Eight Myths about Scientific Realism

ABSTRACT: Selective realist projects have made significant improvements over the last two decades. Judging by the literature, however, antirealist quarters seem little impressed with the results. Section I considers the selectivist case and its perceived shortcomings. One shortcoming is that selectivist offerings are nuanced in ways that deprive them of features that—according to many—cannot be absent from any realism "worth having". Section II (the main part of the paper) considers eight features widely required of realist positions, none of them honored by selectivist projects. Modulo those requirements, even if selectivists managed to clear other shortcomings of their project selectivism would still not be a position worth considering. Next the historical background and present credentials of the requirements in question are examined. All are found to rest on myths and confusions about science and knowledge. If this is correct, realists and antirealists should reject the requirements.

I. Background

The antirealist waves of the 1980s stifled naïve realist projects, but they also gave rise to critical realist reactions, particularly a shift in the way theories are accepted at face value from whole constructs to selected "theory-parts" (existence claims, narratives and structures regarding features beyond the reach of unaided perception). Moves in this "selectivist" direction were variously developed in the 1980s and 1990s, most influentially by Leplin (1984), Worrall (1989b), Kitcher (1993), Leplin (1997), and Psillos (1999). Selectivists see in the history of science a past littered not just with failures but also clear successes, especially after the consolidation of methodologies focused on impressive novel prediction in the early 19th century. The successes selectivists point to involve law-like structures all over physics, functional (as opposed to formally "fundamental") entities like the particles invoked by the kinetic theory of matter, numerous extinct species hypothesized by Darwin and his circle, structures and processes from microbiology, much in Mendelian genetics, myriads of molecular structures, and most of the subatomic entities deemed well-established since the 1950s, along countless causal networks, histories and functional entities in virtually all theories with warrant in terms of impressive novel predictive success. Selectivists thus respond to skeptical readings of the history of science with optimistic readings, which they argue are better justified than Laudan (1981)'s skeptical appeals. History, Leplin (1984) noted early in the debate on selectivism, is not opposed to realism any more than our experience of ordinary objects is unambiguously veridical.

In selectivist terms, successful scientific theories may provide imperfect representations of unobservable aspects of some of their intended domains, but they do get those aspects right to some significant extent—and *that is what matters to a realist stance*. Realism has to do with having warranted augmentative inference at levels that reach into unobservables, i.e. beyond the level allowed by its contrast position—constructive empiricism.

Developing selectivism into a mature project has not proved easy. The initial criteria proposed for identifying theory-parts worthy of realist commitment were either too vague or picked up through "retrospective" projection of current. As Kyle Stanford (2006) cautioned, mere retrospective projection of current science reflects limitations of human imagination as easily as it does truth-content and can be variously misleading; also, it can be self-serving, and worse still it severely weakens selectivism by giving up the traditional realist goal of identifying the truthful parts of a theory while the theory is still alive. Realists need to develop compelling criteria for prospective projection, applicable to theories in full flight, and over the last decade selectivists have moved imaginatively to respond to this challenge. One promising contribution is a stronger emphasis on impressive novel predictions as a marker of success and truth content. This trend is multiply developed in works that revisit in detail the cases most used by antirealists as springboard exemplars of gross epistemic failure, as well as studies of other seemingly germane cases from the last 200 years (e.g. Saatsi 2005, Saatsi & Vickers 2011, Votsis 2011, Vickers 2013, @@@). While the debate is far from over, upgraded proposals are on view in the selectivist analyses just cited. At the very least, the initial antirealist arguments from radical underdetermination and so-called "skeptical inductions" have been weakened by selectivist challenges to the antirealist arguments at work. Still, many critics join Stanford in thinking that selectivism lacks a convincing realist criterion for prospective identification of theory-parts. As said, promising selectivist developments seem on view in this regard, but there is something else.

