

# **Alfred Holl**

## **Epistemological approaches important for IS modeling**

### **1 Motivation**

### **2 Realism**

**2.1 Naïve realism**

**2.2 Critical / hypothetical realism**

### **3 Constructivism**

**3.1 Moderate constructivism**

**3.2 Radical constructivism**

### **4 Preliminary results**

**4.1 Doubts about human perception of reality**

**4.2 Contradictory epistemological approaches**

### **5 Evolutionary epistemology**

**5.1 Evolutionary origin of the cognitive a priori**

**5.2 EE's evolutionary 'mirror'**

**5.3 EE: reliability of human cognition**

**5.4 EE: the 1st epistemological dilemma**

**5.5 EE's: profit**

### **6 Epistemological step model**

### **7 Summary: ubiquitous constructivism**

# 1 Motivation

## Epistemological approaches:

### Is there only one single epistemology? or: What relations between reality and model can you imagine?

Situation: **epistemological complexity**

Answers from humanities are not sufficient,  
therefore reduction to axioms:

- 1 Which of Popper's three levels of existence is accessible to cognition?
- 2 In what way is world 1 accessible to cognition?
- 3 In what quality and to what degree is world 1 accessible to cognition?
- 4 Is definite, objective knowledge of world 1 possible?

<b>Relation reality – model World 1 – World 3</b>	<b>Epistemological approach</b>
<b><u>1 to 1:</u></b> to find, to (re)discover descriptive categories	naïve realism
<b><u>a certain:</u></b> some coincidence, some distortion: to (suitably) invent descriptive categories	critical realism, moderate constructivism  evolutionary epistemology (EE)
<b><u>no:</u></b> to arbitrarily invent descriptive categories	radical constructivism, idealism, solipsism

## 2 Realism 1 --- 2.1 Naïve realism 1

- assumes a **one-to-one (isomorphic) correspondence** between reality and model
- corresponds to a sensualistic mapping theory

Both assumptions are completely **obsolete**.

We can find a lot of arguments against naïve realism in IS/IT, e.g.,

- reduction of W1-complexity in W3-models,
- influence of the model designer on his models,
- mutual influence of model designers and employees

Arguments from biology (sensory and brain physiology) and **psychology of gestalt**:

- **distortion** by perception
- **optical illusions**, e. g. Müller-Lyer, contrast intensification
- ‘retinal abstraction’: – contour intensification
  - color reduction (colored windows)
- three bowls of water (asymmetric reaction)
- symmetric reddening of skin after one-sided impact of heat etc.

**Therefore, we know that human perceptions and human models do not completely coincide with the reality.**

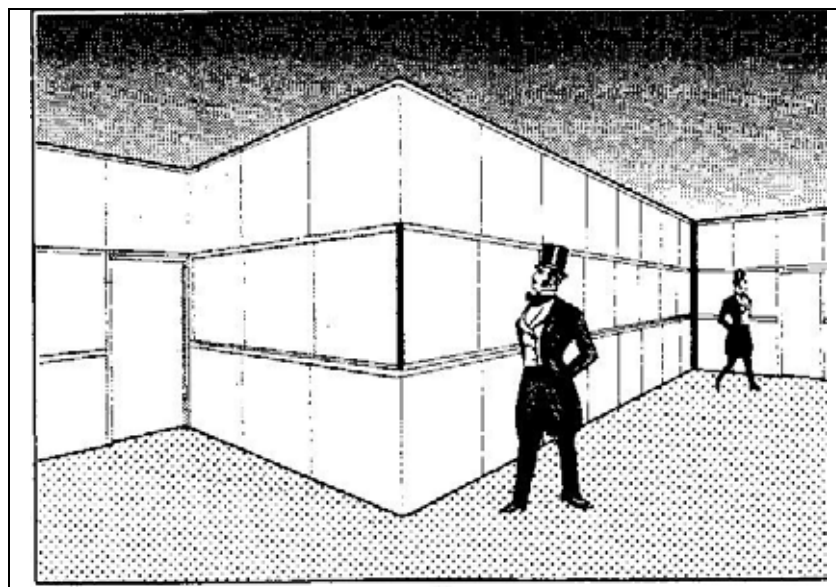
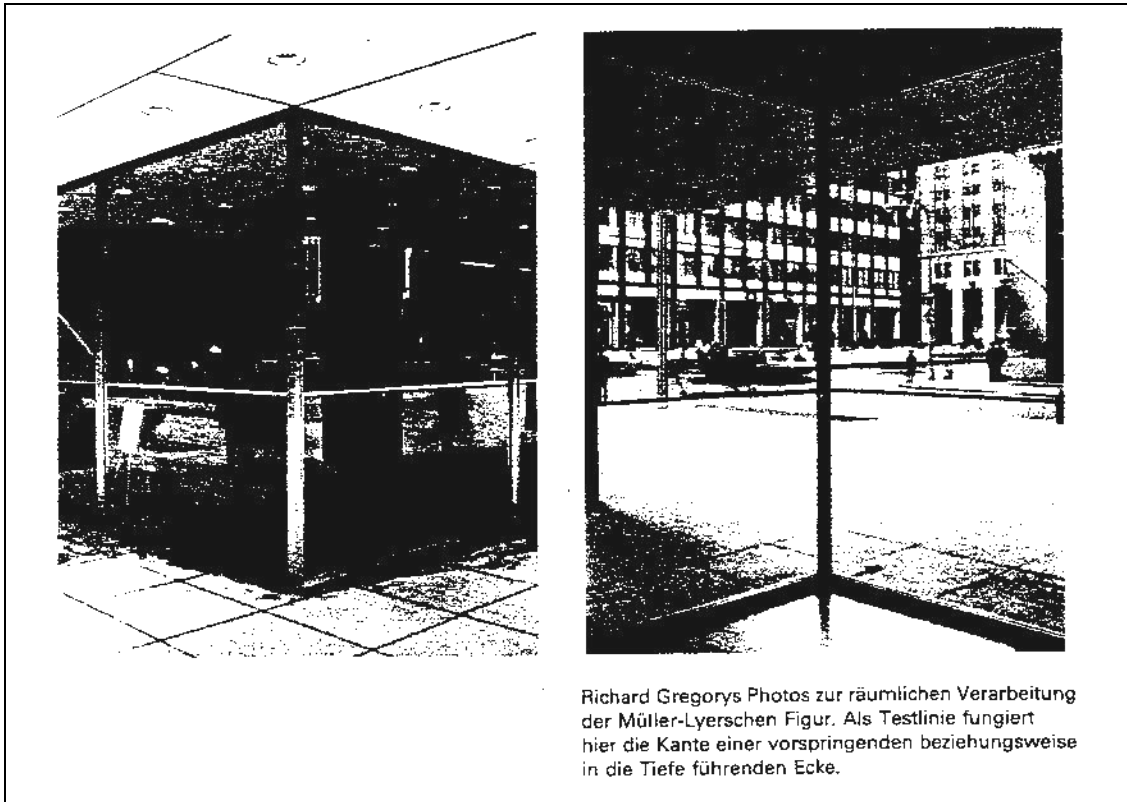
You cannot completely rely on human knowledge.

Distortion effects of that kind arise already with regard to simple optical objects, the more with regard to more complex objects, such as organizations as open social systems.

**Naïve realism has to be refused in IS from the very beginning.**

## 2 Realism 2

### 2.1 Naïve realism → critical realism



**Müller-Lyer's optical illusion**  
**Franz Müller-Lyer (1857-1916)**  
**German sociologist and psychiatrist**  
**(Rock, Wahrnehmung, 1998 [1984], 139)**

## 2 Realism 3

### 2.2 Critical realism

similar: strong critical realism

similar: hypothetic realism (weakest form) Vollmer, EE, 1975, 35

There is always some distortion of reality  
by – the model designer's – **active and interpreting perception,**  
description and formalization.

Therefore, a one-to-one (isomorphic) correspondence  
between reality and model is impossible.

**In spite of this distortion of reality,  
there is some relation between reality and models,  
between immanent categories and descriptive categories.**

What about descriptive categories which humans define,  
e.g. in mathematics?

They are used, but do they exist and how?

Are there corresponding immanent categories?

