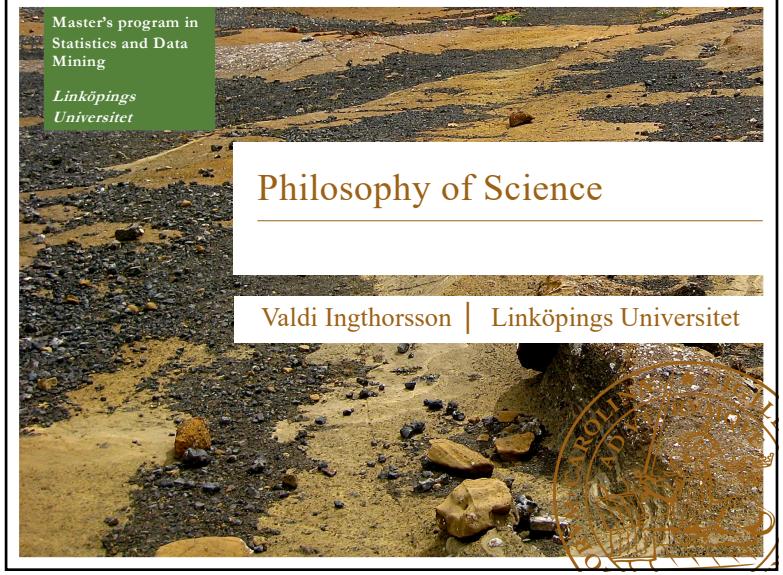

Philosophy of Science

Valdi Ingthorsson | Linköpings Universitet

The Structure of the Course

- 4 x lectures
- 1 x Obligatory discussion seminar analysing a research paper
  - » *Make up for missed seminar by submitting written answers to discussion questions*
- Examination: Home examination
  - 6 essay style questions requiring answers of approximately 1-1,5 pages each.

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Content

- What is philosophy of science?
- **Core concepts:** truth, knowledge, realism vs. anti-realism, empiricism vs. Rationalism, justification, induction, deduction, abduction, objective reality, the subjectivity of experience, preunderstanding, theory dependence of observation…
- **Methods of thought:** hypothetical-deductive method, analytic method,
- **Philosophical views about science:** positivism, falsificationism, theory of paradigms (hermeneutic)
- Differences between the natural and human sciences

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What is Philosophy of Science?

- Medicine studies the body to know how it works
  - Does not study logical fallacies, how observations are dependent on theory/prejudice, or what knowledge is
  - It takes such things for granted
  - They want to know how to stay healty or to heal the sick

- Philosophers of science study science
  - Fallacies in argument
  - Sources of bias
  - What is knowledge, objectivity, truth, validity, reliability?
  - They want to know the best way to conduct science

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Two Different Approaches

Naturalism/A Posteriori

- Look for common denominators among the things we identify as "science"
- Take into account the practical obstacles that the sciences face
- Take into account metaphysical views about the constitution of reality

- Investigation into the nature of science understood as a this-worldly-and-largely-human-enterprise

A Priori approach

- What is the concept of 'science' / 'knowledge' / 'truth'
  - *Induction and deduction ?*
  - *Mathematics ?*

- Investigation into the content of concepts that exist independently of any human activity
  - Science will have to adapt

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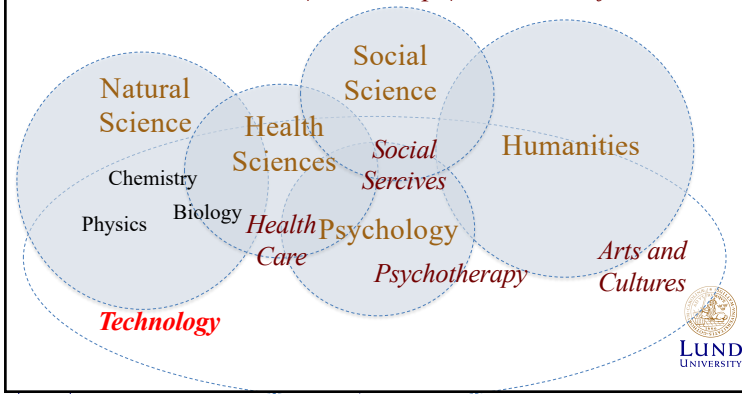
A Comment on "Science"

The Sciences | Vetenskap | Wissenschaft



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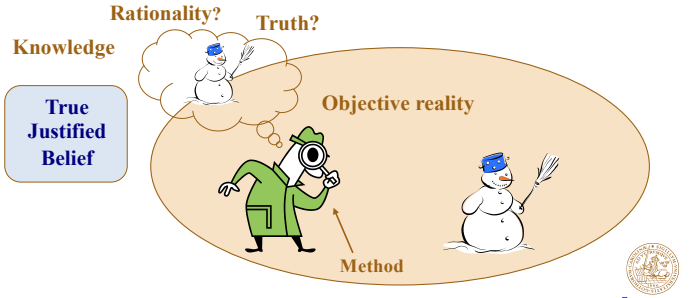
What is Science?

