Microscopes and the Theory-Ladenness of Experience in Bas van Fraassen's Recent Work

Martin Kusch
<martin.kusch@univie.ac.at>

(O) Introduction I: Topic and Sources

- ***Do microscopes allow us to observe microfeatures?***
- Bas van Fraassen, *Scientific Representation* (2008)
- Bas van Fraassen, "Constructive Empiricism Now" (2001)
- Mark Alspector-Kelly, "Seeing the Unobservable" (2004)
- Ian Hacking, "Do we See Through a Microscope?" (1981)
- Paul Teller, "Whither Constructive Empiricism?" (2001)

(O) Introduction II: Theory-Ladenness of Experience

Suggested reading of van Fraassen's analysis:

(a) His opponents' use of terms like "to see" is dependent upon a certain ***realist epistemological theory*** of instrumentally -aided visual experience.

(b) This theory has come to shape the very ***phenomenology*** of instrumentally-aided sensory experience.

(c) This explains the ***strengths of intuitions*** against the constructive empiricist's agnostic position.

(1) van Fraassen's Views in <u>The Scientific Image</u> (1980)

(2) Hacking on Microscopes (1981 (=1983, 1985)), (1982)

(3) van Fraassen's Reply (1985)

(4) Teller on Microscopes (2001)

(5) van Fraassen's Replies (2001), (2008)

(6) Alspector-Kelly on Microscopes (2004)

(7) Defending van Fraassen against Alspector-Kelly

(8) The Theory-Ladenness of Microscope Experience

(1) van Fraassen's Views in The Scientific Image (1980)

(2) Hacking on Microscopes (1981 (=1983, 1985)), (1982)

(3) van Fraassen's Reply (1985)

(4) Teller on Microscopes (2001)

(5) van Fraassen's Replies (2001), (2008)

(6) Alspector-Kelly on Microscopes (2004)

(7) Defending van Fraassen against Alspector-Kelly

(8) The Theory-Ladenness of Microscope Experience

(a) Constructive Empiricism

"Science aims to give us theories which are empirically adequate; and acceptance of a theory involves a belief only that it is empirically adequate." (12)

(b) "Observable"

- The distinction "observable / unobservable" ***classifies entities***.
- X is observable iff it can be perceived ***without*** the aid of ***instruments***.
- "Observable" is ***vague***.

(c) Theory-Ladenness of Observation

- *"... all our language is thoroughly theory-infected. ... But does this mean that we must be scientific realists? We surely have more tolerance of ambiguity than that."*

- *"The fact that we let our language be guided by a given picture, at some point, does not show how much we believe about that picture."* (14)

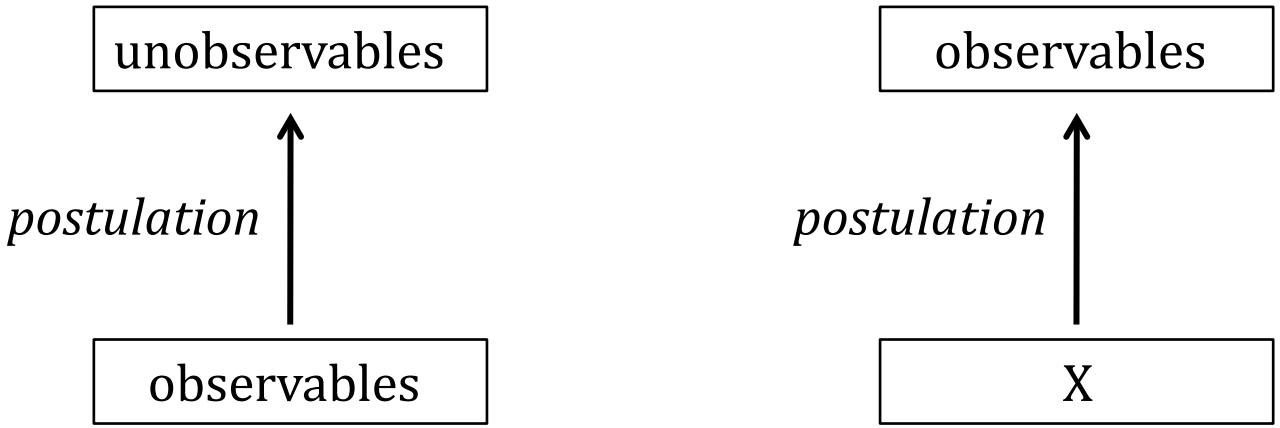
- *"... immersion in the theoretical world picture does not preclude 'bracketing' its ontological implications."* (81)

(d) Observability and Measurement

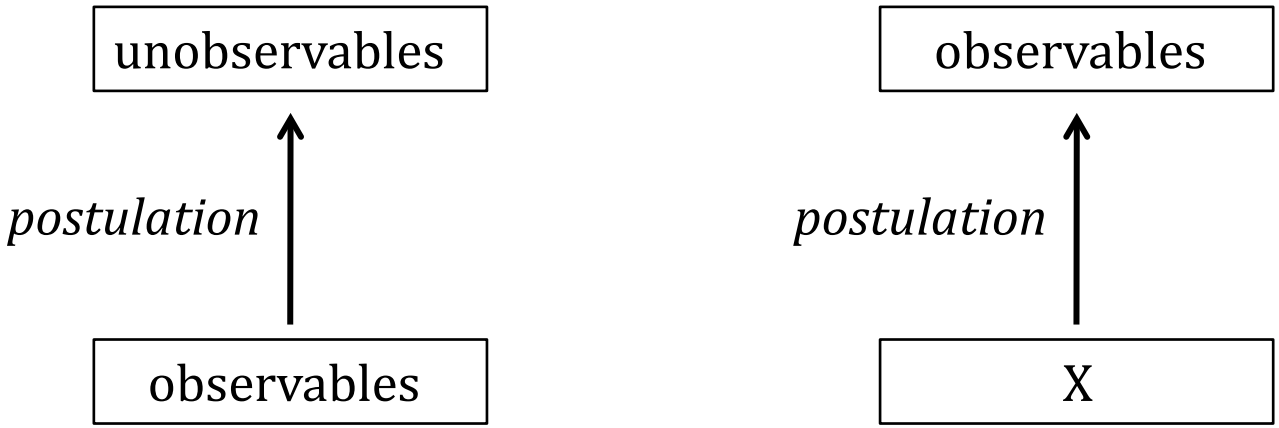
- ***Observation*** is a kind of measurement.
- The human organism can be thought of as a ***measuring device***.
- The ***limitations*** of what it is able to measure will be described by the final physics and biology.

(e) Why Observables are not Postulated Entities

- ***Objection***: Observables are hypothetical, too. Hence there is no justification for treating them differently from unobservables.



- ***Reply***: The only candidates for X are ***sense-data***. And these are *"theoretical entities of an [unscientific] armchair psychology"*. (72)



(1) van Fraassen's Views in The Scientific Image (1980)

(2) Hacking on Microscopes (1981 (=1983, 1985)), (1982)

(3) van Fraassen's Reply (1985)

(4) Teller on Microscopes (2001)

(5) van Fraassen's Replies (2001), (2008)

(6) Alspector-Kelly on Microscopes (2004)

(7) Defending van Fraassen against Alspector-Kelly

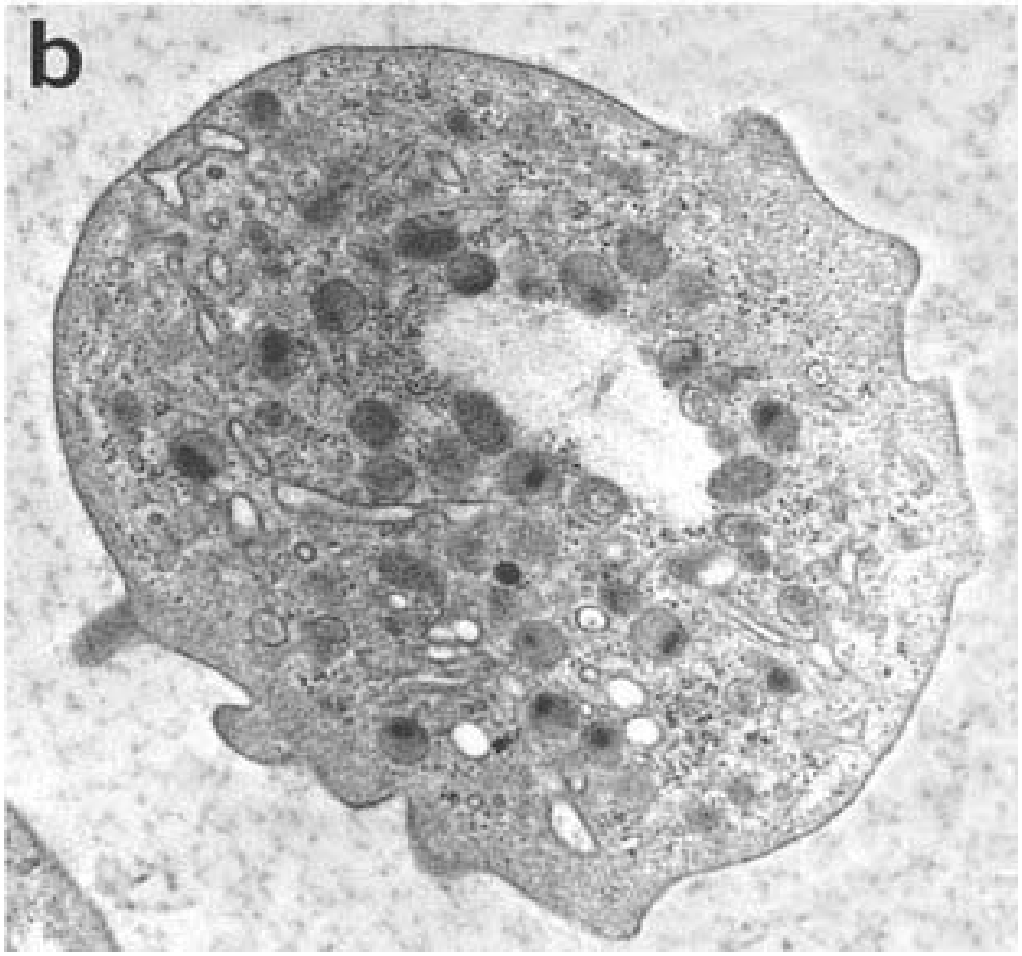
(8) The Theory-Ladenness of Microscope Experience

(a) "Don't just peer: interfere" (1983: 189)

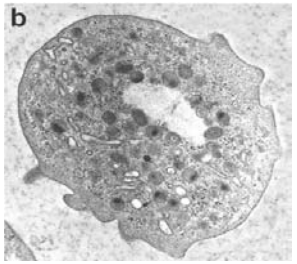
- *"The conviction that a particular part of the cell is there as imaged is, to say the least, reinforced when, using straight-forward physical means, you micro-inject a fluid into just that part of the cell."* (1983: 189-90)

- ***Interference*** is central. This fits with "***manipulative realism***": engineering as the proof of ***scientific realism about entities***.

