Expanding the Empirical Realm: Constructive Empiricism and Augmented Observation

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Abstract: Manifestationalism holds that science aims only to give us theories that are correct about what has been observed thus far. Several philosophers, including Bas van Fraassen, have argued that manifestationalism cannot make sense of the scientific impetus to make new observations, since such observations only risk turning manifestationally adequate theories into inadequate ones. This paper argues that a strikingly similar objection applies to van Fraassen's own constructive empiricism, the view that science aims only to find theories that are empirically adequate. Roughly, the objection is that constructive empiricism cannot make sense of the scientific impetus to expand the limits of what can be observed, since such expansions only risk turning empirically adequate theories into inadequate ones.

1. Introduction

Any empiricism worthy of its name makes a distinction between the empirical and the non-empirical, prioritizing the former over the latter. Different forms of empiricism draw the line in different ways. Logical empiricists made a linguistic distinction between observational and theoretical *terms*, for instance, while Bas van Fraassen (1980) makes a distinction between observable and unobservable parts of the *world*, e.g. entities or processes. Whether a part of the world counts as observable depends, for van Fraassen, on whether the relevant scientific community would be able to observe it directly in the right circumstances. This relativizes observability to a given community: Something may count as observable relative to a community with greater observational powers while counting as unobservable relative to a community that is more observationally limited. To say that something is observable is, for van Fraassen, simply to say that it is observable relative to *our* community.

One consequence of this relativity in what counts as observable is that the line between observable and unobservable would shift if there are sufficiently substantial

changes to the observational powers of the relevant community. An entity that was previously unobservable could become observable, not because of any real changes in the entity itself but because the relevant community has increased its abilities to observe entities of this kind.[1] In this paper, I argue that this malleability in what counts as observable according to van Fraassen creates a problem for van Fraassen's constructive empiricism, which holds that scientific theories are successful in so far as they are correct about the observable aspects of the world. Roughly, the problem is that constructive empiricism seems to imply that scientists who augment their observational powers are risking that a previously successful theory might thereby become unsuccessful. Since scientists themselves do not seem to recognize this as a genuine risk – scientists do not hesitate to augment their observational powers whenever possible – there seems to be tension between constructive empiricism and established scientific practice.

In what follows, I formulate what I consider to be the most plausible version of this argument, and consider some ways in which a Constructive Empiricist might respond. At the end of the day, I am not sure whether this argument constitutes a genuine problem for constructive empiricism, but as far as I can tell there is no obvious or easy response available on constructive empiricism's behalf. Constructive empiricism has been heavily criticized on numerous occasions, but I believe that many – perhaps most – of the objections that have so far been made against constructive empiricism are based on misconceptions of what constructive empiricism is and entails.[2] I am confident that the argument I consider here, whatever its merits in other respects, is not of this kind.

2. Constructive Empiricism and Observability

[1] Of course, the entity would „change" in the sense that it would go from having the property of being observable to a community to lacking that same property. But this is paradigmatic example of a mere „Cambridge change" (cf. Geach 1969); hence the qualified expression „real change" in the main text.
[2] For example, constructive empiricism is often criticized for arbitrarily limiting what we can know to things that happen to be observable (Alspector-Kelly 2001); but in fact constructive empiricism entails nothing about what can and cannot be known (Monton and van Fraassen 2003). Another example: Some authors criticize van Fraassen for rejecting inferences to the best explanation to the truth of theories while accepting inferences to the best explanation to the conclusion that theories are empirically adequate (e.g. Psillos 1996); but in fact van Fraassen rejects both kinds of inferences – because he rejects the entire rule or schema called "Inference to the Best Explanation" (Ladyman et al. 1997).

Van Fraassen's *The Scientific Image* (1980)[3] did not just argue for a new kind of scientific anti-realism, constructive empiricism, but also proposed an influential way of understanding what the scientific realism debate is really about. According to van Fraasen, there are two points of contention between scientific realists and anti-realists. The first concerns the *aim* of science: Scientific realists hold that the aim of science is to give us true theories, while anti-realists hold that the aim of science is something other than truth. The second point of contention concerns what is to *accept* a scientific theory: Scientific realists hold that accepting a theory involves believing that the theory is true; anti-realists hold that one can accept a theory without believing that it is true. In this paper, I will set aside the issue of the nature of scientific acceptance (in part because I have discussed it elsewhere; see Dellsén 2017), and instead focus on the former, i.e. the debate about the aim of science.

Van Fraassen's use of the term 'the aim of science' should not be taken too literally. Science is not the sort of being that could literally be aiming for anything in the sense that, for instance, an archer aims their bow at a target. Nor is van Fraassen referring to the personal aims or goals of individual scientists, or of the majority of scientists at a given time. Rather, van Fraassen uses the term 'aim' simply to refer to the *basic criterion of success* of the scientific enterprise – an enterprise whose participants might have various different personal goals and motives. The aim of science – or of a particular science – is thus to be understood as the basic criterion of success in (the) science. So, realism and anti-realism are in part different views about the basic criterion of success in science: Realism holds that science is genuinely successful only if (or in so far as) its theories are true, while anti-realism holds that science need not give us any true theories in order to be genuinely successful.

