does not seem unreasonable to assume that the increase of observable phenomena would be even greater were we to admit creatures which we are not already aware of (such as extra-terrestrial beings) to our epistemic community. Having evolved under different conditions, they would likely be quite different from human beings. While admitting that almost anything might be observed in the future due to a progressive epistemic community with advanced sense capabilities is not problematic in and of itself, when coupled with van Fraassen's "in principle" standard of observability, it results in complications. If circumstances are such that something could be observed in the future, then it is observable now. Because of the possibility of an advanced epistemic community with greatly expanded sense capabilities, it is possible that anything might be observed in the future. Thus, everything is observable now. If everything is observable, then Grover Maxwell is right and no non-arbitrary line between the observable and unobservable can be drawn.

If the constructive empiricist must classify everything as observable,

the differences between the beliefs of the scientific realist and the constructive empiricist diminish significantly. The theoretical entities of the realist's view are the observable entities of the constructive empiricist's view. The scientific realist claims his theory to be true regarding observables and unobservables alike, while the constructive empiricist claims empirical adequacy, meaning that his theory gives a true account of only the observable phenomena. But if everything is observable, this means that empirically adequate theories give a true account of all the phenomena they address. Claiming empirical adequacy would not then differ from asserting truth, and the aims the scientific realist and the constructive empiricist claim for science would be revealed to be but one and the same aim, although given a different name. Each view has the same attitude towards theoretical entities with the exception that one view (CE) labels all such entities observable and the other view (SR) asserts that observability is not relevant to the discussion of existence.

One of van Fraassen's strategies is to respond to Maxwell by offering clear examples and counter-examples of observability, to prove that there are clear-cut cases of both the observable and the unobservable. Van Fraassen classifies the moons of Jupiter as a clear case of things which are observable (*Scientific Image* 16). He argues that the moons of Jupiter are observable because astronauts would be able to see them "close up" as well as they could through a telescope. However, thirteen years after his book was first published, it continues to be true that human astronauts are presently unable to visit the moons of Jupiter. That astronauts will likely visit the moons of Jupiter in the future is not the issue. The moons of Jupiter scenario serves as an example of the problems an "in principle" standard for observability generates. If the moons of Jupiter are observable, although they have not been observed and could not be observed today, why (to borrow an example from Ian Hacking) are they privileged above blood platelets? We cannot see blood platelets or the moons of Jupiter in an unaided act of perception. Yet according to van Fraassen, the constructive empiricist must withhold belief in the blood platelets, remaining agnostic towards the question of their existence, while recognizing the existence of the moons of Jupiter. Why the difference? It seems absurd to suggest that the possibility that someone might view the moons of Jupiter sometime in the future should have any effect on whether they exist now. But this criticism must be sharpened, for van Fraassen is not interested so much in whether entities exist, as in the proper epistemic attitude towards the question of their existence. However, this recasting of the issue does not resolve the problem. That it is proper for us to believe and affirm the existence of the moons of Jupiter while we must suspend belief in blood platelets is hardly more plausible than believing that there is an actual difference in their ontological status because while both are unobserved, one is "in principle" observable. The possibility that a space

shuttle may someday be built to carry us to the moons of Jupiter seems insufficient grounds for according them greater belief than blood platelets. Additionally, utilizing "in principle" observability, one can argue that the possibility exists that scientists will someday develop a machine that will allow us to be shrunk small enough to see blood platelets. How can we be sure? Journeys to Jupiter and journeys through the human body are both yet fictions on the movie screen. Given their equal fictional status, there seems no justification for according the moons of Jupiter greater ontological status in our beliefs.

Another difficulty arising from van Fraassen's classification of the moons of Jupiter as observable arises because in using this example he not only accepts, but also supports, Maxwell's assumption that things observable solely through the use of tools or scientific instruments are not observable in the sense required for constructive empiricism. That the perception be unaided is a traditional stipulation in discussions of observability. However, one must question whether it is appropriate in a discussion of constructive empiricism. Why curtail instrumentation? It seems contrary both to the way we think of observability in everyday life (surely something seen through a window, binoculars, or even a microscope is what we would call observable) and counter to the purposes of CE.

While it is problematic to confer observability on the moons of Jupiter because there is a probability that they will, in the future, be observable, it is also troubling *not* to regard them as observable. The moons of Jupiter can easily be seen through a telescope; what bars us from declaring this to be evidence of their observability? Postulation of future creatures with electron microscope eyes becomes unnecessary when we have the electron microscope.

There may be more behind van Fraassen's example of the moons of Jupiter than is readily apparent. Although, as I stated above, van Fraassen believes observation must be "unaided," he formulates the moons of Jupiter example this way: "*A look through a telescope* at the moons of Jupiter seems to me a clear case of observation, since astronauts will no doubt be able to see them as well from close up" (*Scientific Image* 16, my emphasis). Focusing on the "in principle" allowance in van Fraassen's definition of observability, this statement seems to mean that there are circumstances such that the moons of Jupiter could be observed, and that they are thus observable. However, lending emphasis to the scientific instrumentation question, the "look through a telescope" part of the sentence becomes significant. Why did van Fraassen include mention of the telescope in his example? He could have mentioned that astronauts will someday see the moons of Jupiter and invoked his "in principle" measure of observability and omitted mention of the telescope entirely. Most likely, the reference to the telescope was merely included because this passage follows soon after

Maxwell is quoted on looking through a window, looking through binoculars, and looking through a high powered microscope. In this context, it is natural for van Fraassen to mention looking through a telescope. But even though his use of "telescope" might not have been meant to be significant, it does draw attention to a point otherwise left unnoticed. That is, although observation is supposed to be the unaided act of perception, the label observation is frequently applied when instrumentation is, in fact, employed.

