The Current Debate on Scientific Realism

Matthias Egg

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Outline

What Is Realism?

Two rough definitions

To be realist about an entity x is to believe that x really exists.
To be realist about a statement or theory X is to believe that X is a true description of reality.

Some clarifications:

- "entity": philosopher's term for "something", e.g., an object, event, process.
- real existence / reality includes the idea of *mind-independence.* Realism is thus opposed to *idealism*.
- Two examples of anti-realist positions:
  1. *phenomenalism*: There are only sense-data.
  2. *constructivism*: Reality is shaped by our concepts.

What Is *Scientific* Realism?

The debate on *scientific* realism differs from the debate on (general) realism in that the following assumption is taken for granted:

Common sense realism

Everyday entities like tables, trees and tigers really do exist.

By contrast, there is disagreement about:

Scientific realism

Scientific entities like genes, electrons and black holes really do exist.

So the central question is: What arguments are there to doubt the existence of genes, electrons or black holes, when one accepts the existence of tables, trees and tigers?

What Is Special about Scientific Entities?

1. Many scientific entities are unobservable. ("Observe" is here used in a narrow sense, which excludes the use of devices like microscopes or detectors.)
2. When scientific theories change, entities described by the old theory may no longer be accepted in the new theory.
3. More than one scientific theory may be compatible with empirical data. And different theories may posit different entities.

These three features correspond to three antirealist positions/arguments:

1. constructive empiricism
2. the pessimistic (meta-)induction
3. the underdetermination of theory by evidence

Scientific Realism vs. Constructive Empiricism

Bas van Fraassen, *The Scientific Image* (1980)*

Scientific realism

"Science aims to give us, in its theories, a literally true story of what the world is like; and acceptance of a scientific theory involves the belief that it is true" (van Fraassen 1980, 8).

Constructive empiricism

"Science aims to give us theories which are empirically adequate; and acceptance of a theory involves as belief only that it is empirically adequate" (ibid., 12).

* All references can be found on p. 17 of the course booklet, unless otherwise stated.

Empirical adequacy

Explication

"A theory is empirically adequate exactly if what it says about the observable things and events in this world, is true — exactly if it 'saves the phenomena' " (van Fraassen 1980, 12).

Example: According to constructive empiricism, accepting the standard model of particle physics does not include believing in electrons, quarks etc., but only believing that the model correctly describes and predicts what we observe.

Why adopt constructive empiricism?

"Constructive empiricism [. . .] makes better sense of science, and of scientific activity, than realism does and does so without inflationary metaphysics" (ibid., 73).

Do Successful Explanations Imply Realism?

Inference to the best explanation (IBE), realist version

Phenomenon Y is observed.
Hypothesis X yields the best explanation for Y.

X is true.

We certainly follow this inference pattern in everyday life. Why shouldn't we follow it in science? But doing so implies realism.

Reply by the constructive empiricist: What we really infer in everyday life is the following:

IBE, empiricist version

Phenomenon Y is observed.
Hypothesis X yields the best explanation for Y.

X is empirically adequate.

A Realist Argument against Constructive Empiricism

Kitcher (2001, Section 6)

Preliminary remark: Scientific success is not just a matter of explanation, but also of prediction and intervention.
IBE should therefore be generalized:

Inference from success to truth

If a hypothesis is successful (in a sufficiently systematic way), then it is
- true (realist version),
- empirically adequate (empiricist version).

- The constructive empiricist admits that success and truth are correlated if the hypothesis is about observables.
- The realist admits that this correlation can break down in certain cases. (E.g.: In error-tolerant systems, false hypotheses can be successful.)
- But the conditions for such breakdown have nothing to do with observability.

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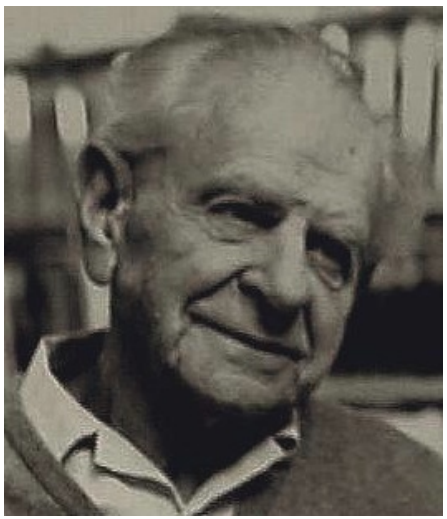
- The realist admits that this correlation can break down in certain cases. (E.g.: In error-tolerant systems, false hypotheses can be successful.)
- But the conditions for such breakdown have nothing to do with observability.
- Therefore, it is unjustified to *only* believe in hypotheses about observables (as the constructive empiricist does).

Preludes to the Pessimistic Induction: Popper



Karl Popper, *The Logic of Scientific Discovery* (1959, german version 1935)

- Scientific theories can never be verified, but only falsified.
- Nevertheless, through the process of theory testing and falsification, theories get more and more truthlike.

For further information and references, see p. 15 of the course booklet.

Preludes to the Pessimistic Induction: Kuhn

Thomas Kuhn, *The Structure of Scientific Revolutions* (1962)

- The history of science can be divided into periods of “normal science”, interrupted by “scientific revolutions”.
- Within normal science, there is consensus about what nature is like, what the scientific problems are and what counts as acceptable solutions to these problems.
- But in scientific revolutions, all of this can change (“paradigm shift”).