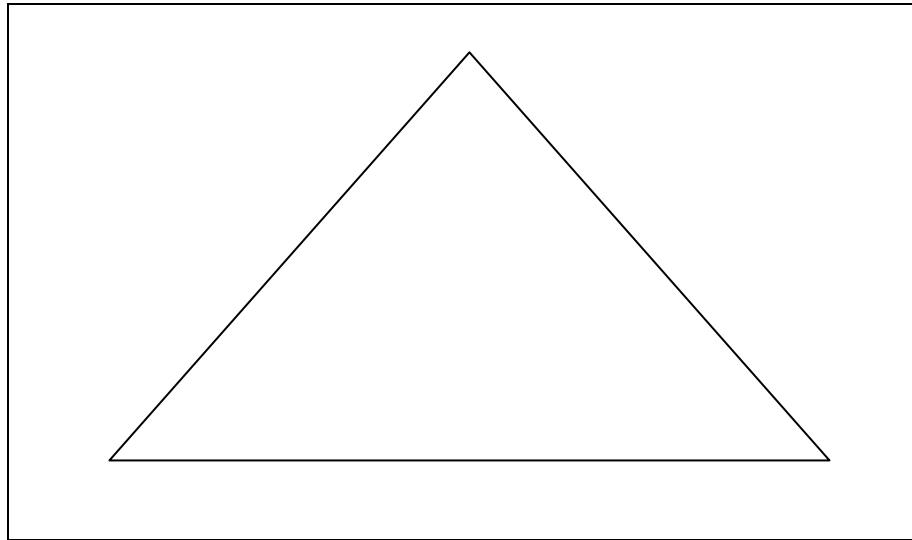
The ideal form of a triangle does not occur in nature,  
cannot be observed,  
numbers do not occur either,  
only certain quantities of similar objects,  
mathematical equations do not occur in nature.

There are different levels of existence.

These considerations lead to **moderate constructivism.**

## 2 Realism 4

### 2.2 Critical realism → moderate constructivism



**1, 2, 3, ...**

**-3/569**

**e,  $\pi$ , i**

$$(2a-3bx)(-5ax+b) = 5x^2-6b$$

# 3 Constructivism 1

## 3.1 Moderate, weak constructivism

**Critical realism** underlines that models are **reconstructions**, lays stress on the reconstructed parts of human knowledge, lays stress on the existence of an **independent reality**.

**Moderate constructivism** underlines that models are **constructions** lays stress on the constructed parts of human knowledge, lays stress on the existence of **constructions**.

### Fact 1:

Every (re-)construction (interpretation) of reality is determined by **biological and social norms of perception** and, therefore, contains some **constructed part** (how big?).

### Statement:

If some relation to empirically observable reality is intended, **human constructions are not completely free and arbitrary**.

### Fact 2:

**There are areas of science where constructions are arbitrary:** mathematics (definitions of mathematical categories).

### Statement:

There are domains of human knowledge **with external reality**, that is, descriptive categories with immanent categories, and domains of human knowledge **without external reality**, that is, descriptive categories without immanent categories.

What about the idea of completely independent human knowledge no matter whether an external reality exists or not?

**If reality were mere fiction, nothing but a human construction?**

## 3 Constructivism 2

### 3.1 Moderate → radical constructivism



Reference?



## **3 Constructivism 3**

### **3.2 Radical, hard constructivism 1**

**Applies to mere artefacts / constructions / speculations without any relation to an observable reality.**

**These constructions are free and arbitrary.**

**It doesn't matter whether an independent reality exists or not, humans consider their constructions as their reality and live in a world of descriptive categories.**

# 3 Constructivism 4

## 3.2 Radical, hard constructivism 2

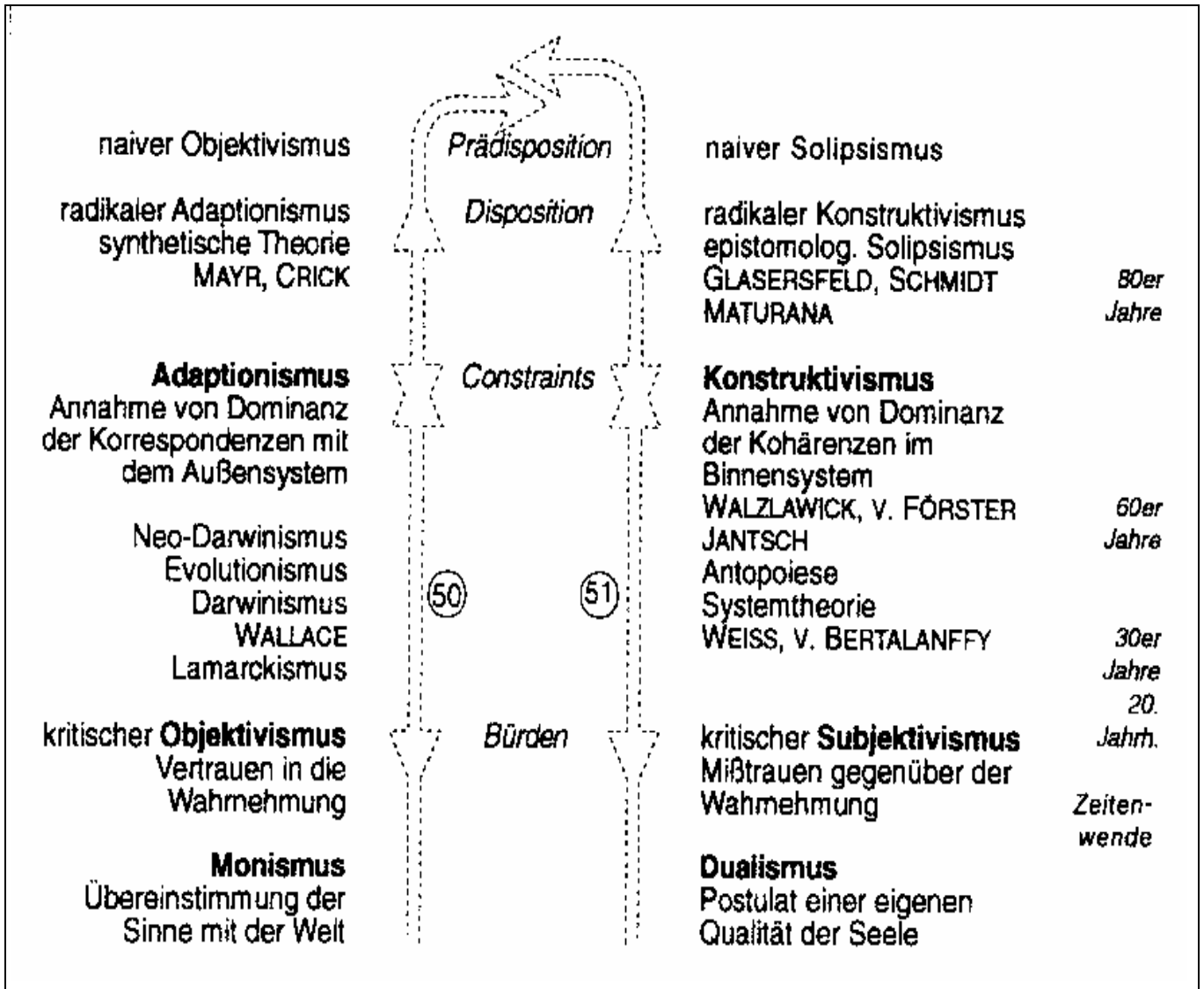


Abb. 50/51: BCD-Serie zum Adaptionismus-Konstruktivismus-Problem. Die Bürden von Objektivismus oder aber Subjektivismus führen zu den Constraints, zum reinen Adaptionismus oder aber reinen Konstruktivismus, mit den Dispositionen und Prädisposition zum radikalen Adaptionismus und naiven Objektivismus oder aber zum radikalen Konstruktivismus und naiven Solipsismus.

### Adaptionism / objectivism vs. constructivism / subjectivism (Riedl, Mit dem Kopf durch die Wand, 247)

## 4. Preliminary results 1

We have arrived at a very strange situation.

### 4.1 Doubts about human perception of reality 1

**Are human-made models reliable?**

**Can we judge the distortions?**

**Critical realism states that there is **some distortion of reality** by perception, description and formalization.**

**But where, up to which degree, why?**

**Critical realism does not give any explanations with regard to**

- areas of distortions
- degrees of distortions
- reasons for distortions
- reasons for false judgments.

