Empiricism

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Abstract

Two major problems have challenged empiricist views in the philosophy of science from Carnap through Quine to van Fraassen: the problem of finding a principled way of distinguishing observable and unobservable entities, and of explaining what is epistemically special about observation. In this chapter, I argue that, by articulating four key features of observation, it's possible to (i) provide a distinction between the observable and the unobservable, (ii) explain what is special about observation, while (iii) avoiding the familiar charges that previous attempts at drawing the observable/unobservable distinction have faced. This offers a novel way to approach an empiricist account of observation.

1. Introduction

Empiricism has a long, distinguished, and complex history, and as is usual with any live philosophical tradition, it is continuously recreated and re-invited as it evolves over time. Traditionally presented as a doctrine, empiricism is often formulated as the claim that experience is the only source of information about the world (for a discussion, see van Fraassen 2002). Understood in this way, empiricism seems to involve a particular belief: in the truth of the claim that characterizes this doctrine, and it becomes an issue whether acquiring that belief outstrips the boundaries of experience and thus of empiricism itself (van Fraassen 2002; Alspector-Kelly 2001 and 2004).

But empiricism also has a second, negative component: a critical reaction to, and a suspicion of, metaphysics. A number of argument empiricists have developed are skeptical arguments of various sorts. They need not be global arguments that question indiscriminately entire areas of investigation, but they are meant to question more targeted issues. In particular, they are arguments against the postulation of entities that are putatively in the world but which are not detectable by experience (substances, essences, possible worlds), and question whether one can have knowledge of the existence of such entities. Targeted skeptical arguments tend to be more effective. Wholesale skeptical arguments are generally less plausible and more easily addressable than their local counterparts.

These two features of empiricism – a positive view regarding the source of information about the world and a negative attitude toward the limits of what can be known – remain by and large constant throughout its history (for additional discussion, see van Fraassen 2002).

Not surprisingly, there are very close connections between empiricism and skepticism. Ancient Greek skeptics, in particular, Pyrrhonists, can be thought of as empiricists in the sense that they clearly embodied a critical attitude toward metaphysics and took seriously the senses as sources of information about the world. However, in the case of Pyrrhonism, these features

should not be thought of as claims or theses about (the nature of) the world: the Pyrrhonist suspends judgment about any such claims. Rather they are expression of a certain attitude toward investigation. As part of that investigation, the skeptic is sensitive to claims to the effect that so and so is the case. The skeptic then questions whether evidence can be provided in support of such claims. If situations incompatible with the claims in question are not ruled out by the evidence, it seems that, according to the standards of those who make such claims, the evidence for them is not available. Additional research is, thus, required, and the skeptic continues to investigate.

Both features are clearly present in the version of empiricism that was articulated in the twentieth century by logical positivists and logical empiricists. A clear suspicion of metaphysics and doctrines regarding experience as a source of information about the world are found throughout the development of these philosophical views. A typical example is, of course, Carnap's work. In his celebrated paper on the rejection (or, perhaps, the overcoming) of metaphysics through a logical analysis of language, a clear anti-metaphysical stance is advanced (Carnap 1932/1959). Moreover, the requirement that scientific theories be testable and that only statements with empirical content express something about the world articulates a clearly empiricist doctrine about experience (Carnap 1936/1937).

Constructive empiricism similarly exemplifies these two features of empiricism. First, we find in constructive empiricism a skeptical attitude toward metaphysics, in particular, about possible worlds and real modalities in nature (van Fraassen 1989; van Fraassen 2002). Second, constructive empiricism advances a doctrine about empirical adequacy as the aim of science; that is, science aims at the truth of the observable aspects of the world, and thus about what can be experienced (van Fraassen 1980; van Fraassen 2008). As van Fraassen notes, a theory is empirically adequate "exactly if what it says about the *observable* things and events in this world, is true – exactly if it 'saves the phenomena'" (van Fraassen 1980: 12; emphasis added).

Both the negative and the positive features of empiricism involve experience: either by rejecting (or, at least, by being agnostic about) the postulation of entities that go beyond what can be experienced, or by articulating approaches to the empirical content of scientific theories that assign a crucial role to experience, which has typically been understood in terms of what can (or cannot) be observed.

