Part I

The Demarcation Problem

Chapter 1

Popper's Falsifiability Criterion

1.1 Popper's Falsifiability

Popper's Problem : To distinguish between science and pseudo-science (astronomy vs astrology)

- Important distinction: *truth* is not the issue – some theories are scientific and false, and some may be unscientific but true.

- Traditional but unsatisfactory answers: empirical method

- Popper's targets: Marx, Freud, Adler

Popper's thesis : *Falsifiability* – the theory contains claims which could be proved to be false.

Characteristics of Pseudo-Science : unfalsifiable

- Any phenomenon can be interpreted in terms of the pseudo-scientific theory

"Whatever happened always confirmed it" (5)

- Example: man drowning vs saving a child

Characteristics of Science : falsifiability

- A scientific theory is always takes risks concerning the empirical observations. It contains the possibility of being falsified. There is confirmation only when there is failure to refute.

"The theory is *incompatible with certain possible results of observation*" (6)

- Example: Einstein 1919

1.2 Kuhn's criticism of Popper

Kuhn's Criticism of Popper : Popper's falsifiability criterion fails to characterize science as it is actually practiced. His criticism at best applies to revolutionary periods of the history of science. Another criterion must be given for normal science.

Kuhn's argument :

- Kuhn's distinction between normal science and revolutionary science

- A lesson from the history of science: most science is normal science. Accordingly, philosophy of science should focus on normal science. And any satisfactory demarcation criterion must apply to normal science.

- Popper's falsifiability criterion at best only applies to revolutionary science, not to normal science. Focus on the usual suspects – Lavoisier, Einstein etc. – narrow view of the history of science

- Within normal science, scientists never test the current theory (or *paradigm* but work on puzzle solving instead.

- Puzzle solving: attempt to connect the research problem with the corpus of currently accepted scientific knowledge $\longrightarrow$ the current theory is always a *premise* of the puzzle solution.

$\longrightarrow$ *Within normal science, the current theory is never tested. Only additional hypotheses or conjectures, containing the current theory as a premise, are.*

Kuhn's thesis : true scientific practice consists in puzzle solving within the currently accepted theory. By contrast, pseudo sciences do not provide the appropriate framework for progressive research.

- Distinction problem vs puzzle

- Kuhn's example: Astrology vs Astronomy

- Astrology cannot be called pseudo science due to the form of its predictions: there were many accepted failures

- Astrology cannot be called pseudo science due to the ways in which astrologists deal with failure of predictions

- Kuhn: astrology ought to be called pseudo science because does not provide the means to engage into the normal course of scientific research of puzzle solving.

- By contrast, astronomy does.

1.3 Lakatos

Lakatos' criticism of Popper : Popper's falsifiability criterion fails to characterize science as it is actually practiced. "For Popper's criterion ignores the remarkable tenacity of scientific theories". Scientific theories are just as unfalsifiable as pseudo scientific theories.

Lakatos' argument : Scientist do not give on a theory because some counter evidence is found. Instead, either the evidence is put into question, or some ad hoc hypothesis is appealed to for rescue.

Example: Vulcan (24)

Lakatos' thesis :

- Research Programs: Hard core set of hypotheses + protective belt of auxiliary hypotheses + puzzle solving machinery

- All programmes "grow in a permanent ocean of anomalies" (25)

- But only scientific programmes "lead to the discovery of hitherto unknown novel facts" (25)

- Pseudo scientific programs "lag behind the facts"

- Examples:

Newton and Halley vs Marxism and the 20th century history of communism

$\longrightarrow$ *The science / pseudo science distinction is reduced to the distinction between progressive and degenerating programmes. No intrinsic characteristic of scientificity.*

1.4 Thagard's proposal

Thagard's goal : to propose a complex criterion which "introduces social and historical features as well as logical ones"

Thagard's criticism of the traditional criteria : the example of astrology

- Reasons offered for why astrology is a pseudoscience:

  1. The physical foundation for astrology has not been articulated.

  2. The reasons people believe in astrology is that they are desperately seeking solutions to their personal problems.

  3. Astrology originated in the magical tradition.

  4. It is neither verifiable nor falsifiable.

- These considerations do not decide the matter because:

  1. There are plenty of theories which we consider perfectly scientific but whose physical foundations are unarticulated or simply not understood at all.

  2. The particular reasons that particular people have for believing a particular theory have nothing to do with whether a theory is scientific or not.

  3. The tradition in which a theory has developed has no bearing on whether it is scientific or not. E.g. Newton's theory.

  4. Astrology is testable – statistical studies, even if the results are controversial.

  5. Falsifiability is not an acceptable demarcation criterion due to the fact that anomalies can always be accommodated by modifying the auxiliary hypotheses.