**Questions:**

**Is human perception, the human cognitive equipment, a cognitive / epistemological prison?**

- **Yes: Edgar Allen Poe (1809-1849): The spectacles**
- **Eye and sun: Is there a pre-established harmony?**

**In order to find answers to these questions, we have to proceed to evolutionary epistemology.**

## 4. Preliminary results 2

### 4.1 Doubts about human perception of reality

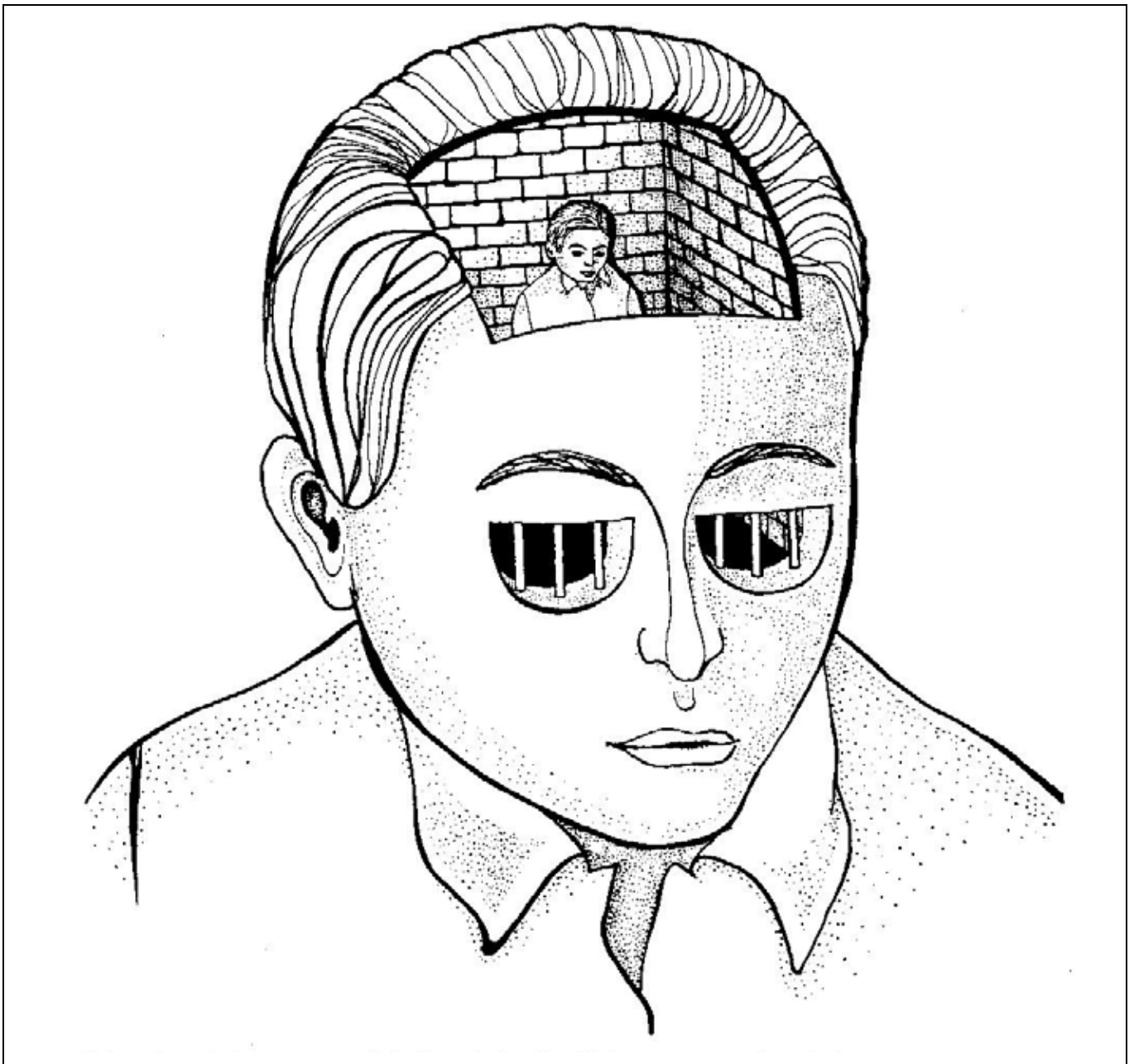


Abb. 21. »Jeder von uns lebt innerhalb des Universums — des Gefängnisses — seines eigenen Gehirns« (Mountcastle, 1975). Die moderne Hirnforschung, insbesondere die funktionale Neuroanatomie, hat gegenüber der alten Sinnesphysiologie die dominierende Rolle des zentralen Verarbeitungssystems hervorgehoben: Die Rezeptoren sind nach heutiger Auffassung nur schmale Schlitze, die lediglich bestimmte energetische Zustände der Umgebung sammeln können. Alles weitere ist die konstruktive Leistung der höheren Hirnfunktionen. Erkenntnistheoretisch bedeutet das das Ende der sensualistischen Abbildtheorie.

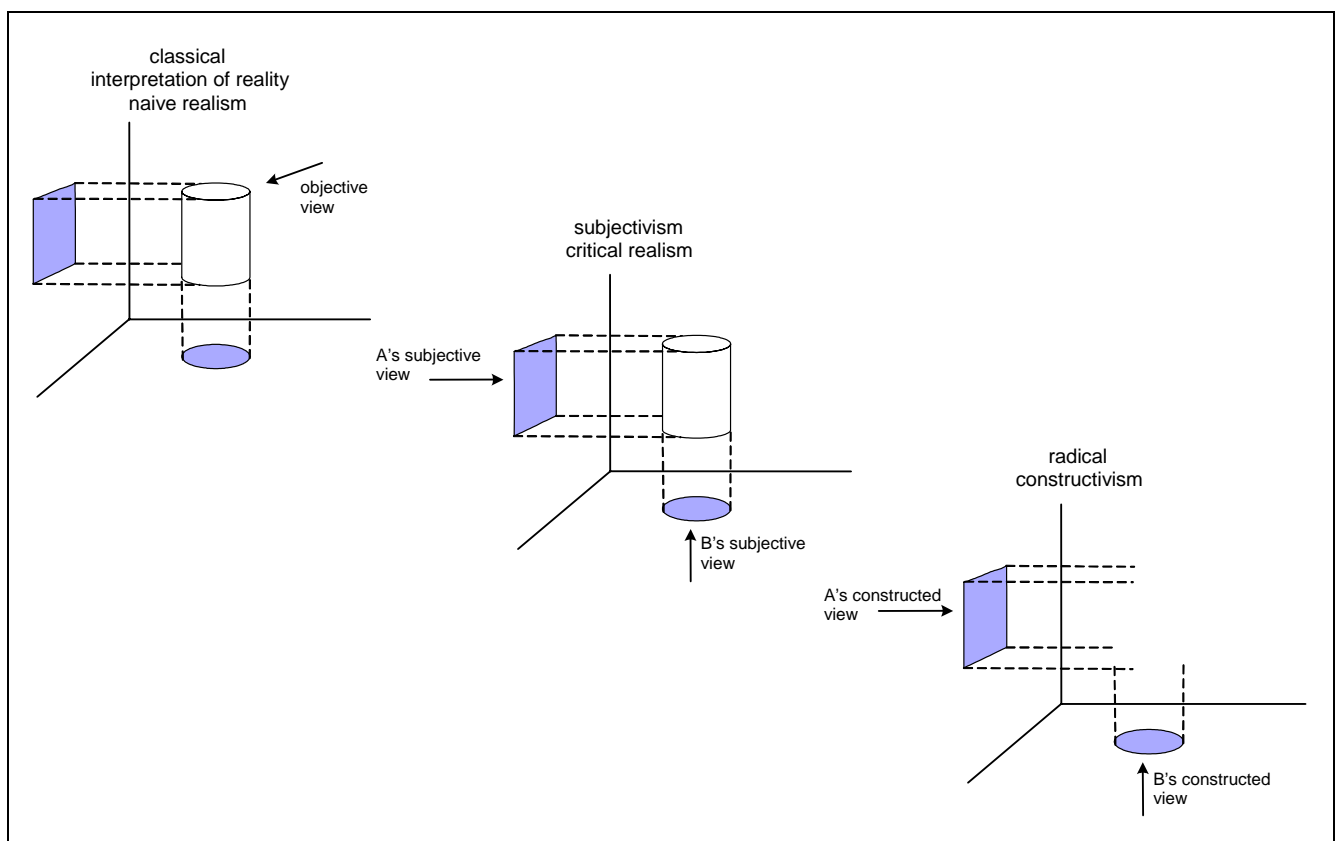
**Human cognitive prison (Oeser, Psychozoikum, 1987, 91)**

## 4. Preliminary results 3

### 4.2 Contradictory epistemological approaches

Are the four epistemological approaches mentioned completely contradictory or even compatible?

