

Do Constructive Empiricists See Paramecia Too?*

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ABSTRACT: According to Bas van Fraassen, a postulated entity which can only be detected by means of some instrument should not be considered observable. In this paper I argue that (1) this is not correct; (2) someone can be a constructive empiricist, adhering to van Fraassen's famous anti-realist position, even admitting that many entities only detectable with a microscope are observable. The case of the paramecium, a very well-known single-celled organism, is particularly instructive in this respect. I maintain that we actually *observe* paramecia and not just *detect* them, contrary to what van Fraassen claims. As a matter of fact, even if we can only perceive these protozoans by using a microscope, we are in condition to know that the relevant counterfactual conditions (like the ones Bueno proposed in 2011) are met. Moreover, paramecia satisfy observability and existence criteria proposed by Buekens (1999) and Ghins (2005). But admitting paramecia and the like among the observables does not threaten Constructive Empiricism, for there will always be a line between observables and unobservables on which van Fraassen's anti-realism can rest.

KEYWORDS: Anti-realism, Constructive Empiricism, microscope, observability, observation, paramecium, van Fraassen.

Constructive Empiricism, the anti-realist position put forward by Bas van Fraassen in his seminal book *The Scientific Image* (1980), crucially relies on the viability of the distinction between observable and unobservable. According to him, though, "observation is perception, and perception is something possible for us, if at all, without instruments" (van Fraassen 2008: 93), as he

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has been maintaining for more than thirty years. This stand, of course, significantly limits the range of the observable, so that viruses and bacteria should not be considered as belonging to this category. But this is not correct, or so we argue. Furthermore, it is our contention that a constructive empiricist can admit that some detections are legitimate instances of observations even in cases in which they can only be performed by means of some device and that she can do so without any harm for her empiricist position, as both van Fraassen and Ian Hacking, ‘the champion of the microscopes’, acknowledge. The case of the paramecium is particularly instructive in this respect.

Paramecium is one of the best known single-celled organisms in existence (supposedly?). Its average size of about 0.25 mm, however, makes it impossible to observe this protozoan without a microscope. Anyway, it is said, our knowledge of it dates back to Antony van Leeuwenhoek’s first detections, at the end of the seventeenth century. Besides, it is extremely common to find images of this microorganism in books (especially textbooks) and journals and also, quite easily, ‘on Youtube’. Notwithstanding, it is still an object of investigation in these days of electronic microscopy.

As a matter of fact, “[its] relatively large size ... , for a microorganism, and its complex fine structure have made it the organism of choice for innumerable morphological and physiological studies” (Hausmann & Allen 2010: 143–144). There exist, indeed, special culturing and preparation techniques of the paramecia for conventional scanning (SEM) and transmission electron microscopy (TEM).

Van Fraassen nevertheless maintains that something is observable if and only if it can be perceived *without* the aid of an instrument and this is not the case of the paramecium. What, then, when a high school student in the Biology Lab looks through an optical microscope and says that she is seeing one of these protozoans? Van Fraassen’s answer is that she is actually *postulating* that there exist certain invariant geometric relations among the image, the paramecium and her eyes, but in fact she has no guarantee that this is the case:

If you say ... about the microscope’s images that they are pictures of e.g. paramecia, then you are asserting that there are certain invariant geometric relations between the object, image, and vantage point. But now you are *postulating* that these relations hold, rather than *gathering information* about whether that is so. (van Fraassen 2001: 160)

The student could not legitimately describe her experience as being an observation, in other words.

But van Fraassen’s opinion counters a widespread one, almost certainly unanimous among scientists and laboratory technicians, about optical microscopes (and paramecia). Indeed, who would say that the student is wrong

in describing her experience as being an observation of a paramecium, apart from van Fraassen (and, perhaps, Martin Kusch)? This single-celled organism has in fact been detected, with different instruments, for more than three centuries.¹ Detecting paramecia is extremely common and it is even possible to interact with them, so that there exist various preparation techniques of a sample, depending on the aim of the microscope user. If the paramecium under investigation is still alive, it is possible to follow its movements; but it would also be possible to dislocate either the paramecium or the microscope itself, in order to obtain different visual angles.