Van Fraassen believes that looking through a telescope or other types of instrumentation such as eyeglasses or a magnifying glass constitutes an example of observation. Yet these are not unaided acts, so by what right are they termed observation? The telescope example provides an important clue. If we could go to Jupiter, we would be able to see that our observations through the telescope were accurate. Instrumentation such as eyeglasses, a telescope, a magnifying glass, etc., can be proven empirically adequate. The telescope allows us to see earth's moon, and we are able to test this observation by taking a rocket or shuttle and having a look for ourselves. Doing so, we find that the telescope is accurate. It is an empirically adequate tool because it provides a true account of the observable phenomena.

In his article, "Do We See Through A Microscope?" Hacking returns to the science behind the philosophy, discussing the history and theory of these tools. His remarks on microscopy, especially the thinking embodied in the "Don't Just Peer: Interfere" section of his article are very helpful in understanding the problems that arise from an "unaided act of perception" definition of observation. He notes that, "Observation, in my book of science, is not passive seeing. Observation is a skill" (135). Van Fraassen chooses to recognize an "observing" and "observing that" distinction. The observation he seems to be discussing is of the former type. However, much of science is not "observing," but "observing that." Indeed, upon being asked to differentiate ourselves from scientists, we might explain the difference by saying that we "observe" phenomena, while the scientist "observes that." That is, whereas our observation is passive, the scientist becomes involved. A scientist is trained to understand while he sees, but we merely look. Hacking notes that one cannot even interpret images seen through a simple light microscope without practice. Otherwise it is as described by Gustav Bergman and we see only "a patch of color which creeps through the field like a shadow over a wall" (Hacking 136).

Earlier, I suggested that we might be able to rationalize our use of the telescope in "observation" because we can test it and determine that it is an empirically adequate tool. Van Fraassen rejects the use of a microscope as observation. Can the microscope be shown to be an empirically adequate instrument? Hacking's notes on this are valuable. He describes in detail how he crafts a tiny glass needle under the microscope

and uses it to poke at a cell (136). His grid argument describes how it is possible to make a large grid with pen and ink, inscribing letters at the corner of each square on the grid. The grid is micrographed, and metal is deposited upon the result. When placed under the microscope, the very tiny grid shows the same structure and letters inscribed on the large grid originally. While we cannot shrink ourselves yet, we can shrink things like grids and look at them under the microscope. There is no question that they exist, or that they have that structure, because "we *made* the grid to be just that way" (Hacking 146, his emphasis).

Naturally, how far we can stretch generalizations regarding an instrument's performance in one area and apply them to another area must be questioned. Because the microscope gives us an accurate image of our grid, is this sufficient reason to suppose that it also gives us an accurate image of a living cell? Because we have seen the moon by telescope and in person, and found the telescope's image to be reliable, are we justified in assuming that this also means that the telescope's image of the moons of Jupiter is accurate? Such questions lead one to wonder whe er van Fraassen is not correct in his exclusion of instrumentation. One can "observe" with scientific instrumentation only through practice, trial and error, and the instrumentation itself is highly dependent upon theory. Unfortunately, van Fraassen cannot be rescued from his rejection of instrumentation in so simple a manner, for in discussing observability, he notes, "To find the limits of what is observable in the world described by theory T we must inquire into T itself, and the theories used as auxiliaries in the testing and application of T" (*Scientific Image* 57). This means that when we have questions as to whether an instrument empirically adequate in one area is also adequate in another, we should turn to science. One of the strengths of CE is that it returns the question of observability to the realm of the scientists. When questioning the ability of different sorts of instrumentation to render things observable, we must turn to the theory behind the instrumentation for our answer.

Noting the problems that arise from van Fraassen's concepts of observability, the epistemic community, and scientific instrumentation, we may be tempted to answer the question, "Is van Fraassen's formulation of constructive empiricism an adequate response to scientific realism?" negatively and move on. One could argue that although CE is a needed response to SR, it does not possess the additional quality of being able to stand on its own merits; it cannot excel beyond its role as a critic of SR. But such a bleak response does injustice to van Fraassen. It seems possible to reformulate CE so that it avoids the difficulties that van Fraassen's formulation engenders: *It is reasonable to suspend belief in the existence of all entities postulated in theories, with the exception of those entities which are presently in fact observable (whether aided or unaided by instrumentation) by our epistemic community as presently constituted.*

How does this formulation avoid the difficulties of the former? This casting of CE has two significant advantages over van Fraassen's: it stipulates that things observable are presently *in fact* (as opposed to *in principle* observable), and adds the stipulation that things are observable without regard to whether the observer was aided or unaided by instrumentation, by the epistemic community we know today. Little green men need not be taken into account. Despite the fact that I do not have telescopic eyes, the moons of Jupiter are observable to me. The "presently in fact" stipulation ensures that some entities are observable, while others are not, without resorting to divisions more arbitrary than our experience.

I have argued that van Fraassen's formulation of CE seems to falter when his views of observability are considered, because he employs an understanding of observability centered around an "in principle" standard. The possibility of a progressing epistemic community, suggests that we may, utilizing this "in principle" guideline, be forced to find that everything is observable, leaving little difference between the conclusions of SR and CE. In this respect, CE seems limited to being a response to SR, without merits of its own. The fact that van Fraassen's excludes some types of scientific instrumentation while accepting others seems untrue to his suggestion that we should allow science to determine the boundaries of unobservability. However, I have suggested that these problems might be resolvable and proposed a possible way in which they could be circumvented: namely, to specify that only today's epistemic community is relevant to what is observable, that things observable must be presently in fact observable, and that scientific instrumentation need not be excluded when found empirically adequate by the relevant theory(s).

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