Practice-Constituted Realism[1]

Bernardo Marques[2]
(IHPST - CNRS & Université Paris 1)

Abstract

Local realism aims to reconcile scientific realism with the historical variability of scientific hypotheses by restricting the realist commitment to limited aspects of successful theories. I argue that local realism relies on a form of semantic minimalism: scientific theories are assumed to possess truth-conditional content independently of scientific practice. As an alternative, I propose a contextualist account according to which scientific theories are best understood as formal structures whose truth-conditions are constituted through practice. The resulting view offers a new perspective on two central arguments in the realism debate: the No-Miracles Argument and the Pessimistic Meta-Induction.

1. Introduction

In recent years, scientific realists have defended their position through the framework of local realism, presenting it as a more cautious and methodologically refined version of earlier realist programs. Local realism aims to provide a more modest form of realism by restricting ontological commitment to those components of scientific theories that can be identified as genuinely robust and that are expected to survive theory change. In this paper, I argue that even this more modest approach remains too strong. I suggest that the problem lies in a set of semantic presuppositions that underlie local realism and shape the broader realism–anti-realism debate.

The disagreement between scientific realism and anti-realism is typically framed as a dispute about the epistemic status of theoretical entities, namely whether we should regard them as genuinely describing a mind-independent reality. Local realists articulate their position through a particular implementation of semantic realism, which I call semantic minimalism. According to semantic minimalism, truth-

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[2] bernardo.marques@univ-paris1.fr

conditional content is an intrinsic feature of theoretical representations: once scientific theories are interpreted, their truth-conditional content is fixed and stabilised across contexts. In other words, truth-conditional content is assumed to be independent of scientific practice. Within this framework, local realists argue that the empirical success of a theory allows us to identify which of its components warrant ontological commitment and to distinguish them from elements that function merely as mathematical devices.

In this paper, I challenge semantic minimalism. I defend instead a contextualist account according to which theories do not possess truth-conditional content prior to being embedded in scientific practice. On this view, truth-conditional content is not an intrinsic feature of theoretical structures but is constituted through their use within scientific activities. My argument proceeds in two steps. First, I draw a parallel with debates in the philosophy of language in order to show that local realism results from a specific implementation of semantic realism, namely a minimalist view on which truth-conditional content is treated as independent of use. Building on this parallel, I introduce a contextualist alternative according to which scientific practice plays a constitutive role in determining truth-conditional content. Second, I show how this shift allows us to develop a contextual form of realism in which theoretical structures, once embedded in scientific practice, acquire truth-conditional content, thereby making a practice-dependent form of realism intelligible. To illustrate how this alternative works, I propose a reinterpretation of two central arguments in the realism debate: the no-miracles argument and the pessimistic meta-induction.

2. Semantic Minimalism and Local Realism

The starting point is the well-established connection between scientific realism and semantic realism.[3] Semantic realism holds that the relation between scientific theories and the world is mediated by the semantic properties of theoretical representations. On this view, representational vehicles (formally well-formed elements of a theory) possess semantic properties that determine the truth-conditional contents they express, and these contents mediate the relation between theories and the world.

For instance, Stathis Psillos characterises the current phase of the scientific realism debate as emerging from a broad consensus around semantic realism, understood as "the view that the vocabulary of scientific theories should be treated in a uniform way on the basis of standard referential semantics." Given this assumption,

[3] Following Herbert Feigl (1950), scientific realists assume that scientific theories possess determinate truth-conditions that allow them to be evaluated with respect to a mind-independent world.

the empirical success of scientific theories provides reason to believe in the reality of the theoretical entities they posit (Psillos 2017, 20). Within this framework, the relation between theories and reality is articulated through truth-evaluable claims: scientific theories are taken to express contents with determinate truth-conditions, with reference playing the central role in bridging theory and world.

