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Does theory change in the history of science undermine scientific realism?

Does the success of a scientific theory entitle us to believe in the reality of its ontological commitments to unobservable entities? This paper argues that the history of theory change undermines a naive scientific realism because empirical and explanatory success has accompanied historic theories later abandoned. It does not decisively undermine scientific realism altogether as selective and structural realist responses show that what survives theory change may not be full ontology but either retained working posits or preserved structure.

Modern science is successful. This idea is powerful and supported by our technological advancements. A close examination prompts the question: what explains this success? This question has both descriptive and normative effects. Scientific realism involves three commitments: A metaphysical commitment to a mind- independent world, a semantic commitment that scientific theories are literally construed and that their theoretical terms genuinely refer, and an epistemic commitment that our best mature theories are at least approximately true. (Chakravartty, 2011) These three commitments form the foundation of naive scientific realism.

Scientific realists hold that the propositions of mature scientific theories are literally construed and approximately true. Theories remain fallible, approximate truth allows for revision while keeping science an ongoing project. Successful referring terms reflect genuine knowledge of unobservables and distinguish scientific realism from sceptical positions. Realists use these commitments within an 'inference to the best explanation' (IBE) of the success of science (Ladyman, 2002). As Putnam's famous 'No Miracles' argument states, realism "is the only philosophy that doesn't make the success of science a miracle" (Putnam, 1975, quoted in Laudan, 1981)

A challenge to the central commitments of naive scientific realism comes from the history of theory change. In "A Confutation of Convergent Realism" (Laudan, 1981. reprinted in Curd and Cover 1998), Laudan argues in what is now known as the 'pessimistic meta-induction' (PMI) that many past theories were empirically and explanatorily successful and yet were later rejected. Their theoretical terms are now treated as non-referring. Current theories are not obviously different in kind. Despite being false older theories were successful and well supported. We therefore have positive inductive reason to expect the

terms of current theories to be replaced in the future. Success fails to grant epistemic warrant as a reliable guide to the truth of unobservables. For example, past empirically successful theories include posits such as phlogiston, caloric, and the ether, which no longer refer to entities accepted as being real or approximately true. Could electrons be next? Laudan's challenge directly undermines two realist commitments: approximate truth and successful reference. If this is right, the history of theory change undermines scientific realism.

One realist response to Laudan, discussed by Ladyman in connection with Kitcher and Psillos is the 'divide et impera' strategy (Ladyman, 2002, pp. 246-252). While still committed to the core claims of scientific realism the response is more discriminating in form. The central idea is that Laudan's examples treat past abandoned theories as single units. The account is overly reductive, whereas a more selective realism offers a differentiated analysis of a theory's essential components. A closer examination of historical theories shows that terms and referents can be divided with only some contributing to empirical success. The essential predictive and explanatory parts of successful theories are retained in successor theories whereas the discarded parts are typically peripheral assumptions, speculative ontologies or mistaken background assumptions.

Psillos's example of Fresnel's wave theory of light is illustrative as it had empirical success, it predicted optical phenomena. This was despite positing the 'luminiferous ether' which was later rejected as non-referring. When replaced by Maxwell's electromagnetic theory, whatever essential content which caused the positing of the 'ether' survives, while the referring term changes to a more explanatorily successful referring ontological posit. (Ladyman, 2002, pp. 246-247) The history of science does not show success arising unexpectedly out of wholesale falsehood, but from essential, partially truth tracking elements, embedded within imperfect theories. The pessimistic challenge from the history of theory change may not decisively undermine scientific realism if realists accept this position.

This strategy is vulnerable to the charge of being ad-hoc and retrospective, since what counts as 'essential' only occurs after a later theory reveals what survives (Psillos, 2022). A scientific realist needs robust criteria for selecting the true or referring parts of theories that carry over to the more successful successor theories; otherwise it may seem "arbitrary" (Ladyman, 2002, p. 52). Even with refined and more discriminating selective responses naive scientific realism still appears vulnerable to the challenge from the history of theory change. If realism

is to survive Laudan's challenge, mere sorting of historical cases is not conclusive. Realists must also show why the success of mature theories, especially those with novel predictions, provide stronger support for their approximate truth.

