Distinctively Scientific Understanding

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1. The general target: understanding *simpliciter*

What is *scientific* understanding, such that it would count as a species of understanding *simpliciter*? An immediate challenge here stems from the fact that 'understanding' in the latter, broader sense is hardly univocal. This explains in part, I suspect, why philosophers have asked and answered so many different questions about scientific understanding more specifically. Thus, to help clarify the aim of the following discussion, let me first say something about the general notion.

Distilling common usage, I take it that, considered most broadly, 'to understand' has three main senses:

1. to grasp the intended meaning of something
2. to interpret something as having meaning
3. to grasp or appreciate the nature of something

While most debates about scientific understanding in the philosophy of science concern (1) and (2) – where the relevant 'something' is typically a scientific theory, or model – what I will be most interested in here, ultimately, is (3) – where the thing to be grasped or appreciated is the nature of science itself. By reflecting all too briefly on the nature of science, my hope is to sketch an account of what scientific understanding is *in contrast* to non-scientific forms of understanding. Arguably, thinking about whether there is such a thing as distinctively scientific understanding is not unrelated to thinking about (1) and (2) in the context of more typical discussions in the philosophy of science, which I will note in passing in what follows. First, however, let me clarify my aim here a bit further, to make my ultimate focus more transparent.

2. A more specific target: scientific understanding

One way of explicating distinctions between (1–3), specifically in relation to the sciences, is to begin with the observation that there are different *objects* of scientific understanding, and to note that these three senses of understanding seem differently applicable to different objects. In other words, what scientific understanding *is* seems to vary with the possible objects of understanding in view. Consider, for example, scientific understanding applied to (putatively) representational devices such as scientific theories, models, data, predictions, and explanations. Narrowly speaking, understanding here is simply a function of competence with certain languages and techniques of description – for instance, competence with certain concepts or branches of mathematics. This is to take the devices themselves, in isolation, as objects of understanding, and there is clearly an *intended* meaning or content here, as in (1), above, grasped by anyone having this narrow sort of understanding. This seems straightforward and uncontroversial.

Understanding becomes more interesting and controversial, though, when its object is not a representational device in itself, but rather its (putatively) representational relationships with aspects of the world: properties; objects; composite systems; events; processes. Here, scientific understanding is a matter of interpreting the content of representations, as in (1) or (2), as *descriptions* of the world. The very idea of '*the*' intended meaning – note the definite article in (1) –

is now controversial because there is often no agreement on what this may be. And if we thus allow the possibility of more than one rendering of putative representational relationships, as per (2), there is inevitably controversy about which, if any, is correct. This is not to say that armed with a theory or a model, an agent (a scientist, say, or a philosopher of science) could not, with full intention, understand some aspect of the world in a particular way, nor that they could not make their intended meaning clear. Rather, it is to say that the idea that there is such a thing as *an* intended meaning to which all epistemic agents must subscribe, on pain of error, is controversial, because *how* representational devices are interpreted in the sciences is a matter of judgment, which often varies. These judgments vary, for example, among participants in debates about scientific realism: realists of different and contrasting stripes, and likewise antirealists (Chakravartty 2017/211).

Widespread disagreement about how to interpret putatively representational devices in relation to the world, however, is just the tip of an iceberg. One may read (2), above, merely as being compatible with disagreement; but one may also read it more zealously, as when some contend that although there are contrasting interpretations, at most one such interpretation is correct – or acceptable, to bracket the question of whether correctness or truth is in fact a requirement. Let me offer a contrary view: when it comes to putatively representational devices in the sciences, the zealous reading of (2) is often untenable; in some cases, more than one interpretation may be acceptable, even if they conflict, subject to some specifiable strictures of acceptability. I submit that in the context of the sciences, a reading of (2) on which different interpretations of representational devices in relation to the world may be acceptable, is often tenable. Sadly, I cannot argue for this here, but let me note at least that this reading is suggested by a rich historical tradition of voluntarism in epistemology up to the present, as in Bas van Fraassen's (2002) assertion that empiricism is not a doctrine but a rationally permissible stance, and my own (2017) to the effect that a number of epistemic stances including empiricist, pragmatist, constructivist, realist, and more metaphysically oriented stances are rationally permissible.