However, the debate overlooks an important choice concerning how semantic realism should be implemented. Semantic realism by itself does not determine whether truth-conditional content should be understood as fixed independently of scientific practice or as emerging through its use. At least two broad strategies are available. Scientific realists have largely adopted an implementation along the lines of semantic minimalism (e.g., Asay 2019; Egg 2016; Psillos 1999, 2017; Worrall 1994). Semantic minimalism takes the semantic properties of representational structures—and thus their truth-conditional contents—to be fixed once an interpretation is established, independently of their concrete use. When semantic realism is combined with this minimalist assumption, the resulting framework involves three substantive commitments about theoretical representation:

1. *Primacy*: theoretical structures are the primary bearers of truth-conditional content fixed independently of their use in scientific practice.
2. *Determinacy*: representational contents possess determinate truth-conditions.
3. *World-grounding*: these truth-conditions are explained by reference to mind-independent entities.

For present purposes, it is crucial to note that these three claims do not follow from semantic realism alone. Rather, they result from the particular minimalist implementation of it. They are therefore not neutral background assumptions but substantive commitments about how representational content is fixed and how it relates to scientific practice. Scientific realism, when formulated in this minimalist way, presupposes that truth-conditional content is available *prior to*—and independently of—the scientific practices in which theories are developed and applied.

This framework finds one of its most promising applications in the development of local realism, which has emerged as one of the most influential contemporary forms of scientific realism. Local realism can be understood as a refined response to earlier criticisms of global forms of realism (e.g., Laudan 1981, Stanford 2003). According to this view, we can sort, within a given theory, those elements that are decisive for its empirical success and that are expected to survive theory-change (Kitcher 1993, Worrall 1989). This constrains the ontological commitments one ought to endorse within a theory, as the empirical success of the

theory should help us distinguish between these elements from those that function merely as mathematical devices.

On this picture, empirical success plays a primarily selective role by helping to identify which theoretical structures should be interpreted realistically. Local realism is thus constructed around the sorting function of scientific practice, which allows us to identify robust formal structures that may legitimately be interpreted as genuinely ontological while setting aside other elements as merely mathematical artefacts. With respect to these robust structures, we can expect both that they will survive theory change and that they warrant ontological commitment. Scientific practice thus serves to separate those parts of a theory that genuinely represent the world from those that do not. Analysed through the lens of semantic minimalism, this strategy is straightforward. Because multiple truth-conditional contents are assumed to exist prior to practice, scientific activity serves mainly to sort which of those contents should be taken as ontologically significant.

Once this background is acknowledged, the opposition between scientific realism and anti-realism can also be reframed.[4] The debate is typically conducted against the background assumption that truth-conditional content is already fixed independently of scientific practice. The central point of disagreement then concerns how such pre-existing contents should be evaluated: whether they successfully refer to mind-independent entities, or whether they should instead be interpreted more cautiously. Anti-realists, after all, do not deny that scientific theories are meaningful or empirically successful. Rather, they resist the realist inference from such success to the approximate truth of the theory as a whole, or to the reality of the theoretical entities it posits. In this sense, anti-realists challenge which semantic properties should be taken as explanatorily or epistemically significant—truth, reference, or empirical adequacy—without rejecting the more basic assumption that theories inherently possess determinate truth-conditional content in the first place. The disagreement concerns whether those contents successfully refer, or which aspects of theoretical discourse should be taken seriously, rather than whether truth-conditional content itself should be treated as the fundamental unit of analysis.

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[4] Stanford (2021) diagnoses a shared background commitment between realists and anti-realists. His identification of the "Maddy–Wilson principle" holds that the predictive and practical success of scientific theories is typically due to some systematic connection between the theory's description of the world and how things actually stand (2021, 220). Importantly, Stanford takes this commitment to be common ground even for those who regard current theories as fundamentally mistaken, insofar as successful theories are still expected to stand in systematic relations to the truth concerning otherwise inaccessible domains (ibid.). This diagnosis effectively presupposes that scientific theories inherently possess truth-conditional contents that can be evaluated—a commitment naturally aligned with semantic realism, and more specifically with a minimalist construal of it.

