

Microscopes and the Theory-Ladenness of Experience in Bas van Fraassen's Recent Work

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Abstract Bas van Fraassen's recent book *Scientific Representation: Paradoxes of Perspective* (2008) modifies and refines the "constructive empiricism" of *The Scientific Image* (1980) in a number of ways. This paper investigates the changes concerning one of the most controversial aspects of the overall position, that is, van Fraassen's agnosticism concerning the veridicality of microscopic observation. The paper tries to make plausible that the new formulation of this agnosticism is an advance over the older rendering. The central part of this investigation is an attempt to answer Marc Alspector-Kelly's 2004-criticism of an early (2001) version of van Fraassen's new position. Alspector-Kelly's contribution it is to date the most extensive attack on van Fraassen's twenty-first-century work on the topic of microscopic observation. One of the central ideas emerging from the present discussion is a link between the debate over the veridicality of microscopic observation and the issue of the theory-ladenness of experience.

Keywords Bas van Fraassen · Ian Hacking · Marc Alspector-Kelly · Paul Teller · Constructive empiricism · Theory-ladenness

1 Introduction

Bas van Fraassen's recent *magnum opus*, *Scientific Representation: Paradoxes of Perspective* (2008), modifies and refines the "constructive empiricism" of *The Scientific Image* (1980) in a number of ways. In this paper, I shall investigate the changes concerning one of the most controversial aspects of the overall position, that is, van Fraassen's agnosticism concerning the veridicality of microscopic observation. I shall try to make

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plausible that the new formulation of this agnosticism is an advance over the older rendering.¹

Scientific Representation discusses microscopes in a twenty-page chapter (2008, 93–113). The bulk of this chapter is identical with a section of van Fraassen’s paper “Constructive Empiricism Now” (2001). This textual history allows me to use Marc Alspecter-Kelly’s 2004-criticism of the 2001-paper as my central foil for van Fraassen’s new position in both the 2001-paper and the 2008-book. Alspecter-Kelly’s critique—revealingly entitled “Seeing the Unobservable”—builds upon earlier treatments of the constructive empiricist’s take on microscopic observation by Ian Hacking (1981, 1983) and Paul Teller (2001). I shall discuss Alspecter-Kelly’s contribution at some length since it is to date the most extensive attack on van Fraassen’s twenty-first-century work on this topic.

One of the central ideas emerging from my discussion is a link between the debate over the veridicality of microscopic observation and the issue of the theory-ladenness of experience. I shall explain the connection in the last section of my paper. Put in a nutshell, I shall suggest that van Fraassen’s opponents’ use of terms like “to see” or “to observe” rests upon a *realist* epistemology of instrumentally-aided visual experience; that this theory has come to shape our very phenomenology of instrumentally-aided sensory experience; and that this shaping explains the strengths of resistance to the constructive empiricist’s agnosticism.

2 van Fraassen’s Views in *The Scientific Image*

Although my focus will be on van Fraassen’s writings of this millennium, a brief look at the position of, and debate over, *The Scientific Image* (1980), will help to set the stage.

van Fraassen’s reflections on observability and its limits are central to his “constructive empiricism”, that is, the idea that “science aims to give us theories which are empirically adequate; and acceptance of a theory involves a belief only that it is empirically adequate” (1980, 12). van Fraassen proposes that the “term ‘observable’ classifies putative entities”; that X is observable if, and only if, it can be perceived without the aid of instruments; and that “‘observable’ is a vague predicate.” (1980, 15–16) A further important idea is that observation is a kind of measurement (1980, 58–59), and that the human organism can be thought of as a measuring device. The limitations of this device will be described by the final physics and biology (1980, 17).

Moreover, van Fraassen registers his “total agreement” with the view that “all our language is thoroughly theory-infected”. Nevertheless, he insists that such theory-ladenness does not commit us to scientific realism: “The fact that we let our language be guided by a given picture, at some point, does not show how much we believe about that picture” (1980, 14). van Fraassen makes a similar claim concerning our “immersion in the theoretical world picture”; this immersion “does not preclude ‘bracketing’ its ontological implications” (1980, 81).

van Fraassen’s central contention is of course that unobservables are *postulated* on the basis of observables. He considers a number of objections to this view; the following one will be important later in this paper. Why should we not treat observables as posits, too? Could we not say that observables are postulated on the basis of our perceptual experience? But if observables are postulated too, then they are on a par with unobservables and should

¹ For an important assessment of the new theme of voluntarism, see Dicken (2010).

be treated in the same way: that is, if both unobservables and observables are postulated entities then we should be agnostic about both or neither.

van Fraassen's reply is swift and uncompromising. The only *prima facie* plausible candidates for entities "below" our observables are sense-data. But sense-data are "theoretical entities of an armchair psychology":

... such entities as sense-data, when they are not already understood in the framework of observable phenomena ordinarily recognized, are theoretical entities. They are, what is worse, the theoretical entities of an armchair psychology that cannot even rightfully claim to be scientific. I wish merely to be agnostic about the existence of the unobservable aspects of the world described by science—but sense-data, I am sure, do not exist (1980, 72).

