HPSC 1001/1901/2101/2901

WHAT IS THIS THING CALLED SCIENCE?

Semester 2, 2020

Lecture 9: Karl Popper

Karl Popper (1902-1994)

A crucial figure in this course. Philosophically, he breaks from many of the empiricist ideas we've been looking at. He was opposed to the idea of an *inductive logic*, and saw testing differently from others. But he did see testing in science as empirical – science is guided (in one way) by observation.

Also: a theory of how *change* works in science. From this point on, scientific change is a major theme.

Popper is just about the only recent philosopher of science who a large number of scientists regard as a hero, an

inspirational figure. He gave practical advice to scientists that they did pay attention to.

Background: Popper grew up in Vienna. Interacted with the Vienna Circle but was not part of the group. Moved to NZ after the rise of Hitler. Later moved to the UK where he had a lot of influence. Eventually knighted.
Political philosophy as well as philosophy of science. A defender of liberal democracy, tolerance, freedom of expression, and the value of "open" societies.

Most important work: *Logik der Forschung* (1934).
Translated as *The Logic of Scientific Discovery* (1959).

The idea at the center of Popper's view: Science as a combination of *conjecture and refutation.*

Think of this as a cycle, endlessly repeating.

Conjecture → Refutation → Conjecture....

Conjecture: a scientist comes up with a hypothesis, a possible explanation for something that goes on in the world. The conjecture can come from anywhere. It need not be derived

from earlier data, though it can be. It can be wild and imaginative – that is fine. Conjecture is a creative process.

Refutation: the conjecture is criticized. We try to show it is wrong. This is done by observation and experiment.
A genuinely scientific conjecture *prohibits* some things from being seen. It is falsifiable. So once a conjecture is offered, people go looking for the observations that would falsify the conjecture. If we see those things, the conjecture has been refuted or falsified (these mean roughly the same thing).
If we do show the conjecture is false, that is great. We have learned something. The cycle begins again.

What if we can't show the conjecture to be false? What if it resists all our attempts to refute it? More on this later....

Science as a cycle of conjecture and refutation – three roles for this idea:
(1) A "criterion of demarcation," (2) a view of the process by which science changes, (3) a view of testing and rationality, especially a replacement for "inductive" views of rationality in science.

(1) What distinguishes science from non-science, especially "pseudo-science"?
Popper: Scientific theories are falsifiable in principle.

> *Falsifiability criterion:* A theory is scientific if and only if it could be refuted (shown to be false) by some possible observation.

To be scientific, a theory has to take risks, has to "stick its neck out." If a theory takes no risks at all, because it is compatible with every possible observation, then it is not scientific.

This is set up as a view about what makes a *theory* scientific. But the main idea can be used in different ways. Perhaps it could be applied to fields rather than single theories, or –

more importantly, I think – to scientific *behavior*. (The same theory could be handled in a scientific or unscientific way.) Keep these options in mind.

The two other applications of the C+R idea: (2) A view of the process by which science changes, and (3) A view of testing, rationality, and the growth of knowledge.

A closer look at the C+R process

Considering all three of the applications above.

Again: conjecture is bold and imaginative. Einstein as a classic example. It is fine to come up with initially very strange ideas, as long as they can be tested.

Again: testing is an attempt to show a theory to be false. One should look for and probe the theory's weak points, not look for "confirmation."

For Popper, this is a description of what science actually tends to be like much of the time, and also a *pre*scription – an account of what scientists *should* do. A good scientist is not wedded to his or her theories, but instead happy to see them

proved wrong. A scientist should maintain a permanent and all-encompassing *critical attitude*.

Suppose we agree with Popper that a combination of creativity and criticism is good in science. Does it matter whether the *same* people play both roles? Suppose person *A* comes up with a conjecture, and they don't want to hear criticism of it, but person *B* is around to critically test it. Is that bad?

Or: suppose some people specialize in conjecture and others specialize in refutation. This is a bit like the familiar division of labor between theoreticians and experimentalists in science.

That division of labor is inevitable to some extent. Would it be bad if the combination of attitudes that Popper values (creativity and a critical attitude) also had a division of labor?

Popper: an individual must always remain critical about their own conjectures, always be looking to falsify them, and always willing to throw them away if they are falsified.

> "[W]henever we propose a solution to a problem, we ought to try as hard as we can to overthrow our solution, rather than defend it." (*LSD* p. xix)

The C+R pattern should be visible at all scales: within individuals and within communities. It's not the same, for Popper, if one team advocates theory X and refuses to consider criticism of it, while another team advocates theory Y and tries to refute X.

But why is this other way of manifesting a C+R pattern worse than Popper's preferred way? Not obvious. Something to think about.

In the framework I introduced at the beginning of the course, this is a question about the relations between level 1 and level 2. From the first week:

Level 1. A fine-grained or zoomed-in perspective on science: observation, reasoning, and belief as activities of individual people.

Level 2. At an intermediate scale: social networks and communities that scientists work within.

Level 3. Embedding of science within a larger society, interacting with government, medicine, etc.

Popper: C+R is presented as a level-1 story, as a description of what individual scientists do and ought to do. But are there other equally good ways to have a C+R combination in a scientific community?

This connects also to Popper's inspirational role for many working scientists. Often they say that what they learned from Popper is that it is *OK to be* wrong in science. In fact, it is not just OK, but *good* to be wrong, as long as you and everyone else learns from the error.
I agree that Popper is onto something important here.

The third role for C+R:
(3) A replacement for "inductive" views of rationality in science.

Remember a feature of the testing of generalizations. One case suffices to show that a generalization (All *F*s are *G*) is

false. (One white raven means the end of an “All ravens are black” conjecture.) Very hard to show a generalization of this kind is true.

Logical empiricism: that is OK. We can gradually build support for a generalization. An “inductive logic” is a theory of how this works.

But the idea of an inductive logic ran into problems (ravens problem, Goodman’s problem from last week). One possible conclusion: an inductive logic is impossible. And the whole idea of the building of *support* for a theory might be an

illusion. Perhaps all we can do is show theories to be false, never show them to be (probably) true.

Popper: that is how things are, and it's fine. Not a threat to the rationality of science. Through testing, we can show conjectures to be false, and this is a *deductive* matter.
If you find a white raven, that shows the falsity of "All ravens are black" in a deductive way.

Suppose we can't find a case that falsifies the conjecture? We should keep looking.

A summary of how Popper wants things to go:

- Scientific theories are falsifiable in principle, and non-scientific theories are not.

- Falsification is deductive. If you observe something incompatible with the theory, the theory is falsified.

- When we try and fail to falsify a theory, it is not confirmed. It has survived testing so far – that is all we can say.

Is this a threat to the rationality of science? No, according to Popper. It is fine if we can only ever show theories to be false. As we do this, knocking out one theory after another,

we are learning at each step. And there is no better method available. As time passes, we continually eliminate errors. That is a kind of progress.

What can we say about a scientific theory that is in the textbooks now, and has not been falsified? All we can say is: it is not been falsified. We have no reason to switch to some other theory.

That's how Popper wants things to go. Next we'll put some pressure on these ideas.