It is precisely along these lines that the different objections to local forms of realism have emerged (e.g., Cordero 2011; Elsamahi 2005; Lyons 2006; Peters 2014). These criticisms focus on a number of issues, ranging from the difficulty of isolating elements that genuinely warrant ontological commitment within particular scientific theories to the problem of identifying historical chains of continuity for the ontological commitments realists wish to preserve (Elsamahi 2005). Despite these different angles of criticism, they share a deeper underlying commitment. They are motivated by a principle of epistemic caution: while they accept that scientific theories generate truth-conditional contents, they deny that we are justified in interpreting these contents as approximately true or as referring to real entities solely on the basis of the empirical success of theories. The disagreement therefore concerns how such contents should be interpreted, not whether truth-conditional content can be associated with scientific theories independently of scientific practice. As we will see, the contextualist alternative challenges precisely this shared assumption. Rather than treating truth-conditional content as fixed independently of scientific practice, it holds that such content is constituted through the very practices in which theoretical structures are deployed.

3. The case for contextualism

In spite of a common genealogy with respect to semantic realism, the debates in philosophy of language and philosophy of science have gradually diverged. In the the philosophy of language, the central issue has shifted towards the best way of implementing semantic realism, giving rise to a widely discussed opposition between semantic minimalism and semantic contextualism (for overviews, see e.g. Borg 2013, Bezuidenhout 2016, Stojanovic 2008). I draw on this parallel to develop an alternative to the minimalist framework underlying local realism. Drawing on these debates, I argue that the contextualist alternative provides a more adequate framework than semantic minimalism for understanding scientific representation.

The central dispute at the heart of the debate concerns the role of contextual (pragmatic) factors in determining truth-conditional content. Minimalists, in response to the growing emphasis placed on pragmatics in particular after Grice's (1957) work, construct meaning through the posit of a core truth-conditional content that remains insensitive to contextual variations. According to this view, we can always ascribe at least a minimal truth-conditional content to a given theoretical structure independently of the context in which that structure is mobilised. Minimalism therefore posits a level of semantic content that is fixed independently of use. The remaining task is to determine how this content is eventually mapped onto particular contexts in order to yield fully determinate truth-conditions. Local realists endorse this minimalist implementation of semantic realism. They assume that scientific theories

automatically generate a set of truth-conditionally evaluable contents independently of the contexts in which they are applied. Scientific practice then enters the picture primarily in a selective role, allowing us to identify which theoretical contents warrant ontological commitment and which merely function as mathematical artefacts.

Contextualism breaks with the minimalist picture, paving the way for a different implementation of semantic realism and, consequently, of scientific realism. Contextualism denies that there is such a thing as truth-conditional content that can be fixed independently of contextual or pragmatic factors. Semantically relevant content is not an intrinsic feature of theoretical structures but depends on the different contexts in which they may be considered. In this way, the only kind of content a scientific theory possesses inherently is a kind of formal—or syntactically well-formed—content that exists independently of its potential applications. This content cannot be evaluated as true or false, nevertheless. The reason for this is that contextualists consider that a given theoretical structure (e.g., a sentence, a model, or a theory) is semantically underdetermined with respect to the determinate truth-conditional content that it may receive in a particular context of use (Bianchi 2010). As a result, the meaning of a theoretical structure cannot be determined without taking into account the pragmatic context in which it is used.