Something seems to be making the selectivist project intellectually unattractive in some quarters, independently of the issue about the criterion for theory-parts. There is, in particular, a perception (not least among many sympathizers of realism) that selectivism advances its case at the cost of diluting its realist import, resulting in *a stance "not worth having*." By the lights of selective realism, an empirically successful theory T contributes significant truths about unobservables but

(1) typically, what makes T approximately true is that abstract versions of some of its parts are truthful, making the realist stance applicable to selected fragments of T rather than the integral whole initially intended;

(2) such truth as T contains need not have universal applicability;

(3) T need not offer literal truth at its most fundamental level;

(4) the significance of T's central terms is high in unificationist rather than epistemic terms;

(5) T adds significantly to our knowledge of unobservables in the intended domain, but there is no reason to expect T to be "right for the most part" at *any* level (what matters is that it yields epistemic gain at theoretical levels).

(6) T may not instantiate uniformly convergent progress towards any "final description;"

(7) the intelligibility T confers to its intended domain is generally incomplete.

Each of the above tenets clashes head on with widespread assumptions and expectations regarding a realist stance about theories. The latter, many believe, *should* (1) constitute integral wholes, (2) apply universally, (3) give correct theoretical description, (4) have central terms that refer, (5) be, at least, *right for the most part.* (6) display epistemic progress, and (7) offer substantial intelligibility of the intended domains, Behind these expectations about scientific theories and what theoretical claims amount to is a view on what a *realist position worth having* comprises: to be worth having, a realist position must encompass strong versions of most of the listed assumptions. Antirealists (and not a few realists) routinely take these assumptions for granted. This aspect of the debate needs discussion because, as noted, the assumptions in question are clearly at odds with the selectivist strategy, which—generalizing Worrall (2016) a bit—might be *the only viable realist game in town.*

II. Taxing Assumptions

There is a view, shared by numerous scientists, according to which scientific realism cannot be a position worth having unless it encompasses most of the traits listed at the end of the last section. One problem with those traits is that they provide antirealists with fodder for criticizing positions that embrace them and realists for dismissing positions that lack them. Let us consider the listed items in detail.

(1) **Theories as Integral Wholes**. Selectivism rejects the view that theories and conceptual networks are intellectual constructs made of non-separable parts. The integral wholes vision commits realism to nothing less than complete theories. Motivations for it come from at least two

fronts. One includes linguistic holism and/or the statement view of theories, endorsed in the 1960s and 1970s by thinkers as superficially different as Ernest Nagel and Thomas Kuhn. Another motivation, good for a weaker version of the vision, has been the presumption that some concepts are grounded in "metaphysical necessities," a position widely held in natural science until the early 1900s. In the 19th century it was thought that breaking of a theory into independently assertible parts had drastic limits. A case in point was the need felt for positing an ether of light, as at the time waves were conceived of within a traditional metaphysics that regarded them as propagating disturbances and thus as ontologically dependent entities that *required* the existence of something being disturbed (@@@). Institutional deference towards similarly presumed conceptual necessities is massively lower now. One major inflection point was the acceptance of Einstein's Special Relativity, which opened the road to changes in both the conception of light and the requirements of intelligibility in physics.

Nobody thinks now that light is completely as Fresnel or Maxwell imagined, yet—having no conceptual links closed to the possibility of scientific revision— there is little question that Fresnel's theory got many things right, e.g. what might be termed "Fresnel's Core": light is made of microscopic transversal undulations, and these undulations follow the Fresnel laws of reflection and refraction. Abstracted from reference to the wave substratum, this schematic part of the theory spells out a descriptive core that all subsequent theories of light have retained. Once conceptual networks are recognized as relations sustained by revisable inductive conjunctions, scientific "good sense" allows shifts in science towards theory-parts cut out from the rest. There is a historical supplement to this. There has never been much serious allegiance to theory "unbreakability" *in scientific practice*. As scientists developed their ideas, virtually all took a realist stance towards just selected parts of a theory at hand while taking a non-realist stance towards other parts (e.g. Newton's approach towards Kepler's cosmology and Galileo's mechanics; 19th century wave theorists towards particle theories of light, Einstein towards Fresnel's Core, Einstein towards Newtonian mechanics, molecular geneticists towards Mendelian genetics, and so forth). Being selective about what to take at face value in a theory is exactly what selective realists do, also what we all do in ordinary life. The idea that proper theories are unbreakable integral wholes just rests on myth.