The importance of being able to identify an object from different points of view, so that it can be considered observable, was stated by Filip Buekens in 1999:

It is crucial to our conception of an observable object that it be the centre of a *perceptual polygon* – it can be perceived or observed from different angles (when the observer moves) and remain observable when it moves in space. ... It comes with our concept of an observable object that it can be observed – identified – to be *that object* from different perceptual angles. The observer must be able to place it at the centre of a perceptual polygon. The ‘able’ in ‘observable’ partly depends on whether this condition can be fulfilled. The angles of the polygon are locations in space from which the observer is able to identify the object as it moves in space, or as he moves in that space. (Buekens 1999: 26)²

According to Buekens, microscopic entities cannot be placed at the center of a perceptual polygon, as there is only one perceptual angle from which we have access to them, the one provided by the instrument. Hence, they are not observable. But, we maintain, this is not true of the paramecium (and of many other microscopic entities).

This microorganism *can* be perceived or observed from different angles, when the observer moves, and remains observable when it moves in space. *Contra* Buekens, it is therefore possible to say that the paramecium can actually be placed at the centre of a perceptual polygon. It is not true that we have

¹ Van Fraassen would not deny this, as he admits that we even detect particles (see van Fraassen 1980: 17). According to him, *to detect* is to be distinguished from *to observe*: “Microscopes, cloud chambers, laser interferometers and other scientific instruments allow us to detect entities, but *detection* has to be carefully distinguished from *observation*. A look through a microscope does not allow us to observe directly a paramecium; only to observe *an image* of a paramecium, or to *detect* a paramecium” (Contessa 2006: 456). See also van Fraassen (2008: 93).

² This passage is an excerpt from “Observing in a Space of Reasons”, an unpublished paper of 1996 (revised in 1999), that could originally be found in Buekens’s page on Tilburg University’s website. A new version of it (but with a different title), that dates 2005, was kindly sent to me by Professor Buekens in 2013. In an e-mail message of 28 October 2013, he authorized citing both 1999 and 2005 (unpublished) versions (“Observing in a Space of Reasons”, in its 1996 version, is also cited by van Fraassen in his 2002 book *The Empirical Stance*).

only one perceptual angle from which we have access to it, despite this being provided by the instrument. Paramecia, then, do satisfy Buekens's observability criterion.

And what about their existence? Remember that, as van Fraassen correctly said, "we can't see things that don't exist" (2001: 158). According to the ontological criteria proposed by Michel Ghins in 2005, however, paramecia *do* exist. They certainly satisfy the *invariance* criterion (almost identical to Buekens's one for observability):

There are no such things as naked phenomena and sense data. We perceive or observe organized objects and not raw phenomena or data. Objects enjoy, among other features, some stability in time; some of their characteristics remain the same and exhibit some permanence over long or short periods of time. Some objects can be moved in space while retaining, according to what we observe, their identity. Or we can move around them, while feeling sure that we still perceive the *same* object. (Ghins 2005: 96)³

The other criterion he talks about, the criterion of *presence*, is also satisfied by the paramecia. As with the pineapple of the example given in his article (see 2005: 96), a paramecium is phenomenally present to the subject, at least possibly. Borrowing Ghins's words, we can say that it certainly is rational to believe that paramecia exist at some place, even if there are none in front of me at this moment; but if I collect a sample of water from the artificial lake of the campus and examine it with a microscope, I will be able to see some paramecia. "Taking over some traditional terminology, it may be said that sensory experience gives content or matter to the object seen or perceived" (Ghins 2005: 96).

Sensory content alone is not enough, of course, but, according to Ghins, the invariance criterion suffices to complement the one of presence and declare that something exists, when it satisfies both requirements. Ghins would say that paramecia exist, then, as they fit the 'existence criteria' present in his article.