According to contextualism, prior to their embedding in scientific practice, scientific theories do not possess determinate truth-conditional content. A theoretical formalism written on a sheet of paper, considered independently of its scientific use, does not yet express a determinate truth-evaluable claim about the world. Only once the theory is embedded in concrete scientific activities can a specific truth-conditional interpretation be attributed to it. In this sense, scientific practice plays a constitutive role: it is through practice that determinate truth-conditional content is established.[5]

We can clarify how this process of *pragmatic enrichment* operates by distinguishing between two complementary directions of enrichment: 'saturation,' a bottom-up process that completes a formal structure by supplying contextual parameters; and 'modulation,' a top-down process in which the aims and constraints of scientific inquiry shape how the formalism is interpreted and applied (Recanati 2004, 2010). Saturation occurs when a formally specified structure is completed through the addition of contextual parameters required for a representation to express a determinate proposition. In scientific contexts, this process can be observed when theoretical formalisms are supplemented, for instance, with specifications of domain, parameter values, or measurement procedures that allow the formalism to be concretely applied. For example, an equation such as a general equation of motion

[5] This means that practice does not create new representational vehicles but rather enriches the formal structure of existing ones.

does not yet express a determinate claim about the world until parameters specifying the system and its physical conditions are fixed.

Modulation, by contrast, concerns context-sensitive adjustments to the way the formal structure of a theory is interpreted or applied. In scientific practice, such adjustments typically include idealisations, approximations, the introduction of cut-offs, and other modelling decisions that shape how a formalism is used in a given context. Scientific practice therefore contributes through both forms of enrichment: it supplies the parameters required to complete the interpretation of a formalism while also shaping how theoretical structures are adapted for particular investigative purposes. These processes correspond broadly to what Hasok Chang describes as epistemic practices: structured activities involving experimental procedures, measurement techniques, modelling conventions, and inferential norms that connect theoretical structures to empirical inquiry. Through this process of pragmatic enrichment, the content of a theoretical structure becomes sufficiently specified to function as a genuine representation of the world and thus becomes apt for truth-conditional evaluation.

Finally, contextualism itself encompasses a range of positions. One may ask whether every theoretical structure requires pragmatic enrichment in order to possess determinate truth-conditional content, or whether this is only the case for certain kinds of theoretical representations. Radical contextualists (in the philosophy of language, for instance Collins 2020; Recanati 2004, 2010) maintain that every linguistic structure exhibits an inescapable gap between its formal content and the proposition it expresses, a gap that can only be filled through pragmatic enrichment. More moderate contextualists (e.g., Maitra 2007, Taylor 2007), by contrast, argue that such gaps arise only in certain cases. Although it is beyond the scope of this paper to argue for this claim, my position aligns with a radical contextualist view: theoretical formalisms are considered as inherently underdetermining the truth-conditional contents they can express, and scientific practice therefore plays a constitutive role in fixing those contents.

4. NMA and the Pessimistic Meta-Induction

The previous sections have argued that the scientific realism has typically been formulated within a minimalist semantic framework that assumes truth-conditional content to be fixed independently of scientific practice. In contrast, I have proposed that scientific theories do not possess context-independent truth-conditional content. Prior to their application, theories provide only a formal or syntactic structure that is not yet directed toward the world. Truth-conditional content emerges only when this structure is embedded within concrete, norm-governed scientific practices.

If this view is correct, it has important consequences for how the central arguments of the realism debate should be understood. In particular, it invites a reassessment of two central arguments that structure contemporary discussions: the No-Miracles Argument and the Pessimistic Meta-Induction. Reconsidering these arguments from the standpoint of contextual realism clarifies both the source of their apparent force and the limitations of the assumptions on which they rely.

Let us begin with the No-Miracles Argument (NMA). As Putnam famously stated, realism is "the only philosophy that doesn't make the success of science a miracle," since it holds that mature scientific theories are typically true and that theoretical terms can continue to refer across theory change (Putnam 1975). More generally, the NMA can be understood as an inference to the best explanation of the following epistemic thesis: mature and predictively successful scientific theories are typically well confirmed and approximately true, and therefore the entities they posit exist in the world (Psillos 2006). In schematic form, the argument presupposes the following structure:

i. Scientific theories possess a determinate truth-conditional content *prior to* their use in practice;
ii. These contents can be evaluated as approximately true or false;
iii. The truth of these contents explains the empirical success of the theory.