(2) **Universality**. Another widespread assumption is that, for realism, proper scientific theories must hold universally. We find this view expressed in e.g. van Fraassen (1980: 86): from a realist perspective, he claims, ‘‘a theory cannot be true unless it can be *extended* consistently, without correction, to all of nature’’

This request rests on myth. There is no reason to think that interesting theories can be so extended even at the lowest phenomenal level. Generalizations limited to the observable level typically turn out to be true only over restricted ranges, just as with theoretical generalizations. The standards of acceptability should not be arbitrarily raised against scientific theories. So, past successful theories could not be extended consistently, without correction, to all of nature. However, as selectivists show, those theories made significant cognitive gains at significant levels, where various assortments of the theoretical descriptions they licensed remain both accurate and illuminating. The universality objection, it seems, burdens realism with a suicidal demand.

(3) **Truthful description**. Realists are allegedly claim that what a theory T says about entities, properties, relations and processes should be construed literally; and to take a realist stance towards T is to believe that what it says is literally true. This view comprises three major lines: (3a) literalism, (3b) accuracy realism, and (3c) a methodological supplement.

(3a) Like their biblical counterparts, theory-literalists think one mistake in a narrative is one mistake too many. Phlogiston theory got some of its central claims wrong, as did also Fresnel’s theory, Mendel theory, Bohr’s 1913 theory of the hydrogen atom, and countless other theories, so those theories were all completely wrong.

The antirealist uses of literalism are straightforward. If departures from literal accuracy, however small, make theories count as different, then the chances of a scientist ever picking *the* right theory will be wretchedly small (argument of the bad lots). And the probability of conjecturing the one (and only one) truthful theory will be hopelessly small (problem of the base rate). And, so, at any given time, the chances that the one truthful theory is among the as yet “conceived alternatives” will be overwhelmingly low.

Happily for realists, the expectations in (3a) belong in fairy-tales. Scientific theorizing is rarely strictly literalist. Scientists effectively abandoned literalism early in modern times, as they began to articulate explanatory idealizations that carried an expectation that nothing in nature exactly realized them. For example, the aim of the kinetic theory of matter developed around 1860 was to causally account for approximate empirical laws that had been gathered in the two previous centuries about the macroscopic behavior of gasses (e.g. $PV = nRT$) and materials (e.g. thermal expansion). Crucially, in the case of gases, the accounts invoked structureless point-particles—the so-called "ideal gas"—that the theorists involved did not believe existed in nature. The ideal gas was *explicitly* an idealization, with a two-fold expectation at work: (i) actual gasses are made of non-ideal corpuscles moving at random and located at relatively large distances from one another "on average"; and (ii) the behavior of those actual corpuscles *instantiated that of the ideal gas to a significant degree* within a certain restricted domain. There was no question that ideal gasses literally construed had to be "real" in order to take the theory realistically. Scientific theories are likewise *generally* false in strictly literal fashion. As with maps, the point of realist interest is the extent to which a theory's depictions match the *intended* domain. Theoretical representations of empirical domains resemble maps far more than they do assertions (e.g. Giere 2006). Selectivists proceed accordingly: taking a realist stance towards a theory T amounts to claiming only that some of the explanations and descriptions distinct to T are correct by *acceptable standards*.

(3b) In mathematized disciplines literalism easily ups its ante. According to a long lived assumption of quantitative exactitude, there are in nature quantities of which concrete systems have definite values, and in a correct theory the claims it makes correspond to the world with total accuracy. This ideal is found in early modern scientists, notably theorists with strong Platonist leanings such as Kepler.

Dear though these expectations of divine accuracy and depth are, they rest on myth. Such correspondence as mathematized theories have to the world is not conditioned to radical accuracy. As Bertrand Russell noted on behalf of sound epistemology,

> "Although this may seem a paradox, all exact science is dominated by the idea of approximation. When a man tells you that he knows the exact truth about anything, you are safe in inferring that he is an inexact man. Every careful measurement in science is

> always given with the probable error [...] every observer admits that he is likely wrong, and knows about how much wrong he is likely to be.” (1931: 42)