By definition, anti-realism is the negation of realism. So, with regard to the aim of science, anti-realism is merely the negative thesis that the aim of science *isn't truth*. Sooner or later, however, any anti-realist will have to provide a positive account of what the aim of science *is*. Constructive empiricism is van Fraassen's attempt to provide such an answer in the tradition of empiricists like Locke, Hume, Carnap and Hempel. According to constructive empiricism, "[s]cience aims to give us theories which are empirically adequate" (van Fraassen 1980: 12). In other words, the basic criterion of success in science is empirical adequacy, rather than truth. But what is "empirical adequacy"? We don't need to bother here with the precise definition;

[3] Although see also van Fraassen 1985, 1989, 2001, 2007.

suffice it to say that a theory is empirically adequate roughly when what the theory says about observable parts of the world is true.

Now, since empirical adequacy is thus defined in terms of what is *observable*, a lot hangs on how we understand this term within van Fraassen's account. As a "rough guide to the avoidance of fallacies", van Fraassen suggests that "X is observable if there are circumstances which are such that, if X is present to us under those circumstances, then we observe it" (1980: 16). In fact, this "rough guide" is not just rough but also incomplete in van Fraassen's view, because it leaves the term "observe" undefined. According to van Fraassen, however, this is as it should be since precisely what is involved in observation is a question to be answered by empirical science rather than philosophical analysis or stipulation (van Fraassen and Muller 2008; see also Musgrave 1985, Dicken and Lipton 2006, Dicken 2009).

Let me highlight three features of van Fraassen's understanding of observability that are relevant to the present discussion. First, as I mentioned previously, observability is relative to one's epistemic community. Something that isn't observable to one community might be observable to another, depending on the observational powers of those in each community. So – to take an extreme and perhaps overworked example – if there are Martians who can observe certain entities that we cannot observe, then those entities will be observable for the Martians but not for us (cf. Churchland 1985).

Second, van Fraassen notes that "'observable' is a *vague predicate*" (1980: 16). So while there will be things that are clearly observable (e.g., tables and chairs), and things that are clearly unobservable (e.g., the exact curvature of spacetime at a given location), there will also be things in between that aren't clearly either observable or unobservable. So unless one adopts a Williamson-style epistemicism about vagueness (Williamson 1992), it will be indeterminate whether certain things are observable or unobservable.

Finally, I wish to highlight that constructive empiricism doesn't need to draw the line between what's observable and what's not in any particular place (cf. van Fraassen 2001: 163; 2008: 110). All that's really required is that there be such a line to be drawn somewhere such that the line can plausible be considered to demarcate the 'empirical' from the 'non-empirical'. Thus, for example, a Constructive Empiricist could (without contradicting herself) hold that entities that can only be detected using microscopes are observable provided the microscopes are widely available and

reliable. In this sense, the distinction between observable and unobservable can be thought of as a 'free parameter' within constructive empiricism.

3. The Manifestationalist Challenge

With these points in place, let us turn now to a potential problem for constructive empiricism that I will call *the manifestationalist challenge.* This challenge arises as one starts to think about the motivations one might have for adopting constructive empiricism rather than scientific realism. Recall that while scientific realism says that science isn't successful until it has given us *true* theories, constructive empiricism says that success in science requires only *empirical adequacy*, i.e. roughly truth with regard to observable aspects of the world. Since empirical adequacy is weaker than truth (i.e., all true theories are empirically adequate, but not *vice versa*), constructive empiricism apparently attributes a more modest epistemic aim to science than does scientific realism. According to van Fraassen himself (see Monton and van Fraassen 2003, quoted below) this is one of the main motivations for constructive empiricism as contrasted with scientific realism: We should not attribute to science a more ambitious epistemic aim if a more modest aim will do just as well.

But as Peter Railton (1990) points out, this apparent benefit of constructive empiricism quickly turns into a problem. For if epistemic modesty is what is at issue, then it seems that an even more modest anti-realist alternative to scientific realism should be preferable to constructive empiricism, viz. what Railton (1990: 234-5) calls *manifestationalism*. Manifestationalism holds that science aims to give us theories that are correct in all of what they say about phenomena that have *actually been observed*. (We might describe such theories as "manifestationally adequate".) Manifestationalism could be understood as a kind of actualistic empiricism, since it essentially holds that the aim of science is restricted to having correct theories about what is observed in the actual world. By contrast, constructive empiricism holds that science also aims to give us correct theories about phenomena that *haven't been* and *won't be* observed – but *could be*.