3 Hacking on Microscopes

The most influential early critic of the implications of constructive empiricism for microscopic observation was of course Ian Hacking. Hacking advances three considerations which are meant to show that van Fraassen's agnosticism concerning unobservables jars with scientific practice.

The first consideration can be summed up in the slogan: "don't just peer: inter-fere" (1983, 189). It applies Hacking's "manipulative realism" to microscopes. According to Hacking, it is microscopists' practical ability to interfere with the entity on the microscope slide that convinces them of the reality of the structures they observe on the lens or the visual display unit (VDU): "The conviction that a particular part of the cell is there as imaged is, to say the least, reinforced when, using straightforward physical means, you microinject a fluid into just that part of the cell" (1983, 189–90).

Hacking's second consideration might be called "the argument from preposterous coincidence". Take the image of black spots on red blood platelets that appears on the screen of the VDU when we put blood samples on the microscope slide of an electron microscope. What moved microscopists to believe that these red spots (called "dense bodies") are real was the fact that their images can be seen regardless of whether one uses an electron microscope or a fluorescence microscope—two kinds of devices that function according to very different physical principles. Given that the same images are produced by both types of microscopes, scientists would regard it a "preposterous coincidence" if the spots still turned out to be artefacts. Hacking insists that this line of thought is not an inference to the best explanation, and that it thus does not beg the question against the constructive empiricist (1983, 201–2).

Hacking's third objection is the "argument of the grid". Assume we draw a grid and reduce it photographically until it is no longer visible. Assume further that we then place the (photographically reduced) object under a microscope. If the latter is working properly, then we are going to see the original grid again. What does this show? Hacking's answer goes as follows:

I know that what I see through the microscope is veridical because we made the grid to be just that way.... Moreover we can check the results with any kind of microscope... Can we entertain the possibility that, all the same, this is some gigantic coincidence?... To be an anti-realist about the grid you would have to invoke a malign Cartesian demon of the microscope (1983, 203).

4 van Fraassen's Reply

In his 1985-reply to Hacking, van Fraassen says nothing about the argument from manipulative realism.² Against the argument from preposterous coincidence, van Fraassen invokes the possibility that the similar outputs of the two microscopes may well be our doing: we may well have so calibrated the two microscopes against each other that the coincidence in output is no coincidence. That is, we might have used the first microscope as the standard for the correctness of the output of the second. But then the two microscopes cannot count as independent witnesses of a real structure (1985, 297–8). Moreover, we do not need the “imputed unobservable structure” in order to explain the similar or even identical outputs of the two microscopes: an alternative explanation is the sameness of the input. The same input entity interacting with similar mechanisms (in the two microscopes) results in similar perceivable image outputs. This explanation suffices: we do not need to go further and commit to the view that the microscopic image is a faithful representation of a micro-structure (1985, 298).

Concerning the argument of the grid, van Fraassen takes issue with Hacking's statement “I know that what I see through the microscope is veridical because we *made* the grid to be just that way.” van Fraassen detects a circularity here. It is a precondition of the possibility of our knowing that the microscopic image is veridical that the photographic reduction has maintained the structure of the drawn grid. And it is a part of the evidence for the belief that photographic reduction has maintained the structure of the drawn grid that the microscopic image is veridical. Furthermore, van Fraassen holds that contrary to what Hacking himself believes, the argument of the grid does involve an inference to the best explanation. After all, for Hacking the best explanation of the microscopic image is that it is veridical and that it was not produced by an evil demon (1985, 298).

I take van Fraassen's replies to Hacking to be on target. But it is worth noting that many if not most readers of the exchange—and Hacking himself—have remained unmoved. This resistance is a phenomenon that needs to be explained. This is where the theory-ladenness of microscopic observation will become important.

5 Teller on Microscopes

Perhaps Hacking's criticisms are still distal causes of van Fraassen's recent reflections on microscopes. And yet the proximate cause surely was Paul Teller's paper “Whither Constructive Empiricism?” (2001).

Teller grants—for argument's sake—van Fraassen's general point about instruments: instruments are important for producing phenomena (that we are able to observe without the help of instruments). Thus, for instance, spectroscopes produce spectrographs and an “observation of an empirical phenomenon only occurs when I look at the spectrograph” (2001, 130). Teller insists however that the model of the spectroscope/spectrograph does not work in the case of microscopes. There is no analogue of the spectrograph in the case of microscopic observation. In the case of microscopes we are *not observing an independent image*. The immediate objects of our perception in the case of microscopes are the microfeatures of the objects on the microscope slide (e.g. the tiny hairs of the paramecium). Picking up on van Fraassen's comments about sense-data, Teller remarks that to hold that we perceive the *microscopic image rather than the object on the microscope slide*

² It was criticized in considerable depth by Resnik (1994).

would be as wrong as to say that we perceive *sense-data rather than physical objects* (2001, 133).

