

What is science?

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- Formal
- Systematic
- Rigorous
- Empirical (based on observation not personal opinion)
- Consistent
- Proven knowledge

(the) Scientific Revolution

- 16 & 17thC (*note earlier Islamic revolution*)
- Renaissance

...Enlightenment

- Copernicus, Galileo, Newton, Harvey
 - earth revolves around the sun
 - laws of motion, gravity
 - blood circulates around arteries and veins

Scientific attitude

- Direct observation (empiricism)
- Demarcation (break with natural law, testing)
- Reject idealism (Plato – senses are illusory)
- Reject essentialism (Aristotle – things have essence that explains what they do)
- Causality (laws)
- Idea of progress

Logical positivism/ logical empiricism

- ***Empiricism*** (observation/experience as the basis of knowledge - *verificationism*)

plus

- ***Rationalism*** (mathematics, logic, reason)

Note: Comte defined *positivism* – a philosophy of science which encompasses scientific method (observe, measure, test)

Induction

- Move from *singular statements* (x occurred at time y) to *universal statements* (encompass all events at all times)
- allows us to **generalise** from singular to universal law (provided we have enough observations under a variety of conditions)
- *Deduction* allows us to move from law/theory to prediction and explanation

The problem of induction

- Hume (how do we know $n+1$ will happen)
- Wittgenstein (the problem of sameness: how do we know that $n+1$ is really the same as n)

Bertrand Russell's inductivist turkey



Falsification (Popper)

an alternative to inductivism

- Science makes definite claims about the world
- Science = hypotheses in search of falsification (e.g. looking for the black swan)
- Science progresses by trial and error (test hypotheses, and eliminate those we reject, refine/ make new hypotheses)

What do you see?



The problem of observation

Seeing is meaning making not just optic nerve response (*fallibility of observation*)

Observation is theory dependent

- Concept (e.g. count crime)
- Hypothesis (direction of causality?)
- Value (what is important)
- Interests (economic benefit?)
- Cultural specificity (belief systems)



Lakatos: *Proofs and Refutations* (1976)

challenges falsification/Popper

- theory is really a series of slightly different theories and techniques that develop over time – around a ‘hard core’ of shared common ideas (*research programmes*)
- Hard core protected from falsification – we simply resolve inconsistencies (CERN speed of light story?)
- *Positive heuristic* – methodological rules for the kind of science you should do, paths to follow etc.

Kuhn: *Scientific Revolutions* (1962)

challenges inductivism – science as a social activity

- Normal (mature) science = theories and techniques structured into a single shared **paradigm** (*typically contains explicit laws, standard applications, measures and techniques*)
- Science as puzzle solving within the paradigm
- Encounters crisis (falsification it cannot reconcile, anomalies that cannot be explained)
- Rival paradigm ‘appears’ and we abandon the old and adopt new paradigm (which in turn becomes normal science)

argues that scientific revolutions are necessary

- periods of normal science allow puzzle solving to go on (if scientists were permanently critical nothing would get done)
- revolution necessary to progress

Merton: Functionalism (1957)

Science = an institution that serves a social function

Norms – particular behaviours are promoted and rewarded

- *Universalism*: truths hold independent of teller
- *Communism*: common ownership of knowledge
- *Disinterestedness*: report what(ever) you find
- *Organised scepticism*: disbelieve until established

Feyerabend *Against Method* (1975)

'anarchist' view of science

- “all methodologies have their limitations and the only rule that survives is ‘anything goes’” (actually not ‘anything’, but you don’t have to be steeped in current methodology)
- *Incommensurability*: meaning depends on context (quantum and classical mechanics coexist and have to be interpreted in their own terms)
- Science is not superior knowledge
- Embrace freedom (from methodological constraints of ‘petrified science’)

Some of the other 'isms'

- *Scientism*: rejection of logical positivism
- *Objectivism* : knowledge 'out there' vs 'what I know' (*individualism*)
- *Realism*: science aims for truth/ tells us what the world is really like vs *relativism* (multiple possible truths)

Social studies of science and technology

- Who are scientists?
- Social context(s)
- Social construction
- Actor networks

Invisible colleges

- scientific elites (the people who really matter – the prolific, the prize-winners)
- *Do prestigious institutions attract more productive staff?*
- Feminist critique
 - leaky pipeline
 - sexism in science
 - *standpoint theory* – feminist privileged perspective on gender relations (in science and technology)

Bloor: The Strong Programme (1976)

a (relativist) sociology of science

Science created from social context/interests

- what are the conditions that bring about knowledge claims (*causality*)
- Failed/successful knowledge claims are equal (*impartiality*)
- We can use the same explanations for success or failure (*symmetry*)
- We should apply the same ideas to thinking about sociology (*reflexivity*)

What about technology?

- Is it just the application of science (move from basic to applied science)
- Or science determines technology (the technology we have is only limited by the bounds of our scientific methods and knowledge)
- Or is technology the application of science in the service of power (Heidegger)