Thus, a major problem that has troubled several empiricist views in the philosophy of science is that of finding a principled way of distinguishing observable and unobservable entities. Logical positivists and logical empiricists have systematically tried to solve this problem in terms of particular theories of meaning, first by articulating verification criteria and, with their demise, by introducing weaker confirmation conditions (see, e.g., Carnap 1936/1937, and Carnap 1956). Similarly, even holist empiricists have attempted to provide an account of the distinction between the observable and the unobservable given that this distinction helps to make sense of the divide between "core beliefs" and "beliefs in the periphery" (Quine 1953). Even though, on Quine's view, the distinction between the observable and the unobservable is not sharp – nor is the distinction between "core beliefs" and "beliefs in the periphery" – in both cases there's still a distinction to be drawn. (I'll return to this point below.) Finally, for constructive empiricists, to demarcate the observable from the unobservable is crucial, given that, as noted, the divide is presupposed in the formulation of empirical adequacy – the very aim of science according to their view (see van Fraassen 1980).

Despite the importance of the problem, so far, no principled way of distinguishing the observable and the unobservable has successfully been developed. In this chapter, I will suggest one way of doing that, and indicate why this way of approaching the issue ends up providing a

better version of empiricism. In particular, one of the interesting outcomes of the proposed distinction is that it yields a very natural answer to an *additional* problem that has also challenged recent empiricist views: the problem of explaining what is (epistemologically) special about observation. Usually, most versions of empiricism in the philosophy of science take more or less for granted that observation *is* epistemologically significant, without pausing to give a reason for that. This has led critics of empiricism to complain about the apparent arbitrariness of the view, which presupposes a divide between the observable and the unobservable that has no clear epistemic import. This point has been made repeatedly in discussions of constructive empiricism (see, e.g., Hacking 1981; Musgrave 1985). The proposal here should overcome these difficulties.

In what follows, I argue that, by articulating four key features of observation, it's possible to (i) provide a distinction between the observable and the unobservable, (ii) explain what is special about observation, while (iii) avoiding the familiar charges that previous attempts at drawing the observable/unobservable distinction have faced. This offers a novel way to approach an empiricist account of observation and, ultimately, a better form of empiricism.

2. The roles of the observable/unobservable divide

Why is it important for empiricist views to distinguish observable and unobservable objects? Because, the answer goes, the distinction plays several key roles within empiricism. In Carnap's approach, the distinction is crucial to characterize the empirical content of scientific theories, which is done ultimately in terms of what can be confirmed via observational sentences. But this presupposes that observational sentences – sentences whose terms only refer to observable entities – can be clearly identified and distinguished from nonobservational ones (see Carnap 1936/1937).

On Quine's view, the distinction plays a different role. Admittedly, there's no *sharp* line between the observable and the unobservable (Quine 1953). Of course, this *doesn't* entail that there's *no* line at all between the corresponding entities. Sets and babies are paradigmatic cases of, respectively, unobservable objects and observable ones, and there is a clear divide between them and their observability status. Despite this, the observable/unobservable divide is significant, as noted, in formulating the Quinean distinction between "core beliefs" and "beliefs in the periphery". Typically, "core beliefs" deal with *unobservable* entities, and thus are particularly entrenched (given their fundamental theoretical role), and widespread throughout science's conceptual framework. "Peripheral beliefs", on the other hand, are usually concerned with entities that *can be observed*, and thus are localized, and can be more easily revised without disturbing the whole conceptual framework. Note, however, that the observable/unobservable distinction and the core/periphery divide need not map neatly into one another. As pointed out, beliefs about sets are typically part of "core beliefs", whereas beliefs about babies usually go to the periphery. But we may have, for example, certain *statistical* beliefs about babies that are part of the periphery, even though they are cast in *mathematical* terms. Despite the absence of a perfect mapping, the observable/unobservable distinction is still significant for the Quinean, given that, as just noted, it does help to make sense of the core/periphery divide.

