Against Empiricism

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Abstract

I examine the motivations for being an empiricist in the philosophy of science and find them wanting. Either the motivations are inherently weak. Or they fail to provide a rationale for the practices of science.

1 Introduction

What is empiricism? The term 'empiricism' covers a multitude of sins, including both conceptual views (regarding the origin of our concepts) and epistemological views (regarding the source of our knowledge). This paper concerns only epistemological empiricism. Here I take to be epistemologically empiricist any view in epistemology or epistemological philosophy of science that gives a central role to perception or related states such as sense-experience, sensation, or sense-data. One can use 'empiricism' in a broader sense, to denote the idea that all significant scientific knowledge depends on some kind of interaction with the world (not necessarily perceptual), denying, for example, that there is important synthetic apriori scientific knowledge. This paper does not take issue with that broader empiricism.

The narrower empiricism that is the focus of this paper is described by Zhai (1990: 15) as follows:

> Traditionally, the proponents of empiricism sought for the starting point of knowledge in sensations that happen to us when we open our sense organs to the world.

Thus Quine (1951) articulates one empiricist view of science by writing that:

> As an empiricist I continue to think of the conceptual scheme of science as a tool, ultimately, for predicting future experience in the light of past experience.

Evidence and observation are central to the epistemology of science, and so definitions and conceptions of these betray empiricist commitments or assumptions. As Bogen and Woodward (1988: 303) assert,

> According to a widely shared view of science, scientific theories predict and explain facts about 'observables': objects and properties which can be perceived by the senses, sometimes augmented by instruments.

Hence the following are empiricist views:

> The proposition *p* is among S's evidence if and only if S knows *p* directly by experience (Maher 1996: 158)

> Observation is an act of gathering information by human sensation without optional interpretations (Chang 2005: 880)

> There are things that one can, under favourable circumstances, perceive with one's unaided senses. Let us call them "observables" (Chakravartty 2007: 3–4)

> For a philosopher, a property is observable if it can be 'directly perceived by the senses'. Hence, such properties as 'blue', 'hard' and 'colder than' are paradigmatic examples of observable properties in the philosopher's understanding of observability (Andreas 2021).

Although some of these claims might be held to be stipulative definitions of 'evidence' or 'observation', they amount to empiricism in this paper's sense when combined with widely accepted claims about the centrality of evidence or of observation to justification or knowledge, especially in the sciences.

Van Fraassen (1980) famously also defines what is observable in terms of what is perceptible. Some realists object that the modal aspect of 'observ*ability*' is inconsistent with his constructive empiricism (Ladyman 2000). Others want to extend the observable to those things that can perceived when our senses are augmented by appropriate instruments, such as the optical microscope. But few realists object to the very idea of tying observation to perception. On the contrary, realists by and large accept the restriction of the observational evidence of science to the perceptual, even if their notion of 'perception' is sometimes more liberal. The locus of their debate with van Fraassen and other anti-realists concerns whether one may justifiably make inferences to conclusions concerning the unobservable (the imperceptible) from such evidence. I shall use terms such as 'observable$_P$' and 'observation$_P$' to reflect the fact that empiricist philosophers of science tend to use the term 'observable', like Chang, Chakravartty, and van Fraassen, to mean something close to 'perceptible'. This conception of observation is so common among philosophers of science that it scarcely receives attention. But it is important to note that this is a distinctively *philosophical* usage. Scientists do not use the term 'observe' to mean something akin to 'perceive'. Particle physicists, for example, report their work using paper titles such as 'Observation of a new boson at a mass of 125 GeV with

the CMS experiment at the LHC' (reporting the discovery of the Higgs boson) or 'The evidence for the observation of $0\nu\beta\beta$ decay', and so on, while astronomers engage in 'The observation of magnetic fields in nondegenerate stars' and molecular biologists author papers reporting 'Direct observation of individual RecA filaments assembling on single DNA molecules'. I shall use terms such as 'observation$_S$' to denote the scientific use of 'observation' etc. The difference between 'observation$_P$' and 'observation$_S$' is important. That philosophers use a concept of observation that is linked to perception whereas scientists do not is significant since it suggests that empiricism is baked into the very terminology that the philosophers employ and thus in many cases may amount to an unquestioned or even unacknowledged assumption.

In this paper I examine the motivations for empiricism and consider whether they support an understanding of science as a rational activity. Some of the motivations are inherently unworkable. Others have consequences that some might be willing to accept. But these, I argue, are such that they make the practice of science unexplainable as a rational activity. For example, if one's view is committed to thoroughgoing scepticism about the future, then the practice of trying to predict the future (as arguably science sometimes does) would be irrational on this view. Note that I do not (for this purpose) assume that the rationality of science as identical to a commitment to realism.

(Terminological clarification: The term 'experience' is used in a range of ways, not all of which are relevant to empiricism. In what follows when I use the word 'experience' I shall intend that as an abbreviation for 'sense-experience', i.e. as referring to the kind of sensory or perceptual state that is relevant to empiricism as defined above. I will take this, as is common among empiricists, to include *reflection*, inner sense-experience of the states and workings of the subject's own mind.)

2 Motivations for empiricism

In this section I list what I take to be the principal motivations for empiricism, while giving some historical context to support the claim that there exists such a motivation. While I have distinguished these motivations, the views of the actual empiricists concerned do not always do so—the motivations are overlapping.