Thagard's thesis : According to Thagard, a theory or discipline which purports to be scientific is pseudoscentific iff:

"1. it has been less progressive than alternative theories over a long period of time, and faces many unsolved problems; but

2. the community of practitioners makes little attempt to develop the theory towards solutions of the problems, shows no concern for attempts to evaluate the theory in relation to others, and is selective in considering confirmations and disconfirmations." (32)

Thagard's assessment of his proposal :

- Comparison with Popper: does not focus on the intrinsic features of the theory and takes into account the way in which the community of advocates of the theory

- Comparison with Lakatos: a non-progressive programme does not become pseudo-scientific unless there are progressive alternative theories available

- Comparison with Kuhn: uncritical puzzle solving – normal science practice – *is* a pseudo-scientific activity when there are alternative, progressive theories available

Other consequences :

- changing demarcation line

- nothing can be pseudo scientific unless it has competitors??? – maybe good for astrology but what about pyramidology today?

1.5 Discussion Questions

1. Kuhn and Lakatos are criticizing Popper's criterion on the basis of the observation of actual scientific practice. It is simply not the case that scientific practice consists in testing theories and looking for possible refutations. Does it necessarily imply that Popper's demarcation criterion is useless? Does a demarcation criterion have to correspond to what scientists do in practice?

2. What is the appropriate target for a demarcation criterion? Theories, scientists, groups of scientists, scientific practice? Is there only one?

Chapter 2

The Arkansas Trial

2.1 Ruse's criteria of scientificity

Ruse's main aim and argument : Ruse intends to show that Creation Science is no science. His argument is that: "by every mark of what constitutes science, creation science fails." He first draws a list of characteristic features of science, and then shows that creation science fails to meet these criteria.

Characteristic features of science :

- Laws: attempt to understand the empirical world as ruled by natural laws

- Explanation: Science seeks to explain phenomena by appeal to laws and even excludes things that did not happen.

- Prediction: Science seeks to predict phenomena, not simply to exlain past phenomena.

- Testability (falsification / confirmation): Claims that science makes are open to testing to be confirmed or falsified.

- Tentative: Science holds tenaciously to its claims, but ultimately is open to rejecting them if the evidence is powerful enough.

- Integrity: Scientists are responsible to professional norms and as a community upholds these standards.

Creation science fails to meet the above characteristics :

- Laws: Creation science depends on laws or regularities being broken – Miracles: Creation and Flood

- Explanation and Prediction: Given the lack of appeal to laws or regularities, creation science cannot predict phenomena, nor explain them – Darwin's Finches

- Testability: Given that creation science attempts no predictions, no testability is possible. And arguably creation scientists are not responsive to disconfirming evidence – Missing link and australopithecus

- Tentativeness: Creation science is characterized by dogmatism

- Integrity: Creation science make appeals to fallacious reasoning and improper citation to support their views – Lewontin's "quote"

2.2 Laudan's criticism of Ruse

Laudan's thesis : Laudan's main point is that the Arkansas decision that creation science is unscientific relies on bad arguments – on mischaracterizations of both creation science and of what science is.

"The core issue is not whether Creationism satisfies some undemanding and highly controversial definitions of what is scientific; the real question is whether the existing evidence provides stronger arguments for evolutionary theory than for Creationism." (52)

Laudan's point is that we'd better reject creationism as bad science (falsified by the evidence available) than as non-science. The demarcation issue is a red herring.

Laudan's argument : the criteria offered to distinguish creation science as non-scientific are either met by creation science or not met by respectable scientific theories, or both. So, no reliable demarcation can be made on the basis of such criteria.

- Testability: Creation science makes a host of claims that are testable, contrary to Ruse, it's just that they are falsified.

- Tentativeness: Ruse's argument does not work because, on the one hand, creation scientists are in fact open to change, and, on the other

hand, many scientists behave as though certain fundamental assumptions are not open to question – flexibility of species / conservation of energy

- Natural Law and Explanation: respectable science contains many existence claims that are not supported by explanatory claims – Gravitation, natural selection

2.3 Ruse's answer to Laudan

About Laudan's proposed shift in question : Ruse explains that Laudan's strategy would have been ineffective:

"the U.S. Constitution does not bar the teaching weak science. What it bars ... is the teaching of religion"

About Laudan's criticism of the criteria :

1. Do the criteria allow for demarcation? – does genuine science fail to meet the requirements?

   - Laudan: slippery slope arguments? If there are some grey areas, it does not mean that there are no clearly white and clearly black areas.

   - Natural Law and Explanation: Ruse admits that some old scientists mingled science with no science, but advocates the criteria for contemporary science. According to him, nomological explanation is crucial to contemporary science.

   - Tentativeness: scientific dogmatism can be largely exaggerated.

2. Does creation science fail to meet the criteria?

   - Laws: What is unscientific in creation science is the claim that there are some phenomena for which (1) laws are broken and (2) no natural law is to be found.

   - Tentativeness: avowed dogmatism on the creationists' side

   - Testability: not in a genuinely scientific way

Ruse's conclusion :

Despite the difficulties, the Arkansas decision grasped something about what makes creation science unscientific.

2.4 Discussion Questions

- The line is blurry between science and pseudo science: does it mean that there is no line at all?

- Should we try to figure out a list of criteria or is it a desperate battle? a useless one? Is Laudan right that we should reject creation science as empirically falsified?

- Is a naturalistic attitude necessary to scientific practice?

Chapter 3

Synthesis