## SCIENCE

Lecture 2: The Problem of Demarcation I

#### Overview

- $\circ\,$  The Problem of Demarcation
- $\circ$  Verificationism
- Falsificationism

### Problem of Demarcation

#### • Recall:

- The unique and extraordinary success of Science since the Scientific Revolution (17<sup>th</sup> century) in providing us with useful knowledge to control and predict natural phenomena
- The desire of other fields of knowledge to attain a similar level of esteem (and influence?) by associating themselves with Science
- 2 main questions:
  - How to determine what is Science and what isn't Science?
  - Why does it even matter?
- 3 possible categories:
  - Science
  - Pseudo-science
  - Non-science (doesn't try to pass itself off as science, e.g. Humanities)
- E.g. Astronomy vs Astrology vs Science Fiction novel (e.g. Dune)

# Exercise: Science, Pseudoscience or Non-science?

- Acupuncture (the belief that by inserting needles into various parts of the body, you can restore normal energy balance to relieve pain and cure various disorders)
- Astronomy
- Botany (the study of plants)
- Creationism (the belief that the theory of evolution is false and that each species was uniquely created by God)
- History
- Homeopathy (the belief that an extremely small quantity of a substance that can cause certain symptoms in a healthy person can cure similar symptoms in an unhealthy person)
- Ethics
- Economics
- Literary Criticism
- Psychology
- Psychoanalysis (a set of theories and therapeutic techniques that deal with the unconscious mind and form a method of treatment for mental disorders by helping people to release repressed emotions and experiences – making the unconscious conscious)

#### Problem of Demarcation

- Not a straightforward question
- Possible criteria:
- 1) Science as "the attempt to understand, explain and predict the world we live in" (B, 1)
  - but then, so does religion, astrology, fortune telling, psychoanalysis and history!
- 2) Science as that which employs experimentation
  - but not all sciences do (e.g. astronomy and many social sciences)
- 3 traditional answers: Verificationism, Falsificationism and Kuhnian Paradigmmatism

#### Verificationism

- Aka the Traditional View of Science where a scientist attempts to confirm a hypothesis by finding evidence to suggest that it is true based on induction
  - Assumes the principle of the uniformity of nature, i.e. that the future will resemble the past
  - Once there is a good amount of supporting evidence, the hypothesis is accepted as provisionally true
- Founders: the Vienna Circle, aka the Logical Positivists (LP) aka Logical Empiricists in the 1920s
- One of LP's central tenets is Verificationism: A criterion of meaning where a
  proposition is **only** <u>meaningful</u> if it can be definitively and conclusively
  determined to be either true or false
- LP held that all knowledge should be reduced to **logical and scientific foundations**
- This is because all meaningful propositions are either <u>analytic a priori</u> (hence logically verifiable; essentially math or logic) or <u>synthetic a posteriori</u> (hence empirically verifiable; essentially science).
- In other words, they deny the possibility of synthetic a priori knowledge
- In this way, LP distinguished science from *metaphysics* (and not pseudoscience per se) which they viewed to be empirically nonverifiable and thus meaningless
- Hence, under LP's simple view of science, there was <u>no focus</u> on whether a theory would be incompatible with every possible experience as Popper's Falsification did; all it focused on was whether the theory could be **empirically** verifiable.

#### Verificationism

- Distinguishes between Contexts of Discovery and Justification
  - COD: the actual historical, psychological process by which a scientist arrives at a given theory (e.g. dreaming of a snake eating its tail) – can be <u>subjective</u>
  - COJ: the means by which a scientist tries to justify his theory, like testing and experimentation – <u>objective</u>
- Distinction between Theories and Observational Facts
  - Theories non-neutral, i.e. scientists can and do disagree about them
  - Observational Facts neutral, i.e. scientists can and do agree about them

### Verificationism - Implications

#### • Science as rational

- Theory Choice is **objectively** settled by looking to the *neutral* observational facts, i.e. facts will determine theory choice
- The term "facts" already suggest the idea of neutrality facts are that which are 'out there' waiting for us to discover. They are objective and not tainted by theory.
- The better theory is simply the one which the evidence supports
- Science progresses linearly and cumulatively due to rational theory choice
  - The old theory is replaced by the new, better theory
  - We are getting ever closer to Objective Truth (e.g. Theory of Everything)
- Psychoanalysis would count as a science under Verificationism since its predictions can be empirically verified.
  - E.g. if a psychoanalytic theory postulated that a man would marry a woman that reminded him of his mum, then it could be verified insofar as one checks whether the man had indeed married someone who reminded him of his mum.