To find out what the world is really like, in a systematic and self-critical manner



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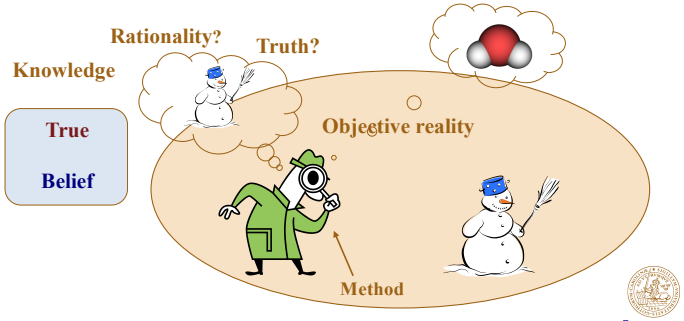
Truth?

Correspondence between the content of belief and whatever feature of the world that the belief is about



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Rival Theories of Truth

Consensus theory:
"Truth is what we have agreed is true!"

Pragmatism:
Ideas are true if they work (give correct predictions)

Coherence Theory:
An idea is true if it is consistent with our established world view

Relativism:
There is no truth

True vs. Believed to be True

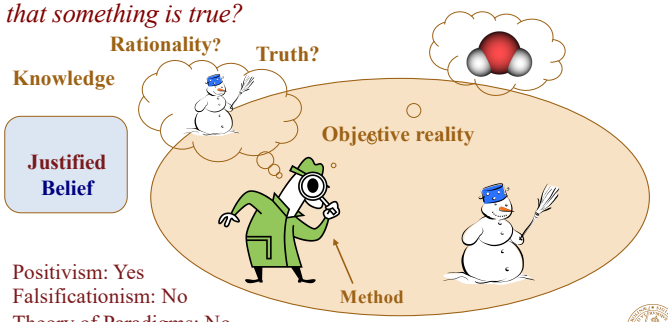
- *True*[1] —"corresponds to reality"
  - An ontological status (what kind of phenomenon it is)
- *True*[2] — "something we know corresponds to reality"
  - Epistemic status (How we know P is true[1])

But this is knowledge; not truth

- Truths[1]: Beliefs that correspond to reality
- Truths[2]: Beliefs known/proven to be True[1]
  - Because they give correct predictions (they work)
  - Because they are coherent with our world view

Justified?

Is there any way we can become sure beyond any doubt that something is true?

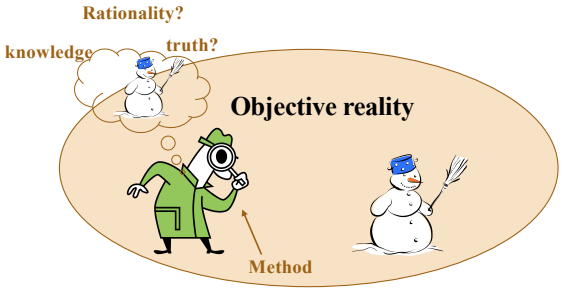


Positivism: Yes
Falsificationism: No
Theory of Paradigms: No
Hermeneutics: No

Knowledge

- Techne—craftmanship, know-how
- Episteme—true justified belief, knowing-that
  - Doxa—popular opinion
- Phronesis—judgement

What We Study: Objective Reality?



The Phenomena We Study

- Physical matter + properties
- Organisms + functions

Natural Sciences

- Consciousness and their contents
- Social interactions and behaviour
- Language and concepts
- Societies
- Intelligence

Human Sciences

But What is Objective Reality?

Basic idea ≈ the world as it is in itself

1. That which exists independently of minds

   Only includes the physical objects around us

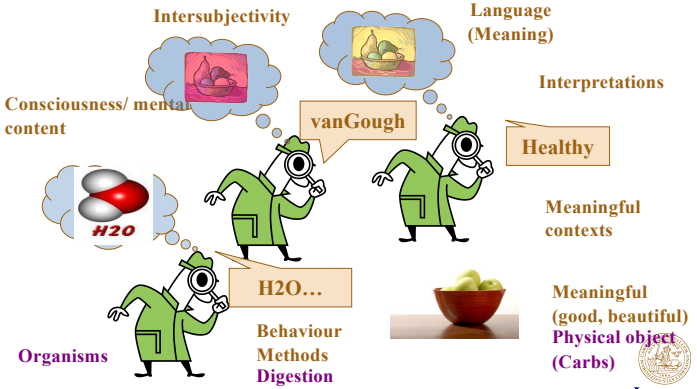
2. That which exists independently of what we believe exists

   Also includes minds and their contents, therefore also social phenomena

Two Meanings of "Objective"

- Objectively real (real existence)
  - The world as it is in itself independently of our attempts to conceive of it and measure it.
    - » NOT: "the world as we objectively think of it"
    - » NOT: "the world as we measure it"
- Objective knowledge/truth (ideas about reality)
  - See things as they really are
  - Unaffected by prejudice/bias
    - » Only rely on measurements?

The Complicated Reality



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Social Constructions: What are They?