Now, some strenuous advocate of van Fraassen's position could counter that we are trying to attest that a detection of a paramecium performed with a microscope is actually an observation by assuming that this microorganism can really be seen, when using this device. But what we have showed is

³ This criterion is ontological, while the argument of the perceptual polygon is epistemological, but the two appear to be in perfect harmony anyway. As a matter of fact, Buekens talks about a relative displacement between the observer and the object (or state of affairs) perceived, making it feasible for the subject to *keep track* of the latter, so that she can feel sure that she still perceives the *same* object (which retains, according to the observer, its identity). Metaphysics and epistemology often go 'hand in hand' and they certainly do in this case, as Ghins suggests (see his 2005: 95).

that, in the case of the paramecium, a visual experience comes along with robust corroborations: it is possible to interfere with the protozoan under investigation, it is possible to apply the method of triangulation using other instruments (even devices whose construction and functioning are based on principles and theories different from the ones governing the construction and functioning of the optical microscope), it is possible to compare what is seen with an extraordinarily large number of reports, images (drawings and pictures) and videos made by other people, we can ask to another person to look at the same sample and report what she is seeing, we can compare what we are seeing with what is said about paramecia in a Biology textbook, we know that the common optical microscope is a reliable device ‘beyond reasonable doubt’, etc.

Moreover, but also as a result of what we have just said, it is possible to verify that the detection of paramecia by means of a microscope qualifies as a genuine veridical perception, for it satisfies (even changing the perceptual angle) the relevant counterfactual conditions, like the ones Otávio Bueno proposed in 2011:

- (i) Had the scene before our eyes been different (within our cognitive device’s sensitivity range), our perceptual experience would have been correspondingly different.
- (ii) Had the scene before our eyes been the same (within our cognitive device’s sensitivity range), our perceptual experience would have been correspondingly the same. (Bueno 2011a: 278, our translation)⁴

The situation seems perfectly akin to observing the *Manneken Pis* in Bruxelles, or any other object that van Fraassen would classify as observable.

We can then be confident that we are observing a paramecium, when we detect one by means of an optical microscope, as it is possible to know that the relevant counterfactual conditions are satisfied – and to have other (robust) corroborations, as in any other case of ordinary observation. When we triangulate, besides, we do not make use of the results of triangulation to make some kind of inference, as was erroneously suggested by Ian Hacking when he wrote about the use of microscopes (scoring an ‘own goal’ that ended up favouring a radical anti-realist position such as van Fraassen’s) (see Hacking 1983 and van Fraassen 1985); when we triangulate, we simply *observe*.

It is not triangulation alone that corroborates the idea that the action performed with a microscope is an observation, though. But van Fraassen maintains that this case is essentially similar to detecting a microparticle in a cloud chamber, as if in both cases the subject were making an inference,

⁴ See also Noë (2003: 94–97) and, for a version of these counterfactual conditionals specific for microscopes, Bueno (2011c: 256).

when this is true only of the second case. Why is that so? An answer is given by Kusch (2013: 13): “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”. This means that, according to Kusch (and van Fraassen), if one says that she is seeing a paramecium, when she detects one *via* a microscope, then this person is inferring or postulating that certain geometrical relations hold, but in fact is in no position to know that this is the case, as was said before.

But what prevents the agent from empirically investigating whether things really are the way she thinks they are? If the answer is that only by performing an unaided act of perception can we claim that we are empirically investigating (that something is the case), then the argument is obviously circular. That would mean that it is not possible to observe a paramecium by using a microscope because something that can only be detected by means of some device cannot be detected (perceived) without it. Maybe an empirical investigation can be performed even by using some device, though. Sara Vollmer seems to defend this idea: “instrument-assisted observation can give precisely the same kind of experiential information that ordinary observation gives about a scene or object” (2000: 362). Van Fraassen does not seem to agree, however: “experience can give us information only about what is both observable and actual”, he wrote in 1985 (253). An investigation is *empirical* only if it is about an actual observable, then. According to van Fraassen and Kusch we cannot empirically investigate if there exist certain invariant geometric relations among the image, the paramecium and the eyes of the observer. This means that we cannot observe the paramecium because it is not observable.⁵ Circularity again.