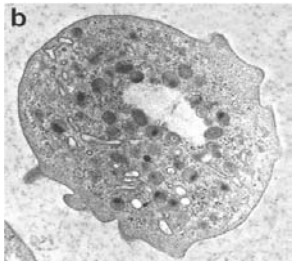
(b) The Argument from Preposterous Coincidence



Red blood platelet with dense bodies

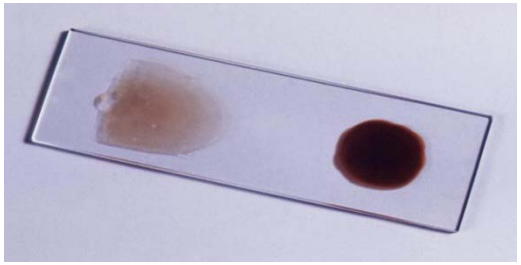


microscopic images

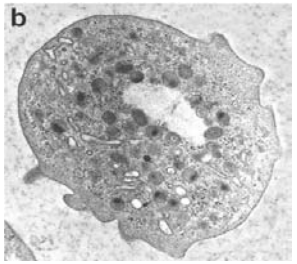


electron microscope

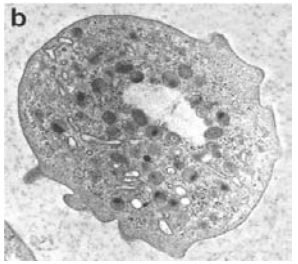
fluorescence microscope



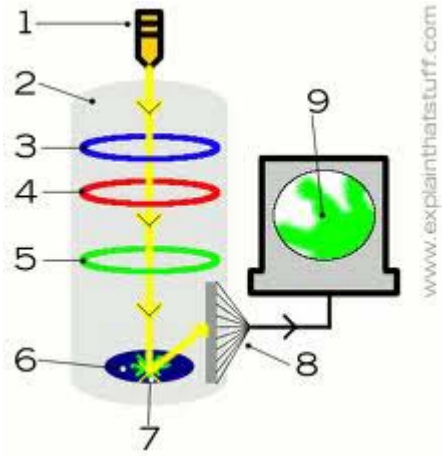
blood sample

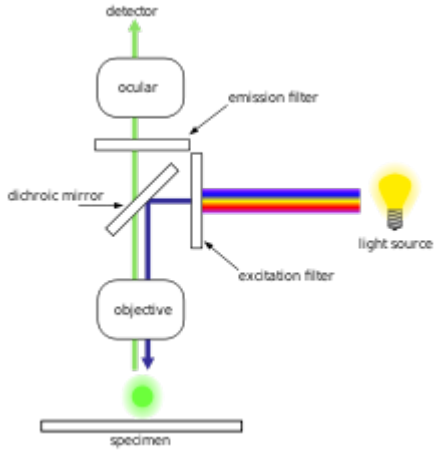


"Preposterous coincidence" if the dense bodies were artifacts!

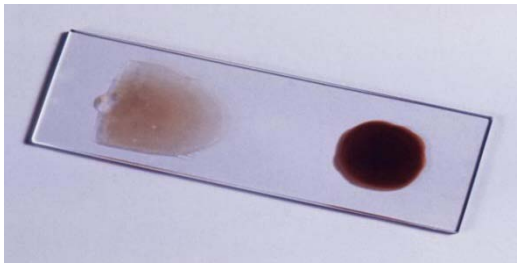


electron microscope



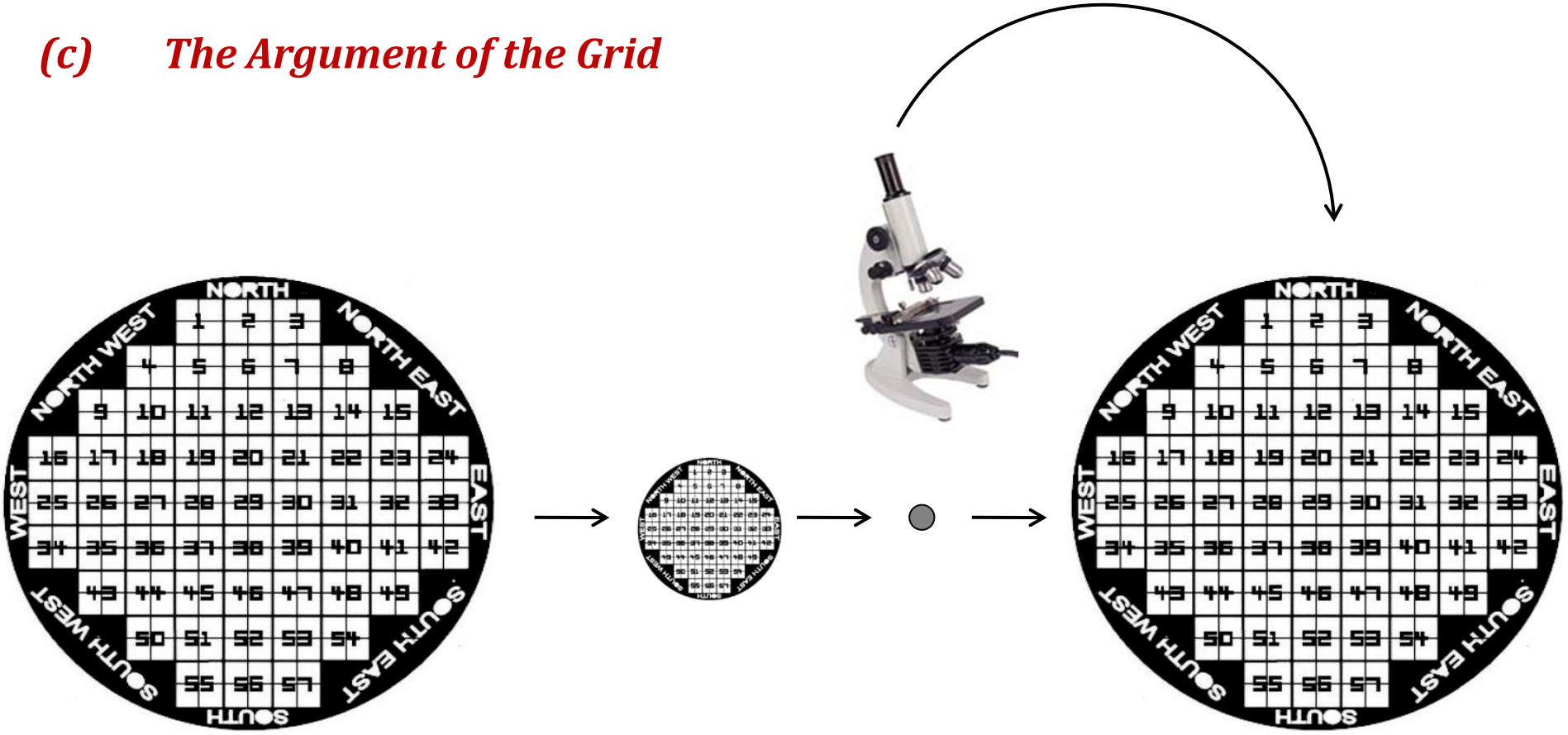


fluorescence microscope



blood sample

(c) The Argument of the Grid



grid drawn with ink and pen

photographic reduction

microscopic image

- ***No-one can seriously deny*** that the structure of the minute disc is that of the large grid.

- We know that the microscopic image is a true picture of the structure of the minute disc, since ***we made the minute disc to have precisely that structure***.

- To deny that the microscopic image is a true picture of the structure of the minute disc amounts to ***invoking scepticism of a Cartesian sort***.

(1) van Fraassen's Views in The Scientific Image (1980)

(2) Hacking on Microscopes (1981 (=1983, 1985)), (1982)

(3) van Fraassen's Reply (1985)

(4) Teller on Microscopes (2001)

(5) van Fraassen's Replies (2001), (2008)

(6) Alspector-Kelly on Microscopes (2004)

(7) Defending van Fraassen against Alspector-Kelly

(8) The Theory-Ladenness of Microscope Experience

(a) Against the Argument from Preposterous Coincidence

- The different types of microscopes might been ***calibrated against each other***: achieving certain similarities in out-puts might have guided their construction.

- If so, then it is ***hardly a surprise*** therefore that the images are similar.

- What explains the ***sameness of the output***—the arrangement of dots on the micrograph—of the two microscopes?

- Answer: the ***sameness of input***, the blood samples.