This question can be solved with an epistemological step model.



**From objectivity via subjectivity to constructivism  
(Goorhuis, Modellbildung, 1994, 93)**

# 5 Evolutionary epistemology (EE) 1

## 5.1 Evolutionary origin of the cognitive a priori 1

Konrad Lorenz 1941 gives a biological reinterpretation of Kant:  
“Kant’s doctrine of the a priori  
in the light of contemporary biology.”

There is **phylogenetic (evolutionary) experience**  
before ontogenetic (individual) experience:  
**Individual a priori is evolutionary a posteriori.**

**Kant’s categories**, that is  
the ways / forms of human perceptive interpretation, are innate:  
time, space, causality, hierarchy etc.

**Kant’s categories do not have any transcendental origin,  
but an evolutionary origin (by mutation and selection).**

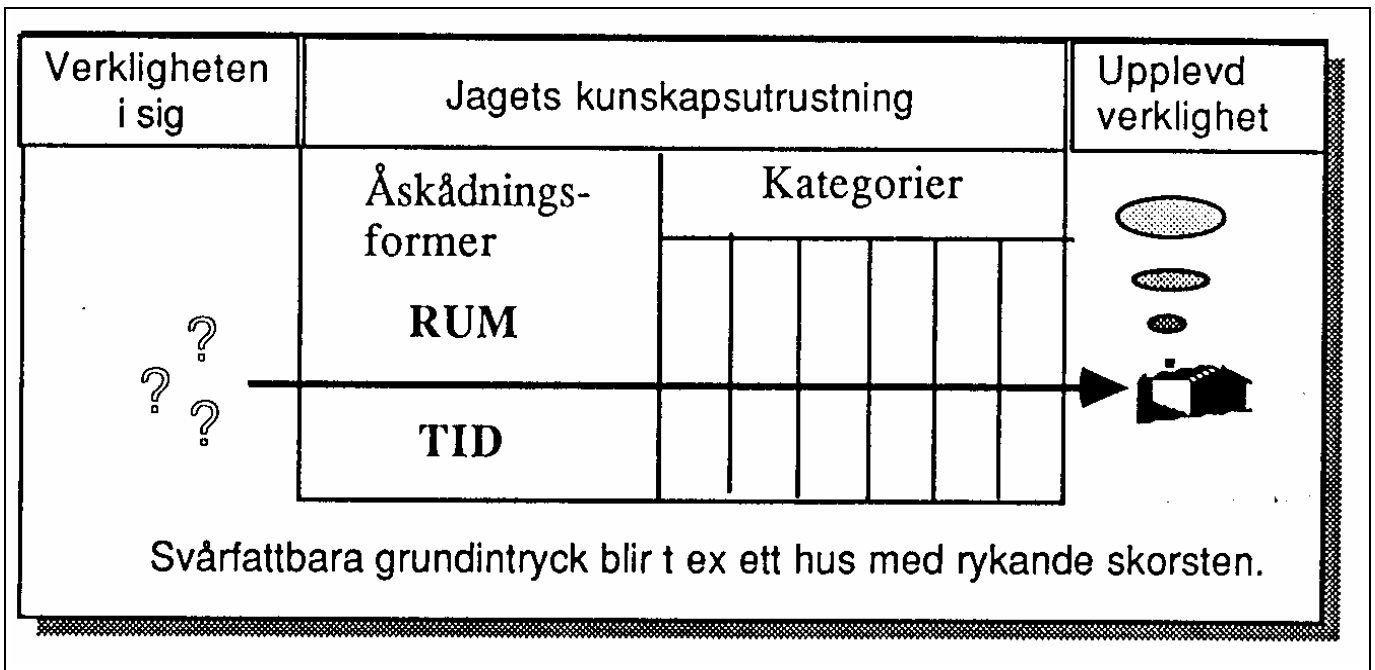
**Kant’s a priori**  
= Lorenz’s **cognitive apparatus** (“Weltbildapparat”)

The **human cognitive apparatus / equipment** is a product of  
evolution (by mutation and selection) as well as  
its **innate ways / forms of perceptive interpretation**  
(Kant’s categories) and the **cognitive strategies** it uses.

Only where selection had influence on cognitive equipment,  
there is some kind of **analogy** between reality and  
sensory-mental interpretations  
(phenomena = “Erscheinungen” [Kant]),  
**reconstructions** of the reality:  
changes in reconstructions correspond to changes in reality  
(e.g. movements).

## 5 Evolutionary epistemology 2

### 5.1 Evolutionary origin of the cognitive a priori 2



**Immanuel Kant's cognitive model**  
(Mårtensson / Nilstun, Vetenskapsteori, 1988, 25)

**“If the eye were not sunlike, it could never see the sun.”**  
(Motto to Konrad Lorenz “Behind the mirror”  
from Goethe, Zahme Xenien)