#### Verificationism - For

- Intuitive! Fits the traditional view of science as the cumulative search for truth via the verification of theories
- Also explains why we think that science is a rational (as opposed to irrational, not empirical) activity

### Verificationism - Against

- The Problem of Induction means that Science as defined by the LP is open to uncertainty
- The Problem of Induction also means that general laws (like the laws of nature) become meaningless under Verificationism since it would be impossible to verify that the law held for <u>all instances</u>
- More fundamentally, the Verification criterion itself proved to be **unverifiable**.
  - Under this doctrine, any meaningful proposition must be either analytic (i.e. logically verifiable) or (empirically) verifiable.
  - But this criterion is itself not analytic for the proposition, "all statements that have meaning must be either analytic or verifiable", it is not immediately clear that the subject, "statements that have meaning", contains the predicate, "analytic or verifiable", which means that it is not analytic.
  - But it is not verifiable also since it is not empirically possible to prove it.
  - So the Verificationist principle is itself unverifiable!

### Verificationism - Against

- Not all sciences actually use experimentation because it is either not possible (e.g. astronomy) or not ethical (e.g. psychology)
- Theory Choice suffers from Underdetermination and thus cannot be objective
- What we intuitively consider to be pseudoscience might be considered science under Verificationism e.g. psychoanalysis
- Data is Theory-laden

#### Theory-ladenness

- i.e. the idea that data is contaminated by theory
- This is because Science is done through the lens of an existing theory/ paradigm such that:
- A) Perception theory-ladenness: Observation is not objective because perception itself is already conditioned by background beliefs (e.g. little sperm men) and/or
- B) Semantic theory-ladenness: Data is recorded in highly theoretical language that already assumes the truth of the theory being tested (e.g. "an electric current is flowing through a copper rod" this statement already assumes that there is such a thing as an electric current, thus 'proving' your theory)
- There is also a third way that data can be theory-laden: Salience where a theory determines which are the relevant variables to study (recall Lecture 1 which are the important variables to observe and which aren't is determined by theory choice which itself is already subjective)
- Hence, even the act of observation, so crucial in science, is not objective
- As opposed to the traditional view of Science (i.e. held by the LP) which holds that facts are: 1) directly given to careful, unprejudiced observers via the senses, 2) are prior to and independent of theory, and 3) constitute a firm and reliable foundation for scientific knowledge
- In other words, the LP's distinction of theories and observational facts is mistaken

#### Falsificationism

- Founder: Karl Popper
- Aim: to distinguish genuine science, e.g. Einstein's theory of relativity, from pseudo-science, e.g. Marxism and psychoanalysis
- Falsificationism as Demarcator: a theory is scientific if and only if it is falsifiable, i.e. it is capable of being proven false.
- In other words, a scientific theory is one which is <u>not</u> <u>compatible</u> with every possible course of experience.
- E.g. of science: Einstein's theory of gravitation which made a <u>definite</u>, <u>precise</u> prediction (e.g. that light rays from distant stars would be deflected by the gravitational field of the sun) which can then be easily proven false by observation.

#### E.g. of Pseudoscience (Article B, 2)

#### • <u>Psychoanalysis</u>

Imagine a man who pushes a child into a river with the intention of murdering him, and another man who sacrifices his life in order to save the child. Freudians can explain both men's behaviour with equal ease: the first was repressed and the second had achieved sublimation.

In other words, Freud's theory could be rendered compatible with any clinical data whatever – unfalsifiable.

#### • <u>Marxism</u>

Marx predicted that capitalism would give way to socialism and then to communism. When that didn't happen, **ad hoc explanations** were given to explain these falsifying results away - e.g. that the inevitable progress to communism had been temporarily slowed by the rise of the welfare state. Like psychoanalysis, Marxism can be rendered compatible with any data - unfalsifiable

#### Falsificationism

- Under falsificationism, unlike verificationism, a scientist is not so much trying to show that the theory is true but that it is false
  - $\,\circ\,$  In other words, she is testing the consequences of a theory via an experiment to try and falsify/refute it
  - Only in the face of repeated falsifying attempts (as opposed to verifying results) is the theory accepted as provisionally true