Similarly to Quine, although much more explicitly than him, van Fraassen insists that the distinction between observable and unobservable entities is vague, given that there are definite cases of observable entities, definite cases of unobservable ones, and cases in which it's not definitely determined whether an object is observable or not (van Fraassen 1980: 16-17). Nonetheless, despite the vagueness, *there's still a distinction in kind* between these two types of

objects: unobservable objects can never be seen, even in principle, with the naked eye; observable ones can.

For van Fraassen, however, there's no need to provide an *explicit characterization* of the observable/unobservable distinction. This is something that ultimately *science* will do. In fact, each scientific theory delimits its range of observable objects through its empirical substructures. Without delimiting that range, the theory couldn't even be tested, given that reference to observable objects is needed for the testing. But, in delimiting this range, each theory is constrained by two crucial features: (a) What is observable depends on *us* (the relevant epistemic community), and so the distinction is *contextual* – different epistemic communities draw the distinction differently. (b) The observable/unobservable divide has *no ontological* significance (van Fraassen 1980: 18), since the fact that something is unobservable (observable) doesn't entail its nonexistence (existence). At best, we have *agnosticism* regarding unobservable entities: such entities may or may not exist, but due to familiar underdetermination considerations, we are unable to decide the issue. After all, the same observable features of the phenomena are compatible with the postulation of radically different unobservable objects, and typically, there's no way of empirically determining which of these postulations is true. For example, the observable aspects of quantum mechanics are compatible with the postulation of both quantum particles that do *not* have simultaneously well-determined position and momentum (following a Copenhagen interpretation) and quantum particles that *do* have well-determined position and momentum (following a Bohmian interpretation). *Empirically*, however, it is unclear how to decide which of these postulations is true (if any). (I'll return to this point below.)

Some realists will, of course, try to undermine such underdetermination arguments by invoking *methodological* criteria. For instance, suppose that theories T_1 and T_2 are empirically equivalent. One of them, say, T_1, could be entailed by a broader theory T that has *additional*, *independent confirmation*. Such confirmation could then be "transferred" to T_1, and in this way, we may have independent reasons to prefer T_1 to T_2, despite their empirical equivalence (see, e.g., Laudan and Leplin 1991: 67). (Although, Laudan himself is not a realist, as opposed to Leplin, this is a move that realists, who are typically dissatisfied with underdetermination arguments, can explore.) Alternatively, a realist could note that one of the two theories might be *simpler* than the other, and thus we may have good reason to prefer it (e.g., Musgrave 1985: 202-204).

Both responses, however, face difficulties. With regard to the *second*, simplicity is indeed a factor in theory choice. The question, however, is whether it plays an *epistemic* or simply a *pragmatic* role (see van Fraassen 1980 and 1985). Simplicity would play an epistemic role if it provided reason to believe in the truth of the theory in question. But why does the fact that a theory is simpler than a rival provide any reason to believe that it is true (or approximately so)? If it doesn't, then invoking simplicity would fail to support realism. Simplicity would play a pragmatic role, in turn, if this role only concerned us, the users of the theory, rather than the connection between the theory and the world. For instance, we may have more reason to *accept* a simpler theory than a more complex rival: it might be easier to work with the former. But this fails, of course, to provide a reason to *believe* in the simpler theory's *truth* – it concerns us, not the world. A realist could concede this point, and note that, just as the anti-realist, realists can also invoke pragmatic reasons in theory acceptance (see Musgrave 1985: 203). That's right. But if realists only had pragmatic reasons for the acceptance of theories, there wouldn't be any reason to entitle them to claim that the selected theory is true (or approximately so). As a result, according to the realist's own standards, realism would only be a superfluous metaphysical addition that fails to yield significant benefits.

Suppose, however, that by systematically attempting to construct simple theories, scientists end up formulating empirically well-confirmed theories (Musgrave 1985: 203-204). Wouldn't this indicate that simplicity is more than just a metaphysical addition, and plays genuine epistemic role in science? Well, if by trying to formulate simple theories, scientists obtain empirically adequate ones, the empiricist would be, of course, the first to applaud! But this still leaves open the issue of whether such theories are true (or approximately so). And the latter issue is the crucial one for the realist.