More recently, in a more comprehensive vein, Paul Teller (2015) complains that “accuracy realism” assumes that the quantities invoked by a theory actually refer. But—he notes—this misunderstands the fabric of theoretical representation, because theories generally formulate *idealizations* that burden quantitative attributions with failure of specificity in picking concrete cases. In the narrowest literal sense, the claim “the meter-standard kept in Paris is 1 meter long” may be true only by *definition*—any attempt to check it with absolute precision against any external objective length would be frustrated by, to begin with, ineliminable thermal and quantum mechanical fluctuations. The point is that one-to-one matching makes no sense as a goal in scientific language, given that so many descriptive words in science are intrinsically vague and/or refer to idealizations. Actual reference to lengths presumes just perspectivally *acceptable* (never absolute) accuracy. At the lowest empirical levels also, completely exact assertions are generally neither relevant nor true. This connects with a related point, namely, the *irrelevancy* of these literalist and accuracy assumptions to the actual realism/antirealism debate. Shaped by the discussions started in the 1980s, the dispute is now primarily about whether or not warranted augmentative scientific inferences reach into unobservable domains. Ordinary realism about chairs, cats and mountains fails the ideals of radical literalism and accuracy no less than scientific realism.

(3c) The methodological supplement claims that science would be merely an instrumentalist affair unless theorists aim to produce a complete description of the way things are, with scientists as pursuers of God-like reportage (perfect “mirror reflection”): scientific theories advance towards the truth, all the truth, and nothing but the truth (see e.g. Sankey 2008’s discussion of this). Although this position lost much of its ancient appeal in the 18th century, to this day some top theoreticians continue to wax lyrical expressing it, especially in “editorials”.

> “The ‘theory of everything’ is one of the most cherished dreams of science. If it is ever discovered, it will describe the workings of the universe at the most fundamental level and thus encompass our entire understanding of nature. It would also answer such

> enduring puzzles as what dark matter is, the reason time flows in only one direction and how gravity works. Small wonder that Stephen Hawking famously said that such a theory would be 'the ultimate triumph of human reason – for then we should know the mind of God' ". (New Scientists, 4 March 2010[1])

This colorful supplement lacks warrant if, as selectivists claim, the realist stance can be consistently and fruitfully applied to selected theory-parts.

The realist badge of honor is not awarded for telling the truth, all the truth, and nothing like the truth about anything—let alone reading the mind of God. It is a distinction for *finite cognitive achievements forged with crooked tools*. See also (6) below.

(4). **Realist Significance of the "Central Tenets" of a Theory**. A related common assumption is this: Even if truthful description may have limits, taking a theory T realistically requires commitment to T's central tenets (i.e. those about the entities, principles and laws that individuate T). In Laudan's version, realism about T commits to the view that the T's central terms *successfully refer*.

There is little question that in numerous scientific theories the central terms fail to refer—on this point we all have a debt of gratitude to Laudan. However, once theories are no longer approached as unbreakable wholes the emphasis on central terms wanes. If anything, the reference that matters is that of theory-parts. Then, on the explanatory side, the scientific focus is on the structures of possibilities of its intended domain D. As such, a theory is not exclusively about the entities and relations invoked at the level of its central terms. Primarily the theory is about D, whose relevant entities and structures include those that may be found at intermediate levels of description—like Fresnel's Core. A theory may thus be individuated by its central tenets, but the latter do not exhaust the theory's realist import. The appropriate realist focus is those theoretical claims derivable from the theory and for which there is strong evidence (and so a strong expectation of truthfulness), not whether the terms involved are "central", "intermediate", or "peripheral".

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[1] "Knowing the mind of God: Seven theories of everything", New Scientists, 4 March 2010: https://www.newscientist.com/article/dn18612-knowing-the-mind-of-god-seven-theories-of-everything/

(5). **Being "right for the most part".** Another related assumption links the realist stance towards a theory with the claim that the theory is right "for the most part". Michael Devitt, for example, voices this assumption when he defines scientific realism as the doctrine according to which "Most of the essential unobservables of well-established current scientific theories exist mind-independently and mostly have the properties attributed to them by science" (2005: 769). In his view, theories that are well-established theories *by today's* methodological standards are right *for the most part*.