6 van Fraassen’s Replies to Teller

This brings us finally to the position of the twenty-first-century van Fraassen (2001, 2008). His new master distinction is between thinking of instruments in general, and microscopes in particular, as either “windows on an invisible world”—as extensions of our senses—or as “engines for the creation of new phenomena”, that is, new observables (2008, 96–7). van Fraassen seeks to defend the coherence of the second view against Teller’s objections. Applied to microscopes this view entails that the latter are best understood as devices for producing “publicly inspectable” images (2001, 157). Moreover, van Fraassen submits that such publicly inspectable images are akin to rainbows in being “public hallucinations”.

Rainbows, dreams, hallucinations, after-images, reflections and objects differ in their respective number of invariances. Rainbows are close to hallucinations because two observers who do not occupy one and the same space–time point will invariably see rainbows in different locations in the sky. For van Fraassen this is the reason why we hesitate to speak of rainbows as “objects”. Rainbows have more invariances than dreams and after-images; for instances, rainbows can be photographed and they have determinate geometrical properties: their subtended angle is always forty-two degrees. This is what earns rainbows the title of “public” hallucinations (2001, 154–7). The following figure (Fig. 1) summarizes these and some further distinctions.

<i>Graven Images</i>	<i>Public Hallucinations</i>		<i>Private Images</i>
painting photo sculpture	"COPY"- QUALIFIED ----- reflection shadow ----- <i><microscope image></i>	NOT "COPY"- QUALIFIED ----- rainbow mirage fata morgana	after-image dream hallucination

Fig. 1 Images

van Fraassen distinguishes between “graven images”, “public hallucinations”, and “private images” (Figure 1, 2008, 104). Graven images are themselves physical objects; private images are “purely subjective, ... personal, not shared, not publicly accessible” (2008, 104). Public hallucinations lie between the categories of graven images and private images. Some of them are “copies” of sorts, like reflections and shadows, others are not, like hallucinations. van Fraassen puts the microscopic image in brackets on the side of “‘copy’-qualified” public hallucinations. The brackets around “microscopic image” are meant to signal the constructive empiricist stance of agnosticism.

Put differently, the reflection of a tree in water, a rainbow, and the image visible on the VDU of an electron microscope are all public hallucinations. But the reflection of the tree is a picture of something real, of something that is observable. In contrast, the rainbow is not a picture of something real. And the image visible on the VDU of the electron microscope may or may not be of something real: van Fraassen thinks that we inspect the microscopic image qua public hallucination, and that we are entitled to be agnostic about whether this image accurately reflects a microstructure.

van Fraassen’s agnosticism concerning the veridicality of microscopic observation is not a new element of his writings of this millennium. But some of his ways of motivating, or explaining, this stance are new. To understand these “ways” correctly, it is important to keep in mind that van Fraassen regards “constructive empiricism” as one of several possible “stances”: his goal is to show that his stance is not incoherent or proven false by his opponents; his goal is not to demonstrate that it is the only viable position (van Fraassen 2002).

A first, such consideration focuses on the distinction between the *empirical study* and the *postulation* of geometrical relations. In the case of the reflection of the tree in water, there are geometrical relations between three empirical phenomena: the eye of the observer, the reflection in water, and the tree. All of these geometrical relations can be studied empirically (of course only against the background of many other assumptions, including further geometrical relations). But in the case of the microscope, the same is not true—at least not true for the constructive empiricist. For the latter the geometrical relations are not all open to empirical study: we cannot empirically investigate the geometrical relations between the eye and the microscopic image on the one side, and the postulated unobservable entity on the other side. For the constructive empiricist this is the difference that makes all the difference: since we are unable to study the geometrical relations between empirical and postulated entities, we are entitled to suspend belief in the latter (2001, 160).

The scientific realist might object here that van Fraassen is assuming the very point he is trying to prove against the realist: to wit, that the object on the slide is not directly observable, and that there is a relevant epistemic difference between the case of the reflection and the case of the microscopic entity. The answer to this is, to repeat, that van Fraassen is not trying to refute the scientific realist. All he is seeking to establish is that the constructive empiricist stance is not incoherent.

A second new idea for motivating the coherence of the agnostic stance is based on the idea that the engine-of-creation view is actually *shared* by constructive empiricist and scientific realist. Hacking, for example, emphasises the importance of “effects” in science (Hacking 1983, 224). van Fraassen suggests that we do not need to go beyond this common baseline. We might think of the microscope image as a copy of a real thing, invisible to unaided perception, but “... it is accurate and in fact more illuminating to keep neutrality in this respect...” (2001, 155; 2008, 109). It is more illuminating since it allows us to identify realist commitments are optional. Such neutrality does not prevent us from

gathering information with microscopes. And it does not prevent us from focusing on the *regularities in the phenomena* that Hacking too rightly stresses.