Sense-experience as providing certainty

In the context of the post-Cartesian search for secure foundations for knowledge, a key function for sense-experience is the provision of certain foundations. That function is clear in the views of, for example, Berkeley and Schlick. It is also present, I claim, in Mill's empiricism.

In common with other early modern empiricists, and indeed non-empiricists, Berkeley held that the immediate objects of experience are the subject's own ideas. For Berke-

ley (1710) that fact provides certainty, since the very 'existence of an idea consists in being perceived'—'their being is to be perceived or known'. For Berkeley, this certainty is crucial. His concern with Locke's (1690) version of empiricism is that if ideas represent external objects, then there arises a sceptical veil-of-perception problem. So if we reject Locke's materialism and adopt idealism instead, then we can avoid scepticism: knowledge of things just is knowledge of ideas and thus is certain (Berkeley 1713): 'That what I see, hear, and feel doth exist, that is to say, is perceived by me, I no more doubt than I do of my own being.' 'We are not for having any man turn sceptic and disbelieve his senses; on the contrary, we give them all the stress and assurance imaginable.'

One does not have to commit to Berkeley's metaphysics in order to share his conviction regarding the certainty of sense-experience, when that experience is taken to be experience of the subject's own states. Moritz Schlick (1934) and C. I. Lewis (1929; 1946) are prominent cases. Schlick, for example, in 'The Foundation of Knowledge' (1959) makes it clear that to aim at a providing a theory of knowledge is to search for absolutely certain foundations. This absolute certainty is to be found in *Konstatierungen* 'affirmations' of one's current inner experiences, and that these supply the contents of 'protocol' or 'basic' statements.

So our first motivation for empiricism is this:

> Certainty Reports of our own sense-experiences are epistemically fundamental because they are certain. They provide the secure foundations of science.

Sense-experience as epistemically privileged

The (alleged) certainty that knowledge of our own sensory states possesses brings with it a countervailing disadvantage. Assuming we do not adopt Berkeley's metaphysics, it can be plausibly argued that we are condemned to the scepticism that he finds and warns us of in Locke's epistemology. Knowledge of sensations (or appearances or sense data) may be certain. But any inference from them to the way things are in the 'external world' is very uncertain at best. For those who regard that challenge as insurmountable, a natural response is to take as epistemically basic our perceptual beliefs about the external world. Now it is easier to see how we might justify our scientific beliefs. On the other hand these beliefs cannot themselves be certain. Illusions and perceptual error are common. Such beliefs are corrigible. So the epistemology cannot be the simple foundationalism that was available when we took the basic beliefs to be certain.

It is this issue that was at the heart of the protocol sentence controversy of the Vienna Circle. As we have seen, Schlick favoured what Hempel (1935, 1952) described as the 'phenomenalist' conception of protocol/basic statements. Whereas Neurath (1932) proposed a 'physicalist' conception of protocol statements as perceptual reports of the observer's environment. Because such statements are corrigible, Schlick's foundational-

ism must be rejected, and so he adopts coherentism in its place. This coherentism means that sensory reports no longer have the status of certain foundations. But that does not weaken the commitment to empiricism. For it remains the case that such reports are still basic or fundamental in the sense that they have a privileged role within the system. Such statements have to be accommodated as they are or must be explained away.[1]

Quine's web of belief, while coherentist and allowing for revision of statements regarding sensory experience, is nonetheless anchored to the world via such statements: 'the ultimate evidence that our whole system of beliefs has to answer up to consists strictly of our own direct observations' (Quine and Ullian 1970). Although revisable, such statements are the anchors because they are still highly reliable: 'Observation sentences, taken narrowly, are comparatively foolproof. That is what makes them the tribunal of science'.[2]

Our second motivation for empiricism is then:

> Privilege Reports of the world as we experience it are epistemically privileged because they are the most certain worldly reports we can have. They provide the most secure epistemic foundations available while also being a epistemic foundation for science.

Sense-experience as the ultimate source of evidence

The first two motivations for empiricism stem from wanting the evidential basis for science to be as epistemically secure as possible. The next two motivations arise from seeing the source of all our evidence. Sense-experience could have this role without being especially reliable at all. Quine (1969) expresses this idea clearly: 'The stimulation of his sensory receptors is all the evidence anybody has had to go on, ultimately, in arriving at his picture of the world'. Or in the words of Hylton and Kemp (2025), 'Observation sentences are the starting point for our acquisition of knowledge, the child's entry into cognitive language. They are also the sentences which are evidentially basic'.

The word 'ultimately' is doing important work. As we saw above, the scientists' use of 'observation' suggests that they work with evidence that is not the stimulation of sensory receptors—they take as evidence observations$_S$ of bosons, magnetic fields, and single DNA molecules. However, these scientific observations$_S$ are clearly the outcome of considerable scientific thinking, both theoretical and experimental. So we can trace an epistemic route backwards, to see where these observations come from and what they

[1] In Bonjour's (1985) modern coherentism, these are 'cognitively spontaneous beliefs'.

[2] Quine's view is anticipated by A. J. Ayer (1936), 'When one speaks of hypotheses being verified in experience, it is important to bear in mind that it is never a single hypothesis that an observation confirms or discredits, but always a system of hypotheses'.

depend on. The empiricist claim is that when we do so, we come to a stop with statements of perception (sense-experience). While observation$_S$ statements are dependent on other statements for their epistemic status, observation$_P$ statements have the distinctive role of being directly related to stimulation, in virtue of which they are evidentially basic—there is nothing beyond them.