The option of adopting manifestationalism about the aim of science seems to suggest that constructive empiricism is unstable with regards to the motivation of epistemic modesty. The argument would go as follows: In so far as we are choosing between constructive empiricism and scientific realism with reference to epistemic modesty, it seems that we should go further and accept manifestationalism rather than

constructive empiricism. After all, manifestationalism is even more modest than constructive empiricism. If, however, we reject the idea of using epistemic modesty as a criterion in the debate, then it seems that we might as well be scientific realists. Either way, the fact that constructive empiricism attributes a more modest aim to science would give us no reason to be constructive empiricists rather than scientific realists. In nutshell, the challenge here is to motivate constructive empiricism without 'proving too much' and end up motivating a more extreme form of anti-realism, viz. Railton's manifestationalism.

In an influential article, Gideon Rosen (1994) has suggested a way to meet this challenge. The idea is to show that manifestationalism makes the aim of science so modest that it can no longer explain why scientists ought to make observations that could otherwise be avoided. Rosen illustrates with an example:

> Consider, for example, an archeologist whose theory covers all the evidence so far collected about Etruscan urns. [The archeologist] has sole license to dig in the last uninspected patch of ground, but it is also in [the archeologist's] power to destroy the site so that no one will ever have a chance to inspect it. What should [the archeologist] do?" (Rosen 1994: 162)

Rosen's question is a little unclear as it stands, because the archeologist might have all sorts of different kinds of reasons to dig or destroy the site. But presumably the issue is what the archaeologist should do in so far as she is trying to satisfy the aim of science, i.e. its criterion of success. What should the archeologist do *qua scientist*? Understood in this way, the answer to this question will depend on what one takes the aim of science to be.[4]

For a manifestationalist, the answer is that the archeologist should destroy the site, because doing so guarantees that her theory will be manifestationally adequate, i.e. correct about all actually observed urns. After all, the archeologist's theory is already correct concerning all urns that have been observed so far, and if there are no other urns to observe then her theory is guaranteed to be correct about all urns that have been and will be observed. Hence by destroying the site the archeologist guarantees that her theory will be successful according to manifestationalism. By

[4] Asay and Bordner (2015: 156-8) argue that manifestationalism has no bearing on what the archaeologist should do, mainly because (they claim) manifestationalism does not "entail anything about which sorts of scientific endeavors one should engage in" (Asay and Bordner 2015: 157). Maybe so, but it does entail something about which scientific endeavors promote the aim of science, i.e. make it more and less likely that our theories are successful according to science's basic criterion of success.

contrast, for a Constructive Empiricist, destroying the site does not in any way help make the theory satisfy science's criterion of success, since the theory will have to answer to all observ*able* entities whether or not they have actually been, or will ever be, observed. Rather, the archeologist should dig, because that way she can test her theory, possibly replace it, and thus increase the likelihood that the theory is empirically adequate.

The point of Rosen's example is of course to illustrate that manifestationalism implies – presumably incorrectly – that science's criterion of success would be satisfied by destroying a potentially vital piece of evidence. By contrast, constructive empiricism can make perfectly good sense of why the scientist should dig rather than destroy the site. Rosen thus concludes that constructive empiricism can be thought of as "the most cautious position – the position most compatible with empiricism in the broad sense – which at the same time renders the phenomena of scientific activity fully intelligible and ratifiable" (1994: 162). The idea, then, is that we should take the aim of science to be as modest as is possible, but not so modest as to render it unable to account for what's wrong with destroying the site in Rosen's example. This position is echoed by van Fraassen himself in a paper co-authored with Bradley Monton:

> Consider a range of possibilities, with 'science aims to give us true theories' on the far right side, and 'science aims to give us theories which are true in what they say about what is being observed right now' on the far left side. Realists submit that attention to the practice of good science, where bold conjectures and audacious theorizing have been rewarded with much predictive success, moves us toward the right. Empiricists, who would wish for epistemic modesty in their paradigms of rational inquiry, would tend toward the left. Constructive empiricism finds an equilibrium point between the two extremes, thus respecting both desiderata (Monton and van Fraassen 2003: 407-8).

So, to summarize, we have seen that constructive empiricism has been criticized as unstable in so far as it is motivated by a desire for epistemic modesty in our accounts of the aim of science. According to the objection, epistemic modesty should push us all the way to a more radically anti-realist position, manifestationalism. In response, Rosen argues (on van Fraassen's behalf) that constructive empiricism is not unstable because if science aimed for anything less than empirical adequacy – as manifestationalism maintains – we couldn't explain why it would be scientifically improper to destroy potentially vital pieces of evidence, such as the archeologist's last

digging site. In the remainder of this paper, I will suggest an argument analogous to Rosen's argument against manifestationalism applies to constructive empiricism itself. The argument concerns what we may want to call 'extended observability', where the limits of what could be observed by an epistemic community are expanded or increased so that previously unobservable entities become observable.