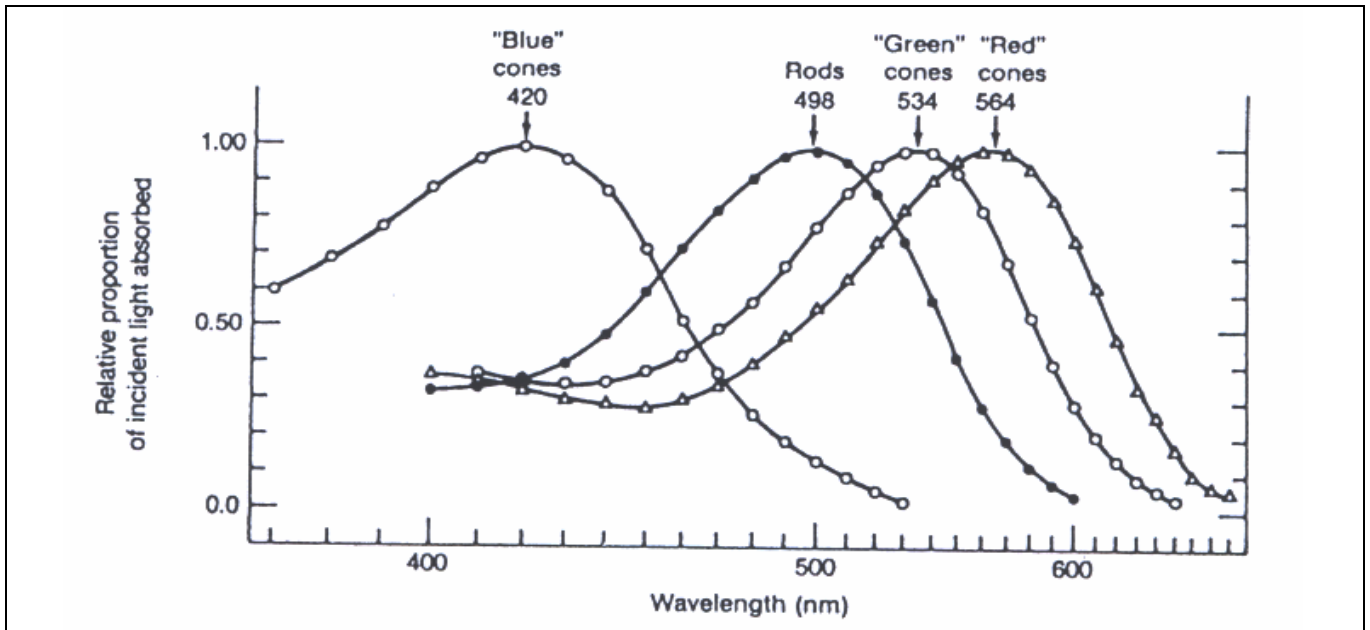
### **Why is the eye sunlike?**

**There is no pre-established harmony between sun and eye as Kant would have put it.**

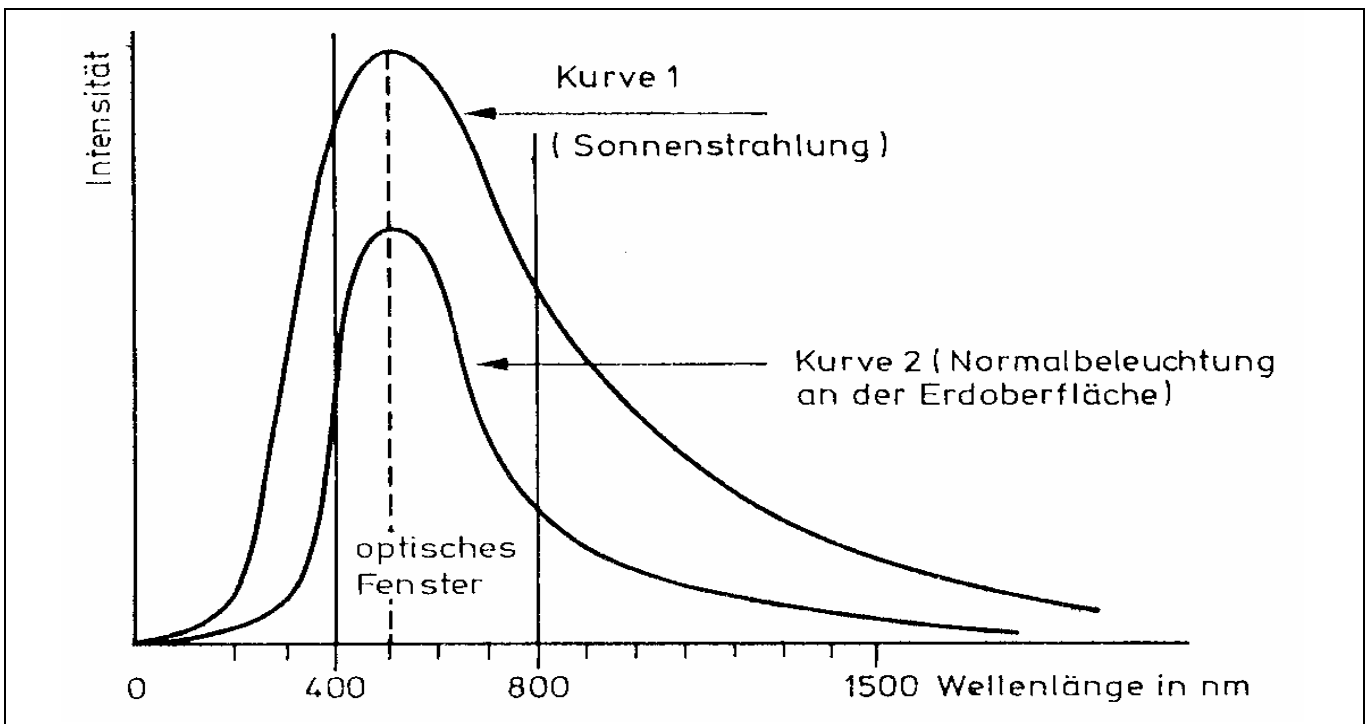
**The fact that we can see the sun is a consequence of the **evolutionary adaptation** of the human eye to the wave-length maximum of the sun radiation.**

## 5 Evolutionary epistemology 3

### 5.1 Evolutionary origin of the cognitive a priori 3



(Churchland / Sejnowski, Computational brain, 1997, 288)



**Maximum of sun radiation: green light**  
(Vollmer, Evolutionäre Erkenntnistheorie, 1990 [1975], 98)

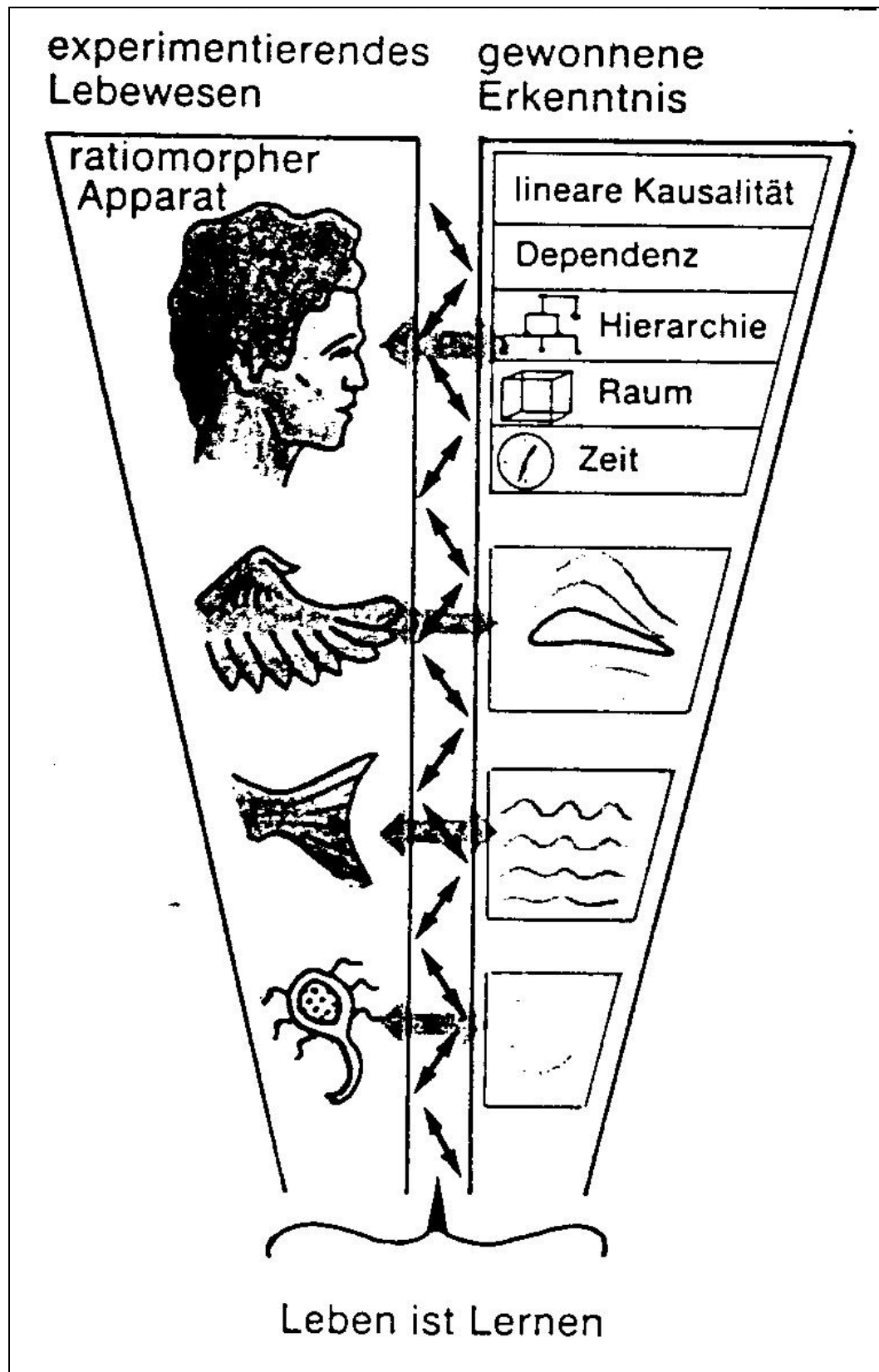


## 5 EE 4 --- 5.1 EE's evolutionary 'mirror' 1

As the **evolutionary mirror** is an **answering mechanism** (Lorenz), human cognition corresponds to and reflects qualities of W1. The human perceptive apparatus is not a total prison.