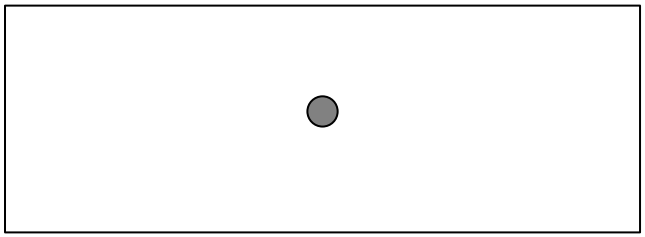
- But it does not follow that an "***imputed unobservable structure***" in the blood is real:

> "*This ... warrants no inference about the reality of the imputed unobservable structure*." (1985: 298)

(b) Against the Argument of the Grid

- Hacking: *"I know that what I see through the microscope is veridical because we made the grid to be just that way."*

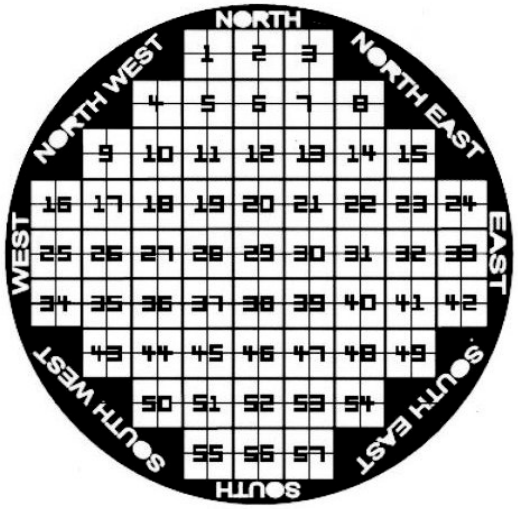
- van Fraassen: *"It is no argument ... Since **the premise needs to imply what is under dispute** (that we successfully made the object to be that way)."* (298)

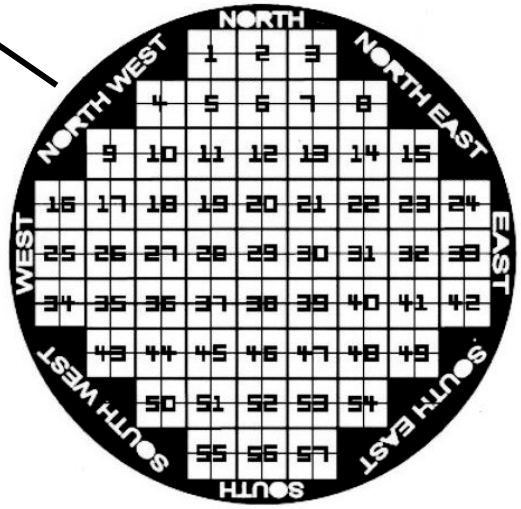


object on slide

veridical?

made in a way that pre-
serves the structure?





phenomenon seen when looking through the microscope

large, observable grid

- Does "*agnosticism on this point*" commit one to belief in a "***Cartesian demon of the microscope***"? (298)

- Only on the assumption that the similarity of large grid and the microscopic image ***must have a true explanation***:

  either it is explained (a) by the object on the slide having the same structure as the original large grid, and (b) the microscopic image being veridical;

  or it is explained by the actions of an evil demon.

- But this involves ***inference to the best explanation*** after all.

(c) Comment

- van Fraassen's comments are on target.

- And yet, for most readers they fail to weaken the intuitive force of Hacking's arguments.

(1) van Fraassen's Views in The Scientific Image (1980)

(2) Hacking on Microscopes (1981 (=1983, 1985)), (1982)

(3) van Fraassen's Reply (1985)

(4) Teller on Microscopes (2001)

(5) van Fraassen's Replies (2001), (2008)

(6) Alspector-Kelly on Microscopes (2004)

(7) Defending van Fraassen against Alspector-Kelly

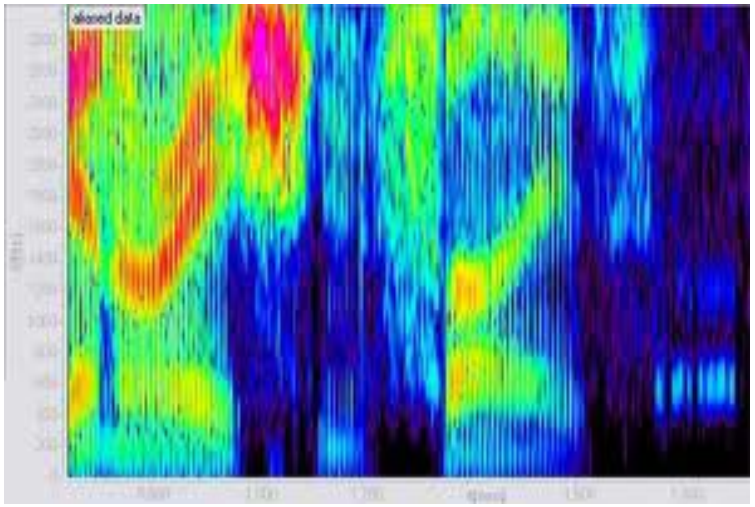
(8) The Theory-Ladenness of Microscope Experience

(a) A Reconstruction of van Fraassen's views

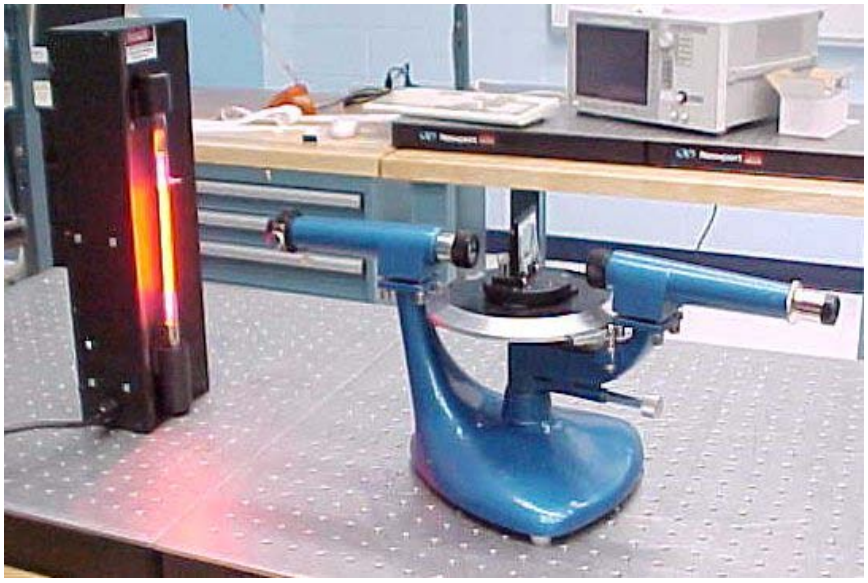
- Instruments ***produce new phenomena***.

- These phenomena can then ***be observed (unaided by instruments)***.

Spectroscopes



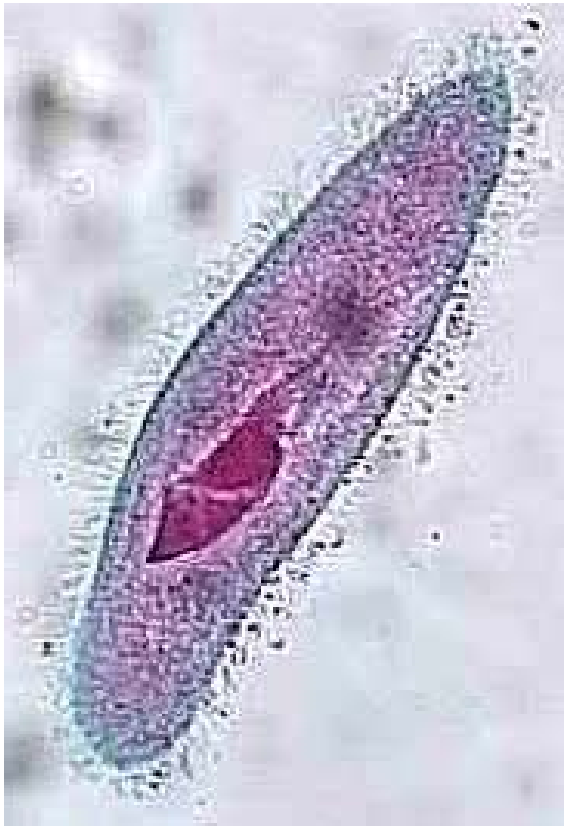
Spectrograph



"… observation of an empirical phenomenon only occurs when I look at the spectrograph …" (130)

(b) Critique: The microscope does not produce new phenomena

- In using a microscope we are ***not inspecting an independent image***.
- Our immediate objects of perception are the ***objects on the slide***. That is phenomenologically irresistable.
- Just like we ***do not perceive sense-data*** when we perceive medium-size physical objects.



paramecium

(1) van Fraassen's Views in The Scientific Image (1980)

(2) Hacking on Microscopes (1981 (=1983, 1985)), (1982)

(3) van Fraassen's Reply (1985)

(4) Teller on Microscopes (2001)

(5) van Fraassen's Replies (2001), (2008)

(6) Alspector-Kelly on Microscopes (2004)

(7) Defending van Fraassen against Alspector-Kelly

(8) The Theory-Ladenness of Microscope Experience

(a) "Observation by instruments"

(i) ***Window on the invisible world:*** (New) microscopes extend(ed) our senses.

(ii) ***Engine of creation:*** (New) microscopes produce(d) new observables. (2008: 96-7)

The products of microscopes are "*optically produced*" and ***"publically inspectable" images***. (157)

These images are ***"public hallucinations"***—like rainbows.

(b) Public hallucinations — the rainbow, e.g.

- Two observers can ***never see the same rainbow***.
- Not enough ***invariances*** to treat them as ***things***.
- Less invariances than ***reflections***—the latter are ***of a thing***.
- More invariances than ***dreams, after-images, private halluciations:***

  the subtended angle is always ***42 degrees***; it can be photographed.

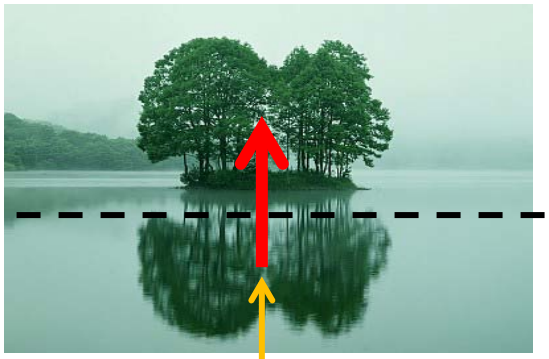
Graven Images	*Public Hallucinations*		*Private Images*
painting photo sculpture	"COPY"-QUALIFIED --- reflection shadow --- ***<microscope Image>***	NOT "COPY"-QUALIFIED --- rainbow mirage fata morgana	after-image dream hallucination

*"**Is it really** of something real, or is it not?" An* answer to this question ***tran-scends the experience***. (2008: 105)

The image as a picture of something real.

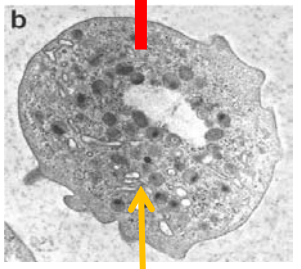
The image is not a picture of something real.

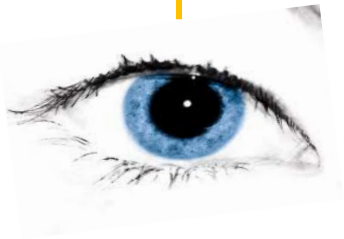
The image may (not) be a picture of something real.



unobservable

?





Public hallucinations, not independent things.