With regard to the *first* response above, note that, by hypothesis, *T entails* T_1 (see Laudan and Leplin 1991: 67). But, in this case, it's no longer clear that *T* could provide *additional*, *independent confirmation* for T_1. After all, since T_1 is derived from *T*, *T* doesn't provide evidential warrant for T_1: this would be question begging. In fact, as J.S. Mill has noticed a long time ago, and David Miller has spelled out in a more general setting (Miller 1994: 51-74), deductively valid arguments – just as the one from *T* to T_1 – are circular. What makes them valid is the fact that the information contained in the conclusion T_1 is already contained in the premise *T*. Thus, to claim that the premise supplies evidence for the conclusion is, in the limit, to claim that the premise supplies evidence for the information that it already provides, which is clearly question begging. But without asserting that a premise yields evidential warrant for its conclusion, the realist is *not* entitled to claim that the independent evidence that supports *T also supports* (even indirectly) T_1. Given that *T entails* T_1, to say so would be to beg the question. As a result, the argument is then blocked.

Still, for van Fraassen, the role played by the observable/unobservable divide is crucial. After all, as noted above, it's in terms of this distinction that the key notion of empirical adequacy is characterized. So, without distinguishing the observable and the unobservable, constructive empiricism – the view according to which science aims to provide empirically adequate theories – couldn't even be formulated.

The considerations so far indicate that the observable/unobservable distinction plays different roles in different empiricist views. But noting that each of these roles is *definitional* can bring all of them together. In fact, the observable/unobservable divide helps to *define* significant notions within these empiricist views: empirical content in Carnap's case, core and periphery beliefs in Quine's, and empirical adequacy in van Fraassen's.

However, in each case, the notions that are thus defined have a significant *epistemological* role. Carnap uses the notion of empirical content to distinguish scientific theories from metaphysical ones, and given that only the former have empirical content – and meaning – our commitment should be restricted to them (Carnap 1936/1937). Quine employs the core/periphery distinction to constrain his otherwise rather radical form of holism: core beliefs, although still open to revision, are much harder to let go, given that, being widespread throughout science's conceptual network, too many other beliefs depend on them (Quine 1953). Finally, van Fraassen uses the notion of empirical adequacy to constrain belief: given underdetermination arguments, there is no need to believe in the truth of a scientific theory, but believing in its empirical adequacy is enough. Hence, our beliefs can be restricted to the observable (van Fraassen 1980). In the end, in each case, the observable/unobservable divide is a mechanism of constraint: it restricts either our commitments or our beliefs.

3. Troubles with the observable/unobservable divide

There are, however, two major troubles with these proposals. First, how exactly should the observable and the unobservable be *distinguished*? Carnap and, to some extent, Quine have

developed approaches to science in which the distinction is *presupposed* without, however, properly articulating a successful, clear-cut criterion. For instance, what is it that makes observational sentences *observational*? The fact that such sentences only contain terms that refer to observable entities *presupposes* that, somehow, we have already managed to draw the distinction in question. But how is that to be done?

Van Fraassen's proposal, by contrast, tries to *undercut* the need for a *philosophical* answer to that question: the answer will be ultimately provided by *science*. But this has invited worries about an inherent *circularity* in the project. After all, as noted above, the empirical adequacy of scientific theories is characterized in terms of the observable; but what is observable is, in turn, circumscribed by scientific theories themselves (see, e.g., Giere 1985). Moreover, van Fraassen's move has also been criticized for being *incoherent*. The constructive empiricist presumably cannot believe it to be *true* that anything is *unobservable*, given that belief in the truth is restricted to the observable. But in this case, how can the observable/unobservable demarcation be correctly drawn? In fact, as Musgrave insists:

> The constructive empiricist can accept [a theory] *T* as empirically adequate, that is, believe to be true only what *T* says about the observable. But "*B* is not observable by humans" cannot, on pain of contradiction, be a statement about something observable by humans. And, in general, the consistent constructive empiricist cannot believe it to be true that *anything* is unobservable by humans. And, if this is so, the consistent constructive empiricist cannot draw a workable observable/unobservable dichotomy at all. (Musgrave 1985: 208)