This supposition sounds reasonable at first hearing but it too seems suicidal for realism. Virtually all the past theories realists want to be realist about seem to have turned out to be wrong "for the most part"—unless "being right" is granted with postmodern largesse. Newtonian mechanics is "right" for a comparatively tiny regime of speeds and fields. Bohr's theory of the atom gets impressive aspects right but otherwise is wrong for the most part of the entire quantum domain. Mendel's theory invites a similar reaction. For all we know, our excellent present physics may be wrong for most of the *total universe*. So, scientifically successful theories seem "wrong for the most part". But they have great realist import, nonetheless. That import comes from the fact that they get right novel *significant unobservable* aspects of their intended domains. As David Bohm urged long ago, piecemeal caution needs to be exercised in one's realist commitment to the entities, regularities and processes invoked by well-established current scientific theories (1957, Chapter V). Two lines of reasoning in particular support this prudence (@@@): (1) Qualities, properties of matter, and categories of laws expressed in terms of some finite set of qualities and laws are generally applicable only within limited contexts (in terms of ranges of conditions and degrees of approximation). (2) There is no reason to suppose that new qualities and laws will *always* lead to mere correction refinements that converge in some simple and uniform way. This may occur in some contexts and within some definite range of conditions, but in different contexts and under changed conditions the qualities, properties and laws may be quite novel and lead to dramatic effects relative to what previous theorizing would have led to expect. For example, for bodies moving with speeds negligible compared to the speed of light, the laws of relativity lead to small corrections of the laws of Newtonian mechanics. But they also lead to such qualitatively new results as the "rest energy" of matter. Further laws yet to discover may be vastly more bizarre.

(6) **Progress**: The realist expectation that successful science achieves cumulative truth content about unobservables is frequently nailed to the idea that "modern science is converging on a single picture of the world". Claims along these lines come in several flavors, in particular (a) linear epistemic progressivism and (b) "metaphysical" realism.

(6a) Convergent progress. Léo Errera expressed the idea in his *Botanique Générale* of 1908: "Truth is on a curve whose asymptote our spirit follows eternally[2]." This expectation has recurrent mystical roots in science. John Herschel, for example, is cited by Marcel de Serres as saying "All human discoveries seem to be made only for the purpose of confirming more strongly the truths come from on high, and contained in the sacred writings[3]."

Convergent progressivism runs against a recurrent realization in modern science. As selectivists recognize, successful theories give knowledge but they usually err at numerous levels of description. Successful theories don't give us everything there is to know about any intended domain, let alone 'The World.' Finite sets of simple laws can provide correct descriptions and predictions when we constrain their context enough, notes Bohm (1957), but we should expect unrestricted theories to be false. Many defenders of scientific objectivity have followed suit, stressing the shift from traditional searches for a comprehensive world-view to explicitly perspectival searches for piece-meal knowledge about domains of current scientific interest, leading to assertions of corresponding partiality.

(6b) In no better shape is the claim that realism is committed to the existence of one true and complete description of the world, whose truth bears one-to-one correspondence to 'mind-independent reality, so that the purpose of science is to discover that description. Critics persuasively dismiss this brand or realism. But no knowledgeable realist has held such a position in generations. It is a thesis recalled from the grave in the late 1970s and 1980s by Hilary Putnam under the label "metaphysical realism," a view he presented as an example of a hopelessly jumbled project (e.g. Putnam, 1978: 49, and 1990: Preface).

2 *Recueil d'Œuvres de Léo Errera: Botanique Générale* (1908), 193. As translated in John Arthur Thomson, *Introduction to Science* (1911): 57

3 Marcel de Serres, 1845. "On the Physical Facts in the Bible Compared with the Discoveries of the Modern Sciences". *The Edinburgh New Philosophical Journal* (Vol. 38): 260. [239-271]

(7) **Intelligibility**: Another claim often associated with realism is that science aims to provide truthful explanations that make the phenomena at hand intelligible. This condition comes in (a) radical and (b) moderate strengths. The radical version calls for explanations that leave the intellect content and with no further whys. The weak condition calls for explanations that make the target phenomena *more* but not necessarily fully intelligible.