(c) Public hallucinations and scientific realism

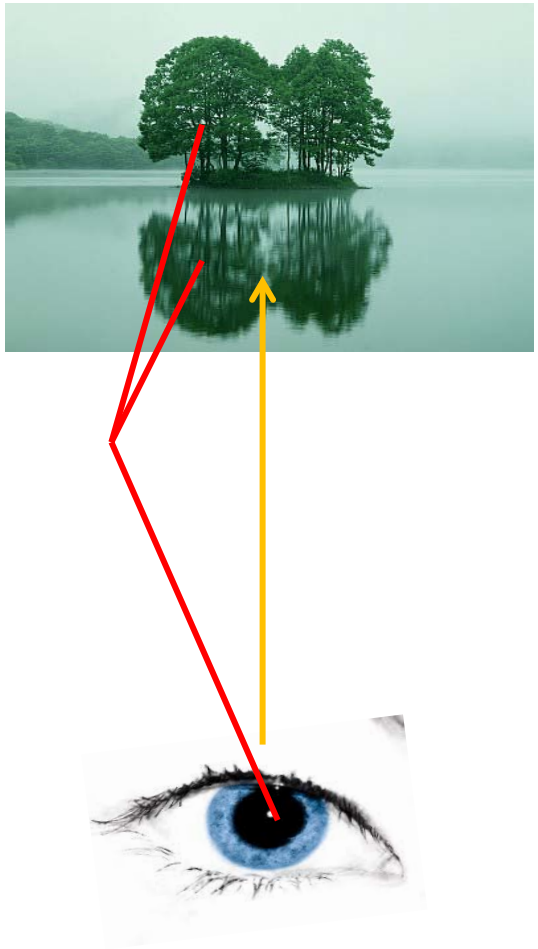
- Assume the ***theories we accept tell us*** that certain images, produced by our ***instruments***, are ***pictures of real things***.

- Do we have to believe that the images are such pictures?

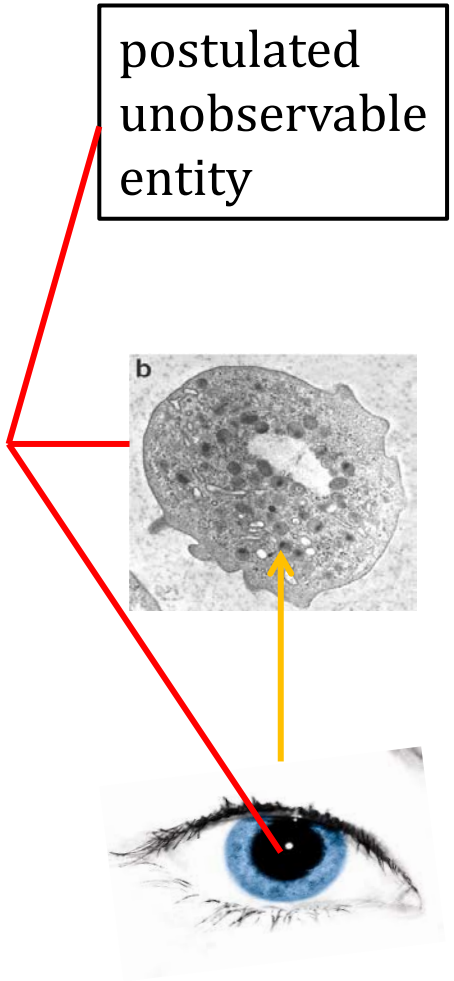
- No. ***Agnosticism*** is an appealing alternative. (2001: 160)

(I) *First reason for agnosticism: empirical study versus postulation (2001)*

Geometrical relations between the three empirical phenomena ***can be studied empirically***.



Geometrical relations between the three empirical phenomena ***cannot be studied empirically. They are postulated***.



(II) Second reason: the minimal or weaker assumption

- ***Scientific realists and empiricists accept the engine-of-creation*** view: that new instruments create new phenomena, ***new "effects"*** (cf. Hacking in *Representing and Intervening*) (2008: 100)

- We can think of the microscopic image as a copy of a real thing, invisible to unaided perception, but: *"... it is ...* ***accurate and in fact more illuminating to keep neutrality*** *in this respect ..."* (2008: 109)

(d) Discussion of Teller's objection

- ***Teller is right***: When our eyes are glued to the microscope, we ***"do not have the experience of seeing an image"***. (2001: 157)

- But it does not follow that we are obliged to say that we see the thing on the slide directly:

(i) The eye-glued-to-the-lens scenario has ***no special privilege***. Cf. the scenario in which the image is scanned and projected.

(ii) An experience has ***two sides***: what really happens to me; and my spontaneous classifying judgment in response.

(iii) Teller ***spontaneously judges*** that he sees a real paremecium.

(iv) But why should this spontaneous judgment be taken as true? Should it not be checked against other data and theories?

(2001: 158-9, 2008: 106)

(e) Observation reports and the way we speak

- For our practical purposes ***we do not need to change the way we speak***: "seeing rainbows", or "seeing paramecia".

- "As long as ***ordinary discourse is not filtered through some theory*** it does not imply that those are objects."

- But we can introduce a "linguistic regimentation or articulation": "a long description of a set-up in which certain physical phenomena—such a blackenings of photographic film—will happen." (2008: 110)

(1) van Fraassen's Views in The Scientific Image (1980)

(2) Hacking on Microscopes (1981 (=1983, 1985)), (1982)

(3) van Fraassen's Reply (1985)

(4) Teller on Microscopes (2001)

(5) van Fraassen's Replies (2001), (2008)

(6) Alspector-Kelly on Microscopes (2004)

(7) Defending van Fraassen against Alspector-Kelly

(8) The Theory-Ladenness of Microscope Experience

First Argument: The argument from phenomenology

Second Argument: The argument from the symmetry of postulation

Third Argument: The argument from sense data and images

Fourth Argument: Against the superiority of unaided perception

First Argument: The argument from phenomenology

Second Argument: The argument from the symmetry of postulation

Third Argument: The argument from sense data and images

Fourth Argument: Against the superiority of unaided perception

- van Fraassen is right about the ***cloud chamber***; here the instrument produces an observable for us to interpret.

- But in the case of the microscope there is no "***intervening observable*** *between eye and slide ...*" (2004: 334)

- The blood cell seen with the microscope does have ***the invariances of a real thing***, not those of a rainbow. (335-6)

- And thus the judgement that we are "*looking at something real*" is "***phenomenologically irresistable***". (336)

First Argument: The argument from phenomenology

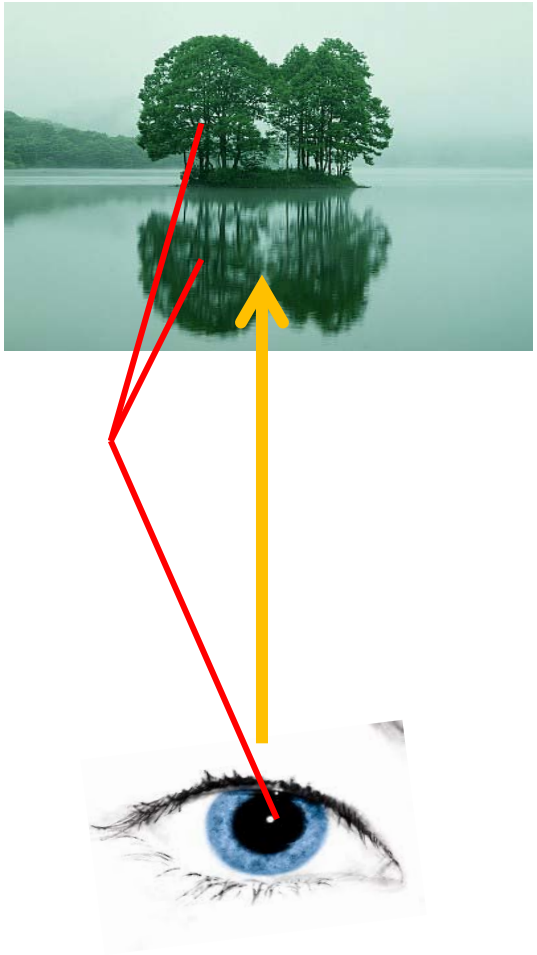
Second Argument: The argument from the symmetry of postulation

Third Argument: The argument from sense data and images

Fourth Argument: Against the superiority of unaided perception

Reflection Case

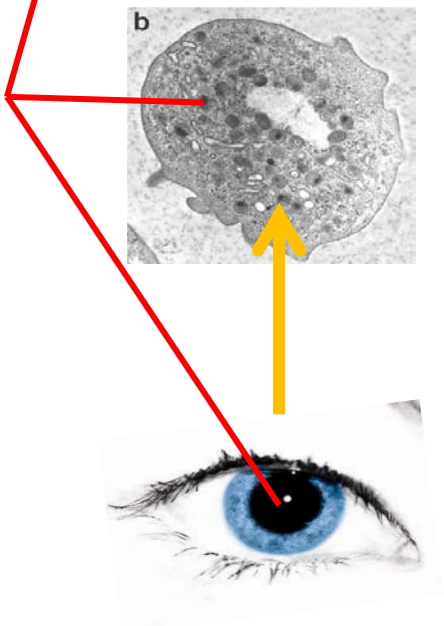
Geometrical relations can be studied empirically.