#### • But why?

- Popper recognised the logical asymmetry between falsifying a theory and verifying one – you can <u>conclusively</u> falsify a theory but never conclusively verify
  - While verifying theories always falls to the problem of induction (as we can never absolutely verify a theory), nonetheless, logically speaking, we can with one result **deductively** prove that a theory is false
  - i.e. to verify that "All As are Bs" is true, we need to examine every single A to ensure that not a single one is not a B – this is patently impossible and thus impossible to truly verify a hypothesis.
  - But it is possible to find just one falsifying instance and therefore conclusively prove a theory false.
  - Popper's falsificationism thus "dissolves" the problem of induction as, according to Popper, we don't do science via induction but by conjecture (imaginatively inventing new theories) and refutation
- It also explains why Popper demands that Science be in the business of generating risky and bold predictions as opposed to vague ones that can always be 'rescued' in the face of falsifying results
  - $\circ~$  A risky theory that continually resists falsification is a better theory and more likely to be true

#### Falsificationism

- Note that Popper's position seems to have shifted over time.
- Initially, he allowed for claims to move from unfalsifiability to falsifiability (that was what he believed would be the case for psychoanalysis).
- In other words, falsifiable meant testable by current technology
- But his supposed last statement on the issue was that falsifiability need only be **logically possible**
- i.e. that the claim in question can, in theory, be falsified by a certain turn of events, regardless of whether currently we have the technology and the means to measure such a falsifying event.
- Yet holding on to such a loose definition of falsifiability might mean that the definition becomes **too broad**, i.e. some disciplines would be seen to be science when they shouldn't be (e.g. psychoanalysis? History? Religion?)
- He would also hold that falsifiability is a <u>necessary and sufficient</u> <u>condition</u> for a claim to be considered scientific.

#### Falsificationism – For

- Intuitive! Does seem fishy if a theory can fit any empirical data whatsoever.
  - This is because a theory that can prove anything actually proves nothing since any prediction accommodates all possible outcomes, thus rendering the prediction useless
  - E.g. of a rain dance: Prediction that it will rain if I dance hard/well enough. Result: it doesn't rain. Conclusion: I must not have danced well or hard enough.
- It also has the support of the scientific community in general
- Furthermore, Falsificationism dissolves the Problem of Induction for Science (as seen earlier)

#### Falsificationism – For

- Description of the progress of science via conjecture and refutation (the coming up of new hypotheses and the rejection of them) seems true
  - E.g. move from Newtonian mechanics to Einsteinian relativity
- Falsificationism also explains the importance of creative thinking/imaginative conjectures for science

   no amount of hard work collecting data will give you a theory – again, intuitive!

### Falsificationism - Against

- Doesn't fit the history of science during 'normal science', only during revolutionary periods (i.e. between paradigms)
  - Scientists do typically try to explain away falsifying results, especially when they are few and isolated, instead of saying that the theory has been falsified
    - E.g. Experimental Error, Anomalies
    - E.g. Discovery of Neptune (Holistic Underdetermination)
  - In general, scientists do not just abandon their theories when confronted with conflicting data; they find some way to try and explain away/incorporate the conflicting data
  - In fact, most scientific theories will be faced with conflicting data
  - If scientists simply abandoned their theories at the first sight of conflicting data (which is what Popper wanted), then little progress would be made.
- Falsification doesn't tell us what exactly is falsified is it the entire theory or is it one of the background assumptions (think holistic underdetermination) – and thus what we should do in the face of such falsifying results

### Falsificationism - Against

- In practice, falsificationism doesn't work in dissolving the problem of induction.
  - For it is impossible to guarantee that the falsifying result is not merely an experimental error.
  - This means that we need to have more instances of falsifying results in order to conclusively falsify the hypothesis.
  - But if so, then we are back to the problem of induction how many falsifying results do we need to conclusively falsify a hypothesis? Coming up with the number could well depend on what the community viewed to be the right number in the past
- Falsificationism as a criterion of demarcation is not that intuitive
  - Recall that for Popper, falsification is a necessary and sufficient condition for a claim to be considered scientific
  - A theory that is falsifiable but has no supporting evidence isthus scientific whereas one which has supporting evidence for it but is not falsifiable is not scientific
  - E.g. astrology which is clearly an e.g. of pseudoscience but has been thoroughly refuted and is thus falsifiable.

#### Falsificationism - Implications

#### Under falsificationism, progress for science is unachievable

- If science is about falsifying hypotheses, and there is an infinite number of hypotheses, <u>how do we</u> <u>even measure progress</u>?
- Eliminating many theories (say 100 million) gets us no closer to the truth as 100 million is infinitely smaller than infinity!
- In other words, according to falsificationism then, progress in terms of getting to the truth is not possible in science.

#### Homework

- Science notes pp. 5-6 (Falsifiability)
- TOK 235-240
- $\circ~$  Articles B and C