⁵ It is a common criticism of van Fraassen’s position that he has never elucidated what ‘to observe’ means (see Sober (2008: 130–131) and Suppe (1989: 25–30), among others). He seems to maintain that the sense in which he uses the verb is the ordinary one (see his 1992: 18), but Alspecter-Kelly correctly replies that: “The claim that we can only see what the human senses can detect without aid or supplementation of some sort is not a conceptual truth; or, if it is, it is far from obvious that it enjoys that status. Nor is the claim obvious from a review of intuitive judgments concerning what we can see” (2004: 332). Should van Fraassen propose some criteria of observation or observability in support of his claims, then, as others have done? This does not seem an option open to him, on pain of incoherence. In fact, he defends that “if anyone wants to frame opinions about just what is observable, I would urge him to draw on physiology and psychology, and empirical science in general, and not to ask philosophers at all” (1992: 20; see also 1980: 57–58). A decade later he added, in a paper with Bradley Monton: “for a philosopher to identify the contingent factors in general that constitute observability in general would run precisely counter to van Fraassen’s contention that what is observable is an empirical question. Given this view, any such philosophical enterprise must end up as either armchair science—worst in the empiricist’s catalog of philosophical sins, next to psychologism—or as metaphysics of the same ilk as modal realism” (2003: 412). The only open option, then, even for a philosopher, is to rely on science. The problem is, as

In view of all this, claiming that the conclusion that we are observing a paramecium (by looking through a microscope) nothing more is than a postulation begs the question, as if that statement were certainly false.⁶ Moreover, van Fraassen here seems to be violating the *neutrality principle* that, in such cases, has always considered adequate.⁷ It is even incoherent, then, his assertion that it is false that a detection of a paramecium, mediated by a microscope, does not represent an instance of observation.

Our opinion is that, on the contrary, this is a clear example of observation, while it is reasonable, instead, so far, to maintain a policy of neutrality in regard to the alleged observations of extrasolar planets that have been announced during the last five years. Peter Kosso comments that “van Fraassen would classify ESPs as observable, on the grounds that a human being in the right place could see them with the naked eye” (Kosso 2006: 225, footnote 1). But this cannot be right, Kosso continues, because it would allow justification to rely on unavailable information, as we are obviously not in any position to see ESPs with the naked eye (and it is not clear that we will ever be).

The fact that the paramecium is allegedly unobservable, according to van Fraassen’s ‘criteria’, while an exoplanet should be considered observable, is not of any help in these cases, because our opinion about the observability status of an entity cannot establish if our attempt to observe it will be successful or not, of course (particularly when the opinion is controversial).

Frederick Suppe explains, that scientific theories “have nothing to say about what is observable – especially in the anthropocentric ways outlined [by van Fraassen]” (1989: 28). We can confidently add that the vast majority of scientists and technicians do not share the opinion that observing is only performing an unaided act of detection – not to mention that van Fraassen admits exceptions to this ‘rule’, as in the case of the detection of the moons of Jupiter *via* a telescope, but not when it comes to detecting a paramecium by means of a common optical microscope (see 1980: 16; and for a criticism to this stand, see Hanson & Levy 1982: 291). It is then clear that, to him, the whole question is not a matter of reliability of the instruments used or of the human sensory apparatus (Delehanty suggests it might somehow be, though, but adds that this should be made clear by van Fraassen (see 2005: 33–34); Menuge (see 1995: 61) argues that it should (also) be a matter of reliability of the device used). We can, in summary, conclude that van Fraassen’s observable/unobservable crucial distinction is founded on a pure semantical postulation/definition, that however seems inappropriate. A different characterization of what ‘to observe’ means, that we believe appropriate, has been (succinctly) put forward in this paper – together with existence criteria we believe related; but van Fraassen is clearly not interested in ontological questions.

⁶ I thank Professor Otávio Bueno, of the University of Miami, for elucidating, in a recent conversation, on the matter of triangulation and on how it is van Fraassen himself who begs the question, when charging of postulation the advocates of a ‘realist interpretation’ of the use of microscopes.