- Created by human activity
- Could have remained uncreated
- Could have been made differently
- Something else could have been made

Artefacts: made by humans in a social context

Concepts: made by humans in a social context

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Types of Social Constructions

- Generic construktion
  - A *product* of a conscious or subconcious social activity

  Courts of law, families
- Discursive construktion
  - *Objects* who are what they are because of how we talk and thinks about them

  particular individuals
- Pragmatic construction
  - Conceptual *categories* whose use is determined by social factors

  ”feminine” ”Cool”

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Weak vs. Strong Constructions

- *Weak social construction* – if the use of the word denoting the construction is partly determined by social factors and yet refers to some non-social fact

The Holocoust, Quarks, Charles, and Diana

- *Strong social construction* – if its use is entirely determined by social factors and does not refer to any non-social fact

”feminine”, ”manly”, ”Cool”

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Hidden Mechanisms

- Bacteria causing diseases
- Why different materials have different properties depending on their chemical composition
- Biological urges that govern behaviour

- Conscious processes (thinking, feeling)
- Unconscious processes (phobias, compulsions, memory)
- Social processes (conformism, hierarchies of power)

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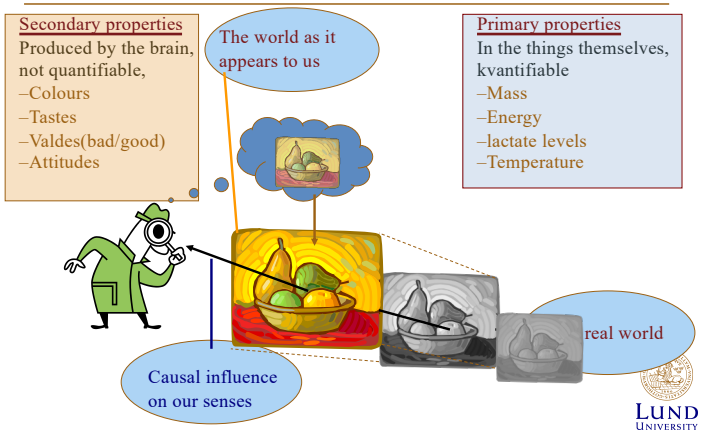
Appearance and Reality



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Natural vs. Human Science

- Natural science studies non-conscous nature; it abides by laws of nature and therefore is fully predictable

The study of a single grain of salt can be generalised to all salt in the universe

- Human science studies conscious nature; it does not obviosly abide by laws of nature and therefore isn't predictable

Study of a single human cannot be generalised to all humans

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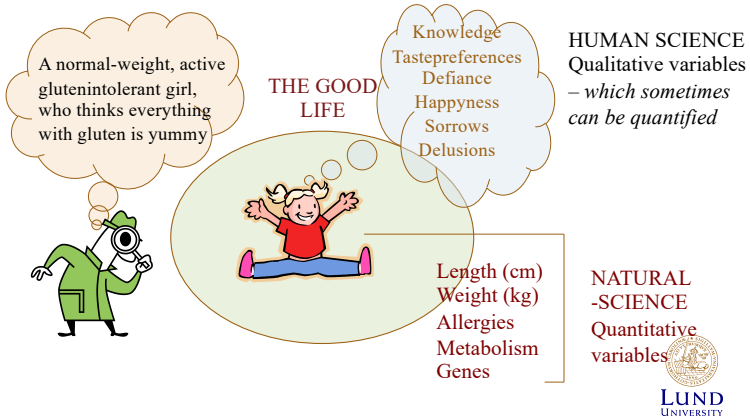
Medical Science



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Choosing a Method

- Objectively measurable variables
  - Variables which the subject cannot report (lactate levels)
  - Variabler which the subject can report (weight, number of visits)
- Subjectively experienced variables
  - Sensory impressions (pain)
  - Complicated cognitive wholes (sense of stigmatisation)

Technical equipment

Questionnaires

Interviews

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Methods

Human Science vs. Natural Science

Qualitative	Quantitative	Physiological Measurements
• Participant observation • Interviews • Text analysis • Discourse analysis	• Field-observations • Surveys	• Oxygen uptake • Temperature • Weighing

Measuring qualitative variables
(which are represented numerically in quantitative studies)

You can ask about physiological variables – but only if you know the subject has made a physiological measurement

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Hypothetico–Deductive Method

Semmelweiss and the Puerpural fever epidemia in Vienna 1844

Ward 1: Mortality10% ⟸ **Why the difference?** ⟹ **Ward 2: Mortality2%**

1. cosmic telluric disturbancies in the atmosphere?
2. Ward 1 overcrowded?
3. Bad food?
4. Bad care?
5. Rough examinations?
6. Priest scares patients to death?
7. Wrong labour position?
8. Corpse-stuff?

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Elementary, dear Watson

Premise 1: logical inference

If mortality is due to poisonous air ⟶ Everyone should suffer equally that breathe same air

Premise 2: observation

We observe that everyone does not suffer equally

Conclusion

Mortality is not due to poisonous air

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The Logical form of the Argument

If P is true then Q

Q is not the case

Therefore P is false

Hypothetico-deductive method

If mortality due to corpse-stuff → Then mortality should decrease if stuff is removed

Test: wash hands with chloride of lime

Mortality decreases

Mortality is caused by corpse-stuff

Falsification vs. Verification

If P then Q
Not Q

Not P

Logically valid: Cannot deny conclusion without at the same time denying some premise too

If P then Q
Q

P

Logically invalid. Can deny conclusion without denying any premise
Q can be caused by something else than P

Validity in Logic

1. All humans are mortal
2. Sokrates is human

---

3. Sokrates is mortal

Valid: cannot deny conclusion without denying some premise

1. When a window is hit by a brick, it breaks
2. The window is broken

---

3. The window has been hit by a brick

Invalid: can deny conclusion without denying any premise

Importance of Controls

If everyone doing therapy gets well → Then the therapy is the cure

Test: evaluate the effects of therapy

60% get well

Therapy is the cure???