In summary:

> Basic Reports of the world as we experience it are epistemically ultimate or basic, in that when we trace back the evidential support for a scientific proposition, we find that this tracing ends with such reports.

Sense-experience as necessary for scientific knowledge

As we shall see, the details of this evidential tracing back to the ultimate source of evidence are more problematic than might appear at first sight. One response to such quibbling (as it might appear to the committed empiricist) is to present an argument for empiricism that aims to cut through all the forgoing detail, with a simple and general argument.

If one had no experience at all of the world, then one could have no scientific knowledge. Imagine a scientist who has been kidnapped and immersed in a sensory deprivation tank. While there, they might be able to expand on their scientific knowledge by making inferences from what they already know. But there would be a limit to what they could thereby achieve. Had they been so immersed in 1850, they would have insufficient resources to come to have much or any knowledge regarding the fields of quantum mechanics, molecular biology, exoplanetary astronomy, plate tectonics, and so forth. It is the lack of sensory experience that prevents them from achieving such knowledge.

> Necessary for science Without sense-experience important components of scientific knowledge would be unavailable. Sense-experience is a necessary precondition of the possibility of (some) scientific knowledge.

Constructive Empiricism

The most prominent contemporary version of empiricism is Bas van Fraassen's Constructive Empiricism (CE). It is not straightforward, however to extract a clear motivation or argument for the centrality of experience from CE. The core claim of CE is not a claim with any clear normative component. It is claim about the aim of the institution of science:

> Science aims to give us theories which are empirically adequate; and acceptance of a theory involves as belief only that it is empirically adequate. (van Fraassen 1980: 12)

Empirical adequacy is a property of theories whose observational component is true. Furthermore, to be observable, according to van Fraassen, is to be perceptible by humans without perceptual aids.

So CE is profoundly empiricist as a description of science. But that tells us little about epistemology. The core of CE consistent with the claim that there could be a similar institution, Schmience, that aims to give us theories which are true and which can give us knowledge when believed, coupled with the claim that Schmience would be an epistemologically superior institution to Science.

Nonetheless, van Fraassen does have a normative epistemology surrounding CE. He does think that science is rational: the aim attributed to science is plausible and achievable. Furthermore, he denies that Schmience would be superior to CE. His comment 'it is not an epistemological principle that one might as well hang for a sheep as for a lamb' (van Fraassen 1980: 73) is a rejection of the thought that if one is willing to accept the uncertainty involved in the inference from the actually observed to the *empirical adequacy* of a theory, one might as well accept the uncertainty involved in the inference from the actually observed to the *truth* of a theory. As Chad Mohler and Bradley Monton (2025) express it:[3]

> One might reasonably think of belief in the empirical adequacy of accepted theories as the weakest attitude one can attribute to scientists at the same time that one is still able to make sense of their scientific activity. At the same time, belief in the empirical adequacy of a theory is sufficiently cautious as to allow the believer to remain faithful to the spirit of empiricism. Thus, constructive empiricism is a view which allows one to regard the activity of science as activity the empiricist can safely endorse.

Although this does not directly state a motivation for empiricism—it seems to assume that one is already an empiricist—it nonetheless furnishes such a motivation:

> Constructive Empiricism The pursuit of empirical adequacy is the epistemological weakest (and hence epistemologically most secure) aim that science could have while also being a plausible aim for science.

3 Can sense-experience provide certainty, and at what cost?

In this section I will argue for the following conclusion:

> Sense-experience cannot both provide certainty and a suitable foundation for science.

[3] See also Rosen (1994).

In effect, this is the question raised already by Neurath and others about whether the certainty provided by sense-experience (such as it is) comes at the cost of inviting scepticism.

Analyses of certainty focus on the following properties: indubitability, infallibility, indefeasibility, and maximal justification. Let S believe that *p*. That belief is certain when:[4]

> **Indubitability** It is not possible for S rationally to doubt whether *p*
>
> **Infallibility** It is not possible for S to be mistaken in believing that *p*.
>
> **Indefeasibility** It is not possible for S's justification for the belief that *p* to be defeated by further information; S cannot therefore be rationally required to revise such a belief.
>
> **Maximal justification** S's belief that *p* achieves some particularly high degree of justification.

There is a substantial literature on why reports of inner experience lack certainty, which I mention in the next section. Following that, I present an argument that does not depend on such a conclusion.

Inner experience and uncertainty

A subset of the arguments against the certainty of reports of inner experience focus on the possibility of such reports misapplying the concepts they use (e.g. Alston 1971; Sellars 1997). Let's say that S's belief is a belief that her current experience is an experience of blue. It is not unusual for the basis of our application of a concept to change and to err. And this is true even if we think of S's language as an idiolect with her own concepts. For example, it might be that S's concept *blue* was fixed in such a way that turquoise is excluded from its extension. Yet changes in her exposure to others' usage or to the range of colours to which she is exposed might cause her dispositions to carve up the colour wheel to change such that she now does take turquoise things to be blue. Thus it is possible for S to be mistaken in believing that this is an experience that falls under the concept *blue*—for this belief, infallibility fails. Now imagine that S is talking to a neuroscientist who persuades S that because of various neural changes she has undergone, it is highly likely that her dispositions regarding colour attribution have changed in the way described, without her being aware of this. S might well then rationally doubt whether

[4] Baron (2022). See also Alston (1971). The fourth of these Baron calls 'Inimitability'.

her experience is an experience of blue. Additionally, this information may well remove the high degree of justification that she has in her belief.