On this view, scientific practice functions primarily as a means of confirming or disconfirming the contents contained within a theory. Practice plays the role of a referee, determining which of the truth-conditional claims encoded in theoretical structures correspond to reality. The success of scientific theories is therefore explained by the fact that some of these contents are (approximately) true. From a contextualist standpoint, however, this explanation reverses the correct order. If there is no truth-conditional content prior to practice, the NMA explains the success of science by appealing to a kind of content that can only be constituted through the very practices whose success it is meant to explain. The contextualist perspective therefore motivates a modified version of the argument, NMA*:

1. Scientific practices employing formal representations exhibit sustained empirical success;
2. This success would be miraculous if these practices were not systematically constrained by how the world is;
3. The world-directed constraints operating within practice license the attribution of truth-conditional content to the formal structures employed in those practices.

The explanatory order is therefore reversed. Rather than assuming that pre-existing truth-conditional contents explain empirical success, contextualism treats empirical success as evidence that scientific practices are reliably constrained by the world. These constraints, in turn, ground the attribution of truth-conditional content to the formal structures used within those practices. Without the world's resistance in concrete experimental contexts, the formal structure would remain a merely mathematical object.

A similar reconsideration can be applied to the pessimistic meta-induction argument (PMI) (Poincaré 1952, Putnam 1978, Laudan 1981). In one common reconstruction (Lewis 2001; Psillos 1996; Saatsi 2005), the argument proceeds as follows:

1. Assume that success of a theory is a reliable test for its truth.
2. So most current successful scientific theories are true.
3. Then most past scientific theories are false, since they differ from current successful theories in significant ways.
4. Many of these past theories were also successful.
5. So successfulness of a theory is not a reliable test for its truth.

From a contextualist standpoint, the argument rests on a problematic assumption: that the relevant type of truth-conditional content remains stable across historical contexts. In other words, the PMI presupposes a form of semantic continuity —the idea that past and present theories can be evaluated according to the same truth-conditional framework despite substantial transformations in scientific practice. Within contextualism, this assumption cannot be maintained. Since truth-conditional content emerges only through specific practices, shifts in scientific practice may alter the very conditions under which content is constituted. As a result, past and present theories cannot simply be evaluated against a single invariant set of truth-conditions independently of the practices within which their contents are constituted.

Consider the familiar case of phlogiston. Contemporary chemistry contains no theoretical framework within which reference to such an entity can be licensed. Yet this does not simply amount to the falsity of a proposition shared with eighteenth-century chemistry. Within the context of eighteenth-century chemical practice, the existence of phlogiston functioned as a live theoretical hypothesis (Chang 2010). Debates over phlogiston are often taken to support the pessimistic meta-induction: anti-realists treat the episode as evidence that successful theories may nevertheless posit nonexistent entities, whereas realists typically attempt to reinterpret the episode in ways that preserve some form of approximate truth or referential continuity (Ladyman 2011, McLeish 2005, Schurz 2009). From a contextualist perspective,

however, the central issue concerns the role of scientific practice in constituting the content of the term itself.

First, theoretical statements involving terms such as "phlogiston" do not possess determinate truth-conditional content independently of the practices within which they are articulated. Within eighteenth-century chemical practice, the phlogiston hypothesis formed part of a broader theoretical framework that allowed chemists to organise observations, formulate hypotheses, and generate successful predictions about combustion phenomena. From the standpoint of contemporary chemical practice, however, no ontological commitment to phlogiston can be sustained. Yet this does not imply that eighteenth-century chemists were simply advancing a false proposition whose truth-value can be straightforwardly assessed using present-day standards. Rather, the historical transition to modern chemistry reflects a transformation in the epistemic practices through which chemical phenomena are investigated and described. The lesson is therefore not that past scientists were simply mistaken in formulating propositions whose truth we can now neutrally assess, but that the conditions under which such propositions acquire determinate truth-conditions evolve together with scientific practice.