Scientific realists contend that a realist commitment is only justified for mature theories. They deny that many of Laudan's historical examples qualify. Mature theories are distinguished by a capacity for novel predictive success. This predictive success carries greater epistemic warrant for the approximate truth of a mature theory contrasted with theories that merely accommodate known phenomena. On this view many of the historical examples are deemed illegitimate.

As Ladyman notes, this is persuasive only if the realist can define 'maturity' and 'novelty' independently of the historical outcomes they are invoked to explain, otherwise the criteria may be ad-hoc or circular. If a historic theory exhibits novel predictive success and yet its central referents are false, this undermines the realist commitment to approximate truth. Laudan examples two historical theories, the ether and caloric theories, both seem mature and enjoyed novel predictive success but are now regarded as false. If realists accept these as characterising mature and novel theories then there is an explanatory problem regarding success as truth inferring.

The crucial question is, what distinguishes genuinely truth-tracking predictive success from the apparent success of false theories of the past? Realists have weakened the pessimistic meta-Induction by excluding many historical cases, but have strengthened the force of cases that remain. Novel predictive success underpinning approximate truth is important for the realist but does not fully refute the argument from historical theory change; realists should remain "agnostic" (Ladyman, 2002, p. 52).

A further realist argument comes in the form of structural realism. Structural realists such as John Worrall argue that the history of theory change undermines certain commitments of scientific realism to unobservables but not realism about structural relations. Science does not necessarily reveal the true nature of unobservable entities but does successfully represent the relational or mathematical structure of the world (Ladyman, 2007) . Despite the more sophisticated attempts of realists to attach realism to the ontologies of past theories through change, realists should focus on the structural relations retained across scientific theory change.

This is a middle ground. The history of theory change poses a serious challenge because successful theories are revised and rejected, yet there is a striking continuity that exists through theory change. The literal truth of terms in a rejected theory has no role in its success, but the empirical success is explained by a continuity in deeper relations. Worrall uses the Fresnel-Maxwell transition, from Ether to Electromagnetic Field, to argue that theory change preserves structural relations rather than ontology, whereas Psillos used the case to argue that realism need not retreat to structure alone as parts of an abandoned theory may still retain referential continuity and approximate truth. Following Worrall, realists should jettison commitment to the approximate truth of unobservable entities and instead commit to the approximately true structural relations represented by our best theories.

A remaining question is whether we can epistemically access these structures. The weakness is that, by abstracting to structures without clear criteria for their role in theories, the position may invite the charge that it is insufficiently informative or substantial. (Ladyman, 2002, p. 261) The history of theory change undermines a naive scientific realism. Laudan's induction shows that many once empirically successful theories were later abandoned and that success alone cannot guarantee the truth or reference of terms in our present theories.

Selective modified realism restricting to mature theories with novel predictive success weakens the force of the Pessimistic Meta Induction whilst remaining vulnerable to charges of retroactivity, circularity and counterexamples.

Structural realism offers a strong response. It concedes that theory change shows that successful past theories failed to describe true unobservable entities, but structural realism denies that this conclusion leads to inexorable refutation of scientific realism. Theory change does not warrant a full commitment to the falsity of all parts of our present best theories. Empirical success is explained by the preservation structure across successive theories. The history of theory change therefore undermines realism about ontological commitments rather than realism as such. Realism survives in a revised structural form, though it still requires clearer content and application.

References:

Chakravartty, A. (2011) 'Scientific Realism', The Stanford Encyclopedia of Philosophy.

Ladyman, J. (2002) *Understanding Philosophy of Science*. 1st edn. London: Routledge.

Ladyman, J. (2007) ‘Structural Realism’, The Stanford Encyclopedia of Philosophy.

Laudan, L (1981) ‘A Confutation of Convergent Realism’. In: M Curd and J.A. Cover. Philosophy of Science: The Central Issues. 1st edn. New York: W.W. Norton, pp. 1114-1135

Psillos, S. (2022) ‘Realism and Theory Change in Science’, The Stanford Encyclopedia of Philosophy