Of course, S can ensure that her current usage is in conformity with her earlier established concept by remembering the conditions of usage for that concept. For example, she may remember using a sample of turquoise as a sample: her concept of *blue* was established in part by stipulating that the turquoise object is blue. By comparing her memory of that earlier object and her current experience she can know that her current experience is an experience of blue. This much is true. But to establish certainty for S this memory needs not merely to be known, but to be known with certainty. And clearly that need not be the case. We know that memory is fallible, it can reasonably be doubted that the justification provided by memory may be defeated and may be lowered from the highest degree.

So S cannot be certain that her experience is an experience of blue, if her concept of blue is a pre-established one. Perhaps then certainty can be regained if we do not think of S's idiolect as an enduring entity. Rather, the content of S's idiolect is determined by her current dispositions. Yet one's own dispositions are not things of which one has certain knowledge. Thus we should conclude that S cannot be certain (by any criterion of certainty) that in judging that her current experience is an experience of blue, she is applying the concept of blue, even her own idiolect's concept of blue, correctly. That is to say, she cannot be certain that it is an experience of blue.

The paucity of current experience

The principal problem in this next objection draws on the fallibility of memory just mentioned. Memory is notoriously unreliable and so distinctly not certain. Hence the only experiential reports that one can regard as certain are the contents of one's *current* experience. Now reflect on the contents of your own current experience. These will primarily be the contents of your current perceptual experiences plus other mental states of which one is conscious (for example that one is having an apparent memory that such and such). The important point here is that there is really very little information here when compared to the quantity of information that our scientific world picture contains. Recall van Fraassen's Constructive Empiricism. That view takes the aim of science to be 'saving the phenomena', where the phenomena are all the perceptual reports of all scientists, including their past experiences. I will later argue that this is too weak an aim to make sense of scientific practice. But even were van Fraassen right that this is the epistemologically weakest aim science could have while consistent with scientific practice, that would be vastly more ambitious than the aim of saving my current experience alone.

Consider a case of only moderately difficult mental arithmetic, such as multiplying two three digit numbers. This process requires the active and accurate engagement of

memory, and most of us will have had the experience of making errors through a failure to remember to carry or a failure of remembering which numbers to carry. Since memory is fallible, processes that depend on it, such as mental arithmetic, cannot be certain. So even basic apriori knowledge is not certain.

The information available to the senses can be increased when that information is symbolically encoded, e.g. in written language or mathematical notation. When the multiplication is written out, one may be able to see directly that it is correct without using any memory. Nonetheless, there is a limit to how much symbolically presented information can fill one's visual field. And even then, it is not possible for a human to process such information without using working memory. (It is a mistake to think that because all of our visual field seems unified and of consistent clarity that in fact we have detailed access to all of it simultaneously—this is known as the 'grand illusion of vision' (O'Regan and Noë 2001; Dennett 1991).) The grand illusion is brought about by saccades (rapid eye movements) and interpolation of information. As we read lines of text, working memory is essential to being able to connect the contents of what we are reading—individuals with seriously impaired working memory have trouble in understanding long sentences.

If we exclude what memory gives us, since it cannot deliver certainty, then at most what we can be certain of is the content of one's current experience. What one knows with certainty—if we grant the certainty of reports of experience—is merely what one learns immediately when, one's eyes having been closed and other senses blocked, those senses are suddenly opened to experience. This content is very limited, even if it includes symbolically encoded information. That limited content is too limited for us to be able to make sense of science as being founded on this basis.

This problem is a different one from that raised by Berkeley for the realist Locke, that there is no good inference from reports of inner experience to anything concerning the external world. Here the problem concerns not the inference but the paucity of the evidence from which that inference is to proceed.

4 Is sense-experience epistemically privileged?

We now turn to a more plausible view of the evidential basis for science, that it includes perceptual reports of external states of affairs, memory reports and other reports of one's own mental states. It is acknowledged that these do not provide absolute certainty. Rather their epistemically privileged status comes from their *relative* certainty: such reports, while dubitable, fallible, defeasible, and revisable, are less dubitable, fallible, defeasible, and revisable than reports stemming from other sources. The confirmatory inferences from evidence to theory in science are typically ampliative, i.e. they 'go beyond' (are not logically entailed by) the evidence. And so the basis of science in reports of sense experience is more certain than the claims ampliatively inferred from them.

In general, however, it is not the case that the conclusions of ampliative inferences are less certain than the propositions used as evidence. The Condorcet Jury Theorem tells us that the majority view of a group is more likely to be correct than the view of any individual member, when all individuals have a high degree of reliability (List and Goodin 2001). And this holds true when the individual views are all perceptual reports and the 'majority view' is an inference from these reports. For example, three balls are put into an opaque bag. It is known that any ball is either yellow or orange. The following process takes place under poor lighting conditions, such that while it is possible to distinguish yellow balls from orange balls, it is also possible to make an error and take an orange ball to be yellow. A thousand individuals are each asked independently to take a ball out of the bag at random, look at it very briefly, and then replace it. They then report the colour of the ball, in ignorance of the reports of the other withdrawals. Our data for the first 999 withdrawals are the reports of the subjects of the form 'Withdrawal number *n* is of a yellow/orange ball'. As it happens, 997 reports are of a yellow ball and two are of an orange ball. Now consider the hypothesis 'Withdrawal number 1000 will be of a yellow ball'. Our hypothesis is ampliative given this data—it is not entailed by the data. Nonetheless, we should be much more confident in the truth of this proposition than we are in any of the data propositions.