4. Extended Observability

Let me start by distinguishing two ways in which observability can be extended according to constructive empiricism's conception of observability:

> *Epistemic immigration*: The epistemic community expands to include beings that are observationally superior in some respect.
>
> *Epistemic upgrading*: Individual agents within an epistemic community increase their observational capacities.

In both cases, the limits of observability have been *extended* in the sense that the resulting a community can observe entities that were previously unobservable. Nevertheless, it is important not to confuse these two ways in which observability can be extended within a community. Epistemic immigration does not require any individual agents to increase their observational capacities; rather, the change in observability is due only to a change in who counts as members of the relevant community. By contrast, epistemic upgrading does not require that there be any changes in who counts as members of the community; rather, the change in observability is due only to changes in the members' observational capacities.

Although these two ways of extending observability have not been clearly distinguished to my knowledge, examples of both have been extensively discussed in the literature on scientific realism, anti-realism and empiricism. For instance, Paul Churchland's thought experiment of microscope-fused humanoids is a good example of epistemic immigration:[5]

> [...] consider a race of hominoid creatures each of whom is born with an electron microscope permanently in place over his left `eye'. The scope is biologically constituted, let us suppose, and it projects its image onto a human-style retina,

[5] See also Kitcher's (2001: 178) case of "Hawkeye".

> with the rest of their neurophysiology paralleling our own (Churchland 1985: 43-4).

For Churchland, this thought experiment puts pressure on the distinction between observable and unobservable, because we can presumably imagine beings of this sort for any range of things that we cannot observe – making anything in principle susceptible to being observed by some beings that could enter into our community.

In response to Churchland, van Fraassen rightly points out that Churchland's argument is only a problem for those who seek a definition of 'observable' that isn't relativized to an epistemic community. Once we relativize observability to a community, we can simply say that the limits of observability would change as the community changes:

> [...] suppose we have accepted these humanoids as persons, as members of our epistemic community. In that case we have already broadened the extension of *us*, and what is observable to them is observable (van Fraassen 1985: 256).

Van Fraassen's point here, I take it, is that the fact that the limits of observability can change doesn't mean that there is no line to be drawn between observable and unobservable; it just means that the line needs to be drawn *at a given time*. That much seems correct. But notice that van Fraassen is here effectively acknowledging that epistemic immigration is possible according to his own understanding of what observability amounts to.

So epistemic immigration is clearly possible on a van Fraassen-style understanding of observability, i.e. one that relativizes observability to an epistemic community. What about epistemic upgrading? Here I wish to make another distinction, which I borrow from Paul Humphreys (2004: 4ff), between two different kinds of epistemic upgrading. In *observational extrapolation*, one expands the range of observable values of a property whose values can already be observed within a limited range. For example, using our eyes and a ruler, we can measure the size of a given object with some particular precision – perhaps down to half a millimeter or so. Using an ordinary optical microscope, we can make the same size measurements but with considerably more precision – perhaps down to a micrometer at least (depending on which microscope we use, of course). If one *observes* the size of the object through the microscope, then this counts as a case in which one uses the microscope as a means to expand the range of observable values of the property *size*. We would thus have a case of observational extrapolation.

In the other kind of epistemic upgrading discussed by Humphreys, *observational augmentation*, one manages to increase the number of properties whose values can be observed at all. Thus, in observational augmentation, one was previously unable to observe any values of a given property, and some of those values can now be observed. If there are any cases of observational augmentation, they would presumably involve observations of properties like electron spin, ionizing radiation, and magnetic fields – presumably by means of sophisticated measurement devices of various sorts. Of course, it will no doubt be controversial whether these are really cases of observational augmentation, since many empiricists are wont to reply that when scientists claim to 'observe' the spin of an electron, or an electromagnetic field, they are using 'observe' in a loose and imprecise way that should only be taken as a manner of speaking. What scientists genuinely observe is the readings on their measurement apparatuses, the numbers on their computer screens, and so forth. So, the argument goes, scientists don't really augment their observational capacities; rather, they simply use their (unaugmented) observational capacities in a more efficient way, using instruments.

This reply may appear plausible for observational augmentation, but it is much less plausible when applied to observational extrapolation. What we observe when we use a microscope, for example, doesn't seem to be the image on the end of the microscope's eyepiece; rather, it seems more plausible that we use the microscope to observe what is placed under it. This is even clearer when it comes to instruments that we use to enhance our senses on a daily basis, such as eyeglasses and hearing aids. According to the current objection, you would strictly speaking be observing the image displayed on the inside of your eyeglasses rather than the objects in front of you as soon as you put them on your nose. If a person with normal eyesight and no glasses is standing next to you, they would of course observe the objects rather than an image on your eyeglasses. So that person would, strictly speaking, be observing something entirely different from what you are observing. At this point, one will surely start to wonder whether a notion of 'observation' that works in this way could be the notion that is most relevant to an understanding of science. Scientists do make a distinction between empirical and non-empirical results/claims, but they do not distinguish between results obtained with and without the use of eyeglasses, hearing aids, or even microscopes. In so far as constructive empiricism is supposed to make sense of science as it is actually practiced, it thus seems more plausible to adopt a more

flexible definition of 'observable' that allows for observational extrapolation and perhaps also observational augmentation.