This permissive reading of (2) has consequences for other senses of scientific understanding. For instance, it suggests that while (1) may be a natural way to think about understanding whose objects are scientific representations in themselves (that is, in isolation, narrowly construed), it is a dubious way to think about understanding whose objects are their supposed relations to things that are, thereby, ostensibly represented, since conflicting interpretations of representational devices in relation to the world may be, in some cases and *ex hypothesi*, rationally permissible. This is to say that (1) is generally *not* a natural way to think about understanding aspects of the world as described by the sciences, because the notion of 'an intended meaning' often has no univocal purchase here. Similarly, in this scientific context, a voluntarist reading of (2) immediately suggests a voluntarist reading of (3) – that is, recall, understanding explicated in terms of grasping or appreciating the nature of something (i.e., some aspect of the world: properties; objects; events; etc.). It is only by interpreting theories, models, and so on in relation these aspects, as per (2), that we have *scientific* understandings of those aspects, as per (3). Thus, in these cases, voluntarism with respect to (2) yields voluntarism with respect to (3).

Instead of rehearsing arguments for the preceding drawn from the tradition of voluntarist epistemology, I would like now to proceed in a different way. Rather than focusing on what it means to understand a particular scientific theory or model, or to understand what such representational devices may tell us about target systems in the world, I would like to step back and consider what it is to have a scientific understanding of the world at all. This is what I gestured toward at the start when I noted that my interest here, ultimately, is to grasp or appreciate something, as per (3) – that something being the nature of science itself – in hopes of shedding light on distinctively scientific

understanding, in contrast to other modes of understanding such as artistic, literary, or religious understanding. As a first step in this direction, let me turn now to a brief, synoptic reflection on the origins and evolution of the sciences as forms of inquiry, in support of some thoughts about the very idea of scientific understanding broadly conceived.

3. Origins of distinctively scientific understanding

The emergence of proximate antecedents of the sciences as we know them today – forms of inquiry belonging to a tradition that extends to and includes the modern sciences – is commonly associated with the Scientific Revolution, overlapping the Renaissance and the Enlightenment. Leaving aside certain controversies regarding how neatly or determinately these periods may be characterized, historically, it is fair to say that over this duration, the formation of a robust conception of what science is, as something distinctive in comparison to prior forms of inquiry, was intertwined with a coalescing humanist worldview, a perspective that shaped (among other things) what we think of as scientific understanding. Centrally, this radical-in-its-time, humanistic worldview emphasized reason and science as a basis for understanding the world and our place in it, and for making it a better place. The understanding component of this outlook arose in conjunction with what we may describe as changing commitments in metaphysics and epistemology, and the activist component in conjunction with developments in value theory, but given our present focus, I will consider only the former here.[1]

During the Renaissance, the term '*umanista'* was applied to those engaged in the study of classical antiquity: in particular, its languages, texts, cultures, and thought. During the Middle Ages much of this had been lost or ignored, but these subject matters were reclaimed with the rediscovery of Latin texts, and the relocation to Italy of troves of Greek texts from Constantinople after its fall to the Ottoman Empire. A renewed scholarly consideration of these materials proved a boon to the burgeoning sciences. Their exploration revealed what scholars regarded as a reverence for human dignity, expressed in terms of a deep respect for human self-expression and inquiry fueled by the application of reason. Where once a deference to supernatural forces, God, and revelation served as a secure and, in many cases, unassailable basis for understanding human interactions with and knowledge of the world, there was now room, increasingly, for humanity itself to take the reins of investigation and understanding – an expanding terrain in which Protagoras' ancient dictum, 'man is the measure of all things', could take root in the form of a larger, more authoritative epistemological role for human beings in investigating various aspects of reality.

Gathering momentum, this confluence of ideas grew and intensified leading into and throughout the Enlightenment. Nicolaus Copernicus, Galileo Galilei, Francis Bacon, Isaac Newton, and other natural philosophers elaborated new methodological instructions for inquiring into a range of phenomena in accordance with their own, relatively recently liberated and evolving humanist conceptions of reason and rationality, yielding to new understandings of the natural world as well as the social. Many works to emerge in this period, for example, laid foundations for the advent of sociology and economics, and instigated profound developments in social and political theory. Humanists rediscovered excerpts from Cicero and Plutarch revealing that ancient thinkers

[1] My brief consideration of 'proximate antecedents' of recent and contemporary science in what follows should not be taken to diminish earlier interweavings of science and humanism in the ancient world – not only in Greece but also in China and India, for example – and associated with medieval Islamicate science, for instance. For references to historical sources and a more detailed account of the more recent period (mentioned here in a highly condensed way), see Chakravartty 2025.

had considered the idea of a heliocentric cosmos, which inspired Copernicus – but note, crucially, bolstered by his own analysis of his and others' empirical data. In all of this, I think, is what we might properly recognize as distinctively scientific understanding, which persists to this day.