More generally, if less rigorously, speaking for myself, I have no less confidence in many claims of science than I do in propositions I believe on the basis of sense-experience. I am pretty confident that the colour of this book cover is blue. But I am even more confident that water is a compound of hydrogen and oxygen or that humans and chimpanzees have a common ancestor. For the former to be wrong, I would have to have made a single misjudgment of colour, which is not so very uncommon, even in good lighting conditions. Whereas for the scientific claims to be wrong, many thousands of individuals would have had to have made errors.

Reports of sense experience are not *per se* especially reliable. Error and illusion can make some such reports very unreliable indeed. Careless and inattentive reports, visual reports made in bad lighting conditions, reports affected by prior expectations or desires, and so on. Focusing on reports from very careful observers, operating under optimal conditions—e.g. an exemplary scientist in her laboratory—does not change matters. Consider thermoception, our ability to detect heat and cold. As we all know, human thermoception is very imprecise and is very susceptible to interference from bodily condition, prior exposure, expectation, and other effects. Reports of thermoception thus have a low degree of certainty, even when couched in imprecise terms. Consider next a very high quality resistance thermometer—this will provide a much higher degree of certainty than thermoception. Vision is a more reliable source of information than thermoception. But since vision can err, it is possible to find alternatives that do better (AI analyses of images, for example).

The very general argument against the epistemic privilege of sense-experience is this. Once we consider the senses as evolved instruments for providing information to a subject about her environment, then we can see that like any instrument they can function well or poorly and that in principle (and in this case, in practice) alternatives can be even more reliable. There is nothing special about perception as regards its reliability or thus the degree of certainty that should be attached to perceptual reports.

5 Is sense-experience evidentially basic?

Perhaps the most common current rationale for taking sense-experience to be basic is the idea that if we trace our reasoning in science back through the theoretical inferences we make, the evidential chains must end somewhere. That somewhere is sense-experience. So, even if reports of sense-perception are not certain nor even more certain than other reports, they are nonetheless evidentially basic.

Furthermore, this may be taken to support the stronger claim that sense-experience is the *only* source of justification. Other reports are evidence only insofar as they stand in for the evidence of sense-experience. *Real* evidence is gained solely from sense-experience. Patrick Maher's (1996: 158) account of evidence is just this:

> E is evidence iff E is known directly by experience.

Elsewhere I have argued against this and related views that take evidence to be non-inferential (Bird 2004). Note first that this is *not* how scientists and others use the term 'evidence'. An astrophysicist will tell you that the cosmic microwave background radiation (CMBR) is the most significant piece of evidence supporting the Big Bang theory. But there is no possibility of directly experiencing CMBR. So such views as Maher's have to say that the proposition asserting the existence of CMBR is not really evidence but is just *proxy*-evidence, used in place of the totality of experiential evidence behind the discovery of the CMBR.

One simple reason why this is wrong is that it entails that no inferred proposition p can be proxy-evidence for a subject who has forgotten the experiences from which p was inferred (Bird 2022: 117–18, 124–5). But this is a common phenomenon. I know that the melting point of lead is 327.5 °C. But I cannot remember how I came to know this, whether by being taught this in class, having read it, or by seeing a set of measurements made on melting lead. When experience provides us with useful knowledge of the world, the latter often being after a simple inference, our long-term memory retains the useful information gained but does not retain details of the experience behind it. We might then use the inferred information as evidence—in the case of lead's low melting point, as evidence for relativistic contraction and the inert-pair effect. In this case, I would be using as evidence a proposition that is not directly known by experience. So it would

have to be proxy-evidence, standing in for more basic evidence that is directly known by experience.[5] But I don't have any such evidence—my memory discarded that long ago.[6]

So the claim that inferred 'evidence' is not really evidence, being at best a proxy for evidence that is directly gained from experience, does not stand up.

The claim just considered, that all evidence is (directly) experiential, goes beyond that with which we started, namely that all justification finds its way back to a source that is experiential. The latter is consistent with something the stronger view denies, that once justification is passed on to an inferred proposition, then the latter has genuine justification not merely proxy justification, in a way that is not dependent on the retention as evidence of the premise proposition. On this view, one could forget all one's experience and the propositions directly known through experience, yet retain justified belief in the inferred propositions. Nonetheless, it is still the case that the justification that the inferred propositions have is dependent on the uninferred, experiential propositions having had the justification they did have at the time the inferences being made from them.

This weaker claim is nonetheless also false. The important idea at the centre of the claim has two components. First, that there is a distinction between inferred and uninferred beliefs. And, secondly, that the uninferred beliefs include only the beliefs produced by sense-experience. Both components should be rejected.

Mill's (1843) view of scientific evidence articulates the target idea nicely:

> Our business with observation is only in its connection with the appropriate problem of logic, the estimation of evidence. We have to consider, not how or what to observe, but under what conditions observation is to be relied on; what is needful, in order that the fact, supposed to be observed, may safely be received as true.
>
> The answer to this question is very simple, at least in its first aspect. The sole condition is, that what is supposed to have been observed shall really have been observed; that it be an observation, not an inference. For in almost every act of our perceiving faculties, observation and inference are intimately blended. What we are said to observe is usually a compound result, of which one-tenth may be observation, and the remaining nine-tenths inference.

[5] Note that even if I did see the experiment, I do not come to know the melting point of lead by direct experience. Quite apart from the theory-ladenness of the measurement methods, a scientific measurement of temperature is not a one-off reading of a thermometer, but is inferred statistically from multiple readings (Bogen and Woodward 1988).