Not if 60% of those who didn't get therapy get well anyway!!

Danger of confounders

Confounder: an unknown cause that produces the same effect as they hypothetical cause, deceiving us into believing that the hypothesis works

If everyone who eats proteins get larger muscles → Then protein causes muscle growth

Test: monitor what happens to people eating protein

80% get larger muscles

Protein causes growth???

Not if the real cause is the training; training is the confounder

How Should We Conduct Science?

- Positivism
  - Knowledge by observation
- Falsificationism
  - Knowledge by excluding falsity
- Kuhn's Theory of Paradigms
  - Observations and falsifications are only judged to be valid in the context of a paradigm
- Hermeneutics
  - How to interpret meaningful contexts

Positivism

GENERALLY

- Pure reason does not give knowledge about the world
- Observation and controlled experiment can give knowledge about the world

Principle of verification: a claim is meaningless until its truth can be justified empirically

Positivistic Science

Naive positivism

1. Science starts with observation not guided by theory
2. General laws can be inductively inferred from a a large base of data

Problem: induction is logically invalid

Sophisticated positivism

- Probabilistic laws can be inferred from a large base of data – they become our hypotheses
- Hypotheses can be further tested using the hypothetico-deductive method

Induction

Observation 1: Raven is black

Observation 2. Raven is black

Observation 3: Raven is black

...Observation 3.980.000: Raven is black

Conclusion: *All Ravens are black – Invalid*

Valid conclusion: All known occurrences of Ravens have been black

But this is not a general law nor does it explain why Ravens are black

Two Types of Inductive Inferences

Inference from the specific to the general.

1. This raven is black
2. This raven is black
3. This raven is black
4. etcetera

- *All* ravens are black

Any inference in which conclusion is plausible but not necessary

- I saw my girlfriend kiss another man

- I think she is having an affair"

"allows hypotheses to emerge from patterns found in the data"???

Two Types ?

1. This raven is black
2. This raven is black
3. This raven is black
4. …

- *Nature is Uniform*
- *When you find a consistent pattern you may have found a uniformity*

- *All* ravens are black

- I saw my girlfriend kiss another man
- *In our society it is a general rule that you only kiss those your are involved with*

- I think she is having an affair"

Looks more like abduction/Inference to the best explanation

Maybe different after all

Attempt to infer what many observations say about population in light of background theory

1. This raven is black
2. This raven is black
3. This raven is black
4. …

- All ravens are black
- Alt: 98% of the raven population is black

Attempt to explain particular observations in light of background theory

- I saw my girlfriend kiss another man
- *Social rule: it is a betrayal to kiss other than those you are involved with*

- I think she is having an affair

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The Problem with Positivism

1. The principle of verification cannot be empirically verified: *is it meaningless?*
2. Observation without hypothesis is impossible: all observation involves interpretation
3. Neither induction or deduction guarantees truth of conclusions
4. Difficult to find anything but correlations
5. We cannot objectively observe the content of ideas; nor intersubjectively

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Observation: knowledge via senses

- Can we trust our senses?
- Are sensations free from interpretation/hypotheses
- Do we see what is there, or only what we expect to see?
- Can you learn to see more than you expect?

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Observations are Theory-dependent

They presuppose a preunderstanding of the observed

1. Experiences do not arise like photos in a camera
2. Experiences are like advanced computer generated images where something has been added and something removed (subconsciously).
3. How much is added and/or removed depends on our preunderstanding
4. Without preunderstanding, no meaningful experience

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Preunderstanding

- Understanding arises against the backdrop of certain preconditions
  - Preunderstanding–Gadamer
  - Paradigms–Kuhn
  - General backgroundstheories –Feyerabend
  - Horizon of expectations– Popper

Attention test

Watch

???

What's up ?

Qu'est que ce?

What is going on? IV

Components in our Preunderstanding

- Language and concepts
  - Allow us to perceive things as certain kinds of things, or part of a structure
  - "healthy/unhealthy", "fit/unfit", "handle"
- Beliefs, representations, theorier
  - Everything is made of matter, mental health affects body
- Personal experience
  - Practical "know-how"(how does a ruptured ligament "feel"

Preunderstanding: 4 important aspects

- A mixture of ***articulated*** and ***unarticulated*** (tacit) knowledge; people reflect upon it to various degrees
- ***Holistic***
- ***Revisable*** and in continuous revision
- Partly ***context-relative***

Analytic Vs. Hermeneutic Method

1. Divide the problem in as many parts as is needed to solve it –*Analysis*
2. Arrange the parts, simplest first and combine them into more complex wholes until they make up a coherent and clear whole – *Synthesis*

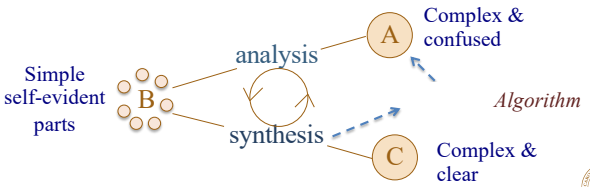

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Image upscaling using machine learning

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Where do Hypotheses Come From?