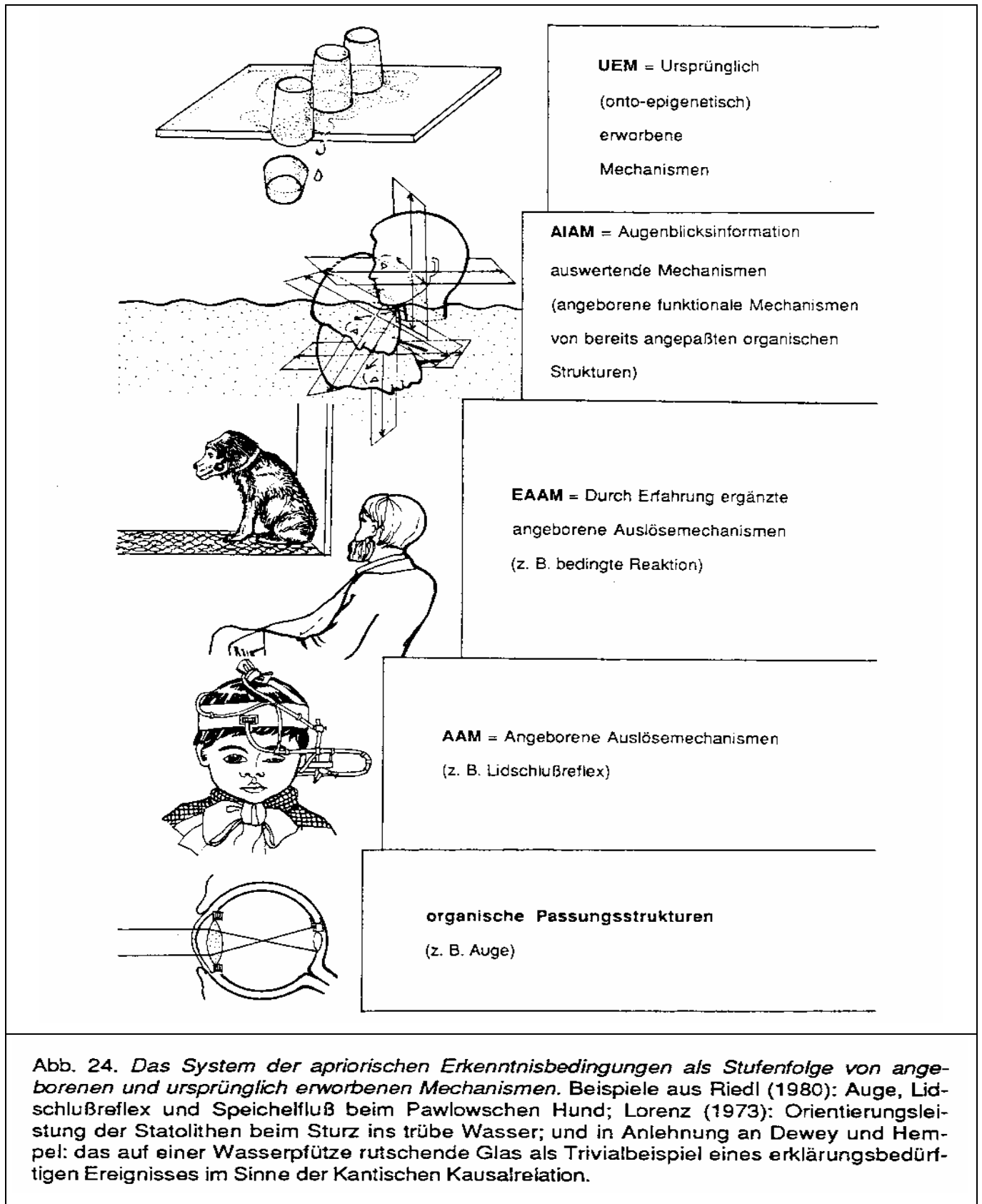
<p><b>'mesocosmic' reality</b> <b>(inorganic)</b></p>	<p><b>Answer of the evolution (organic):</b> <b>'reflection' (Konrad Lorenz),</b> <b>approxim. prelimin. hypothesis</b></p>
<p><b>water</b> <b>air</b> <b>gravitation</b> <b>ground / gravitation</b></p>	<p><b>anatomic equipment:</b> <b>fin of a fish</b> <b>wing of a bird</b> <b>tree, skeleton</b> <b>leg, foot</b></p>
<p><b>electromagnetic waves</b> <b>acoustic waves</b> <b>chemical substances</b> <b>solids</b> <b>movement of molecules</b></p>	<p><b>senses:</b> <b>eye: color, bright, dark</b> <b>ear: loudness, height of sounds</b> <b>nose, tongue: smell</b> <b>sense of touch</b> <b>sense of temperature</b></p>
<p><b>change of objects</b> <b>regular simultaneous</b> <b>coincidence, similarity</b> <b>regular "sucedaneous"</b> <b>coincidence of features,</b> <b>temporal sequence</b> <b>spatial extension</b></p>	<p><b>perceptive-cognitive framework of</b> <b>cat. / hypotheses of human thinking</b> <b>as functions of the human brain:</b> <b>category of time</b> <b>category of analogy, induction,</b> <b>gestalt perception</b> <b>disposition to association, to acquire</b> <b>conditional reflexes (post),</b> <b>category of causality (propter)</b> <b>category of space</b></p>
<p><b>micro/macrocsmic object</b> <b>social construct</b></p>	<p><b>no evolutionary answer,</b> <b>no selected cognitive strategy,</b> <b>mistakes in human knowledge</b></p>

## 5 EE 5 -- 5.1 EE's evolutionary 'mirror' 2



**Evolutionary Epistemology**  
(dtv-Atlas Philosophie, 1991, 188)

## 5 EE 6 --- 5.1 EE's evolutionary 'mirror' 2



**Aprioristic cognitive conditions (read from bottom to top)  
(Oeser, Psychozoikum, 1987, 188)**

## 5 Evolutionary epistemology 7

### 5.2 EE: reliability of human cognition; cognitive strategies selected by evolution 1

**On the one hand, cognition is reliable:**

Nature can be “calculated”, cognition is reliable and objects of cognition can be well understood

**in those areas only**

where cognitive strategies are **necessary for survival**, were **selected/produced** during evolution, are therefore **adequate**:  
“**Mesocosm**” (Gerhard Vollmer)

Proved strategies correspond to (mirrored) qualities of W1.

Otherwise:

**“Humans would be completely confused and lose their ways.”**

“ein ratloses Tappen in völliger Verwirrung”

(Riedl, Biology of cognition, 1979, 186)

**On the other hand, cognition is not reliable:**

Nature can scarcely be “calculated” and objects of cognition can scarcely be understood

in those areas where cognitive strategies

are **not necessary for survival**,

were **not selected** during evolution, are **not adequate**:

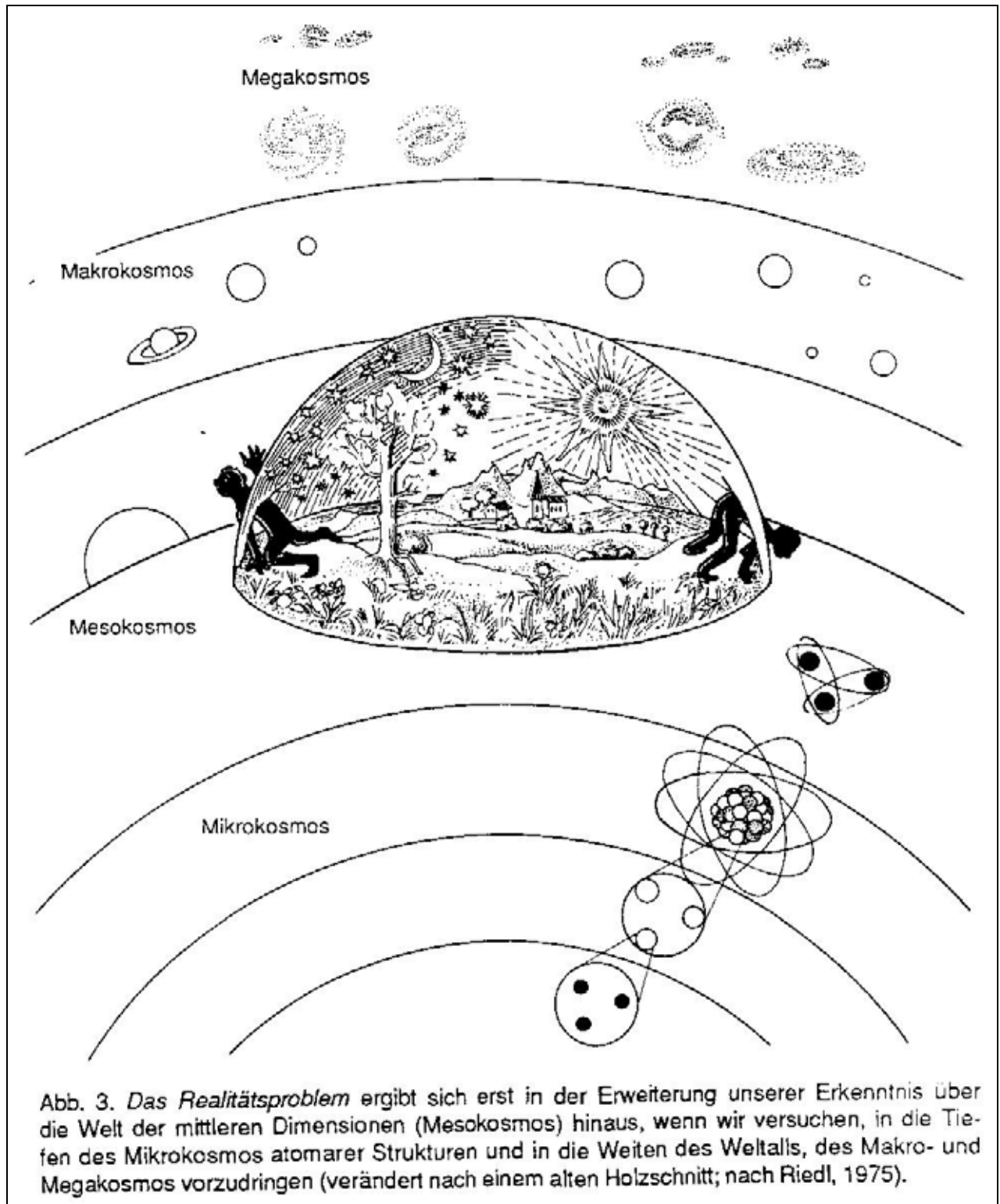
“Micro- / Macrocosm”