A further argument against a blanket ban on the idea of observing through instruments appeals to the idea that instruments could (and have already, to a large extent) become part of 'us' – or, more specifically, of our minds. According to the *extended mind thesis* (Clark and Chalmers 1998), our minds extend out to the world in certain cases to things to which we have a sufficiently reliable access, such as notebooks and smartphones. If so, our minds can also be said to extend to certain instruments that help us perceive and process things that were previously beyond our ken. Adam Toon (2014) explores this kind of issue in a recent paper, in which he argues that this possibility "provides the realist with a new argument against the constructive empiricist view of instruments" (2014: 410) and suggests that constructive empiricism should be replaced with an "empiricism for cyborgs" in which the limits of observability depend on what sort of instruments our minds extend to at a given time.[6]

A third and final objection to the blanket ban on observation through instruments is that it seems unmotivated and arbitrary once we allow for the possibility of epistemic immigration, i.e. that the limits of observability could change due to observationally superior agents becoming part of our epistemic community. Having acknowledged that what counts as observable is relative to an epistemic community that might include, for example, humanoids with electron microscopes instead of eyes, what motivates the focus on specifically human physiology among the rest of us? If the microscope-fused humanoids count as observing what is under *their* microscopes, it seems that the rest of us (more or less normal humans) should also – on pain of drawing a completely arbitrary distinction – count as observing what is under *our* microscopes.

Let us take stock. I have distinguished between two ways in which the limits of what is observable can be extended: In *epistemic immigration*, the relevant community is itself extended to include new, observationally superior beings. It seems undeniable that epistemic immigration is possible on a relativized notion of

[6] I think Toon is essentially correct here, although I must note that there is no such thing as "the constructive empiricist view of instruments". Constructive empiricism is perfectly compatible with any view of instruments, even if its originator, van Fraassen, has particular views about the latter. So, in my view, Toon's "empiricism for cyborgs" should be viewed as an extension of, rather than a competitor to, constructive empiricism.

observability such as van Fraassen's – and indeed we find that van Fraassen explicitly acknowledges this possibility. In addition to epistemic immigration, it seems plausible that the limits of observability could be extended through epistemic upgrading, i.e. a process whereby individual members of an epistemic community increase their observational capacities. There are two kinds of epistemic upgrading, observational extrapolation and observational augmentation, and while some empiricists might be inclined to reject the possibility of observational augmentation, it seems exceedingly implausible to say that observational extrapolation would be impossible.

5. The Argument from Extended Observability

For our present purposes, the most important upshot of the considerations adduced in the last section is that the limits of what counts as observable can be extended; moreover, it is at least partly in our own power whether or not we extend these limits, since it is at least partly in our power whether we allow for epistemic immigration, and perhaps it is also in our power whether we engage in epistemic upgrading (assuming epistemic upgrading is indeed possible). We are now finally in a position to set up the argument against constructive empiricism that I am interested in exploring.

The basic idea behind the argument is that constructive empiricism implies that expanding the limits of observability carries a kind of risk for scientists that their already successful (because empirically adequate) theories will become unsuccessful (because empirically *in*adequate). It carries such a risk because once the limits of observability have expanded, all theories will be measured against a higher standard than before – viz. correctness with regard to not just all the previously observable entities but also with regard to the entities that have just become observable now that the limits of observability have expanded. This means that it is at least possible for some of the theories that were previously empirically adequate – given the previous limits for observability – to become empirically inadequate – given the new limits for observability. So constructive empiricism implies that expanding the limits of observability carries a risk of going against the aim of science, i.e. of impeding scientific success. Thus, all other things being equal, constructive empiricism implies that scientists have an important scientific reason not seek to expand the limits of observability.

To illustrate, suppose that a given community of scientists were offered the choice of accepting into their community a number of beings who could perceive electromagnetic fields in much the same way that we see ordinary light. (This would be a case of epistemic immigration.) Or, to use a different kind of example, suppose a new instrument could be constructed through which magnetic fields could be detected with the same reliability and effortlessness with which most humans currently perceive ordinary light. (This would be a case of epistemic upgrading.) From the point of view of a scientific realist, there is no reason whatsoever not to allow this type of epistemic immigration or upgrading, since the only possible upshot is that we obtain another means to (reliably) measure electromagnetism, which in turn would increase our chances of obtaining true theories about electromagnetism and related phenomena.