(7a) Leibniz's rationalist objection to Newton's Theory of Gravitation exemplifies the radical version. He complained that if gravity were thought as a real force, then its effect would be a mysterious action at a distance. Leibniz blamed Newton for introducing "occult" forces into science, and until the end of his life Newton hoped to produce a properly "intelligible" account of gravity involving only action by contact interactions—he did not succeed. Modern scientific theories do not provide radical intelligibility. Once Galileo gave up his initial hope of presenting inertial motion as uniform circular motion, the theory of free fall he accepted left open at least as many whys as it closed. Why or how Galileo's mysterious mathematical structures arise in nature? The same goes for subsequent theorizing. Why or how the regularity given as Newton's law of gravitation arises? Why or how Fresnel's Core arise? Why or how the speed of light is a universal invariant? Contemporary fundamental theories fail radical intelligibility just as clearly.

Realists need not worry about this. Calls for radical intelligibility rest on views of cognition now widely recognized as mythical. Barring mystical insight and such, all actual understanding comes with opaque spots. At every scientific stage scientific warrant (and intelligibility) stops somewhere, albeit usually not at the traditional empiricist boundaries. Realism is compatible with suspending judgment about whether a certain theoretical claim correctly describes a fundamental or derivative aspect of nature. This is exemplified in the stance realists take towards e.g. Fresnel's Core, the invariance of light's speed, and fundamental principles in general.

A theory that saves all the known phenomena but whose reliable parts comprise only structures and explanations at phenomenal levels, provides the lowest level of understanding. This makes for a constructive empiricist take, which escapes skepticism by accepting realism about just the theory's empirical substructures. The point here is that radical theoretical intelligibility is not necessary for taking a realist stance towards a theory. From a selectivist perspective, the key factor for taking a theory-part realistically is not the "intelligibility" it confers but its indispensability for maintaining the theory's predictive power in the context of current *background knowledge.* Ptolemaic orbits were denied realist interpretation not primarily because they failed the intelligibility requirement—Ptolemaic constructions went out of their way to honor, of all requirements, *intelligibility* (then guided by the Principle of Uniform Circular Motion for heavenly bodies and the Aristotelian arguments for the fixity of the Earth). Rather, Ptolemaic orbits were refused realist interpretation because the epicycles, deferents and equants they invoked were grossly *underdetermined by extant knowledge* (i.e. available data and cosmological principles). Positive evidence for the orbits specifically proposed was lacking.

None of this is not to question the realist relevance of theories that seek to achieve deep understanding. What is denied is that *scientific* realism must embrace radical intelligibility. Radical intelligibility is a trait realism about observables and every day affairs neither honors nor is expected to honor.

(7b) This brings us to cogent versions of the moderate intelligibility condition. Selectivists take a realist stance only towards theory-parts deemed to be both indispensable for the theory's success and free of compelling specific doubts against them (@@@). That is, the realist stance goes *only* to tenets for which there is strong positive evidence by modern scientific standards. In all the cases highlighted by realists, the selections supported by the strongest level of evidence available make the target domain intelligible well beyond the observable levels. When, by contrast, the positive evidence for a theory does not reach the unobservable explanatory posits that make the relevant phenomena intelligible, then the best stance to take about the theory is not realism but *constructive empiricism*. This clarifies what introductory characterizations of scientific realism get right about the intelligibility condition: A good theory must not have just significant predictive power but must also make the relevant phenomena *intelligible* (Richard DeWitt 2010: 72). If the theory parts that do this lack evidential warrant, then the reasonable stance towards them is constructive empiricism.

(8) **Realism Worth having.** Topping the above assumptions, there is a popular notion to the effect that a realist stance failing to adhere to most of the above requirements is "*not a realism worth having*". Against this idea, I have argued that none of the listed assumptions is worth

having. Every one of them lacks convincing warrant. Moreover, even if the assumptions did get proper warrant they face a deeper problem: the assumptions are *irrelevant* to the current realism/antirealism debate—they do not expose relevant contrasts between inferences limited to the phenomenal level and inferences that reach into theoretical levels.

In modern science, virtually all interesting augmentative inferences violate the listed assumptions. So, the latter simply and arbitrarily raise the epistemological standards of acceptability against theoretical assertions. If the above considerations are correct, then, realists and antirealists should reject the assumptions examined in this paper—they all rest on counterproductive myths and confusions.

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