For further information and references, see pp. 15–16 of the course booklet.

Realism and the History of Science

Inference from success to truth, realist version

If a hypothesis/theory is successful (in a sufficiently systematic way), then it is true.

Larry Laudan, *A Confutation of Convergent Realism* (1981):

> *I daresay that for every highly successful theory in the past of science which we now believe to be a genuinely referring theory, one could find half a dozen once successful theories which we now regard as substantially non-referring. (Laudan 1981, 35)*

Pessimistic (meta-)induction

Since most of past successful theories turned out to be false, present successful theories are probably false.

Successful Theories That Turned Out to Be False

According to Laudan (1981, 33)

- the crystalline spheres of ancient and medieval astronomy;
- the humoral theory of medicine;
- the effluvial theory of static electricity;
- 'catastrophist' geology, with its commitment to a universal (Noachian) deluge;
- the phlogiston theory of chemistry;
- the caloric theory of heat;
- the vibratory theory of heat;
- the vital force theories of physiology;
- the electromagnetic aether;
- the optical aether;
- the theory of circular inertia;
- theories of spontaneous generation.

Realist Strategies against the Pessimistic Induction

1. Point out fallacies in the pessimistic induction; (E.g. *turnover fallacy:* Since false theories are shorter-lived than true theories, it is not surprising to find more of them in the history.)
2. Only claim truth for mature scientific theories; maturity is usually spelt out in terms of *novel predictive success*. Problem: Some of the theories on Laudan's list are mature in this sense.
3. Only claim truth for parts of mature theories, e.g. claims about structure ($\rightarrow$ *structural realism*) or about experimentally manipulable entities ($\rightarrow$ *entitiy realism*, see Hacking 1983, Cartwright 1983). These parts are then claimed to be unaffected by scientific theory change.

Underdetermination of Falsification

Remember Popper's claim that a theory can be conclusively falsified by finding that one of its predictions is contradicted by an experimental result.

But a contradiction between prediction and experiment does not imply the falsity of the theory; it could have other reasons, e.g.:

- a mistake in the auxiliary hypotheses employed to derive predictions from a theory,
- a malfunction of a measurement apparatus,
- a mistake in data analysis.

Underdetermination of Falsification

Experimental testing can only show that (at least) one of the hypotheses from which a prediction was derived is false, but it does not tell us which one.

Underdetermination of Theory Choice

Underdetermination of Theory by Evidence

Every finite set of empirical data is compatible with infinitely many, mutually incompatible theories.

This can be shown by constructing empirically equivalent rivals to a given theory T.

Example: According to T', the world behaves

$$\begin{cases} \text{as } T \text{ says,} & \text{whenever the universe is observed,} \\ \text{in some other way,} & \text{at all other times.} \end{cases}$$

T and T' are (by construction) incompatible with each other, but empirically equivalent.

Objection to this kind of underdetermination: it is just as much an argument against common sense realism as against scientific realism. It is therefore of no use to the antirealist who accepts common sense realism.

Empirically Equivalent *Scientific* Theories

Some examples:

- Newtonian mechanics assuming that the universe is at absolute rest vs. (quasi-)Newtonian mechanics assuming that the universe moves at some constant velocity;
- Special relativity vs. Lorentz ether theory;
- Matrix mechanics (as developed by Heisenberg, Born and Jordan) vs. Wave mechanics (by de Broglie and Schrödinger);
- Bohmian mechanics vs. collapse-versions of quantum mechanics.

Note, however, that it is not always clear whether the two theories mentioned are really different theories or just different formulations of the same theory and whether both theories are to count as scientifically respectable.

Eliminative Inference and Unconceived Alternatives

Many scientific claims are based on *eliminative inference:*

- Hypotheses $H_1, \ldots, H_n$ could account for a given set of phenomena.
- Tests show $H_1, \ldots, H_{i-1}, H_{i+1}, \ldots, H_n$ to be false.
- Conclusion: H_i is true.

Kyle Stanford, *Exceeding Our Grasp* (2006)

The Problem of Unconceived Alternatives

Eliminative inferences are unreliable if there are plausible and sufficiently distinct alternative hypotheses that were not taken into consideration.

Why Are Unconceived Alternatives a Problem?

The Problem of Unconceived Alternatives (PUA)

Eliminative inferences are unreliable if there are plausible and sufficiently distinct alternative hypotheses that were not taken into consideration.

Recurrent, Transient Underdetermination

Past theorists failed to consider plausible and radically distinct alternatives to their own theories, namely the theories that came to be accepted later. Past theorists were thus subject to the PUA.

New Induction

Since present theorists are not relevantly different from past theorists, they are subject to the PUA as well.

Comments on Stanford's *New Induction*

- While the original pessimistic induction was about theories, the new induction is about theorists.
- Nevertheless, there are relevant similarities between the two arguments, so some of the realist strategies against the pessimistic induction may also work against the new induction.
- In particular, the realist can claim: Insofar as unconceived alternatives are plausible, they are not "radically distinct". There are always parts of earlier theories which are retained in later theories.
- But: Realism needs a criterion to discern *which* parts of a theory are likely to be preserved in later theories.