[6] In Bird (2004) I discuss other examples, not involving memory, where earlier evidence is discarded but later, inferred evidence, is retained and correctly used as evidence.

Mill goes on to explain that, strictly, observation is only of our sensations:

> Observation extends only to the sensations by which we recognize objects; but the propositions which we make use of, either in science or in common life, relate mostly to the objects themselves.

And consequently, he says, there are no perceptual errors:[7]

> Innumerable instances might be given, and analyzed in the same manner, of what are vulgarly called errors of sense. There are none of them properly errors of sense; they are erroneous inferences from sense
> ...
> The logic of observation, then, consists solely in a correct discrimination between that, in a result of observation, which has really been perceived, and that which is an inference from the perception.'

Regarding the first component of the target idea, there is not a clear distinction between beliefs that are the result of inference and those that are not. Let S learn 'all and only red tomatoes are ripe'. Initially, when S sees a red tomato, she makes the inference to its being ripe. But after repeatedly seeing red tomatoes and making this inference (she is employed as a tomato picker), she begins immediately to see the red tomatoes as ripe, making no inference. Perhaps she is making an unconscious inference. But this is an empirical claim and not an especially compelling one either, given what we know about neural networks. Let's focus instead on the easier case for the empiricist, S's judgment that this tomato is red. S's experience of the world, like ours, is that in some lighting conditions objects can look red that are not red. In such conditions she desists from asserting that a tomato that appears red is red. So when S does assert that the tomato is red, is she making the unconscious inference in this case from her observation that lighting conditions are normal and that the tomato appears red, to the conclusion that the tomato is red?

I do not take the lack of a clear distinction between inferred and uninferred beliefs to be, *per se*, a problem for the motivation for empiricism discussed in the preceding section, that uninferred, experiential beliefs are more certain than inferred, theoretical beliefs. For the latter can easily be modified into the view that the more experiential and less dependent on inference a belief is, the more certain it is. However, it is a problem for the current view, since it is a view about where justification enters the system of one's beliefs. That idea is comprehensible when one can say '*these* are the uninferred beliefs. It is from these (or some subset of these) that justification comes that is received by the

[7] Consequently, Mill can also be regarded as supporting the certainty motivation for empiricism.

beliefs inferred from them'. Without a clear distinction, I find it difficult to understand what the proposal is saying.

An objection to the second component of this view argues that in order to permit science to be rational, more beliefs than just experiential beliefs must be sources of evidence and justification. In my book *Knowing Science* (2022) I argue that scientists' dependence on *testimony* and on *instruments* cannot be accounted for in empiricist terms. Let us take testimony. The empiricist view of testimony says that testimony provides justification for a testimonial belief only when the subject has evidence that the testifier is a reliable source. This view is widely regarded as unworkable. In particular, the widespread dependence on testimony in science and on our trusting (rather than verifying) the reliability of our sources in science, shows that we cannot trace the justification we have for those scientific beliefs that are dependent (in part) on testimony back to experience. So either science is irrational in its dependence on testimony. Or testimony can supply a subject with evidence and with justification that do not derive solely from sense-experience. Likewise, a scientist will often use an instrument to generate data and evidence while not being able to give any account of that instrument's reliability. So either the scientist is being irrational. Or, once again, the beliefs she has as a result of using the instrument are not justified solely on the basis of sense-experience.

6 Is sense-experience necessary for science?

The final, very general argument for empiricism, is simply that without sense-experience we could know at most very little about the world. The individual kept in a sensory deprivation tank could not expand their scientific knowledge by much—they could not acquire the knowledge that scientists do acquire by experiment and observation.

While this is currently true, it is only a contingent truth, and may even not be true in the future. Above I noted that when learning important facts we forget the experience by which we learned them and retain in long-term, semantic memory only the propositional content of the fact. So when asked, 'What is the melting point of lead?' I can answer '327.5 °C' although I have no recollection of how I learned this. The remembered fact itself is somehow encoded in the hippocampus. Now imagine that neuroscientists learn how to encode information in the hippocampus directly (or, alternatively, they learn how to attach an electronic chip that extends the hippocampus and which can be appropriately encoded with uploaded information). Thanks to such a process, when someone asks me, 'What is the boiling point of caesium?' I can answer '671 °C' even though there was no experience through which I learned this. Let's assume that the encoding process takes place when I am under sedation or am asleep. So I may have no means of distinguishing which of my semantic memories were acquired by the laborious

business of reading textbooks and which were acquired via this neural intervention. So I can increase my scientific knowledge without any new sense-experiences.[8]

We should, furthermore, consider the increasingly automated and computerised nature of science (I give a real example below). Experiments can be carried out by machines and their results can also be encoded/uploaded to my hippocampus while I sleep, permitting me to reflect scientifically on their results when I am awake. We can extend the science fiction to allow me to instruct the automated scientific machinery to carry out experiments and to upload their results to my brain. Thus I could be a complete scientist, extending my scientific knowledge through experiment, all while remaining in the sensory deprivation tank, having no new sense-experiences.

While this is science fiction, it is not a fiction that is inconsistent with what we know. Sense-experience is not necessary for knowing or doing science. We are well on the way to AI controlled and managed science (King et al. 2009). AI can already generate hypotheses, devise tests of those hypotheses, and analyse the results.[9] Currently humans have to define the research field and direct AI towards the interesting questions. Nonetheless, the generation of new scientific knowledge, from conceiving the hypothesis, through experiment, to production of publishable paper has all been achieved. In so doing, the AI has no sense-experience. Science without sensation is already here.