Microscope Case

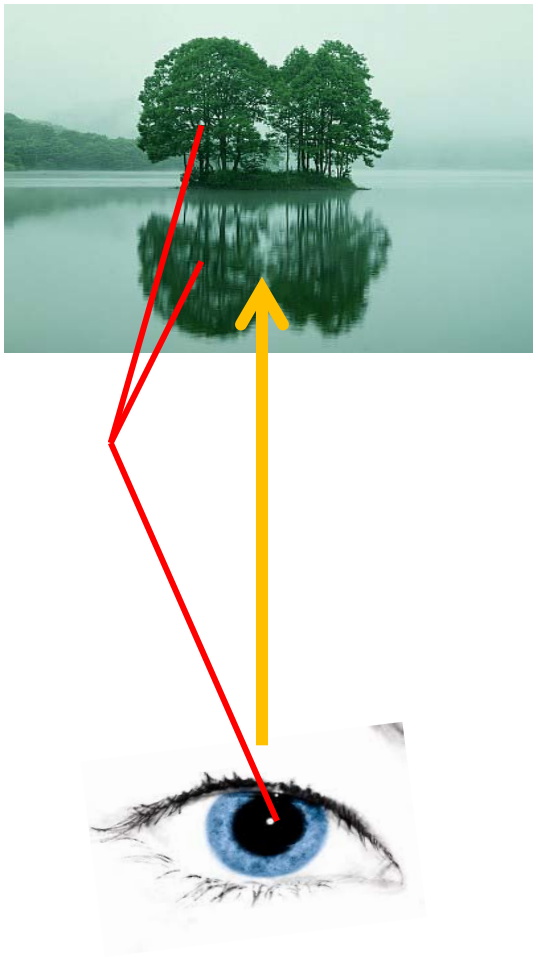
Geometrical relations are postulated.

postulated unobservable entity



Reflection Case

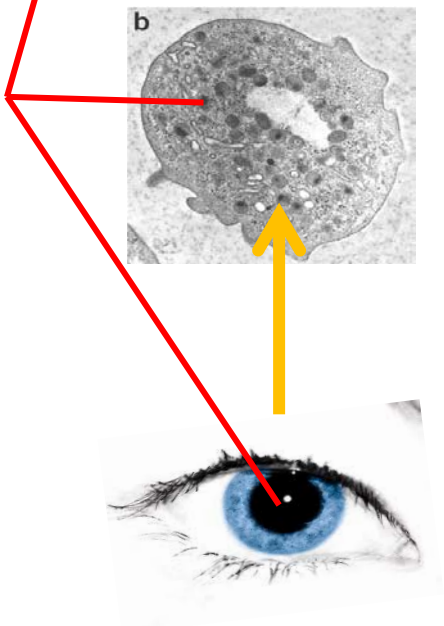
Geometrical relations can be studied empirically.



Microscope Case

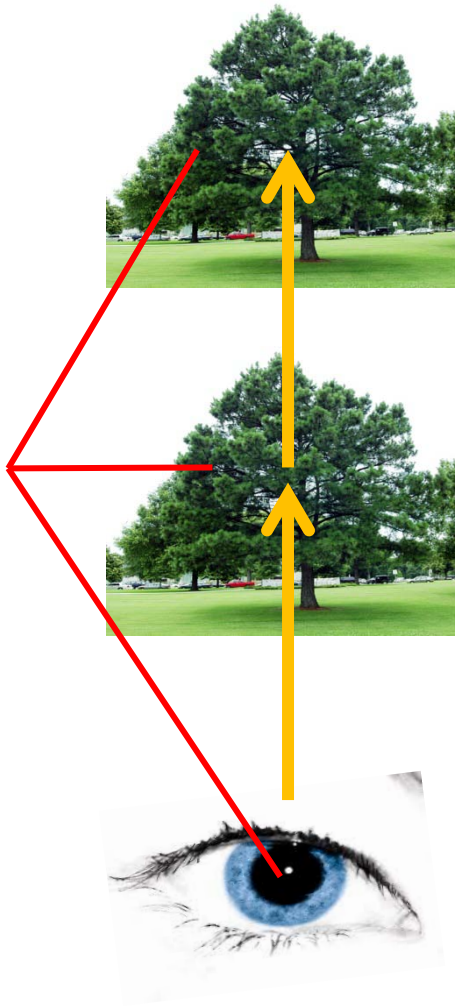
Geometrical relations are postulated.

postulated unobservable entity



Tree Perception Case

Geometrical relations are postulated.



- ***We also postulate*** "*appropriate relations*" in the case where we ***look directly at a tree***; between

  the tree,

  our perceptual experience of the tree, and

  our bodily location.

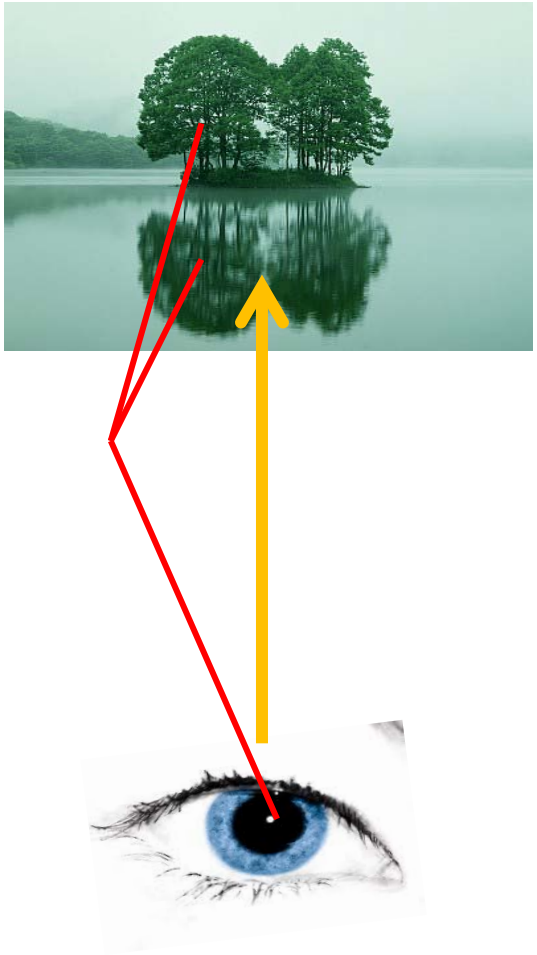
- The judgement "*the tree is in front of me*" ***presupposes*** that

  the ***light-rays*** are reflected according to "*certain rules of geometrical optics*";

  "*other **cues** as to location and distance do not mislead as they do in the 'Ames Room' illusion*." (336)

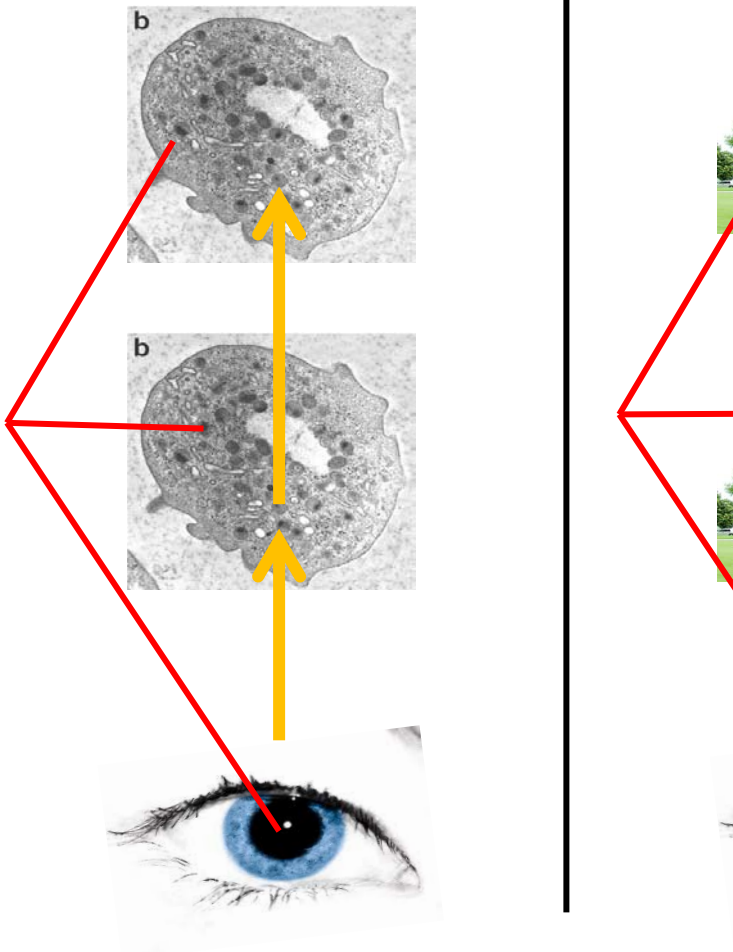
Reflection Case

Geometrical relations can be studied empirically.



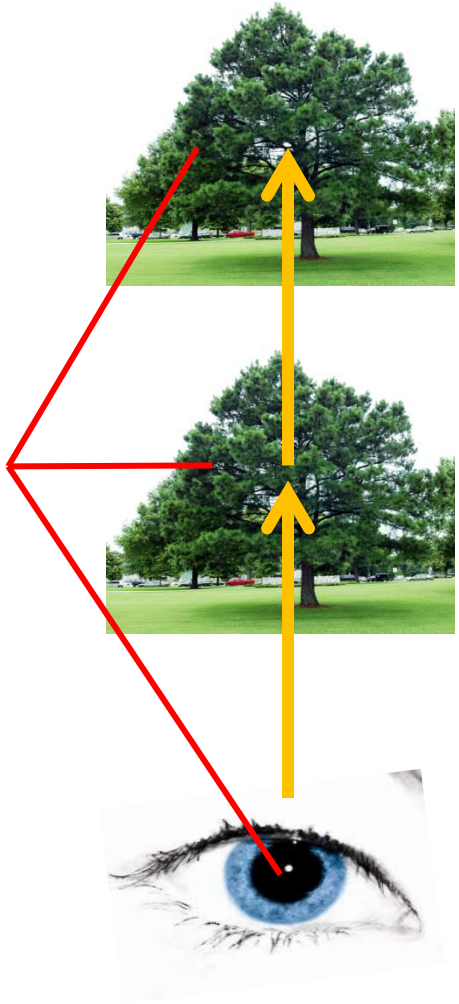
Microscope Case

Geometrical relations are postulated.



Tree Perception Case

Geometrical relations are postulated.



- It is ***odd*** to speak of "postulating" these relations when we look directly at a tree.

- But it is ***no less odd*** to speak of "postulating" geometrical relations in the case of experienced microscopists.