⁷ In *The Scientific Image*, for example, he wrote: “I wish merely to be agnostic about the existence of the unobservable aspects of the world described by science” (1980: 72). But he appears not to be maintaining an agnostic stance, in the case of the detection of (the allegedly unobservable) paramecia by means of a microscope.

Copies of *The Scientific Image*, paramecia, extrasolar planets and flying horses are all instances of observable entities, or so we claim, as they can be observed under appropriate conditions. This has been largely attested in the first two cases, for observations of copies of the book van Fraassen wrote in 1980 and of the mentioned microscopic zoophytes happen all the time in the world; in the case of the exoplanets, on the other hand, there still exist margins of doubt about they having really been observed; in the case of flying horses, finally, the certainty that an observation of one of them has never happened made van Fraassen declare that they do not exist (see 1980: 15).

Now, there are entities (posited, of course) that he considers unobservable, like the electrons, which (it is reasonable to think) will never be observed, for various reasons, independently of future technological developments. There are limits for observability, in other words, despite we having widened them a little (or, changing perspective, having got a little closer to them), particularly in the last centuries. Bueno says that in the case of certain instruments like the scanning tunneling microscope, for example, we do not know if the relevant counterfactual conditions are actually met. He writes: “Even if it is possible that the counterfactual conditions are satisfied, it is difficult *to know* that this is, in fact, the case” (Bueno 2011a: 289, our translation).⁸ As a consequence, agnosticism is the most reasonable attitude when we deal with the results provided by this instrument.

The *internalist requirement* – that the subject must be aware, even implicitly or intuitively, of the fact that the relevant counterfactual conditions are satisfied – seems to correctly capture what actually happens in ordinary observation (aided or not).⁹ Many instances of aided detection satisfy it and rightly qualify as observations; others fail to meet it, as in Bueno’s example, and cannot be considered as instances of observation. The argument that any attempt to divide ‘theory’ and ‘observation’ would be arbitrary, because of an alleged continuity between (unaided) perception and (aided) detection of any

⁸ Bueno claims “that it is at least a necessary requirement to have a certain piece of knowledge that I should be able to support it if challenged” (Bueno 2011b: 189); therefore, as “the internalist would insist, one needs to know that the process is indeed reliable in order to be in a position to defend knowledge claims that emerge from this process against potential challenges” (Bueno 2011b: 190). See also Bueno (2011a: 281–282).

⁹ By appealing to the satisfaction of the relevant counterfactual conditions, in fact, it is also possible to avoid classifying cases of ‘veridical hallucinations’ as instances of perception, as it should be; but not to avoid classifying as such cases of ‘abnormal forms of prosthetic or artificial perception’, as, on the contrary, Alva Noë does (incorrectly) in his “Causation and Perception: The Puzzle Unravelled” (2003). Adding the internalist requirement, on the other hand, correctly blocks this possibility. The aim here is not to discuss Noë’s position in detail, though, but just to mention another argument that should favour our characterization of observation over van Fraassen’s one, that doesn’t seem to be of any help when it gets to discussing cases of ‘veridical hallucinations’ and the like.

kind and the consequent lack of a criterion allowing us to trace an objective boundary – as in the classic article by Grover Maxwell, “The ontological status of theoretical entities” (1962) – is then refuted by the requirements that an action has to meet in order to be classified as an observation.¹⁰

It seems, in sum, that observation is actually a matter of meeting the relevant counterfactual conditions (and of the agent being somehow aware that this is the case) rather than a matter of unaided perception or (worse) of aided detection of something that could, at least in principle, be perceived ‘directly’ (without the help of any device), as van Fraassen maintains (see his 1980: 16). A consequence is that the dividing line lies somewhere different from where van Fraassen thinks it does. But there is one and it is principled, as he requires it to be.¹¹