It remains true, of course, that the AI must interact causally with the world. But this does not mean that the AI thus has senses, let alone sensory experience. Let's say AI devises a hypothesis and implements an experiment to test it, which involves taking the temperature of a substance, for which it uses a standard resistance thermometer. If you or I use the thermometer we look at its digital readout. When the AI uses it, the same readout data are sent digitally to the AI. If the thermometer is not part of our senses when we use it, it is not part of the senses of the AI when it uses it.

The conclusion we should reach is that the senses are our in-built, evolved mechanisms for receiving information about the external world. But they are not the only way information can be received. Information can be passed along causal channels without those channels constituting or depending on senses.

[8] Some developments in this kind of neural enhancement have already occurred. Neuralink, for example, is developing microchips that can be implanted in human brains to read neural signals and to allow users to control electronic devices by thought. See https://neuralink.com, accessed 2026-08-28. Research on the artificial enhancement of memory is currently focussed on improving the ability to form and to access memories. See https://www.darpa.mil/research/programs/restoring-active-memory, accessed 2026-08-28.

[9] For a recent development, see, for example, Sakana.ai's AI Scientist https://sakana.ai/ai-scientist/, accessed 2026-08-27.

7 Does Constructive Empiricism describe the aim of science?

Does the minimalist epistemology of constructive empiricism provide grounding for its empiricism? Above we saw that the argument given depends on Constructive Empiricism being a plausible account of the aim of science. If Constructive Empiricism is too weak to make sense of scientific practice, then this justification fails. In this section I argue that this is so.

> **Radio Astronomy** Radio astronomy involves the use of radio telescopes to investigate the cosmos and its history by detecting radio frequency electromagnetic radiation and has led to a large number of important discoveries that could not have been made using standard telescopes, such as the discovery of pulsars by Jocelyn Bell Burnell and Antony Hewish in 1967 and the first detection of the cosmic microwave background by Arno Penzias and Robert Woodrow Wilson in 1964. A radio telescope detects weak signals and uses a series of electronic amplifiers to increase signal strength. The signals are then digitized and stored in a database. The database can be interrogated by scientists using appropriate software, e.g. for statistical analysis. The digitized signals received by several widely separated radio telescopes can be compared in a technique known as *radio interferometry*, which allows for the generation of a higher resolution signal. Again the process of comparison of signals is automated, requiring considerable computing power.[10] The astronomer's engagement with the process of observation is through the analysis of digitized, processed electronic data. A recent example of this was the measurement of the power of 'black hole jets' using observations from the Very Long Baseline Array (VLBA) and the European VLBI Network (Prabu et al. 2026). These radio telescope arrays produce data that is processed by standard digital procedures and then exported to Difmap, an interactive program used by the radio astronomers to produce images from radio interferometers, which can be used to model the black hole jet. This work confirmed various hypotheses and assumptions about black holes, for example the assumption made in galaxy-formation models, that roughly 10% of accreted rest-mass energy can go into jets.

[10] These techniques were pioneered at Cambridge, using the Cambridge Titan computer. The collection of data by Penzias and Wilson was analogue, using ink and paper charts, but was still automated.

When Galileo saw the moons of Jupiter through a telescope, his perceptual experience was essential to that act of observation. He could not have known about the moons without that experience or one much like it. The radio astronomer, however, has no perceptual experience that is characteristic of (let alone essential to) her observations. Her engagement with the observation is through her computer terminal. Using Difmap, she can ask for the data to be presented in a visual way, but that will typically be a representation of the data, not a recreation of the visible features of astronomical object being investigated (a black hole is not visible, after all). Quite what visual experience she has will depend on what commands she types into her computer, what software she is running, and so forth. Radio astronomy is not a unique case. On the contrary, it is characteristic of modern science, where a great deal is automated and computerised. Typically, what a scientist engages with is linguistic (where 'language' includes mathematical symbols). At the most trivial level, what experiences she has depends on what language the astronomer's software uses. That experience need not be visual. It could be auditory or rendered in Braille.

In the light of Radio Astronomy, what are we to make of Constructive Empiricism's claim that science aims at empirical adequacy? Let's consider the hypothesis mentioned above, the jet hypothesis, assumed in galaxy formation models, that roughly 10% of accreted rest-mass energy can go into jets. What does the empirical adequacy of this hypothesis amount to? It has no direct consequences for anything humanly perceptible. Its indirect consequences concern the appearance of the scientist's computer screen and depend on the construction of radio telescopes and details of the hardware and software used to interrogate the data, and the actual commands issued by the scientist at her keyboard. The empirical adequacy of the jet hypothesis is therefore a matter of the truth of conditional propositions of the form:

> (CE-RT) If a radio telescope is constructed to specifications X, software W is run on the collected data, commands C are issued by the scientist, then she will have experiences E on looking at her computer screen.

A simple but powerful objection to constructive empiricism is that it is utterly implausible that science should have the aim of establishing the truth of propositions of the form of (CE-RT). There is no reason why anyone should have any interest in such propositions for their own sake. Rosen (1994: 162) says that constructive empiricism is the most cautious empiricist stance which renders the phenomena of scientific activity fully intelligible and ratifiable. I submit that it is far from intelligible to see science as content to spend considerable intellectual and other resources in order to determine the truth of (CE-RT)-type propositions. Much more plausible is the contention that science makes that investment in order to find out about the nature of black holes and of galaxy formation.

