



Some tentative remarks about
The Scientific Enterprise,
which may prompt some useful discussion

Scope & ambition of our charge

Our main task appears to be this: to produce accounts of **replicability** and **reproducibility** in science that

- can serve as **effective guides** to practice;
- will **apply equally** to physics, chemistry, the life sciences, the earth sciences, engineering, statistics, psychology, and the social sciences.

Some things that will help:

- a wealth of different examples;
- careful attention to different questions concerning R&R that can arise, in different contexts.

Two aims scientists might have

Specific scientific investigations might aim at either of two very different goals (I do not mean for these to be exhaustive):

- **explanation** of some phenomena;
- **accurate mapping** of some aspect of the world's structure.

Each kind of investigation will give rise to questions concerning R&R. But these questions are likely to look different.

For example: use of **controlled experiment** (or an adequate observational surrogate) is essential to the discovery of explanatory principles; it is not essential in the same way to accurate mapping.

A closer look at explanation

Once, philosophers took for granted that the search for explanation was of a piece with the search for **natural laws**.

That approach has given way to a focus on **generalizations about objective dependencies**, as the central kind of explanatory principle.

- example: principle of thermal expansion/contraction of metals

An interest in these kinds of dependency hypotheses goes hand in hand with an interest in **controlled experiment**.

And this in turn generates a specific question about replicability: We need to know whether or not to diagnose a given failure to replicate a controlled experiment as a failure to control for potentially relevant variables. Contrast:

- cold fusion (Pons & Fleischmann)
- bogus ‘refutation’ of the above principle concerning metals

Shallow vs. deep explanation

A candidate dependency hypothesis may be assessed on (among others) these three dimensions:

- how **well integrated** is it with other dependency hypotheses in the same domain?
- to what extent are there **theoretical resources** that can be brought to bear, when judging its credibility?
- to what extent is further scientific research **predicated** on it?

These factors make a difference to

- our ability to assess what counts as an adequate replication of an experimental test of the hypothesis;
- how pervasive de facto tests of the hypothesis are;
- whether a replicable test of the hypothesis is even necessary.

Some key epistemic issues

Our questions fall under a much larger (and more amorphous) question about science:

- What **is** scientific justification?

A tad more exactly:

- Given some body of empirical evidence E, and some scientific hypothesis H, what conditions are necessary and sufficient for E to render H **credible** (perhaps, to some specified degree)?

For comparison: In the late 19th and early 20th centuries, mathematicians and philosophers asked a parallel question:

- What **is** mathematical justification?

They succeeded in producing a complete, detailed, powerful answer, in the form of modern quantificational logic.

Can the same be done for empirical science?

Some key epistemic issues

Probably not. There are at least four deep disanalogies between these enterprises:

- Scientific justification is **ampliative**.
- The status of being “scientifically justified” is **revisable**.
- The possibility of empirically justifying some scientific claim appears to require that we take for granted that – in some sense – **nature is not capricious**.
- Empirical justification cannot be a matter of the purely **structural relationships** between evidence and hypothesis.

Upshot: Despite decades of research, the general question about scientific justification has not produced results nearly as decisive as logic was, for mathematics.

- Though there **have** been results: e.g., Bayesian confirmation theory.

Epistemic/sociological issues

One reason we may reasonably demand R&R is as a check, not on some proposed hypothesis, but on **each other**.

Scientific research is a social activity, and as such, requires **trust**. Demanding R&R helps reinforce trust, in at least three ways:

- by nullifying incentives to cheat;
- by counteracting perfectly understandable psychological forces such as confirmation bias, pressure to publish, perhaps others;
- by avoiding certain kinds of statistical errors, such as the unwitting filtering out of null results.