

PHIL 265

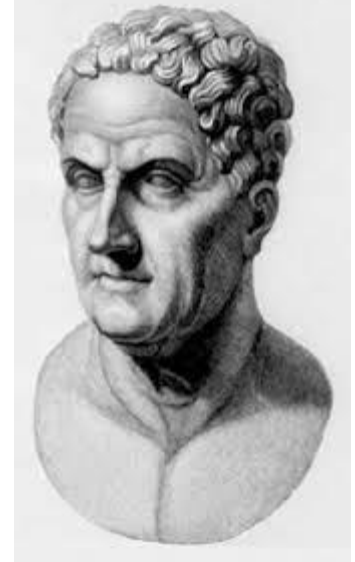
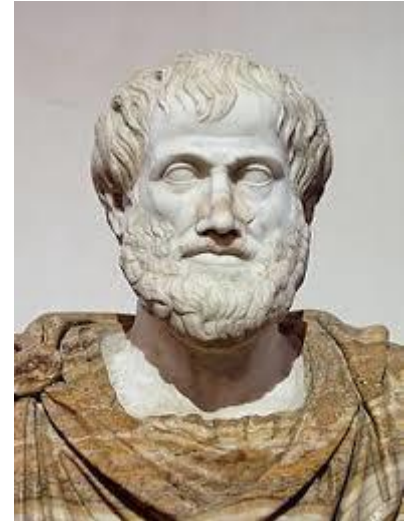
Philosophy of Science

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Scientific method vs. authorities

- During the middle ages (scholasticism), university research and teaching consisted mainly in the interpretation of texts by authorities, such as:
 - Aristotle (384 – 322 BC) in physics
 - Galen (129 – 200/217 AD) in medicine



Scientific revolution

- Modern science emerged during the **scientific revolution** in 1550 – 1700.
- ‘Natural philosophy’: Copernicus, Galileo, Descartes, Boyle, Newton, etc.
 - Critical attitude towards received views and authorities
 - Gaining knowledge by detailed **observation** and **experiment** of natural phenomena

Empiricism

- Empiricism: Beliefs are ultimately justified (become knowledge) by sense experience.
- Empiricism vs rationalism
- **Naive empiricism** calls for the systematic study of the empirical world, deriving scientific theories from observation.

Naive empiricism

- Francis Bacon (1561–1626)
- The first figure of naive empiricism
- He argued that the main impediment to objective knowledge is the biasing of observations by pre-existing conceptions.



Naive empiricism

- Bacon's method:
 - Step 1: Collect as much **observational data** as possible without any prior **theoretical assumptions** or opinion about what is relevant.
 - Step 2: Use **induction** (generalization from many samples) to derive laws and theories.
- Example: Investigate physical nature of heat by gathering and examining many objects that feel warm, e.g., fire, stones in the sun, feathers, etc.

Naive empiricism

- “I frame no hypotheses; for whatever is not deduced from the [observational] phenomena must be called a hypothesis; and hypotheses ... have no place in experimental philosophy. In this philosophy particular propositions are inferred from the phenomena, and afterwards rendered general by induction. Thus it was that ... [my] laws of motion and gravitation were discovered.”

■ Isaac Newton, *Principia*, 1687

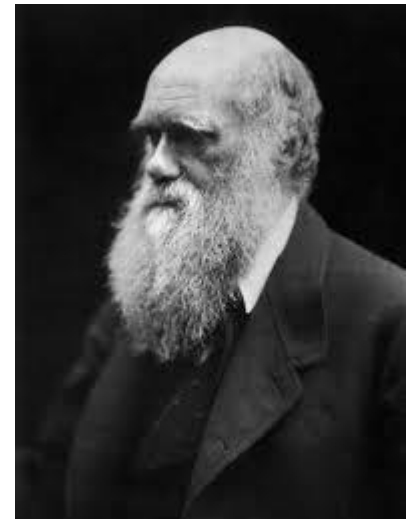


Naive empiricism: Problems

- There is more data than anyone **could** collect.
- Not all sorts of data are **relevant** to the scientific question.
- Prior knowledge tells one which observations are probably relevant, which phenomena are related, how to effectively investigate and form further hypotheses.

Naive empiricism: Problems

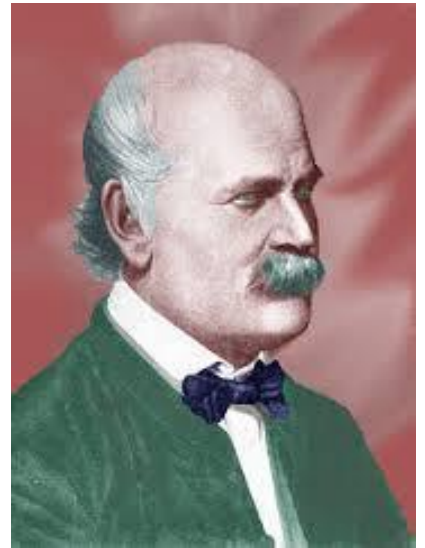
- “About thirty years ago there was much talk that geologists ought only to observe and not to theorize; and I well remember someone saying that at this rate a man might as well go into a gravel-pit and count the pebbles and describe the colors. How odd it is that anyone should not see that all observation must be for or against some view if it is to be of any service!”