- Generation of hypotheses is a source of bias
  - …when not generated from experience (fantasy)
  - …when generated from prejudiced observations
- Positivists suggest we declare fantasy as nonsense and rinse our observations from prejudice
- But, is this possible?
  - No, says hermeneutics, and falsificationism agrees

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Critical Rationalism/Falsificationism

1. Observation without pre-judgement is impossible
2. Science starts with problems, not observations
3. Hypotheses are not generated by observation
4. Hypotheses cannot be definitely verified–but they can be definitely falsified

Context of Discovery
Vs.
Context of Justification

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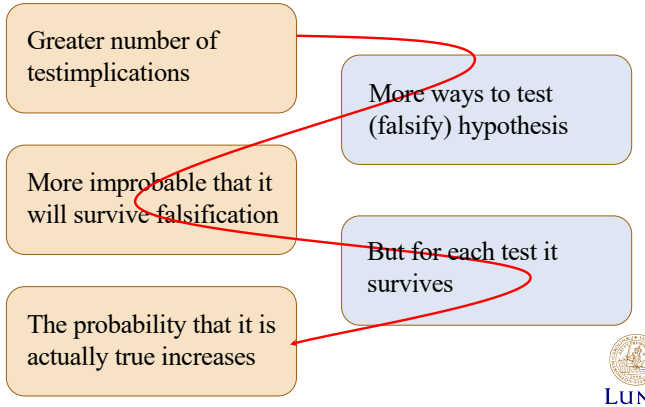
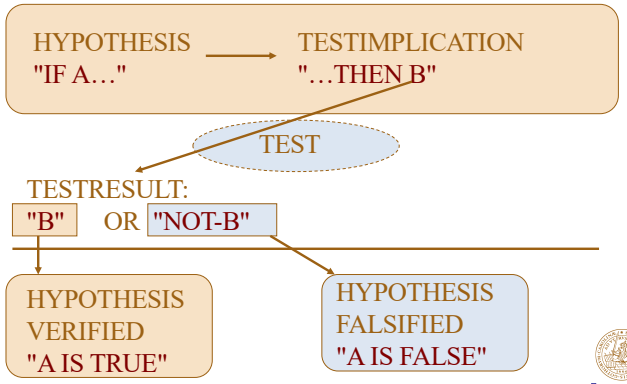
Principle of Falsification

- Hypotheses must be falsifiable (in principle)
  - Hypotheses must entail conditions which would show it to be false
- The greater number of testimplications the better
- Form as many hypotheses as you can not just one
- Do not attempt to verify the hypotheses–try to falsify them
- If we fail to falsify an hypothesis then maybe it is true

Testimplications and Probability



Hypothetical-Deductive Method



Hermeneutics in Natural Science

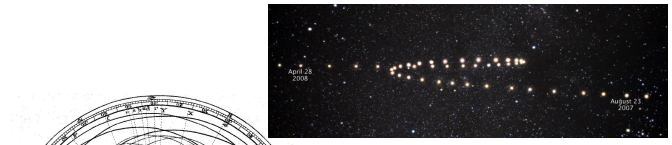
Why does repetitive static work lead to chronic muscle pain?

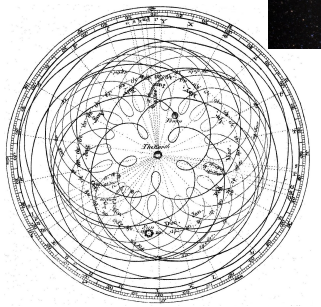
1. Accumulation of metabolites and inflammatory substances
   - » Lactate
   - » Pyruvate
   - » Prostaglandin E_2
   - » Glutamate
2. Hypertrophy of type I muscle fibers
3. Disturbed metabolism due to mitochondrial changes
4. Mechanical damage due to shear-forces

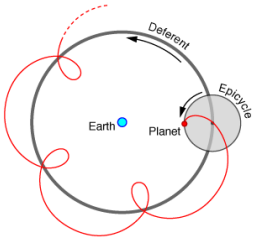
Kuhn about Science

- Every hypothesis has at some time or other been falsified
- Accepting/Rejecting hypotheses has not always been a completely rational process
- Hypotheses are accepted/rejected in the light of a paradigm – not merely by observations or experiments
- A paradigm consists of the total pre-understanding of a research group – including such factors as ambition, religious beliefs, social values, trust …