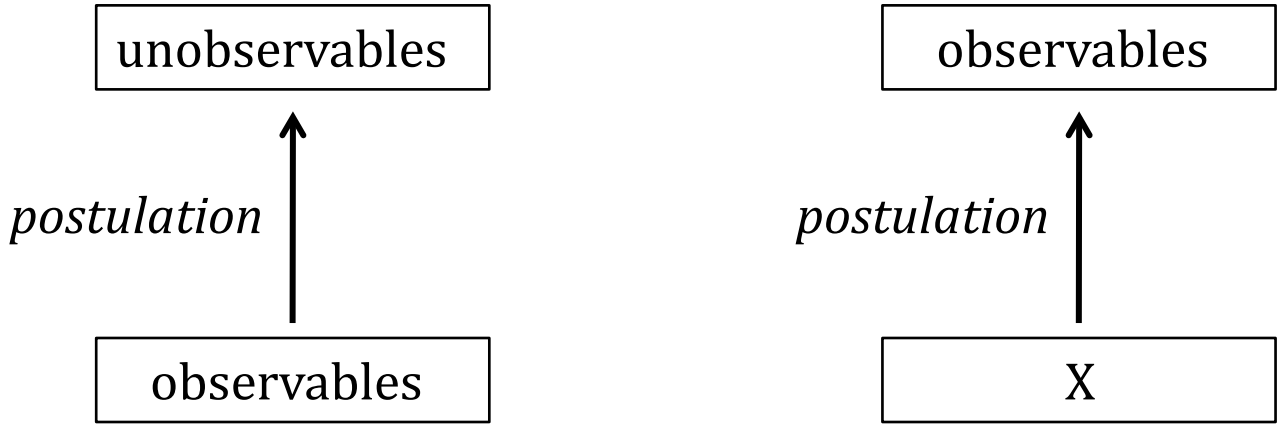
First Argument: The argument from phenomenology

Second Argument: The argument from the symmetry of postulation

Third Argument: The argument from sense data and images

Fourth Argument: Against the superiority of unaided perception

- Earlier arguments to the effect that unaided perception also involves postulation were rejected in ***The Scientific Image*** as a ***mistaken invocation of sense data***.



- van Fraassen (2001) ***leaves room*** for the thought that unaided perception involves the postulation of observables.

- ***Images*** and hallucinations are for him ***empirical phenomena***.

- They are ***too invariant to be counted as objects***. And this distinguishes them from ***sense data***.

- They thus ***qualify as the needed "X"***: proximate empirical phenomena on the basis of which distal observables are postulated.

First Argument: The argument from phenomenology

Second Argument: The argument from the symmetry of postulation

Third Argument: The argument from sense data and images

Fourth Argument: Against the superiority of unaided perception

- van Fraassen's idea that ***observation is measurement does nothing to establish*** the superiority of unaided perception. (341)

- Two epistemic considerations underlie our use of "to see" :

  (a) ***correlation*** between our perceptual experiences and properties of the objects we are directed at;

  (b) ***fidelity***: the perceptual experience is a good guide to (many of) the properties of the scene or object with which it is correlated. (344-5)

- *"Paradigmatic vision is of unobscured objects nearby and in front of our eyes, emanating or reflecting electromagnetic radiation within the visible range, whose straight-line path from object to eye proceed sthrough nothing more disruptive than air, and reaches a subject who is wide awake and attentive, enjoys 20/20 vision, and a mind unclouded by drugs."*

  (343)

- Many perceptual-enhancement technologies ***depart to various degrees from the paradigmatic case*** of perceptual experience.

- But the history of our decisions concerning "to see" shows that this ***does not count against*** application of the word:

  e.g. telephones, hearing aids, night-vision goggles, television, the Hubble telescope, the (electron) microscope.

- The ***unusual causal route is outweighed*** by the considerations of ***correlation and fidelity***: the epistemic values. (346)

- The ***science behind*** these technologies convinces us of this.

- The constructive empiricist has to accept these scientific results.

(1) van Fraassen's Views in The Scientific Image (1980)

(2) Hacking on Microscopes (1981 (=1983, 1985)), (1982)

(3) van Fraassen's Reply (1985)

(4) Teller on Microscopes (2001)

(5) van Fraassen's Replies (2001), (2008)

(6) Alspector-Kelly on Microscopes (2004)

(7) Defending van Fraassen against Alspector-Kelly

(8) The Theory-Ladenness of Microscope Experience

First Argument: The argument from phenomenology

Second Argument: The argument from the symmetry of postulation

Third Argument: The argument from sense data and images

Fourth Argument: Against the superiority of unaided perception

- Is the judgement that we are seeing real dense bodies "***phenomenologically irresistible***"?

- Why give the "eye-glued-to-the-microscope" scenario more weight then the "scanned-and-projected-image" scenario?

- This consideration ***weakens*** the feeling of the "phenomenologically irresistible".

- *"We know that the rainbow is illusory, in part, because it does not behave properly. ... But the putative blood cell seen through the microscope is well-behaved, so far as we know ..."* (335)

- What does ***"the putative blood cell"*** refer to?

  (a) Not the ***image***: it does not have the invariance of a thing.

  (b) Not the ***microstructure*** (invisible to unaided perception): this would beg the question.

- *"We know that the rainbow is illusory, in part, because it does not behave properly. ... But the putative blood cell seen through the microscope is well-behaved, so far as we know ..."* (335)

- If (b), "***how far do we know***"? Judgements of invariance are theoretical. But what does ***acceptance of the theory*** involve?

  (i) That we can see the ***microstructure*** of blood?

  (ii) That we can't (be sure) but that there is ***a regularity*** (invariance) between various ***observable phenomena*** brought about by the eye-blood-microscope system.

First Argument: The argument from phenomenology

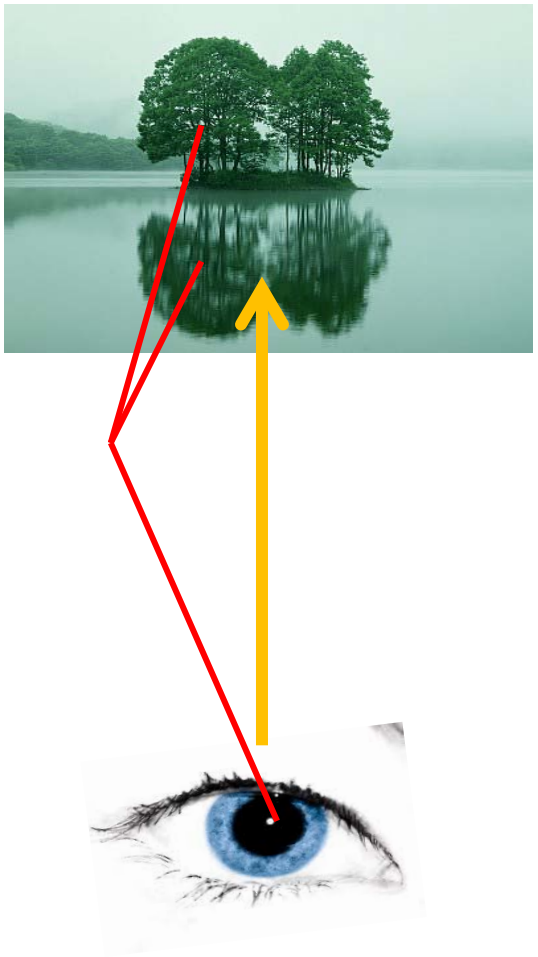
Second Argument: The argument from the symmetry of postulation

Third Argument: The argument from sense data and images

Fourth Argument: Against the superiority of unaided perception

Reflection Case

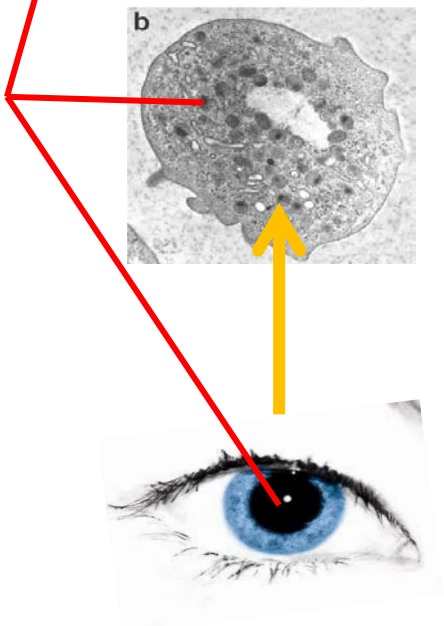
Geometrical relations can be studied empirically.



Microscope Case

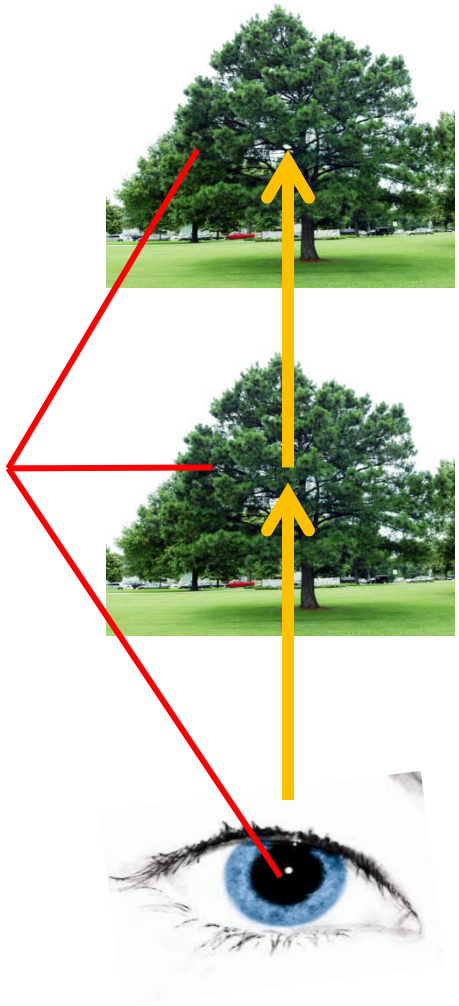
Geometrical relations are postulated.

postulated unobservable entity



Tree Perception Case

Geometrical relations are postulated.



- van Fraassen is ***not saying*** that the *Reflection Case* and the *Tree Perception Case* involve ***no postulations***.

- But in the *Reflection Case* we have ***unaided visual access to three*** objects; in the *Microscope Case* only ***to two***.

- ***A greater part of the set of all*** (geometrical) relations between the three objects can be ***studied empirically*** in the *Reflection Case*.

- The difference ***motivates an agnosticism*** in the *Microscope Case*.

- Does the Tree *Perception Case* involve ***three observables***? The dialectic seems to presuppose that it does.

- But is the ***visual experience an observable***? What is its degree of invariance? A private hallucination? Can we photograph it?

- Assume the visual experience were an observable. Do when then ***observe both the visual experience and the tree***?

(I) ***Postulation*** in judging that ***I perceive the tree*** in front of me (according to Alspector-Kelly):

(i) Presupposition that various *"cues as to location and distance* ***do not mislead*** *as they do in the 'Ames Room' illusion"*.

(ii) Presupposition that the light-rays are reflected according to certain ***rules of geometrical optics***.

- No reliable perception without that these presuppositions are met.

- But it is ***not part of our epistemic folkways*** that one needs to be aware of these presuppositions in order to see.