The constructive empiricist has, of course, addressed these worries (see van Fraassen 1980; van Fraassen 1985: 255-256 and 303-305). But, arguably, an account of observation in which these worries don't even get off the ground would be preferable. After all, what is ultimately at stake here is the *significance* of drawing a line between the observable and the unobservable. Typically, realists find it simply *arbitrary* to try to draw that line in the first place, let alone extract any epistemological significance from the resulting demarcation. So, what is needed is an account that captures what is *epistemologically significant* about observation – that *even realists could grant*. If such an account could be articulated, it may then be possible to motivate the demarcation that empiricists are looking for without creating the sense of arbitrariness. After all, the demarcation would be formulated based on features of observation that *even realists agree are significant*. This would alleviate the realists' worries, and would help explain where the sense of arbitrariness comes from. In brief, the idea is that if notions not necessarily shared by realists (such as a brute assumption of the primacy of vision) are invoked in the attempt to demarcate the observable and the unobservable, the resulting account could never be recognized by realists as epistemologically well motivated.

This immediately leads to the second difficulty with the above empiricist accounts. Even if we grant that the observable/unobservable distinction could be drawn, how can we justify its *epistemological role* of constraining beliefs and commitments? Musgrave put the point in vivid terms:

> Can a distinction [between observable and unobservable entities] which is admitted to be rough-and-ready, species-specific, and of no ontological significance really bear such an epistemological burden? (Musgrave 1985: 205)

On his view, the answer is clearly *no*. Ian Hacking, also a realist (although of a different kind), would concur. As he points out:

> Taking van Fraassen's view to the extreme you would say that you have observed or seen something by the use of an optical instrument only if human beings with *fairly normal vision* could have *seen* that very thing with the *naked eye*. The ironist will retort: "*What's so great about 20-20 human vision*?" It is doubtless of some small interest to know the limits of the naked eye, just as it is a challenge to climb a rock face without pitons or Everest without oxygen. But if you care chiefly to get to the top you will use all the tools that are handy. *Observation, in my book of science, is not passive seeing. Observation is a skill. Any skilled artisan cares for new tools*. (Hacking 1985: 135; italics added.)

In other words, Hacking explicitly challenges the assumption, taken more or less for granted, that *there is something special about vision* – or observation, narrowly construed. However, he also raises an additional issue about the *nature* of observation. Observation cannot be mere looking, but requires the development of particular *skills*. As opposed to the constructive empiricist, Hacking conceives of observation as involving certain *instruments*. In this way, on Hacking's view, we may be able, in the end, even to *see* with a microscope (Hacking 1985:149-151). Clearly, a broader notion is in place here. Would it be possible to make sense of that notion in a minimal way, acceptable to both realists and empiricists?

These are significant challenges. And if empiricism is to be a reasonable view, it's crucial to be able to address them.

4. Levels of observation

Is there something special about observation that justifies the role it plays within empiricism? Interestingly, even the constructive empiricist hasn't provided an account of what is epistemically special about observation. The closest we get is a discussion of what can be called the *empiricist dogma*, namely, the claim that experience is the only legitimate source of information about the world (see van Fraassen 1985). Given that observation is clearly a form of experience, presumably in this way we could explain what is special about observation: it's the only proper source of information about the world. But, as van Fraassen (2002) has later pointed out, any conceptualization of empiricism in terms of the empiricist dogma is actually incoherent. And given that the discussion of experience in van Fraassen (1985) *presupposes* the empiricist dogma, with his rejection of the dogma, a different account is required.

In fact, even if we grant that empiricism should not be identified with the empiricist dogma, this is not sufficient to justify the claim that the empiricist need not provide an account of what makes observation special. After all, as noted, the constructive empiricist relies on the epistemic priority of the observable to delineate the distinction between truth and empirical adequacy. The question still remains: Why does observation have such an epistemic priority?

To answer this question, we first need to be clear about what it takes to have epistemic access to an object. According to Jody Azzouni, there are two forms of epistemic access to a given object (Azzouni 1997: 474-477; see also Azzouni 2004). We have a *thick* form of epistemic access if this access: (i) is *robust*, (ii) can be *refined*, (iii) enables us to *track* the object, and is such that (iv) certain properties of the object itself play a role in *how we come to know* other properties of the object. Let me say a few things about each of these conditions.