van Fraassen offers a reply to Teller in light of these considerations. Teller is right about the phenomenology: when our eyes are glued to the microscope, we “do not have the experience of seeing an image” (2001, 157). But phenomenology on its own does not compel us to accept that we observe microstructures of objects on the microscope slide. First of all, Teller’s “eyes-are-glued” scenario has no special privilege. If we scan the microscope’s output and project it onto the wall, our phenomenology changes. And with this change goes our inclination to claim that we observe the object itself rather than its image. The same is true, of course, when we replace a tree in front of our eyes with its projection. van Fraassen is not insisting on a difference between the case of the tree and the case of the paramecium. His point is rather that our epistemic attitude is altered even by fairly slight changes in phenomenology. And this reminder might weaken the confidence we place upon epistemic considerations based upon phenomenology—at least in the scenario envisaged by Teller. Second, Teller’s experience, like any experience, has two sides: what really happens to him, and how he responds in a spontaneous judgement. Teller spontaneously judges that he sees the “real paramecium”. And yet, what weight should we give this spontaneous judgement? Should it not be checked against other data rather than stand on its own? Cannot spontaneous judgements turn out wrong? (2001, 158–9; 2008, 106).

Finally, van Fraassen holds that our talk of “seeing” rainbows or paramecia is misleading: it misleads us into thinking that we are seeing an object (in the case of rainbows) or real microstructures (in the case of microscopes). Put differently, the talk gives the false impression that we do not need to marshal arguments in defence of the belief that rainbows are objects, or that the postulated microstructures are real. No doubt, in many instances it would help to regiment our language so that such locutions are ruled out and replaced by others, for instance: “a long description of a set-up in which certain physical phenomena—such a blackenings of photographic film—will happen” (2008, 110). But van Fraassen also notes, in what one might call a “Wittgensteinian moment”, that such linguistic regimentation is not always necessary: “As long as ordinary discourse is not filtered through some theory it does not imply that those [for e.g. rainbows or paramecia] are objects” (ibid.).

7 Alspector-Kelly on Constructive Empiricism and Microscopes

I now turn to the most important criticism of van Fraassen’s recent views on microscopes: Marc Alspector-Kelly’s 2004 paper, “Seeing the Unobservable”. I shall focus on what I take to be the four main arguments: the argument from phenomenology, the argument from the symmetry of postulation, the argument against the superiority of unaided perception, and the argument from empiricism. Alspector-Kelly picks up on the central ideas of Hacking and Teller, and develops them further as objections also to van Fraassen’s recent position.

7.1 First Argument: The Argument from Phenomenology

This argument is a variant of Teller’s main point. Alspector-Kelly grants that van Fraassen is right about instruments like the cloud chamber. Cloud chambers produce observables for us to interpret. But in the case of the microscope there is no “intervening observable between eye and slide” (2004, 334). Alspector-Kelly invokes van Fraassen’s own emphasis

on invariances to drive home the point: the blood cell seen through the microscope, he insists, has the invariance of a real thing; and thus it is unlike the rainbow. It is *for this reason* that, when looking at the VDU of a microscope, we find it “phenomenologically irresistible” to judge that we are “looking at something real”. (2004, 335–6).

7.2 Second Argument: The argument from the Symmetry of Postulation

Recall van Fraassen’s contrast between the case of a reflection of a tree in water—where geometrical relations can be studied empirically—and the case of the microscope—where a good number of the geometrical relations are postulated rather than studied empirically. As we saw above, van Fraassen assumes that the constructive empiricist is entitled to assume the inaccessibility of some geometrical relations in the latter case.

Alspector-Kelly argues against van Fraassen’s agnostic consideration for the microscope case by comparing this case with the situation in which I directly look at a tree. He insists that the postulation of “appropriate relations” plays an important role even in such cases of ordinary perception. The appropriate relations obtain between the tree, my perceptual experience of the tree, and my bodily location. More precisely, the judgement “the tree is in front of me” presupposes that the light-rays are reflected according to “certain rules of geometrical optics”; and that “other cues as to location and distance do not mislead as they do in the ‘Ames Room’ illusion” (2004, 336).

Alspector-Kelly’s point is that the structure of the microscope case is just like the structure of the tree perception case. In the latter scenario we are willing to say that we see the tree itself—never mind all the various postulations and presuppositions. But then we should also be willing to analyse the microscope case in the same way: we see the paramecium or the dense bodies, not their images.

7.3 Third Argument: Against the Superiority of Unaided Perception

Alspector-Kelly accuses van Fraassen of failing to establish that perception *without* instruments is more reliable than perception *based on* instruments. The general idea that observation is measurement cannot be used to establish such superiority. It is true that unaided perception involves correlations between perceptual experiences on the one side, and properties of medium-size objects on the other side. And yet, Alspector-Kelly believes that science identifies similar correlations also in cases of instrumentally-aided perception. For instance, optics reassures us that our visual experiences while using optical microscopes put us in direct perceptual touch with microfeatures and microstructures of the objects on the microscope slide (2004, 341).