- One need not be aware of, and able to exclude, ***error-possibilities*** like the Ames Room illusion.

(II) ***Postulation in the case of the microscope***:

- Alspector-Kelly does not list specific ***presuppositions for microscopic seeing***—textbooks on microscopy do.

- Is it really part of our epistemic folkways in science that one need not be aware of the error-possibilities in order to ***make scientific knowledge with the help of microscopes***? Not clear.

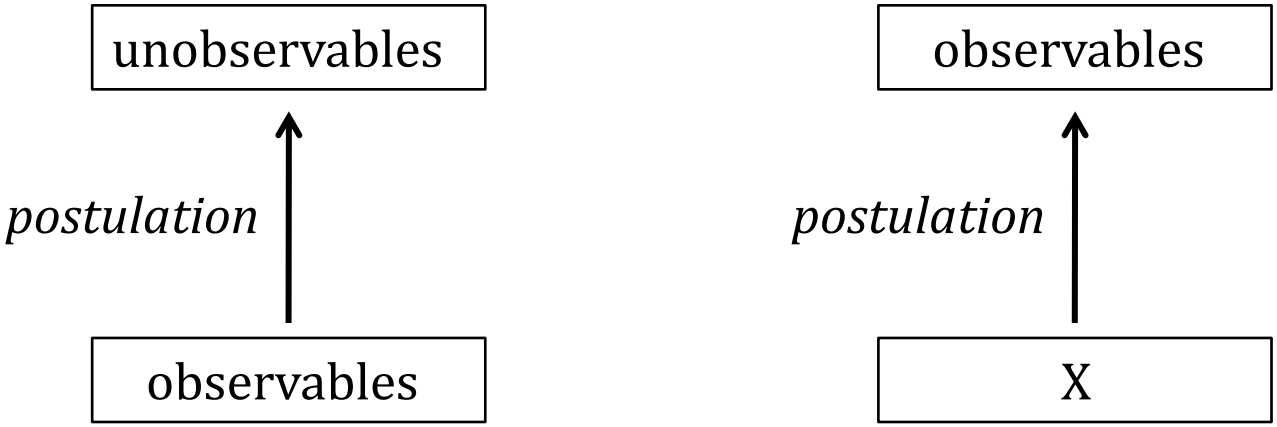
- Textbooks or manuals in microscopy aim to enable the scientist-microscopist to ***rule out explicitly*** a wide range of defeating conditions.

First Argument: The argument from phenomenology

Second Argument: The argument from the symmetry of postulation

Third Argument: The argument from sense data and images

Fourth Argument: Against the superiority of unaided perception



- Alspector-Kelly claims that the ***"images" and "hallucinations"*** of van Fraassen (2001, 2008) can play exactly the role that van Fraassen earlier (in 1980) denied sense-data.

- We postulate observable objects on their basis. But we speak of "perceiving" of these objects. Hence the we can also speak of perceiving the microstructure of objects.

- Alspector-Kelly overlooks ...

(i) that the observables on the basis of which van Fraassen thinks in science we postulate unobservables are ***publicly accessible***. But we do not have such images for ordinary perception.

(ii) that his interpretation would lead to an ***infinite regress***: van Fraassen's observables would be postulated on the basis of further observables, and so on.

(Don't say: "So much the worse ..." Charity would suggest rejecting the assimilation of images to sense data.)

First Argument: The argument from phenomenology

Second Argument: The argument from the symmetry of postulation

Third Argument: The argument from sense data and images

Fourth Argument: Against the superiority of unaided perception

- Of course there are ***various epistemic considerations*** underlying our use of "to see".

- But Alspector-Kelly overlooks that there are ***many other factors***, too: analogy, metaphor, etc.:

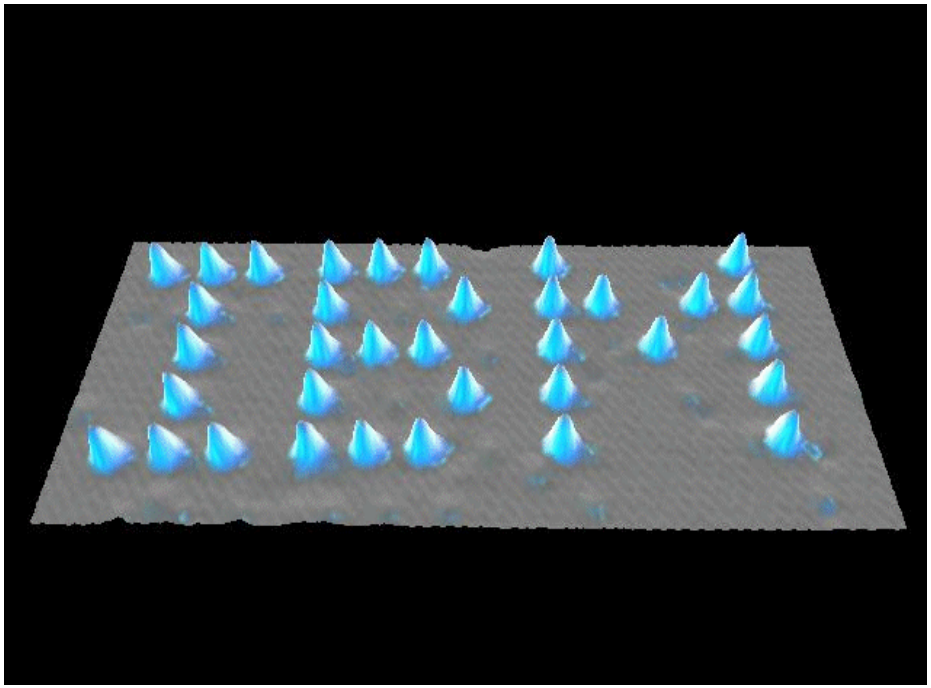
  after all, we say that we see rainbows, dreams, or hallucinations (in some languages, anyway).

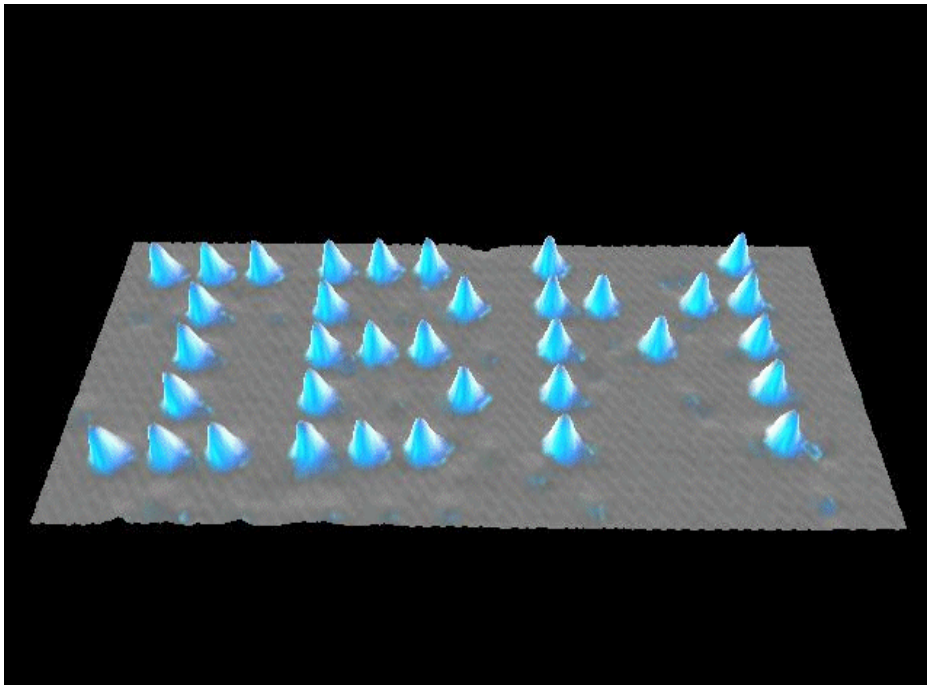
- Note also that our readiness to speak of "seeing" in the case of, say, the ***Hubble Telescope*** or the ***Scanning Tunneling Electron Microscope*** is rather unstable.

- Cf. the discussions in Joseph C. Pitt (2004, 2005):

  - Most "naïve" subjects are prone to say that the Hubble Space Telescope allows us to see very distant objects in the universe or that the STEM allows us to see nanoscale objects.

  - They do so when first encountering pictures of the two instruments like the following:





But once it is explained to “naïve subjects” how the images are produced, and how much computer “enhancement” is involved—e.g. the colors are computer generated—they quickly change their mind.

- Note also Hacking's (1983) reference to ***Simon Henry Gage's The Microscope*** (17 editions between 1880 and 1941), and the standard American textbook for a long time.

- Gage insisted (as Hacking puts it) that "***we do not, after all, see through a microscope***" (1983: 187), on the grounds that

"... the images of minute objects are not delineated microscopically by means of the ordinary laws of refraction; they are not dioptical results, but depend entirely on the laws of diffraction." (quoted from Hacking 1983: 187)

- Alspector-Kelly is right to say that we believe electron microscopes and telescopes to be strong on ***correlation*** and that we do so on the basis of scientific theories.

- ***But what exactly does that mean?*** The claim can be spelled out in a scientific-realist and a constructive-empiricist way:

  (a) the correlation with ***unobservables***;

  (b) the correlation with ***other observables***.

(1) van Fraassen's Views in The Scientific Image (1980)

(2) Hacking on Microscopes (1981 (=1983, 1985)), (1982)

(3) van Fraassen's Reply (1985)

(4) Teller on Microscopes (2001)

(5) van Fraassen's Replies (2001), (2008)

(6) Alspector-Kelly on Microscopes (2004)

(7) Defending van Fraassen against Alspector-Kelly

(8) The Theory-Ladenness of Microscope Experience

Two kinds of theory-ladenness

- theory-ladenness of the ***content*** of our experience
- theory-ladenness of the experiential ***attitude or act***
- The latter played a great role in debates over the reliability of self-observation (introspection) in psychology (a century ago).
- Attending to it allows us to reconstruct and perhaps strengthen van Fraassen's reply to his critics.

Teller vs. van Fraassen I

- Teller insists that his ***experience*** in looking through the microscope is that of ***seeing real microstructures***—not an image.

- And this, for Teller, ***supports the philosophical theory/thesis*** that microscopic observation is veridical and of microstructures.