The *robustness* of an epistemic access process, which can be instrumentally mediated or not, indicates that the access in question operates independently of what we believe (e.g. we blink, walk away and the object is still there). We can also *refine* our access to the object (e.g. we can move in closer for a better inspection). Moreover, we can *track* spatiotemporally an object, say, an insect, and study its location for several hours. We can also "connect certain properties of the objects […] with our capacity to *know* about their properties" (Azzouni 1997: 476). For example,

we can easily explain why we can determine "how fast a flock of antelopes is moving: they are large opaque objects that do not travel very fast (even when panicked)" (Azzouni 1997: 476).

Although *none* of the four conditions above *is formulated in terms of the notion of observation*, the connection between thick epistemic access and observation should be clear enough. Observation is one way of having thick epistemic access. However, in Azzouni's view, observation is by no means the *only* way of obtaining such access. For instance, he takes that we have thick epistemic access to atoms (via appropriate microscopes), even though strictly speaking, I would say, we have never *observed* them. As I'll argue below, the empiricist has no reason to accept that we do have thick epistemic access to atoms, although he or she will certainly stress that observation is a case – the most basic case – of thick epistemic access.

In contrast with thick epistemic access, there is a *thin* form of access as well (Azzouni 1997: 479). We have *thin* epistemic access to an object if the access to this object is obtained *through a theory* that has five virtues: (i) simplicity, (ii) familiarity, (iii) scope, (iv) fecundity, and (v) success under testing. On Quine's view, these five theoretical virtues provide good epistemic reasons to adopt a theory (see Quine 1976: 247). This form of access is considerably *weaker* than that provided by thick epistemic access. Using van Fraassen's distinction between acceptance and belief (van Fraassen 1980; van Fraassen 1985), we can say that *thin* epistemic access allows us to *accept* the entities postulated by a given theory, but it may not provide reasons to *believe* that such entities exist. Only a *strong* form of *thick* epistemic access provides decisive reason to believe in the existence of the entities in question. (We can call it *ultra-thick* epistemic access!) What is this *strong* form?

Although Azzouni doesn't make this point, it is important to highlight that even *thick* epistemic access comes in degrees (in this sense, there are different *forms* of such access). The degrees range from *unaided observation* of an object (the basic form of access), through *measurements of certain properties* of this object (e.g. divergence of an electric field), to *measurement of immediate effects* of this object (e.g. a track left by a pion in a cloud chamber). Michael Dickson discusses this point in the context of a very interesting examination of realism in quantum mechanics (see Dickson 1995: 125-131). Of course, there may be some overlap between these forms of epistemic access. For example, in some cases, the measurement of an immediate effect of an object is also a measurement of certain properties of this object. Despite this, observation is still more basic – and it yields the *ultra-thick* form of epistemic access. This is because both measurement of properties of an object and measurement of the immediate effects of an object ultimately *depend on observation*. It is ultimately *through observation* that these measurements are carried out, but observation *alone* does *not* generate these types of measurements (we often need appropriate instruments to make the measurements).

5. What is so special about observation?

My claim is that the empiricist can adopt the distinction between thick and thin epistemic access – suitably understood to include the strong form of thick epistemic access (*ultra-thick*) – to explain what is epistemically special about observation. After all, observation does provide us with *thick* epistemic access to objects (given that, as noted above, it satisfies the four conditions of thick epistemic access). But observation also provides the *most basic* form of thick epistemic access (*ultra-thick* access), given that observation does not depend on any other type of measurement, but such measurements depend on observation. This, in turn, explains why we have reason to believe in the existence of observable (and observed) entities: because of the particularly strong form of access we have to them.