In this context, Alspector-Kelly also investigates the “epistemic considerations” that underlie our concept of seeing, and that explain why we speak of “seeing the paramecium” when looking down a microscope. “Correlation” is one central epistemic consideration here, it concerns “the reliability of the causal process that connects perceiver and perceived”. The other consideration is “fidelity”, to wit, “the extent to which features of the scene which the perceiver seems to see (hear, etc.) are to be found, and suitably located, in the perceiver’s physical environment” (2004, 344–5). Instrumentally-aided perception can score high in both dimensions.

Moreover, Alspector-Kelly discusses our use of “to see” and its cognates. He acknowledges that the paradigmatic case of vision is:

... of unobscured objects nearby and in front of our eyes, emanating or reflecting electromagnetic radiation within the visible range, whose straight-line path from object to eye proceeds through nothing more disruptive than air, and reaches a subject who is wide awake and attentive, enjoys 20/20 vision, and a mind unclouded by drugs (2004, 343).

But Alspector-Kelly immediately goes on to argue that we have plenty of perceptual-enhancement technologies that depart from this paradigmatic case. In these cases—for instance, night-vision goggles, television, the Hubble telescope, the (electron) microscope—the causal route from object to perception is different from that of paradigmatic vision. Nevertheless, the history of our decisions concerning the use of “to see” amply demonstrate that deviation from the paradigmatic case is no ground for barring the use of “to see”. The unusual causal route is often outweighed by the epistemic values of correlation and fidelity—values that an empiricist should take seriously, too (2004, 346).

Alspector-Kelly seeks to secure his third argument by rejecting what he regards as two *prima facie* possible, but unsatisfactory, constructive-empiricist responses. The first reply would be to dismiss, or be agnostic about, the scientific theories that underlie our talk of seeing in the case of microscopes or telescopes. Alspector-Kelly finds such reaction unacceptable. The dispute between constructive empiricist and scientific realist must not be carried into science itself. For determining the limits of the observable, both sides must take scientific results at face value (2004, 347)

In the same spirit Alspector-Kelly also opposes any suggestion according to which the constructive empiricist might opt for his or her own, more restricted, use of “to see”, a use that would allow us to speak of seeing only in the case of instrumentally unaided visual perception but not in the case of using microscopes. This route is not open, Alspector-Kelly thinks, since the concept of seeing that we now have is the result of our ability to perceptually track the world with high degrees of correlation and fidelity.

Finally, note that Alspector-Kelly does not allow for *any* in-principle limits to observability: “... who knows what we might not be able to so represent given suitable training...” (2004, 348)

7.4 Fourth Argument: The Argument from Empiricism³

This argument overlaps with the third, but for clarity’s sake it is still worth presenting separately. Alspector-Kelly addresses the possibility that van Fraassen might seek to defend constructive empiricism with reference to “voluntarism”, that is, to repeat, the idea that scientific realism and constructive empiricism are two “stances” neither one of which is able to refute the other, and neither one of which is irrational or incoherent (van Fraassen 2002). Might not van Fraassen insist that—although “to see” is usually used in a realist sense even when our eyes are instrumentally aided (say, by electron microscopes)—it is nevertheless coherent and hence legitimate for constructive empiricists to restrict “to see” to cases of using one’s naked eyes?

Alspector-Kelly takes this move to be incoherent. If van Fraassen opts for a defense of constructive empiricism in terms of voluntarism, then he can no longer use a general appeal to empiricism to motivate his agnosticism about unobservables. Empiricism asks us to limit our commitments to empirical phenomena.⁴ But the extension of “empirical

³ I am grateful to one of my referees for urging me to explicitly address this criticism.

⁴ Here I follow one of my referees’ reconstruction of Alspector-Kelly’s argument.

phenomenon” can be fixed in two ways: by appeal only to naked-eye observation, or by appeal to *both* naked-eye *and* aided-eye observation. Which one of the two renderings is adequate is not up to the constructive empiricist. The decision has to be left to science and is prior to the dispute between constructive empiricism and scientific realism. And science tells us that, say, “the electron microscope ... generates reliable images in a manner that, while certainly not identical to the process involved in the generation of naked-eye images, is as reliable as that process” (2004, 347).

7.5 Summa Summarum: van Fraassen Faces a Dilemma

Either he tries to motivate his constructive empiricism with a general appeal to empiricism. Or he tries to immunize constructive empiricism against realist criticism by falling back on voluntarism. In the first case, his position is undermined by science. In the second case constructive empiricism ceases to be a plausible form of empiricism. Incoherence lies at the end of both routes.

8 Defending van Fraassen Against Alspector-Kelly

In this section I shall try to show that the position of van Fraassen (2001, 2008) is able to withstand and fend off Alspector-Kelly’s criticisms. To do so is also to demonstrate the new dialectical instruments that van Fraassen’s recent work has introduced. I take up the four arguments in their original order.

8.1 First Argument: The Argument from Phenomenology

Alspector-Kelly’s first argument was meant to deepen Teller’s insistence on the phenomenology of looking through a microscope: as Alspector-Kelly puts it, the judgement that we see real dense bodies or paramecia is “phenomenologically irresistible”.