Things will look differently from constructive empiricism's point of view. This new means of observing electromagnetism might help us get better – more empirically accurate – theories in various ways. But it will also elevate the standards against which any given theory is judged, and thereby make those standards harder to achieve. In particular, a theory of electromagnetism that had been empirically adequate before – because correct about all the entities that were observable at the time – could become empirically inadequate afterwards – because incorrect about some new set of entities that became observable by virtue of the epistemic immigration or upgrading would just have taken place. So constructive empiricism implies, in a way scientific realism does not, that epistemic immigration and upgrading involves risking that currently successful theories would become unsuccessful.

It seems to me that this implication of constructive empiricism is problematic for two related reasons. First, if there was a risk for science to regress in this way through epistemic immigration and upgrading, we should expect scientists and scientific policy makers to be at least somewhat aware of this risk – if not explicitly in their pronouncements and stated aims, then at least implicitly through their planning and actions. However, I think it's fair to say that there is no indication from scientific practice that scientists and scientific policy makers are in any way cautious or wary with regard to epistemic upgrading and immigration. If they were, we should expect a lot more energy and resources to be spent on researching where exactly the current boundaries of observability are located – exactly which entities are observable and which entities are not – and on coming up with plans for how to avoid transgressing

those boundaries. The fact that we don't see anything of this sort in scientific practice is thus a strike against constructive empiricism as an account of the aim of science.

A second, but related, reason it is problematic for constructive empiricism to imply that epistemic immigration and upgrading involves risking that successful theories would become unsuccessful concerns its normative implications. An often-overlooked fact about the scientific realism debate is that the various positions in this debate have important normative implications.[7] For example, a scientific realist – who values truth beyond empirical adequacy – thinks that the work of a scientist is not finished once they have obtained empirically adequate theories of a given phenomenon; rather, the scientists must also choose which of a set of empirically adequate theories is also true. So while a scientist who follows constructive empiricism's advice would move on to researching other phenomena as soon as they are convinced that empirical adequacy has been achieved, the realist-inclined scientist might rationally choose to spend their time and resources on finding the true theory of a phenomenon for which they have already achieved empirical adequacy.

The point here is that whether scientists follow constructive empiricism or scientific realism will have real-life normative implications for how they conduct their research. Whether we, as philosophers, prefer constructive empiricism or scientific realism (or some other account of the aim of science) should thus depend – at least in part – on whether we agree with each account's normative implications. The situation here is analogous to that in normative ethics, where we choose between ethical theories, e.g. utilitarianism and deontology, at least partly by appealing to the normative implications of each theory. For example, it is a *prima facie* objection to utilitarianism that it seems to recommend involuntary organ donations in which a single person is sacrificed to save the lives of five other people; similarly, it is a *prima facie* objection to Kantian deontology that it offers a blanket ban on lying, even to axe-murderers who are searching for their next victims.

What normative recommendation would constructive empiricism give a community of scientists who are faced with a choice of either (a) allowing or banning epistemic immigration, e.g. from creatures who are able to directly perceive electromagnetic fields, or (b) engaging in or abstaining from epistemic upgrading, e.g. by inventing and constructing a highly reliable and accessible instrument for perceiving electromagnetic fields? Of course, the answer will depend on exactly what

[7] For more on this general point, see Dellsén 2019.

other foreseeable benefits and drawbacks there are to each course of action. But one important consideration for the constructive empiricist would be that extending the limits of observability in this way risks making empirically successful theories unsuccessful. So there will be circumstances – however contrived and convoluted – in which constructive empiricism implies that epistemic immigration and upgrading should be avoided or even banned (at least in so far as we are seeking scientific success). By contrast, scientific realism will have no such implications, since for the realist there is never any risk of changing which theories count as successful. After all, what counts as *the truth* is always and everywhere the same, regardless of what is observable within one's epistemic community.

Now, isn't there something troubling, even absurd, in suggesting that epistemic immigration and upgrading could be something to be avoided? In both cases, we are simply extending the realm of entities that can be observed by us. How could that possibly be a bad thing? From an empiricist perspective, i.e. from the perspective of those who prioritize the empirical over the non-empirical aspects of science, epistemic immigration and upgrading give us a world in which a larger proportion of entities are located on the favored side of the empirical/non-empirical divide. Again, it is hard to see any reason to think this could ever be a bad thing. So the implication from constructive empiricism that it would (at least sometimes) be unadvisable for scientists to allow epistemic immigration or engage in epistemic upgrading appears to be an awkward normative implication, much like utilitarianism's (apparent) implication regarding involuntary organ donation and Kantian deontology's (apparent) implication regarding a blanket ban on lying.

6. Two Empiricist Rejoinders (with Replies)

How might a constructive empiricist, such as van Fraassen himself, respond to the argument of the previous section? Before concluding this paper, I will consider two possible responses that I think has a great deal of *prima facie* plausibility – even though I don't think either is ultimately successful. According to the first response, any change to the limits of observability is, by constructive empiricism's lights, a change in the criterion of success in science, and thus a change in the nature of science itself. As a result, comparing scientific success before and after a change in observability is effectively a comparison of success in different enterprises – an earlier science and a later science – for which there is no common standard of comparison. And since there

is no common standard of comparison, any such comparison of scientific success before and after a change in observability is misguided.