■ *Charles Darwin (1861)*

Theory-guided empiricism

- Before the advent of the germ theory of disease, Ignaz Semmelweis (Hungarian physician) argued in 1847 that incidence of childbed fever could be reduced by physicians washing their hands in chlorine.



Theory-guided empiricism

- Why do mothers in Clinic 1 die more often than in Clinic 2?
- Theory 1
- Perhaps because of miasma ('bad air')?
 - It was commonly assumed that many diseases (such epidemics as the Black death) spread by noxious air.
- Collect data on the orientation of windows and on winds, comparing both clinics.

Theory-guided empiricism

- Why do mothers in Clinic 1 die more often than in Clinic 2?
- Theory 2
- Perhaps patients in Clinic 1 think more about death and die because of low morale?
 - Semmelweis had noticed that patients in one clinic had a better view of the priest giving the last rites to those who were dying.
- Experiment with the priest's routines.

Theory-guided empiricism

- Why do mothers in Clinic 1 die more often than in Clinic 2?
- Theory 3
- Perhaps because of the position they lie in during labour?
 - Semmelweis had noticed that in Clinic 2 more mothers were poor and had given birth in the streets, so perhaps not lying on their backs.
- Experiment with position during labour.

Theory-guided empiricism

- Why do mothers in Clinic 1 (medical students) die more often than in Clinic 2 (midwife students)?
- Theory 4
- Perhaps doctors and medical students cause the disease (by transferring 'cadaverous particles')?
 - A colleague had died of similar symptoms after being accidentally poked by a student's scalpel during dissection of a dead body.
- Experiment with doctors' hygiene
 - Semmelweis became convinced of this theory (though generally accepted much later).

Scientific knowledge

- Scientific knowledge



- Reasoning



- Facts



- Observation



- Sense experience

Facts

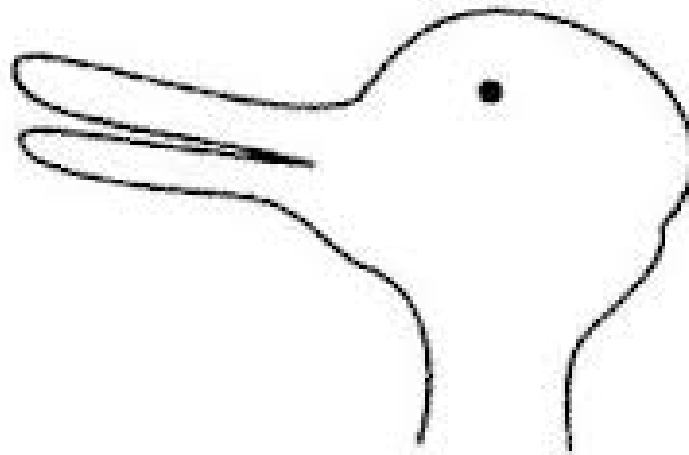
- “Scientific knowledge is derived from the facts.”
- The main assumptions:
 1. “Facts are **directly** given to careful, unprejudiced observers via the senses.”
 2. “Facts are **prior to** and **independent** of theory.”
 3. “Facts constitute a firm and **reliable** foundation for scientific knowledge.”

Facts

- External objects
- ↓
- Perceptual experience
- ↓
- Observation statements

Perceptual experience

- Do two persons looking at a picture have the same visual experience?



Perceptual experience

- Do two persons looking at a picture have the same visual experience?



Perceptual experience

- Factors from **outside**
 - Objects
 - Light
- Factors from **inside**
 - Knowledge
 - Experience
 - Training
 - Expectations



Observation statements

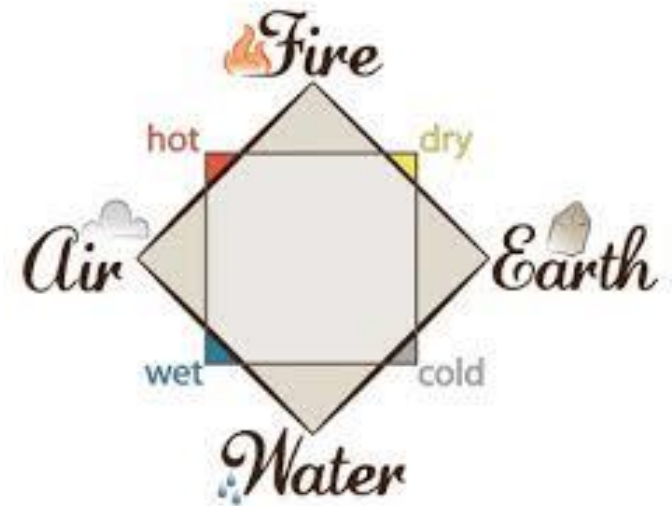
- How to formulate and express a given perceptual experience?
 - Conceptual framework
 - Names of objects
 - Terms for properties

Facts vs theories

- Observation statements are theory-
dependent:
 - The formation of beliefs and statements are based on our prior knowledge.
- In what sense, observation statements do
precede theories?
 - The truth or falsity of the observation statements is determined by observation.

Fallibility of facts!

- When our conceptual framework changes, some observation statements might turn out to be false.
- Example: Aristotle's four elements
 - Observation statement:
The fire is going up.



Fallibility of facts!

- Disagreement over the **observable** phenomena
- Instruments
 - The naked eye vs. telescope



Facts

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- The main assumptions:
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 2. “Facts are **prior to** and **independent** of theory.”
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- Which assumption is correct in its unqualified form?