One problem here is that Alspector-Kelly fails to address van Fraassen’s replies to Teller. For instance, is not the conviction that we are seeing the microstructure of the object on the slide (rather than an image), entirely dependent on the scenario in which we have the eye glued to the microscope? And does not our conviction evaporate the moment we scan and project the image on a screen?

Moreover, Alspector-Kelly claims that Teller’s position can be further supported by noting that “the putative blood cell seen through the microscope is well-behaved, so far as we know...”, that is, better behaved than a rainbow (2004, 335) The obvious counter for a constructive empiricist here is to ask what “the putative blood cell” is supposed to refer to. Could it be the microscopic image that we see when we put drops of blood on the slide? Obviously not, for the question at issue is precisely whether the microscopic image is a picture of something real or not. Could it be the microfeatures of the object on the slide? This is of course precisely the question under dispute. According to the constructive-empiricist stance, the answer is negative. For whether this microscopic object is well-behaved or not, is, for the constructive empiricist, something that we *infer* on the basis of the microscopic image. The microscopic object is precisely not seen, according to van Fraassen. To claim *that it is* is simply to beg the question under dispute.

Or consider the phrase “so far as we know” added to the claim that the putative blood-cell is well behaved. What is it that we know here? Does not this knowledge involve theoretical claims? And how are we to relate to them? That is, what does acceptance of the

theory involve? Does it involve that we are able to see the *micro-structure* of blood? Or does it merely amount to the claim that there is a *regularity* (invariance) between various *observable phenomena* brought about by the eye-blood-microscope system? Clearly, the scientific realist and the constructive empiricist will opt for different answers here.

8.2 Second Argument: The Argument from the Symmetry of Postulation

This brings us back to Alspector-Kelly's idea according to which the direct perception of a tree involves as much or as little postulation as does the use of a microscope. There are several things to say in reply.

To begin with, note that van Fraassen is *not saying* that the case of the perception of the reflection of the tree in water involves *no postulations* at all. His claim is rather that—for the constructive empiricist—in the reflection case we have *unaided visual access to three* objects, whereas in the case of the microscope we have such access only to two objects. It follows that—still from the constructive empiricist perspective—a greater part of the set of all (geometrical) relations between the three respective objects can be studied empirically in the reflection case. It is this difference that motivates an agnosticism in the microscope case.

Alspector-Kelly assumes that the case of a direct perception of a tree involves three observables: the tree, the eye, and the visual experience. It is doubtful however whether visual experience is an observable by van Fraassen's criteria. Visual experience does not seem to reach the level of invariance of a public hallucination. After all, unlike, say rainbows, visual experience cannot be photo-graphed. Its degree of invariance is thus closer to a private than to a public hallucination.

According to Alspector-Kelly the following postulations and presuppositions are involved in judging that I perceive the tree in front of me: the presupposition that various "cues as to location and distance do not mislead as they do in the 'Ames Room' illusion", and the presupposition that the light-rays are reflected according to familiar rules of geometrical optics. True enough, there is no reliable perception without that these presuppositions are met. And yet, it is not part of our folk epistemology that one needs to be aware of these presuppositions—otherwise children and most adults would not be perceiving anything. One need not be aware of, and able to exclude, error possibilities like the Ames Room illusion in order to see medium-sized objects.

Perhaps Alspector-Kelly will agree with this, but then go on to insist that talk of postulation makes as much or as little sense in the case of microscopes as it does in the case of the perception of the tree. This does not seem obvious. At least there is a difference in degree here. It is part of our epistemic folkways that the scientist working with electron microscopes is expected to be aware of important error possibilities when trying to produce scientific data with the help of her instruments. Even a superficial glance at textbooks and manuals in electron microscopy suggests as much. Such texts very much aim to enable the scientist to rule out explicitly a wide range of defeating conditions. This is not to deny that there are plenty of people—for instance, doctors or schoolchildren—who successfully use various kinds of microscopes without understanding how they work. But the electron microscopist working at the forefront of science is generally expected to do better. If that is true then the two cases of microscopy and ordinary perception do come apart—at least to a degree.

8.3 Third Argument: Against the Superiority of Unaided Perception

Alspector-Kelly is right to note that there are various epistemic considerations underlying our use of “to see”. But I wonder whether they alone suffice to explain this use.

Recall that it is important for Alspector-Kelly that epistemic considerations play a very prominent (even if perhaps not sufficient) role in shaping our use of “to see”. After all, he hypothesises that our use of “to see” tracks correlation and fidelity. And he holds that therefore philosophers should follow scientists and non-scientists in applying the language of seeing to microscopes.

One reason to feel uneasy about this line of thought is that it downplays other factors involved in determining our applications of “to see”. One such factor, well familiar to linguists studying etymology, is analogy. There is something similar between visual perception of things in the world, and visual imagination in dreams and hallucinations. And on that basis, we—at least we speakers of Finnish or Hungarian—allow for the expressions “seeing a dream”, or “seeing a halluci-nation”. It is not open to Alspector-Kelly to dismiss the role of analogy as taking second place to the virtues of correlation and fidelity. At least it is not open to him without presenting some hard and fast data on the relative importance of the different factors.