Teller vs. van Fraassen II

- van Fraassen's reply suggests that Teller's ***spontaneous judgement*** ("I see the paramecium") is part of his experience.

- The judgement (and thus the experience) is ***laden with the theory*** or thesis of microscopic observation as veridical of microfeatures.

Hacking vs. van Fraassen I

- Hacking insists that his ***experience*** in looking through the microscope is that of ***manipulating real and visible microstructures***.

- But he goes further than Teller in providing what he takes to be ***arguments that back up the phenomenological point***:

  - We do not get incoherent results when looking at blood samples through two different kinds of microscopes.

  - Something that we made ourselves (i.e. the grid) cannot be an artefact of the microscope.

Hacking vs. van Fraassen II

- van Fraassen can be read as insisting that ***Hacking's arguments beg the question at issue, and thus provide no independent support for the (theory-laden) phenomenology***.

Alspector-Kelly I

- The ***irresistible phenomenology*** is again the backbone. It is thought to support the idea that ***ordinary and microscopic seeing are alike***.

- But it is to Alspector-Kelly's credit that he seeks to ***offer an reconstruction of our "folk-theory"*** of seeing that supports his view.

- Note that all of his arguments seek to establish that microscopic observation is just like ***and feels just like*** macroscopic observation.

Alspector-Kelly II

- But his theoretical considerations **...**

  (a) ***build upon a phenomenology that is laden with the theory***;

  (b) and they beg the question against the constructive empiricist.

van Fraassen

- The critics' (our?) experience of microscopic observation is ***laden with the epistemic theory of microscopes as windows***.

- Of course, the critics might not see it that way **...**

- There is little chance to convince the critics—but from the point of view of the constructive realist, ***their position is not obligatory***.

- ***And that is enough ... for the voluntarist.***

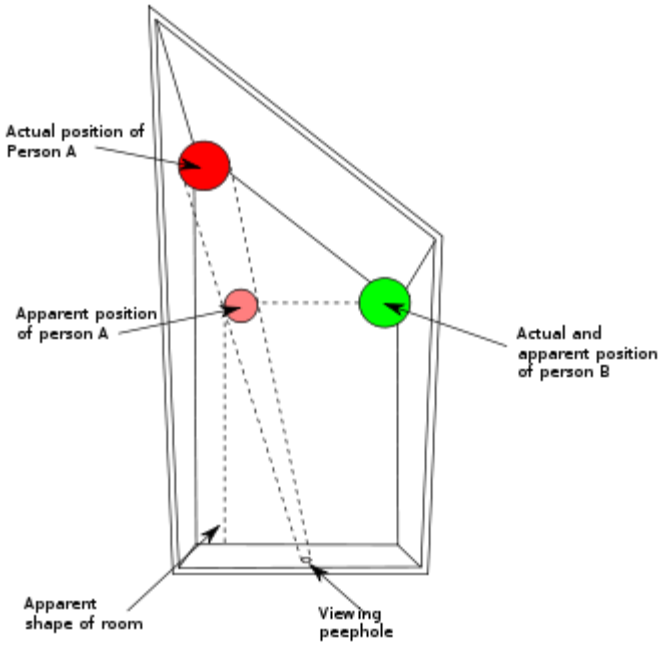
The End …

Ames Room Illusion

An Ames room is constructed so that from the front it appears to be cubic-shaped.

But this is a trick of perspective and the true shape of the room is trapezoidal:

the walls are slanted, the ceiling and floor are at an incline, and the right corner is much closer to the front-positioned observer than the left corner.



A person standing in one corner appears to the observer to be a giant, while a person standing in the other corner appears to be a dwarf.

“One needs theory to make a microscope. You do not need theory to use one. ... Practice—and I mean in general doing, not looking—creates the ability to distinguish between visible artifacts of the preparation or the instrument, and the real structure that is seen with the microscope. This practical ability breeds conviction.”

(1983: 191)

"... think about practice, not theory. ... engineering, not theorizing is the proof of scientific realism about entities.” (1982)

"Two physical processes—electron transmission and fluorescent re-emission—are used to detect the bodies. These processes have virtually nothing in common between them. ...

It would be a preposterous coincidence if, time and again, two completely different physical processes produced identical visual configurations which were, however, artifacts of the physical processes rather than real structures in the cell." (1983: 201)

“... we are not concerned with explanation. We see the same constellations of dots whether we use an electron microscope or fluorescent staining, and it is no 'explanation' of this to say that some definite kind of thing (...) is responsible ...” (1983: 202)

“My argument from coincidence says simply that it would be a preposterous coincidence if two totally different kinds of physical systems were to produce exactly the same arrangements of dots on micrographs.” (1983: 202)

"... we look at the tiny disc through almost any kind of microscope and see exactly the same shapes and letters as were originally drawn ...."

"It is impossible seriously to entertain the thought that the minute disc ... does not in fact have the structure of a labelled grid."

"I know that what I see through the microscope is veridical because we made the grid to be just that way. ... Moreover we can check the results with any kind of microscope ..."

"Can we entertain the possibility that, all the same, this is some gigantic coincidence? ... To be an anti-realist about the grid you would have to invoke a malign Cartesian demon of the microscope." (203)

Imagine I have several processes which produce very different visual images when set in motion under similar circumstances. I study them, note certain similarities; as I repeat this, I discard similarities that do not persist and also build machines to process the visual output in a way that emphasises and brings out the noticed persistent similarities.

Eventually the refined products of these processes are strikingly similar when initiated in similar circumstances. Now I point to the similarities and say that they are too striking to be there by coincidence, though, of course, the discarded similarities were mere ideosyncracies of the individual processes. What is the status of my assertion? What principle of reasoning could support it?

Since I have carefully selected against non-persistent similarities in what I allow to survive the visual output processing, it is not all that surprising that I have persistent similarities to display to you. (297-8)

"... instruments expand our stock of available phenomena rather than providing 'windows' through which we look more deeply at phenomena that exist beforehand." (2001: 130)

"But the phenomena themselves ... are what we can observe after the instruments have done their work, without the further use of instruments." (2001: 130)

"The pointless epistemic risk argument ... ´Should what we imagine 'lies behind' the phenomena, including the phenomena produced by our instruments, be ever so different from what we imagine, it would make no difference to what we experience or notice and so no difference to what matters." (2001: 130)

“There is no mental or visual image, like a photographic plate, which then needs to be interpreted. ... there is no pre-phenomenal object produced in the microscope that we can then independently inspect ‘after putting the microscope back on the shelf".

“It is not an image of, but the paramecium itself and its waving cilia which we see when we open our eyes and look with the aid of the instrument ... just as much as it is the cat itself, not an image of the cat, which we see when we open our eyes and see the cat on the mat.”

“Trained microscopists do not view images-or-appearances-view-able-without-a-microscope any more than, when we look at a tomato, our immediate objects of perception are sense data which we then interpret. ...” (2001: 133)

We can assimilate microscopes to *"experimental arrangements that produce telling new effects for us to see" (2001: 154).*

We can see them as *"creating new observable phenomena to be saved". (155).*

We can assimilate microscopes to *"experimental arrangements that produce telling new effects for us to see" (2001: 154).*

We can see them as *"creating new observable phenomena to be saved". (155).*

".... optical phenomena ... reflections in water ... rainbows."

"... we talk about them as if they were things."

"They refuse to allow us to represent them to ourselves as things, or even as properties of things in any straightforward way." (156-7)

“Since we can't see things that don't exist, the phrase 'seeing an image' is code for something we are describing metaphorically or analogically. ...

My experiences are the events that happen to me of which I am aware. Such an event has two sides, so to say: what really happens to me and the spontaneous judgement I make in response, which classifies that event in some way. In good cases the two coincide, but often they do not. For example, I trip over a marmot but take it to be a cat. What happened to me was that I tripped over a marmot, but I 'experienced it as' tripping over a cat.” (158)

"We classify someone's experience as the experience of seeing an image of an X in three cases:

(a) if we judge that s/he is seeing a real thing that we classify as a 'picture' of an X (this would apply if the microscope is hooked up to a projector or monitor);

(b) if s/he judges that s/he is seeing a real X, and we take that to be an illusion, or hallucination, whether private or public;

(c) if s/he judges that it is as if s/he is seeing a real X but s/he takes that to be an illusion." (158)

“What then is the important fact that Teller is pointing out about looking into a microscope? It is that he spontaneously judges that he is seeing e.g. real paramecia, and that he has no inclination to correct that statement as illusory.

... he contrasts it with experiences in which the spontaneous judgement includes a classification of that very experience as what I would call a public hallucination.

But this difference pertains in the first instance not to what is really happening to him, but to his response to what is happening to him...

The question whether the experience of 'seeing' in a microscope is or is not a public hallucination is not settled by this. Instead, that question becomes a theoretical question about what happens in the optical microscope.”

"If you see a reflection of a tree in the water, you can also look at the tree and gather information about the geometric relations between the tree, the reflection and your vantage point.

If you say similarly about the microscope's image that they are pictures of e.g. paramecia, then you are asserting that there are certain invariant relations between the object, image and vantage point. ...

But now you are postulating that these relations hold ..." (160)

“In light of van Fraassen's recent extension of the concept of empirical phenomena to include the rainbow and its ilk, this response won't do.

Images and hallucinations are empirical phenomena without empirical objects.

Even if we have no other way of describing them except as objects—as seems the case with the rainbow—that does not require that we take such talk as committal.

It therefore requires no more commitment to sense-data than does the possibility that microscope-viewings are public hallucinations.” (337-8)

“Insofar as it is appropriate to speak of a perceptual image when characterising the view through the microscope—even when, so far as the science of microscopy informs us, that view is veridical—it is appropriate to speak of a perceptual image when characterising naked-eye visualisation, even when that view is veridical. van Fraassen's dichotomy between postulation-free information-gathering by the naked eye and postulation-laden microscopic imagery is spurious.” (338)

(II) ***Second reason: historical support***

- Classic experiments by Rutherford, Millikan, Perrin and Einstein produced phenomena that were taken as images of particles as ***"enduring, moving, massive individuals."***

- More recent physics suggests a very different idea of particles; e.g. their number can vary with frame of reference. In this way, they resemble shadows or rainbows.

- There thus is good reason to be agnostic about the images of particles as enduring, ... individuals. (2001: 161)

(f) What really matters

- The important point is that there is an observable/unobservable distinction.

- It does not matter much if the optical microscope is taken in the way Teller proposes.

- But ***not the electron microscope***! (2008: 110)