**“The nonsense of prejudice always starts at the boundary of the area of selection.”**

(Riedl, Biology of cognition, 1979, 186)

## 5 Evolutionary epistemology 8

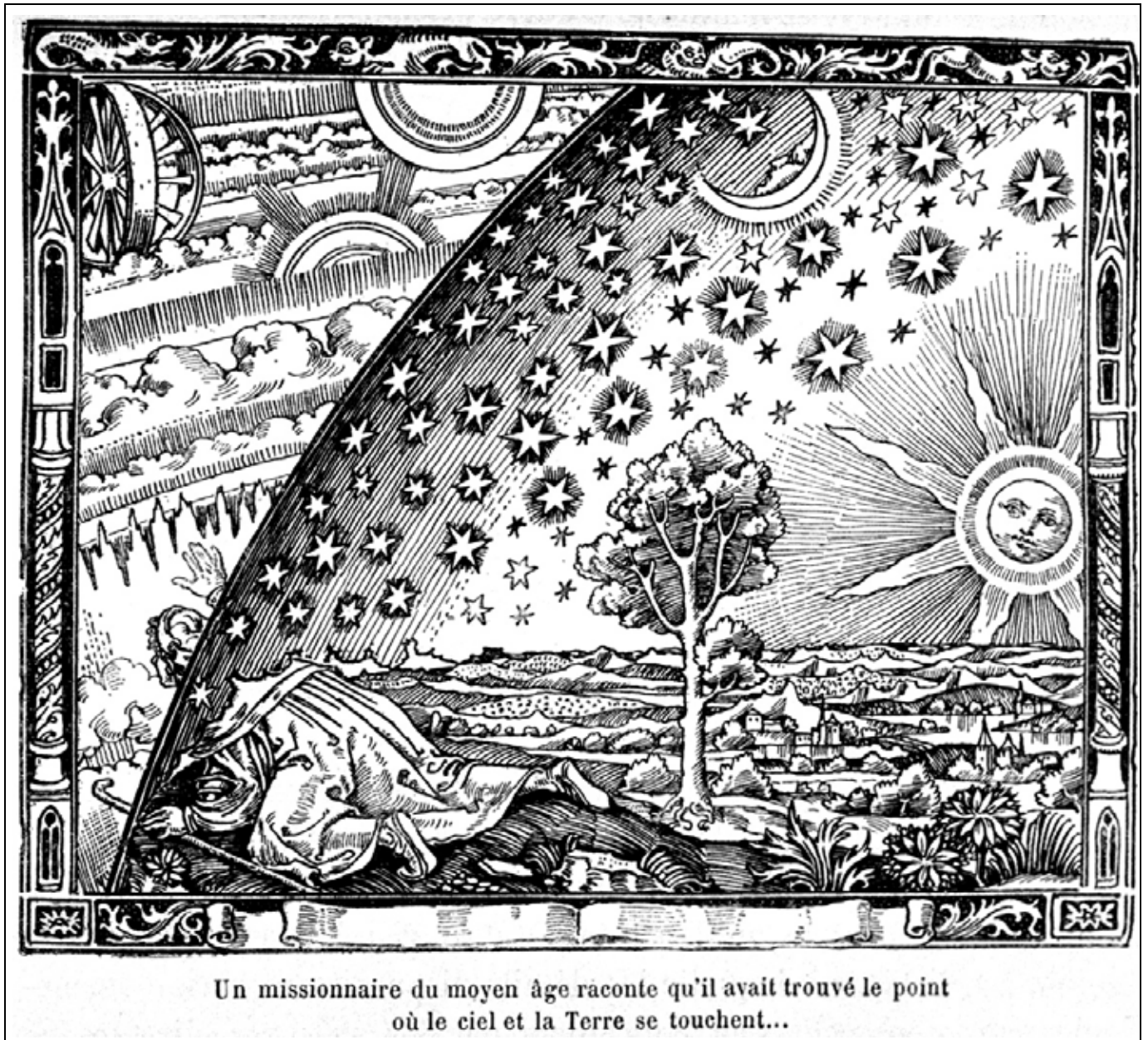
### 5.2 EE: reliability of human cognition; cognitive strategies selected by evolution 2



**Mesocosm (Oeser, Psychozoikum, 1987, 17)**

## 5 Evolutionary epistemology 8a

### 5.2 EE: reliability of human cognition; cognitive strategies selected by evolution 2a



**Rupert Riedl's illustration in  
Die Ordnung des Lebendigen. Systembedingungen der Evolution,  
1975, is adapted from  
Camille Flammarion (1842-1925):  
L'atmosphère, météorologie populaire, Paris 1888, p. 163**

## 5 Evolutionary epistemology 9

### 5.3 EE: the 1<sup>st</sup> epistemological dilemma

The set / system of categories

(**cognitive equipment / apparatus**, “Weltbildapparat”)

- makes objects of indirect cognition accessible to human experience
- is **the only way of human cognitive access to reality**
- does not explain objects of indirect cognition
- does not develop isomorphous models, but **functional models**
- restricts the liberty of thoughts to a certain degree (framework)
- is not complete: perception is missing for lots of real categories
- must not be dogmatically considered as absolute, but as approximative

Kant’s categories are **innate hypotheses** developed by evolution

→ all human knowledge is a collection of hypotheses

→ Popper’s theorem of **falsification**

# **5 Evolutionary epistemology 10 --- 5.4 EE's profit**

## **1. Estimation of the degree of distortion**

not too big, depending on the object domain;

consequence: approximative knowledge

with different quality is possible

**Motivation: the human sensory-mental apparatus**

**for the production of world images**

**is a result of selective evolution,**

**its reliable function in mesocosm is necessary for survival,**

**its reliable function in micro / macrocosm is not.**

## **2. Explanation of epistemologically wrong judgments**

**Cognitive strategies (naive realistic)**

**acquired during evolution**

**for simple primary cognitive situations**

**(in Younger Stone Age, Neolithic period)**

**are transferred to complex secondary cognitive situations**

**(scientific exactness in microcosm and macrocosm)**

**because of too vague knowledge**

**of fundamental epistemological problem complexes:**

**divergence of biological and technical-cultural evolution**

## **3. Profit for information systems: counter-measures**

**Considerable reduction of the undesired consequences**

**of fundamental epistemological problem complexes**

**can be achieved by**

**systematically recognizing them and**

**consciously dealing with them.**

**There is no general 'recipe' for perfect models,  
EE does not lead to new modeling techniques  
as the principal epistemological problems cannot be removed  
by any modeling method!**