Note also that our readiness to speak of “seeing” in the case of, say, the Hubble Space Telescope (HST) or the Scanning Tunnelling Electron Microscope (STEM) is rather unstable (cf. Pitt 2005). Upon first encountering images produced by the HST or the STEM most “naïve” subjects are indeed happy to speak of the HST allowing us to *see* very distant objects in the universe, or the STEM enabling us to *observe* nanoscale objects. And yet, the naïve subjects’ willingness to speak of seeing and observing in these cases is easily disrupted. Once the subjects learn how the images are produced, and how much computer enhancement is involved—e.g. all the colours are computer generated—they begin to withdraw terms like “seeing” and “observing”. Of course, Alspector-Kelly’s comments on correlation and fidelity might be thought to predict some of these reactions. But in the absence of more detailed experimental investigations it remains an open question what kinds of factors make “naïve” subjects withdraw talk of “seeing” when they learn more about HST or STEM: are these factors considerations focused on the loss of fidelity or correlation or are they to do with decreasing similarity with paradigmatic ordinary cases of perceiving medium-size objects? (Pitt 2005).

Telling is also Hacking’s reference to Simon Henry Gage’s *The Microscope*, the standard American textbook for a long time (17 editions between 1880 and 1941). Gage insisted (as Hacking puts it) that “we do not, after all, see through a microscope” (1983, 187), on the grounds that “... the images of minute objects are not delineated microscopically by means of the ordinary laws of refraction; they are not dioptical results, but depend entirely on the laws of diffraction.” (quoted from Hacking 1983, 187) In other words, Gage withdrew talk of seeing through a microscope not because of a lack of correlation or fidelity but on the grounds that the physical process of creating images with a microscope is unlike that of ordinary perception.

Admittedly, Alspector-Kelly is right to say that we believe electron microscopes and telescopes to be strong on *correlation*, and that we do so on the basis of scientific theories. But again, the claim can be spelled out in a scientific-realist and a constructive-empiricist way:

- (a) the correlation holds between observables and *unobservables*; and
- (b) the correlation holds between observables, for instance between the

VDU of the electron microscope and other measurements.

Once more Alspector-Kelly is begging the question as he is assuming, without further argument, that (a) is the correct answer.⁵ As constructive empiricism has it, there is nothing incoherent in the thought that we find out by inference, not observation, “how unobservable things are” (where “unobservable” means unobservable by our naked eyes).

8.4 Fourth Argument: The Argument from Empiricism

Recall van Fraassen’s dilemma, as Alspector-Kelly sees it. van Fraassen has only two *prima facie* plausible routes for motivating the constructive empiricist view. Either he refers to general empiricist constraints on going beyond the empirical phenomena. Or he opts for voluntarism and insists that restricting “to see” to uses of the naked eye is not incoherent. As we saw above, neither option strikes Alspector-Kelly as defensible. If, on the one hand, van Fraassen wishes to rely on general empiricist constraints on going beyond the realm of empirical phenomena, then he has to let science tell him how far that realm extends. And Alspector-Kelly believes that our best scientific theories force us to admit that, say, the microfeatures of objects on the microscopic slide are empirical phenomena. If, on the other hand, van Fraassen chooses to withdraw to the voluntaristic stance, then his position no longer deserves to be called “empiricism”.

I am not convinced. To begin with, consider the claim that there is no relevant epistemological distinction between using one’s naked eyes and using one’s instrumentally-aided eyes, since science tells us that the creation of images in both cases is roughly equally reliable. Assume that were true. It still would not follow that there is no distinction here for the constructive empiricist to rely on. The phenomenon of naked-eye observation calls for one (kind of) theory; the phenomenon of instrumentally-aided eye-use calls for at least two (kinds of) theories: the theory covering naked-eye observation and theories of the instrument and its interaction with our naked eyes. This is, for the constructive empiricist a relevant difference. He cannot formulate his constructive empiricist view without commitment to theories about naked-eye observation. He therefore believes what these theories tell him about the reliability of such observation. But the case of the theories about the instruments and instrumentally-aided perception is different. The constructive empiricist can develop his position and do his philosophical-explanatory work *vis-à-vis* science without committing himself to a risky realist rendering of these theories. This is not, of course, to say, that he regards these theories as problematic or doubtful. Indeed, he happily admits that theories about electron microscopes are important for predicting the images that will appear on the VDU when certain preparations are placed on the slide. But, by the constructive empiricist’s own lights, for his purposes he does not need to treat as real or observable the entities that these theories rightly or wrongly postulate between the preparation and the image. When the scientific theory describes correlations between micro-organisms on the slide and images on the VDU the constructive empiricist interprets this as shorthand for the relation between the observable preparation and a range of observable images on the VDU. And this is not incoherent.