Note, however, that the empiricist would *deny* Azzouni's contention that we have thick epistemic access to atoms and other unobservable particles. Clearly, observation provides us with thick epistemic access to *observable* objects. But in the case of *un*observable objects, the *robustness* condition is *not* satisfied. There is no way in which we are justified in *literally* claiming that "we blink, walk away and the unobservable object is still there". For whether the unobservable object is there or not is what *needs to be established*, and it can only be established – if it can be established at all – ultimately via certain *instruments* (e.g. appropriate microscopy devices) *and* (in many cases) a *theory* that is taken to be simple, familiar, successful under testing etc. But, with regard to the *theory* that is used, such methodological criteria, providing only a *thin* form of epistemic access, give no reason to believe in the existence of the corresponding object. And with regard to the *instruments*, of course they need to be used to detect unobservable particles. But several such instruments depend heavily on the relevant theories (particularly quantum mechanics) for their construction and implementation, and as a result, they arguably only satisfy the criteria for *thin* epistemic access. Moreover, even the *interpretation* of the results will depend on theories. Thus, the *nature* of the unobservable objects that are detected will not be uniquely determined, given that different theories will yield different answers regarding the properties of the objects in question. So, we have a case of underdetermination here. Thus, the empiricist is warranted in claiming that we have, at best, *thin* epistemic access to unobservable entities – not thick – and hence agnosticism about these entities is warranted.

Furthermore, as noted above, there is an important asymmetry between the observable and the unobservable. Even when instruments of access to unobservable entities are constructed (such as, various types of microscopy devices), they ultimately *presuppose* access to something observable: the outcomes of the devices *are observable*. This means that *any* thick form of epistemic access ultimately *relies on* observation. (This doesn't mean, of course, that the results of observation are not open to revision. No foundationalism is presupposed here.) So, observation does provide a very special form of thick epistemic access. Given the asymmetry between observation and other forms of epistemic access, we are entitled to take observation as an *ultra-thick* form of epistemic access. And this explains why observation is so special for the empiricist: it constrains belief at the right point, the point in which we have good reason to believe in the existence of the objects in question, without being subject to underdetermination considerations.

Moreover, we can also use thick epistemic access as a way of distinguishing observable entities from unobservable ones. The entities to which we have a thick form of access are those that are observable. Note that, given the way in which thick epistemic access was characterized, it *doesn't* invoke the notion of observation. After all, remember that the characterization was cast in terms of four conditions. We have thick epistemic access to an object if the access: (i) is *robust* (i.e. it's independent of the object), (ii) can be *refined* (for example, via better resolution), (iii) allows us to *track the object* (e.g. by determining its position and trajectory), and (iv) uses properties of the object to get to know other projects of the object. *None* of these conditions is *characterized in terms of observation*, even though, of course, *observation satisfies them* (after all, as noted, observation *is* a form of epistemic access). Thus, as opposed to Giere's charge against van Fraassen, no circularity is involved here.

The resulting account is not incoherent either. After all, by delimiting the range of the observable, we thereby also delimit the range of the unobservable. Hence, as opposed to Musgrave's criticism, the empiricist can coherently draw the line between the observable and the unobservable. In fact, some objects fail to satisfy the above conditions. Electrons provide an example, since it is unclear that they can be tracked, or whether we can have a robust access to them. As a result, we have no reason to believe that they are observable. Moreover, we can come

to believe to be true that *something* is unobservable by humans – if we suppose that quantum mechanics is empirically adequate, given that the theory would postulate such objects, although we only have a thin form of epistemic access to them. Furthermore, instrumentally mediated thick forms of epistemic access will count as observation, since the four conditions above hold (and are known to hold). It is then possible to provide a principle divide between observable and unobservable without unduly fixing the observable at the level of the naked eye.

Furthermore, the four features of observation highlighted above are also features that the realist would grant as significant. Realists agree that observation is robust, can be refined, allows us to track certain objects, and to use certain properties of a given object to get to know other properties of that object. These are indeed minimal features of observation. Interestingly, these features also allow us to make sense of what is special about observation, in a way that even realists can accept. Hopefully, in this way, the attempt to draw the distinction between the observable and the unobservable will no longer seem to be arbitrary. This doesn't mean, of course, that the way of drawing the distinction suggested here is uncontroversial. It's not. For instance, some realists may still insist that we have thick epistemic access to atoms, which empiricists will question. But, at least, the observable/unobservable distinction, as drawn here, will no longer seem arbitrary, given that *significant* features of observation – recognized as such even by realists – are being captured.