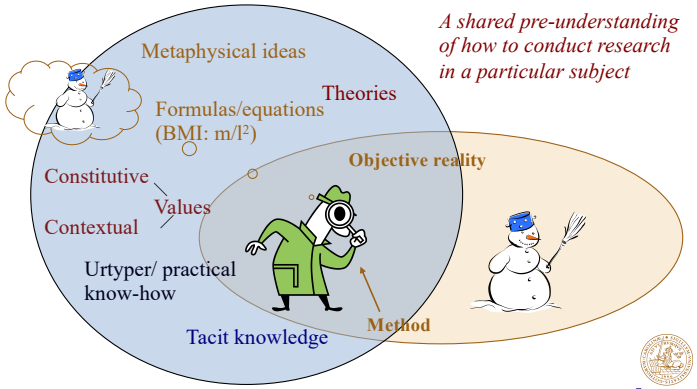
Kopernican revolution





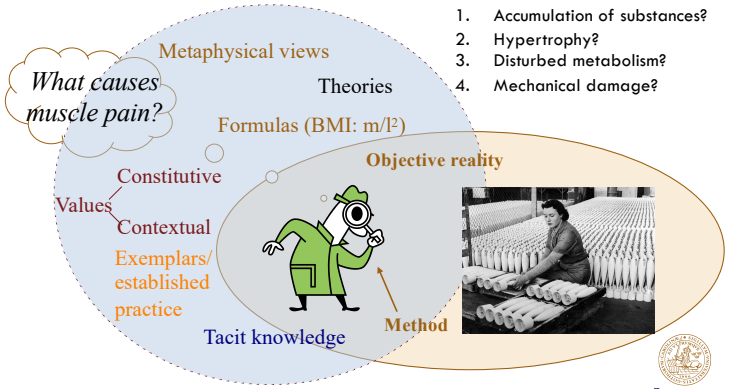


Paradigms



A shared pre-understanding of how to conduct research in a particular subject

Hermeneutics in Natural Science



1. Accumulation of substances?
2. Hypertrophy?
3. Disturbed metabolism?
4. Mechanical damage?

Common Preunderstanding of

- What kind of objects are we dealing with?
- How should an hypothesis be formulated?
- Which equations can we use?
- How should we go about doing research (valid methods)
- What counts as a valid solution?
- Which researchers' opinion are most highly valued?
- What is useful for my career?
- How to behave as a researcher?

Are Paradigms incommensurable?

- Different paradigms are incommensurable and therefore cannot be compared completely rationally
- Since
  - Scientific revolutions are irrational and therefore the substitution of one paradigm for another cannot be justified as scientific progress
  - Paradigms are social constructions not the result of pure scientific research.

Equations

- Mathematical formulations of *hypotheses* about certain distinctions or categories or relationships
  - But they are often received as "definitions" that are eternally valid – and which cannot be questioned

MESS (minimum effective strain stimulation) = 3 x bodyweight

BMI (body mass index) = mass/length^2

Overweight = BMI 25-30 Obesity = BMI >30

Kuhn: The Development of Science

- ***Prescientific period:*** no established way of doing science
- ***Normal science***: A group arrives at a mutual understanding about how to do science.
  - Everyone works according to the agreement
  - Only map out consequences and applications of the paradigm
  - No one questions anything and problems are pushed aside
- ***Crisis***: Every consequence is mapped out and no furhter advances are made
  - the problems build up and can no longer be ignored
- ***Scientific revolution***: A radically new way of thinking emerges
  - A period of normal science takes over…etcetera.

Descriptive/normative?

- Kuhn's theory of paradigms is not normative
  - Does not say how science *should* be conducted.
- Describes what science is actually like
  - How our minds work
  - How science is related to society

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Relativistic?

- If paradigms are incommensurable
  - no way to justify that one paradigm is better than another
  - to change a paradigm is a leap of faith, or change of fashion

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Two Problems with Qualitative Research

Qualitative research claims to be naturalistic inductive inquiry, where themes/categories are inductively derived from data

1.naturalistic inductive inquiry is generally considered to be an indefensible position in the philosophy of science

- It is called 'naïve inductivism'.

2.naïve inductivism and hermeneutics are generally considered to be contrary and incompatible views.

Is qualitative research simultaneously theory-free and theory-dependent inquiry? — it cannot be both.

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Meaning unit	Condensed meaning unit Description close to the text	Condensed meaning unit Interpretation of the underlying meaning	Sub-theme	Theme
She kicks about and hits the care provider when she is putting shampoo to her hair. // She tries to push the care providers away.	Using physical violence when being undressed and washed.	Fighting to defend her body zone against intrusion.	Fighting to protect her personal space	Interaction as a process of respecting and invading each other's privacy
When the care providers are in her room she closes the door from the outside so the care providers are locked up in her room and she stays outside in the corridor.	Closing the door between herself and the care providers.	Marking a boundary against others.		
She comes out to the corridor. She wears T-shirt, plastic pants and diapers and she has faeces all over her body. She walks into another resident's room and locks the door. // The care provider goes to see what she is doing and it appears that she has laid down in his bed.	Appearing undressed and "dirty" in commonly used areas and in other residents' rooms and beds.	Crossing fellow residents' physical space.	Invading the physical space of others	
She goes into the ward office and starts to mess about among the staff's documents.	Causing a mess in the ward office.	Crossing the care providers' physical space.		
The care provider knocks on her door, waits for an answer.	Knocks on the door and waits for an answer.	Asking permission and waiting for an answer before entering her room.	Paying respect to her physical space	
The care providers permit her to rise and rummage about, she is allowed to move around while they are looking after her. // She is wandering around in the bathroom during the showering.	Permitting her to rise, rummage about, move around and wander during the morning toilet.	Allowing a certain amount of freedom of movement during the morning toilet.	Paying respect to her personal space	
She sits in a chair in her room restrained by a belt. // The care providers put her into a shower chair and restrain her with a belt, which is tied to the back of the chair.	Using physical restraints.		Invading her personal space	
The care provider sits on her bed and leans over her.	Sits on her bed and leans over her.	Coming too close.		
Care providers ask: "Shall we go to the toilet?" "Shall we take a shower?"	Addressing her as we instead of you.	Treating private matters as common matters.		
The care provider is talking with others about her rash and itch.	Discussing private matters over her head.			