To respond to this argument the constructive empiricist will have to argue that there is more to the empirical adequacy of the jet hypothesis than just (CE-RT)-type propositions. But what? For many hypotheses it is difficult to devise any kind of test at all. So it is perfectly plausible that radio telescopes are the only way of connecting the jet hypothesis to human experience. While it *might* be that there are other ways of making the connection, of which we have not yet conceived, they are unlikely to make any more direct a connection between the jet hypothesis and human experience than (CE-RT), and so the same objection stands.

In summary, Constructive Empiricism denies that the value of science rests in its ability to provide knowledge of (unobservable$_P$ aspects of) the universe, as a realist might claim. Rather, according to Constructive Empiricism, the value of science lies in its providing theories that are empirically adequate, i.e. in its successfully predicting the observable$_P$ phenomena. Modern science not only generates theories about the unobservable$_P$, its measurements and methods of analysis are also focussed on the unobservable$_P$, since they involve collecting data on entirely unobservable$_P$ entities (such as microwave radiation) and analysing that data automatically, with computers whose processes are likewise unobservable—with the exception only of what appears on a scientist's computer screen. Since the latter is of no intrinsic value, Constructive Empiricism can give no account of the value of this sort of science—a sort of science that is increasingly the norm. Consequently, Constructive Empiricism tells us that this kind of science is of little value. This is not a plausible rationalisation of the practices of science.

Recall now the Constructive Empiricist argument for its empiricism. It was that empiricism (in the form of Constructive Empiricism) is the view of science's aim that is the least epistemically demanding while also plausible as a rationale for scientific practice. Our discussion shows that this is false. In the context especially (but not I think uniquely) of the automation, digitisation, and computerisation of science, it is not possible to connect the aim of science to what is observable$_P$, i.e. perceptible. That is too weak an aim to make sense of science. So that rationale for empiricism fails.

8 Conclusion—Science without empiricism

The empiricist picture of empirical knowledge and science in particular is this. We open our senses to the world and we construct hypotheses to accommodate what we experience. Within this general picture there is much to debate. Are the reports of sense-experience reports of the physical world or of our inner experience, of how the world appears to one? Is 'accommodating' sense-experience a matter of inferring explanatory truths about the physical world, or something weaker, such as inferring a possible model that would successfully predict those experiences? Some empiricists are optimists, holding that we can infer that the best explanation of our experiences is likely to be true, and some are pessimists, denying that we can rationally make such an inference, maintaining

that we should aim at something less demanding, empirical adequacy. Nonetheless, the shared picture is clear: the starting point of scientific reasoning is always experience and whatever we accept in science is accepted on the basis of some kind of inference from that starting point.

An anti-empiricist epistemology of science denies that the starting point is inevitably sense-experience. Other sources of information about the world are available. One can, for example, take a reliabilist approach—so long as one's belief is produced by a reliable process, it is knowledge. Reliabilism need not discriminate between kinds of process nor require any of them to depend on sense-experience.[11]

In my *Knowing Science* I advocate a knowledge-first picture in which the starting point for scientific reasoning is what the scientist (or, better, the scientific community) currently knows. Again, this knowledge does not have to be of any special type, e.g. uninferred or experiential knowledge. *All* knowledge may be used as a starting point, and it is no surprise that scientists thus take to be observational evidence knowledge that is highly theory-dependent in nature. Theory-dependence is a problem for empiricism that needs to be explained away. Whereas it is precisely the fact that we build instruments and inferential techniques based on well-established theories, theories that are known to be true, that allows us to expand our knowledge so widely and so deeply. If one traces scientific reasoning back, it is true that one will often find scientists having perceptual experiences as part of doing science. Often, however, especially in modern science, this will be of negligible scientific or epistemological interest—a scientist reading her computer screen, for example. Such experiences are not essential to science and they are not the foundation for science. For it is part of this picture that even when such perceptions do play a role, they may be discarded—they are scaffolding at best. The knowledge they help generate stands on its own feet once generated and has no epistemological need for its origins to remain as part of the epistemological system. This goes both for any experiences a modern scientist has and for any experiences her historical predecessors had. The knowledge gained by past scientists has been passed to us in large part on the basis of testimony, a source of knowledge that is not essentially experiential but is not inferred either. And while those predecessors and often modern scientists too did or do depend on their senses for engagement in science, that is not for evidentially foundational reasons—it is because we humans have evolved to interact with the world through our senses. Increasingly those senses are irrelevant in science. Instruments have made them redundant. It is often said, by the optimistic empiricists for example, that instruments *extend* our senses. But this is not the case. Instruments produce knowledge by detecting and measuring

[11] In his reliabilist account of justified belief, Goldman (1979) does distinguish between inferred and uninferred beliefs in a manner that threatens to relapse into something like empiricism. But I do not take this to be a necessary feature of reliabilism.

things, such as magnetic fields and subatomic particles, that were never available to our senses at all. Remaining uses of the senses to interact with machines are also being minimized and potentially phased out altogether, as AI does science without experience and artificial neural enhancements for humans bypass the need for perception. For most of human history, the use of human or other animal muscle power was necessary for producing the essentials of existence. But starting with the invention of the steam-engine we began to find that this was not an inevitable fact of life. Likewise, empiricism is not a necessary feature of knowledge. At best it is an historical phase necessitated in its time only by the constraints of our bodies, constraints that scientific knowledge has itself increasingly allowed us to transcend.

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