Let me extract the core of this notion of scientific understanding, describing it in terms of what I take to be its two most important elements. The first is an essential empiricism – an empiricism not confined to any part of the academic-philosophical extension of various technical positions fixated narrowly (one way or another) on human experience or experiential modalities, but rather defined by the looser sense of 'empiricism' in light of which all of us (scientists and philosophers of science alike) have always been empiricists. This looser sense encompasses the epistemic sensibilities of all those who recognize the unrivaled potency of systematic empirical investigation and evidence for grasping, to whatever extent we are able, the nature of natural and social phenomena, which may or may not be strictly delimited by means of or in terms of the senses alone. This is what some identify with a vaguely naturalistic orientation, concretized initially, historically, in terms of an endorsement of human capacities for inquiry at the expense of received dogma, which then leads us to the second element of a distinctively scientific understanding.

Immanuel Kant (1996/1784) described enlightenment as an emergence from an immature state in which one is unable to think critically about traditional forms of epistemic and other authority, and thus fails to take ownership of one's own reason and understanding. David Cooper (1999, 7-8) describes this as the embodiment of 'rational subjectivity': the human potential for rational, autonomous, adjudication of 'truth and value', adding that 'on this characterization, the scientific image is the paradigmatic expression of humanism'. This humanistic conception of inquiry, which I earlier portrayed as facilitating and co-evolving with the development of the sciences, is the second core feature of a distinctively scientific understanding of the world, and the foremost component of this feature is a principled openness to critical scrutiny. The sciences thereby contain the seeds of their own destruction, growth, and amelioration, driven by a relentless pursuit of more effective means of empirical investigation. It is this integral combination of empiricism broadly construed and humanist critique, I submit, that is distinctively scientific.

4. Natural speciations of scientific understanding

It follows from the preceding that any inquiry exemplifying the combination of features just adduced – a broadly conceived empiricism married to an unwavering commitment to critical scrutiny – should be regarded as scientific. A fully elaborated case for this, of the sort I imagine would be required for it to be widely persuasive, would involve comparative reflection on different (including non-scientific) practices of representation, interpretation, and understanding, and a discussion of how disciplines that do not themselves fall under the historically and culturally contingent heading of 'the sciences' sometimes pursue and incorporate scientific understandings of their subject matters. Unfortunately, I cannot elaborate these things here. Nevertheless, let me conclude with yet further claims for which I would be likewise happy to argue, which may also help to reinforce the plausibility of what we might call a *humanist empiricism*, with which to furnish an account of what it is to have distinctively scientific understanding.

Earlier, I gestured toward philosophical arguments offstage supporting a voluntarist reading of (2) – that is, interpreting something as having meaning – in connection with forms of scientific representation and their targets, which then yields a relatedly voluntarist reading of (3) – namely, grasping the natures of things in the world thus putatively represented. I went on to promise an appeal to the history of the sciences intimating a similarly voluntarist diagnosis of

scientific understanding more generally, which I hope is now credible, in the following way. Empiricism broadly construed is multiply realizable; it allows for different assessments of empirical evidence and the drawing of different conclusions as a result. Consider the diversity of opinions among particle physicists regarding the existence of the Higgs boson before its putative detection in 2010, or the fierce debates between theoretical physicists in recent decades about whether string theory is sufficiently responsive to empirical inquiry to justify its prominence in research on quantum gravity. In the absence of certainties, humanistic inquiry must come to terms with human limitations and epistemic fragilities that naturally produce such differences of opinion. The result is an inherent tolerance of even hotly contested interpretations within the bounds of the sciences.

In closing, and though I cannot argue for this here, I hope I have done enough at least to foster the further idea that this notion of tolerance, another celebrated value of the Enlightenment, extends yet further to more purely philosophical concerns. There is nothing in humanist empiricism, for example, that entails scient*ism* – at its worst, an excessive confidence in the certainty or scope of scientific knowledge – even though some scientists and philosophers of science are, as it happens, scientistic. Indeed, there is nothing here that entails the rejection of religion, though a story may well be owed to safeguard the epistemic credentials and standing of the sciences in cases of ostensibly factual conflict with other possible modes of inquiry. The openness characteristic of voluntarism allows for an impressive range of concretizations of scientific understandings of aspects of the world, which is as it should be.

In his discussion of the value-theoretic dimension of humanism, Edward Said (2004, 28) once observed that 'humanism is not a way of consolidating and affirming what "we" have always known and felt, but rather a means of questioning, upsetting, and reformulating so much of what is presented to us as commodified, packaged, uncontroversial, and uncritically codified certainties.' Extending this to the metaphysical and epistemological dimensions of humanist empiricism, whatever we take ourselves to have established on empirical grounds, and with good reason, science too is in the business of questioning, upsetting, and reformulating, and this is indispensable to what it means to have a scientific understanding of the world.

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