Second, contextualism should not be interpreted as supporting either anti-realism or any of the familiar realist alternatives.[6] The contextualist lesson is not that theoretical statements involving phlogiston theory were simply false, nor that the broader theoretical structure should be retained in some weakened or residual form. Rather, the episode illustrates that successful scientific practices engage with real phenomena while remaining open to substantial reinterpretation at the theoretical level. In this sense, contextualism shifts the explanatory priority: the empirical success of scientific theories is grounded in the practices through which their content is constituted, rather than in a pre-existing content assumed to reside in theoretical structures. Here, Chang's notion of epistemic practice is particularly helpful. Chang defines an epistemic activity as "a more-or-less coherent set of mental or physical operations that are intended to contribute to the production or improvement of knowledge in a particular way, in accordance with some discernible rules (though the rules may be unarticulated)" (Chang 2012, 15–16). A system of practice, in turn, consists of a coordinated set of such activities oriented toward particular epistemic

[6] The position defended here also differs from the so-called experimental realism (Cartwright, 1983, Chen 2023, Hacking, 1982). Whereas experimental realism grounds ontological commitment in experimental intervention, the present account focuses on the constitution of truth-conditional content through scientific practice. As a result, successful intervention does not by itself license ontological commitment to the entities manipulated in practice.

aims.[7] On this view, the historical development of science involves transformations not only in theoretical claims but also in the systems of practice through which determinate truth-conditional content itself is constituted.

5. Conclusion

Local realism has sometimes been criticised for securing only limited or "pyrrhic" victories for scientific realism (Stanford 2003). In this respect, the present account may appear to move even further in that direction, by reducing the ambitions traditionally associated with realist interpretations of science. This naturally raises the question: how realist is contextualism?

The shift from semantic minimalism to contextualism fundamentally reorients the goals of the realism debate. If truth-conditional content is not a pre-existing property of a theory but instead emerges through its embedding in scientific practice, then the familiar transition from empirical success to ontological commitment can no longer be treated as a straightforward inference. Ontological commitments cannot simply be read off from theoretical structures (not even partially); rather, they arise within interpretative frameworks shaped by the practices through which theories acquire determinate content.

Within the contextualist framework, scientific practices can still track genuine patterns, causal structures, or regularities in the world. The sustained empirical success of these practices indicates that they are systematically constrained by how the world is. Yet this success does not provide a metaphysical guarantee that the entities invoked in our theoretical explanations exist exactly as described. Instead, it shows that theory-mediated practices interact with the world in ways that reliably produce stable and informative representations. Contextual realism therefore points towards a form of practice-constituted realism. On this view, the empirical success of science is grounded in the structured practices through which theoretical content is constituted and stabilised. These practices sustain our engagement with real phenomena, even though the theoretical vocabularies used to describe them may undergo substantial revision. Scientific theories are thus best understood as the

[7] This contextualist reconstruction can be read as a pragmatist form of scientific realism broadly in line with the view defended by Chang (2012, 2022). It preserves the realist commitment that scientific practices are constrained by the world, while rejecting the assumption that truth-conditional content exists prior to practice. Chang explains epistemic success in terms of the stabilisation of world-constrained epistemic activities. The present account complements this view by showing how ruth-conditional content is constituted through practice, thereby providing a bridge between theoretical structures and empirical constraint. As Chang (2012, 170) puts it, "the operational coherence of activities relying on a true proposition are not consequences or indications of its truth […] Rather, operational coherence is constitutive of truth." This aligns with the contextualist claim that truth-conditional content is not pre-given, but emerges from the success-constrained practices themselves.

historically evolving outcome of practices through which the world constrains and informs our representations.

6. References

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