Alspector-Kelly’s fourth argument seems to me to be based on a misunderstanding of the dialectic between the two stances of scientific realism and constructive empiricism. He

⁵ Alspector-Kelly’s fourth argument has some similarities with Paul Churchland’s argument that there could be aliens with electromicroscopes for eyes. But the former is not open to van Fraassen’s response that “observe” varies with communities. Cf. Churchland (1985)—I am grateful to Paul Dicken for suggesting the parallel, and to a referee for preventing me from taking it too far.

rightly insists that we should let science inform us about our eyes and their abilities to pick out information from the environment. He is also correct to emphasize that, in some sense, these scientific results are prior to the dispute between scientific realist and constructive empiricist. But then Alspector-Kelly takes a wrong turn. He does not recognize the importance and possibility of reading the results of science in a way that is neutral with respect to the debate between scientific realist and constructive empiricist. He does not take account of the possibility that certain formulations or interpretations of scientific theories—by scientists themselves or philosophers—simply presuppose without argument the truth of scientific realism. As Alspector-Kelly has it, any mention of this possibility should be dismissed as an illegitimate attempt to carry the philosophical dispute into science. And that response seems to me question-begging. van Fraassen is entitled to demand that the scientific evidence be rendered in a neutral way, and that this neutral way is precisely the constructive-empiricist interpretation.

9 The Theory-Ladeness of Microscope Experience

To summarize and conclude I shall relate the debate over the veridicality of microscope observation to the issue of the theory-ladeness of experience. In order to do so, it is important to distinguish between two forms that the theory-ladeness of experience can take:

- (a) the theory-ladeness of what our experience is about, that is, the theory-ladeness of the experiential *content*, and
- (b) the theory-ladeness of the experiential *attitude* or *act*.

We have a simple case of (a) when, in the case of the famous duck-rabbit picture, we see a duck because we have been told to expect this very species of a bird. We have an instance of (b) when we experience the mental act of believing of having a distinctive “feel” because we have learnt a psychological theory that posits such qualia for belief attitudes. (b)-type theory-ladeness once played an important role in debates over the reliability of self-observation or introspection in psychology (cf. Kusch 1999). It is type-(b) theory-ladeness that is relevant in the present context.

Consider once more the central disagreement between Teller and van Fraassen. Teller insists that his *experience* in looking down the microscope is not an experience of seeing an image but the experience of *seeing real micro-structures*. And the fact of the latter experience supports, according to Teller, the *philosophical theory or thesis* that microscopic observation is veridical of microstructures. van Fraassen’s reply analyses Teller’s experience and focuses on its central conceptual part, the spontaneous judgement “I see the paramecium”. van Fraassen’s point here is that the spontaneous judgement is no independent confirmation of Teller’s realist epistemology of instrumentally-aided visual experience. Rather Teller’s spontaneous judgement is *an expression* of that very realist epistemology. Teller’s spontaneous judgement seems compelling to him only because his microscopic experience is already laden with the philosophical view of microscopes-as-windows on an (otherwise) invisible world. This is not to deny that many non-philosophers in our culture will also spontaneously make judgements of the realist thought when using microscopes. But that a philosophical theory has found widespread acceptance—indeed that it has become part of our folk-understanding of microscopes—does not make it less of a theory, or less philosophical.

Hacking and Alspector-Kelly represent variants of this theme. Hacking seeks to back up the phenomenological point by drawing attention to the ways in which microscopists manipulate the objects on the slide; the ways in which microscopists triangulate the deliveries of different types of microscopes; and the ways in which microscopists move objects back and forth across the line of what is observable by unaided perception. These considerations complicate the picture but they do nothing to block the suspicion that the underlying experience of seeing the microstructure is laden with the realist theory. Only against the backdrop of this theory is it plausible to think that the microscopist observes herself as manipulating the microstructures; only against the backdrop of this theory is it plausible to suppress the worry that sameness of output is not an independent given but our doing; and only against the backdrop of this theory is it plausible to overlook the circularity involved in the argument of the grid.

Alspector-Kelly is explicit about the pull the argument from phenomenology has on him. Like Hacking he aims to underpin it with further, allegedly independent, reflections some of which try to turn the tables on van Fraassen. But here too the constructive empiricist can make a plausible case that the further arguments are toothless without the argument from phenomenology, and that the latter invokes a realist theory-laden experience. None of Alspector-Kelly's arguments is launched from a platform that would be neutral regarding the two opposed views. His insistence that "the putative blood cell seen through the microscope is well-behaved" presupposes the realism it seeks to establish; and his belief that ordinary and microscopic observation have exactly the same structure is based upon, rather than grounds, Alspector-Kelly's phenomenology. Nor does it help to invoke our folk-theory of seeing as supporting the case of the realist: even if this theory were realist it would only confirm the suspicion of the constructive empiricist, to wit, that we may be in the grip of a false or at least unconfirmed theory.^{6,7}

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⁶ Paul Dicken has suggested to me that the theory-ladenness of phenomenology also fits well with van Fraassen's voluntarism. One's epistemic stance does not only come with its own meta-philosophical standards, it also comes with its own phenomenology.

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