Figure 3 Examples of meaning units, condensed meaning units, sub-themes and themes from content analysis of observations about interaction between a woman with dementia and her care providers.

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'Transferability' vs Generalisability?

- Is it reasonable to think that what was found in this study could also hold for other corresponding situations/individuals?
  - Yes if we accurately capture the type of individual/group we were investigating
- Could this interpretation of what is going on be inspiring, or revealing, or enlightening for others?
  - It gives a richer pre-understanding of what might be going on elsewhere
- Yes, but if the interview study is big, we can generalise in the standard way

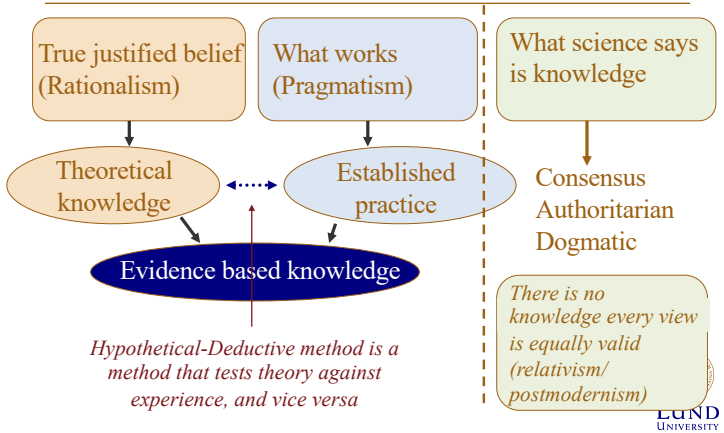
Validity-Reliability

- ***Validity:*** concerns the truth of the conclusions (given the evidence) – how reasonable is it to assume that they are true (less reasonable by the number of alternative explanations)
- ***Reliability:*** concerns the risk for the data failing to justly representing the views of the informant at the time of the interview –is it reasonable to believe that the data is biased? (lower reliability if risk for bias is high)

Validity and Reliability II

- ***Internal validity:*** concerns the ability of the study design to answer its aims ≈ relevance of the method
- ***External validity:*** generalizability of the conclusions beyond the sample population
- ***Validating data***: controlling for the reliability of the data
- ***Validating a method***: checking the reliability and/or validity of a study design/method by triangulation

Theories of Knowledge



Appearance and Reality

- Appearance: The world as it appears to be in experience
- Reality: How the world really is

- ” Everything is only an Appearance!” (the mind makes it real?)
  - Our senses deceive us?
  - Our prejudices deceive us?
    - » ”Deceive” implies a deviation from something – from what?

- We can speculate about the reality that gives rise to the appearance
  - Then we must be able to form ideas about things we do not perceive

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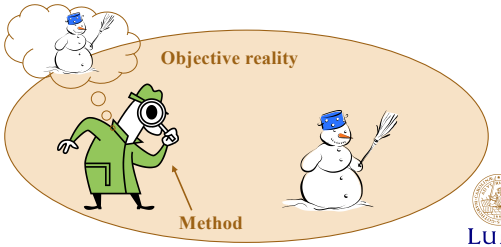
Realism

Generally: Most ideas represent objectively real phenomena

But science is constantly finding out that things are not as they appear to be



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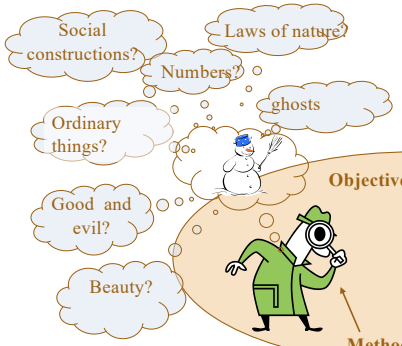
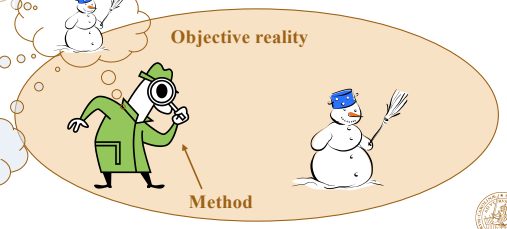
Selective realism



Some ideas represent objectively real entities, but not all



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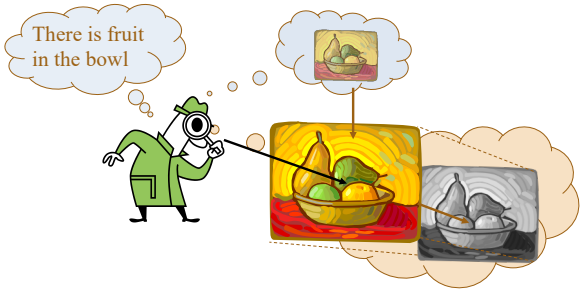
Extreme anti-realism