To develop this response a little further, consider van Fraassen's analogy between science and chess. In explaining what he means by attributing an *aim* to science, van Fraassen notes that he means this in the same sense in which "[t]he aim of the game of chess is to checkmate your opponent" (van Fraassen 1980: 8). Now, suppose the rules concerning *checkmate* are changed so that what we currently refer to as a stalemate is henceforth considered as a kind of checkmate. Thus the 'aim' of the game of chess – its criterion of success – would now be different from what it was before, and chess players would have to adapt to the new rules, e.g. by making appropriate changes in their training and strategies. Now we can ask ourselves the following question: Would the game that is being played after the rule change be the same game as was being played before? Or would we rather be playing a different, albeit very similar, game afterwards? If we say that we are playing a different game after the rule change, then it seems that success and failure before and after the change cannot really be compared in a meaningful way. That would be to compare success and failure in one game with success and failure in another, e.g. like comparing success in tennis with success in badminton. Such across-game comparisons do not seem to make any sense.

Similarly, a constructive empiricist might argue that if the limits of observability change from one time, t_1, to another, t_2, we in effect have two separate criteria for success at t_1 and t_2 according to CE. These can be roughly stated as follows:

> *Empirical adequacy*$_1$: Being correct about what is observable for the relevant scientific community at t_1.
>
> *Empirical adequacy*$_2$: Being correct about what is observable for the relevant scientific community at t_2.

Now, since the basic criterion of success in an endeavor such as science is arguably constitutive of it, this would mean that we really have two distinct (but of course very similar) endeavors at t_1 and t_2. These two endeavors can be labelled *science*$_1$ and *science*$_2$. Of course, since science$_1$ and science$_2$ are so similar, one would be forgiven for confusing the two in most contexts (just as someone who confuses regular chess with stalemate-inclusive chess would surely be forgiven that in most contexts). Nevertheless, the two endeavors would be genuinely distinct, as evidenced by the fact that their constitutive criteria of success would be different.

Now the point of all of this would be to show that, in case of epistemic immigration or upgrading, there wouldn't strictly speaking be a single endeavor, science, such that success and failure in that endeavor can be meaningfully compared at t_1 and t_2 respectively. Of course, we can still ask whether the endeavor we have is successful according to each of the criteria operative at t_1 and t_2 respectively, i.e. empirical adequacy$_1$ and empirical adequacy$_2$. But changing the limits of observability will not itself have any effect on whether our theories count as empirically adequate$_1$, for example: If they were empirically adequate$_1$ before the change, they will be empirically adequate$_1$ afterwards as well (assuming all else remains equal in the process). And the same will be true, *mutatis mutandis*, for empirical adequacy$_2$. But if it's misguided in this way to compare scientific success and failure before and after epistemic immigration or upgrading, i.e. success and failure in science$_1$ and science$_2$ respectively, then the argument I presented in the previous section doesn't seem to get off the ground.

So that's the empiricist rejoinder to the argument of the last section. I have said that I do not ultimately think it is successful. So what's my reply? Well, consider the issue from the point of view of scientists themselves. For scientists, what matters is to satisfy the criterion of scientific success, whatever it is, that is in play at for them at a given time. I does not matter to working scientists whether they are, strictly speaking, doing science$_1$ or science$_2$; what matters is only that they be successful at whatever enterprise they are engaged with. So, in their deliberation about what they should do in order to satisfy the criterion of success, scientists should take into account what the criterion will be in the near-to-distant future when their action takes place or bears fruit, as opposed to what the criterion is at the time of deliberation. And this holds even if the criterion at that point will be a criterion in a different endeavor, science$_2$, since they will then have gone over from doing science$_1$ to doing science$_2$.

To understand this point fully, it may be useful to go back to the chess analogy. A chess player who knows or strongly suspects that the rules of chess will change soon in the way we envisioned before (making a stalemate count as a kind of checkmate) should take that into account in her deliberation, e.g. in deciding how to prepare for her next tournament. It doesn't matter to the chess player whether the game that is being played at the next tournament is, strictly speaking, a different game than what she is used to play (chess$_2$ as opposed to chess$_1$, if you will). The chess player simply wants to be successful relative to whatever criterion of success is in play at the

time at which the game is played. Similarly, I am suggesting, a scientist will want to satisfy the criterion of success for the enterprise in which she is working – regardless of whether that criterion is empirical adequacy$_1$ in science$_1$ or empirical adequacy$_2$ in science$_2$.