Admitting paramecia among the observables, therefore, would not represent the first step of a *slippery slope* that would annihilate Constructive Empiricism. The outcome would ‘simply’ be, instead, a displacement of the observable/unobservable line. Hacking, who notoriously contended that microscopes allow us to commit with the existence of the so-called ‘microscopic reality’, is aware of the fact that such a displacement would not affect van Fraassen’s philosophical position:

Imagine a reader initially attracted by van Fraassen, and who thought that objects seen only with light microscopes do not count as observable. The reader could change his mind, and admit such objects into the class of observable entities. This would still leave intact the main philosophical positions of van Fraassen’s anti-realism. (Hacking 1983: 208)

It is a common opinion that a line dividing observables and unobservables will always exist. Because of this, van Fraassen considers that in the (unlikely)

¹⁰ Something along the lines of Maxwell’s argument can be found in Feyerabend (1960: 18) and Mitsuo Nixon (2004), but it seems that, for them, observation is just a matter of training the observer. Alspector-Kelly has an argument similar to Maxwell’s too, but based on the idea that “what does matter, as it should – especially to the empiricist – is the epistemological value of the transaction, that is, the reliability of the causal process and fidelity of the perceptual experience that is its product” (2004: 346). What counts for van Fraassen, on the contrary, is just that the transaction be or can somehow be performed using no instruments (without modifying the observer’s physiology, though, as Muller warns (2005: 67–69 and 88)). Being so, “van Fraassen’s reluctance to extend the concept of seeing beyond naked-eye vision is (...) epistemically unfounded” (Alspector-Kelly 2004: 346). We agree with Alspector-Kelly, who goes on saying, about Maxwell’s continuity argument: “Are there any entities that lie, in principle, beyond the reach of perceptual experience? I share Maxwell’s reluctance to prejudge the issue, but we can identify the reasons why there might be” (2004: 348). Our opinion is that there are in fact entities that lie beyond the reach of perceptual experience (Alspector-Kelly is not sure about this) and that the above requirements correctly capture the reasons why it is so (provided these entities exist).

¹¹ Personal communication (Belo Horizonte, Brazil, 2007).

event of admitting paramecia and the like among the observables, this concession to the critics of his orthodox position could even represent a lost battle, but ‘in a war he believes he can win’, as has reaffirmed in his last book:

What about the observable/unobservable distinction then? The main points of our discussion are not much affected by just where precisely the line is drawn. I draw the line this side of things only appearing in optical microscope images, but won't really mind very much if you take this option only, for example, for the electron microscope. After all, optical microscopes don't reveal all that much of the cosmos, no matter how veridical or accurate their images are. *The empiricist point is not lost if the line is drawn in a somewhat different way from the way I draw it.* The point would be lost only if no such line drawing was to be considered relevant to our understanding of science. (van Fraassen 2008: 110)

The acknowledgement that some ‘aided’ detections are genuine instances of observation and, as a consequence, that entities only detectable by means of some device are in fact observable will not ‘keep van Fraassen awake at night’, then.¹² Someone can be a constructive empiricist even not agreeing with him on the matter of the so-called ‘observation instruments’. Unless she believes that electrons are observable, of course.

Not only is it our contention that a line separating what is observable by us (even with the aid of some device) from what is unobservable actually exists, however, but also that it is possible to think that technological progress is taking us closer to identifying it and not, as van Fraassen maintains, that by admitting the use of microscopes and the like we are shifting the line. There are limits to the possibility to know that the relevant counterfactual conditions are satisfied, as Bueno said, and they are independent of the state of the art of scientific technology. They depend, actually, on “our limitations, *qua* human beings”, as van Fraassen wrote (1980: 17). As a matter of fact, “what is observable ... is a function of facts about us *qua* organisms in the world” (van Fraassen 1980: 57–58). Microscopes and other devices, by letting us acquire some knowledge about the ‘microscopic reality’, do not shift any border. What they do, instead, is allowing us to ‘catch a glimpse’ of our constitutive limitations and to get to know something more about where the boundary crucial for Constructive Empiricism lies.

¹² Even if it might be said that, strictly speaking, *his* anti-realism will not survive this admission, as it would be false that we should be agnostic about the existence of paramecia and the like.

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