- Reality is construed by our words and thoughts— (idealism/relativism)



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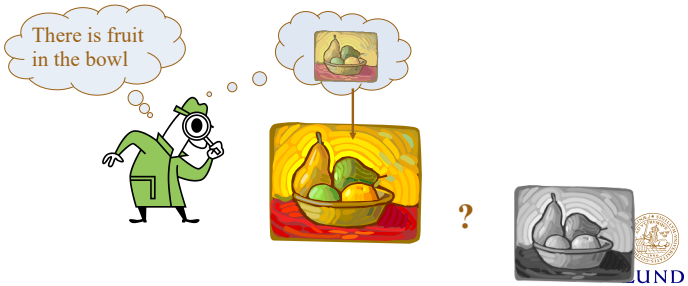
Moderate anti-realism (scepticism)

- We have no clear conception about the distinction between thought and reality, or how they relate to each other

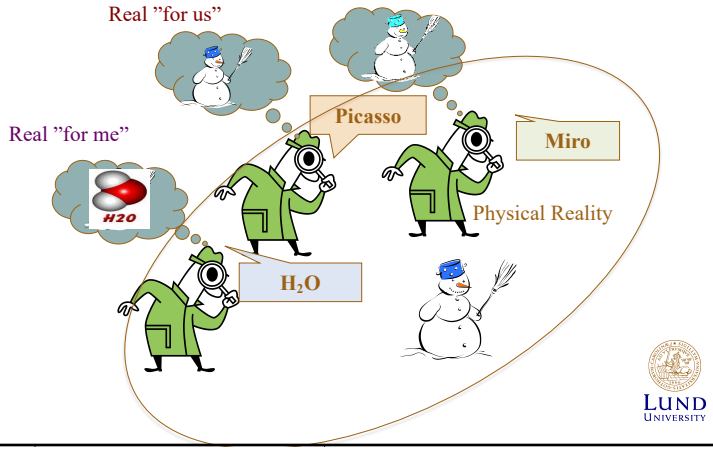


”Everything is relative”!

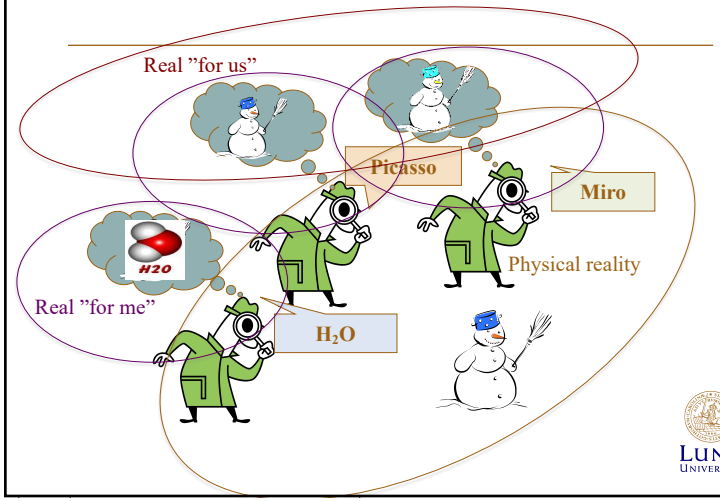
- Relative to what? – to me (the subject)
- Relative from what – reality (or nothing?)

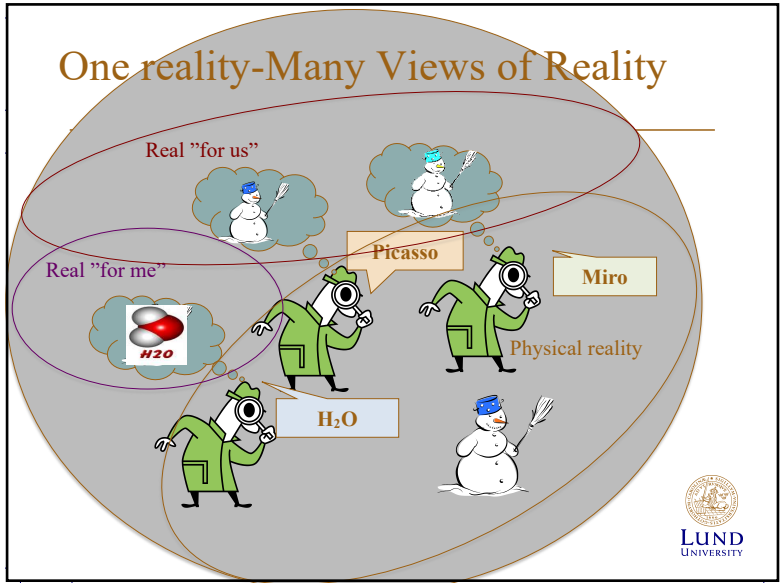
- Respect for the opinion of others?
  - But what about the Taliban?
    - » Terrorists?
    - » Pedophiles?
    - » Rapists?
    - » Misogynists (women haters)?
    - » Rasists?

Physicalism



Many realities ?




One reality-Many Views of Reality
Real ”for us”
Real ”for me”
H2O
Picasso
Miro
Physical reality
H2O
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