Accordingly, it seems to me that if it's in scientists' power to prevent the criterion of success in their discipline (whatever it is)[8] from changing between t_1 and t_2 in a way that makes their own theories unsuccessful according to the criterion in play at t_2, then they would be rational in doing so – at least in so far as they seek scientific success in the first place. And now we are back where we started: If constructive empiricism is correct that the criterion for success in science is empirical adequacy, then scientists who expand the limits of what can be observed risk making theories that were successful according to the previous criterion for success into scientifically unsuccessful theories according to the criterion in place after the expansion of the limits of observability. This holds even if criteria of success are constitutive of enterprises like science, because then these scientists can be described as changing the enterprise in which they are engaged from one in which their theories are successful – what I've been calling science$_1$ – into one in which their theories are unsuccessful – science$_2$. As before, however, it doesn't seem as if there is any indication in scientific practice that scientists are concerned about 'risks' of this kind, nor does it seem to be a reasonable normative implication that it would sometimes be irrational for conscientious scientists to avoid or ban epistemic immigration and upgrading.

A second empiricist rejoinder is to concede that the argument of the previous does undermine the empiricist position formulated by van Fraassen (1980) but insist that the argument can be avoided with a small modification. Specifically, the empiricist could insist that the aim of science is not just for one's theories to be empirically adequate, but also to increase the range of observable entities. So, on this picture, science has two related aims: The first is to have theories that are correct about observables; the second is to increase the number of entities that count as observable. Given this additional aim of science, the constructive empiricist (of this modified variety) can explain why scientists ought to expand the limits of observable by

[8] The parenthesis here is meant to indicate that "criterion of success" is being used as non-rigid designator here to whatever is the criterion in the discipline that scientists happen to be engaged in.

appealing to the fact that doing so makes additional things observable, thus satisfying the second aim of science.[9]

The first thing to say about this rejoinder is that it is clearly somewhat *ad hoc*, in these of being a modification to a theory that is specifically designed to avoid a problem and isn't independently motivated. Still, *ad hoc* theories can be true (as the history of science surely teaches us) so that by itself is not a knock-down argument against this rejoinder. A related point is that this conjunctive version of constructive empiricism would clearly be *less simple* than scientific realism, which posits only one aim for science, viz. that its theories be true). To this van Fraassen (or a van Fraassenite) could reply that he (she) places no epistemic weight on simplicity in scientific theory choice, so why should they be concerned with having a less simple account of science than the realist? So, again, I don't think pointing to the complexity of this new empiricist account of the aim of science constitutes a knock-down argument either.

But there is a more serious problem in the vicinity here. That problem emerges when we consider the issue from the point of view of a scientific realism. From the realist's perspective, the second aim proposed by the current rejoinder is perfectly explicable as a means to obtaining true theories. Scientists should aim to expand the limits of observability, i.e. turn unobservable entities into observables ones, because science aims to discover the truth about *all* entities – not just the observables ones – and expanding the limits of observability enables us to confirm theories about previously-unobservable entities more strongly and more efficiently. The scientific realist can thus *explain* why the constructive empiricist must add the second aim in order to avoid the present problem. So, in a sense, adding this second aim to constructive empiricism is not *ad hoc* from the scientific realist's perspective.

It seems to me that this last point – that scientific realism can explain why an apparently *ad hoc* modification must be made to constructive empiricism, while constructive empiricism (in its original or modified variety) clearly cannot – is the most serious problem with the second empiricist rejoinder. In science and philosophy, one must sometimes learn to live with theories that are not as simple as one would like, or that have been modified *ad hoc* to avoid some problems; but it's another thing

[9] Many thanks to Hedda Hassel Mørch and Andreas Brekke Carlsson for raising this concern.

entirely to cling to a theory whose *ad hoc* modification is unmotivated by its own lights and yet perfectly explicable according to a rival theory.

7. Conclusion

I have argued that there is a tension in constructive empiricism's view of science, coupled with van Fraassen's relativized notion of observability. Specifically, I have argued that constructive empiricism implies that scientists have reason to prevent or discourage expanding the limits of what could be observed, because such an expansion risks making empirically adequate theories into empirically inadequate ones. This implication, I argued, is problematic – in part because there doesn't seem to be anything in scientific practice to suggest that scientists themselves take there to be any risk of this kind involved in expanding the limits of observability, and in part because this has the awkward normative implication that scientists should sometimes abstain from or even ban certain ways of expanding the current limits of observability.

I am not going to seriously propose a solution to the problem, but I'll end with a question that I think is worth thinking about. Might it be that this problem can be avoided by defining empirical adequacy not in terms of what is observable to the community at a time, as van Fraassen does, but rather in terms of what *has been, is, or will be* observable to the community – i.e. in terms of what is observable not at a specific time (now or in the past) but at *any time whatsoever*? I am not entirely sure this solves all the problems of the kind I've been concerned with, and it also might bring new problems that I haven't thought of. But it might be a step in the right direction for those who, like me, are intrigued and impressed by the view of science we find in van Fraassen's constructive empiricism.[10]

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