Finally, note that the notion of thick epistemic access is formulated in terms of an activity (as something we do rather than something we just undergo). In particular, on this account, observation (ultra-thick epistemic access) involves a number of things *we do* to objects: we try to *track* these objects, we *interact* with them, we *refine* our mechanisms of access to them, we *use* properties of these objects to get to know other properties of these objects. Observation, as opposed to Hacking's charge against constructive empiricism, is certainly *not* a passive, detached enterprise. It's indeed a *skill*. And, as such, it can be improved, refined, made more sophisticated, and revised. With a notion of observation tied to thick epistemic access, the empiricist no longer has a passive concept lurking in the background.

Now, *instruments*, such as various kinds of microscopes, might be used in processes that are *described* by scientists as being observational. Physicists, for example, say things like: "With scanning tunneling microscopes (STM), we are finally able to *see* atoms!" This may initially seem bizarre. An STM, by systematically scanning, with its tip, a specimen, provides at best *topographical* information about it (see Chen 1993). The topographical information is then *converted*, through computer software, into visual information, by using a variety of now hidden coding conventions. However, with *different coding conventions*, the resulting images of atoms would *look very different*. Once again, in contrast to observation, we seem to have underdetermination. Thus, it is unclear that *seeing* applies in this case (see, also, Bueno 2011).

Now, Hacking admits that the notion of observation used by scientists in contexts like this is rather broad: "This is doubtless a liberal extension of the notion of seeing" (Hacking 1985: 151). But what motivates scientists to engage in such a use? Well, given that many features of observation seem to be found in thick epistemic access, the extension, although liberal, isn't unnatural (see Azzouni 1997). That would indeed be so if we had thick epistemic access to the corresponding objects (including atoms) in the first place! It's not clear, however, as noted above, that the robustness condition, for example, is actually met. But, still, due to the close connection between observation and thick epistemic access, we can make sense of this way of speaking, and why in fact we have here not literal seeing, but "a liberal extension" of the notion.

This is an additional illustration of the significant asymmetry in the use of instruments in science: instruments ultimate require observation, but not vice versa. This is, the empiricist would say, as it should be.

6. Conclusion

As argued above, by articulating further the notion of thick epistemic access, it's possible to (i) offer a distinction between observable and unobservable entities, (ii) account for what is special about observation, and (iii) resist the familiar difficulties that earlier attempts at drawing the distinction have encountered. In the end, this provides a novel way to approach an empiricist account of observation and a better form of empiricism as well.

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Further reading

A collection of essays that offers careful studies of the cultural and philosophical context of logical empiricism as well as of the roles of experience and empirical knowledge within this program is R. Giere and A. Richardson (eds.), *Origins of Logical Empiricism* (Minneapolis: University of Minnesota Press, 1996). In *Carnap's Construction of the World* (Cambridge: Cambridge University Press, 1998), A. Richardson examines the role of Carnap's *Aufbau* in the development of logical empiricism. Some of the challenges that Quine raised to Carnap are examined in R. Creath, "Quine's Challenge to Carnap", in M. Friedman and R. Creath (eds.), *The Cambridge Companion to Carnap* (Cambridge: Cambridge University Press, 2007, 316-335). Brad Monton (ed.), *Images of Empiricism: Essays on Science and Stances, with a Reply from Bas C. van Fraassen* (Oxford: Oxford University Press, 2007) collects excellent essays on constructive empiricism focusing on both *The Scientific Image* (van Fraassen 1980) and *The Empirical Stance* (van Fraassen 2002). A monograph that articulates a critical assessment of constructive empiricism is P. Dicken, *Constructive Empiricism: Epistemology and the Philosophy of Science* (Hampshire: Palgrave Macmillan, 2010). In a series of insightful papers, F. Muller thoughtfully engaged with a variety of issues raised by observability within constructive empiricism; see, in particular, "Can Constructive Empiricism Adopt the Concept of Observability?", *Philosophy of Science* 71 (2004): 637-654; "The Deep Black Sea: Observability and Modality Afloat", *British Journal for the Philosophy of Science* 56 (2005): 61-99, and "How to Talk about Unobservables" (co-authored with B. van Fraassen), *Analysis* 68 (2008): 197-205.