## 6 Epistemological step model 1

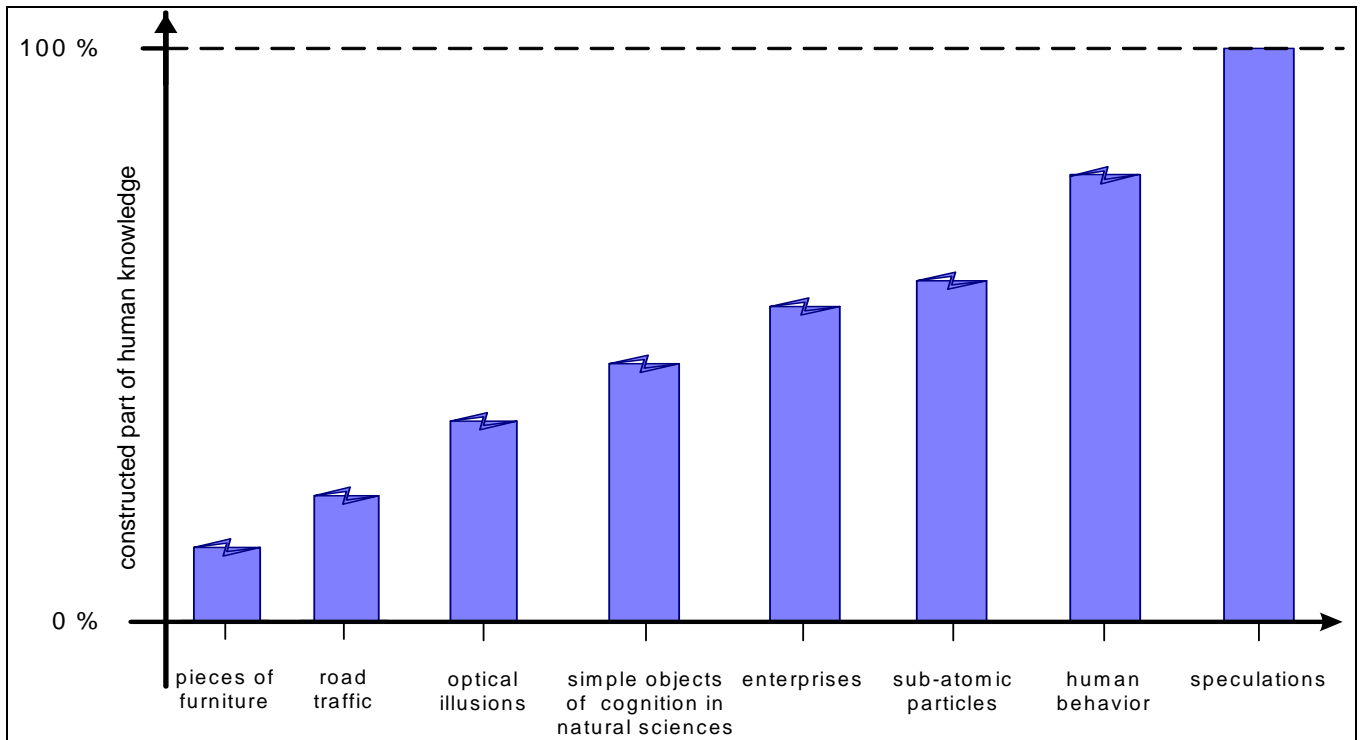
**No epistemological approach is able to adequately cope with every object and situation of cognition.**

**The adequacy of an epistemological approach depends on the regarded object of cognition.**

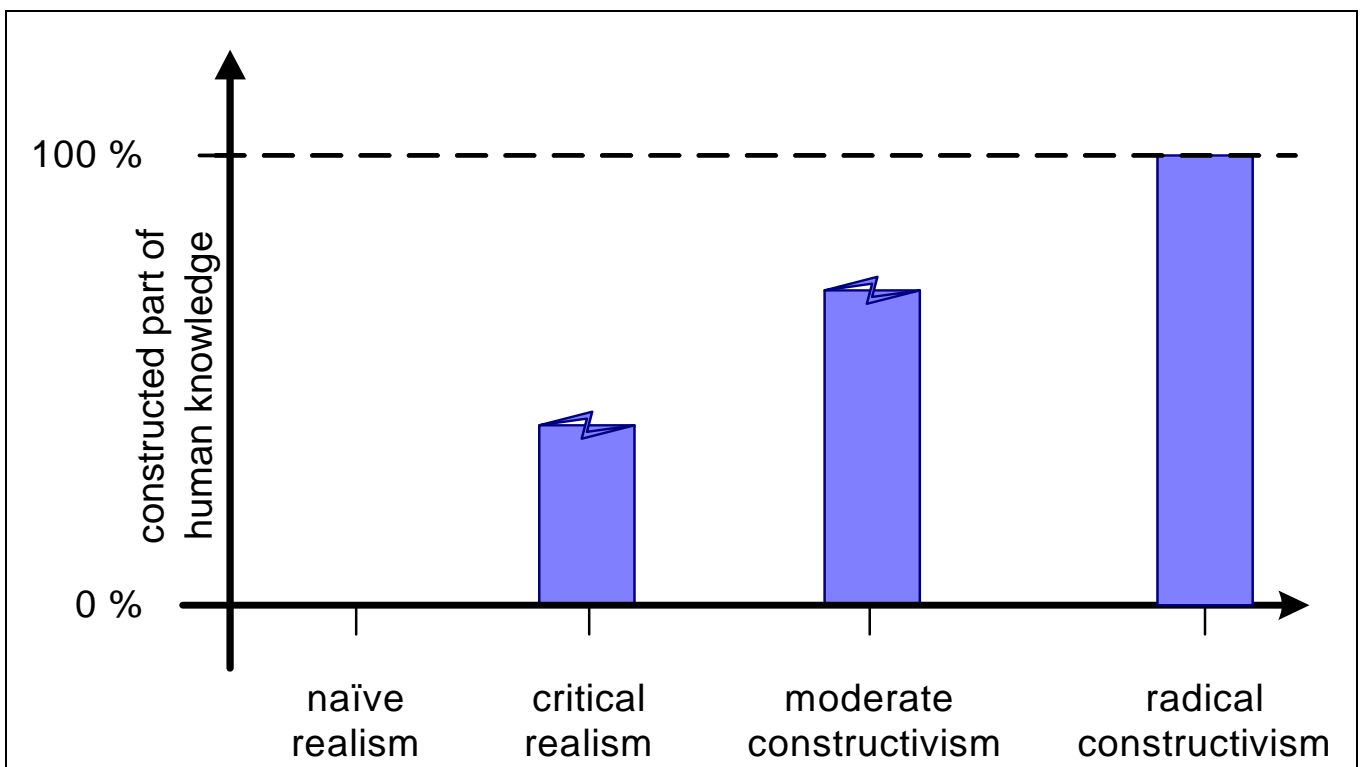
**Therefore, we need an epistemological step model spanning the spectrum from naïve realism to hard constructivism.**

**The constructed parts of human knowledge with regard to**  
– particular objects of cognition and  
– particular epistemological approaches  
**show a parallelism which leads to the epistemological step model.**

## 6 Epistemological step model 2



**(Holl / Maydt, Epistemological foundations of RE, 2007, 47)**



**(Holl / Maydt, Epistemological foundations of RE, 2007, 48)**

## 6 Epistemological step model 3

In the concrete case of a given object of cognition,  
**the simplest adequate approach has to be chosen.**

<b>Relation reality – model</b>	<b>Epistemological approach</b>	<b>Scope in a step / layer model</b>
<b>1 to 1</b>	<b>naive realism</b>	<b>simple objects in the physical world</b>
<b>a certain</b>	<b>critical realism, moderate constructivism</b>	<b>complex objects, optical illusions, sub-atomic particles, enterprises, economy, human society</b>
	<b>evolutionary epistemology</b>	<b>special explanatory value</b>
<b>no</b>	<b>radical constructivism</b>	<b>speculations, psychiatry</b>

The discrete step model can be replaced by a **continuous model**.  
As the boundaries between the steps are not hard,  
this model with **discrete** steps can also be interpreted  
as a model with a **continuous** inclined plane.

### Remark

The same idea applies for human **free will**.

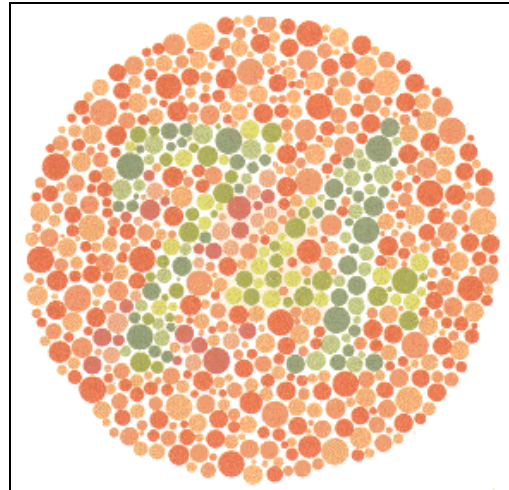
It depends on the **object of the will**, on the situation:

- rational objects: conscious, responsible decisions are possible
- everyday situations which require quick decisions:  
influence possible, often not necessary
- emotional objects: influence is nearly impossible

## 7 Summary: ubiquitous constructivism

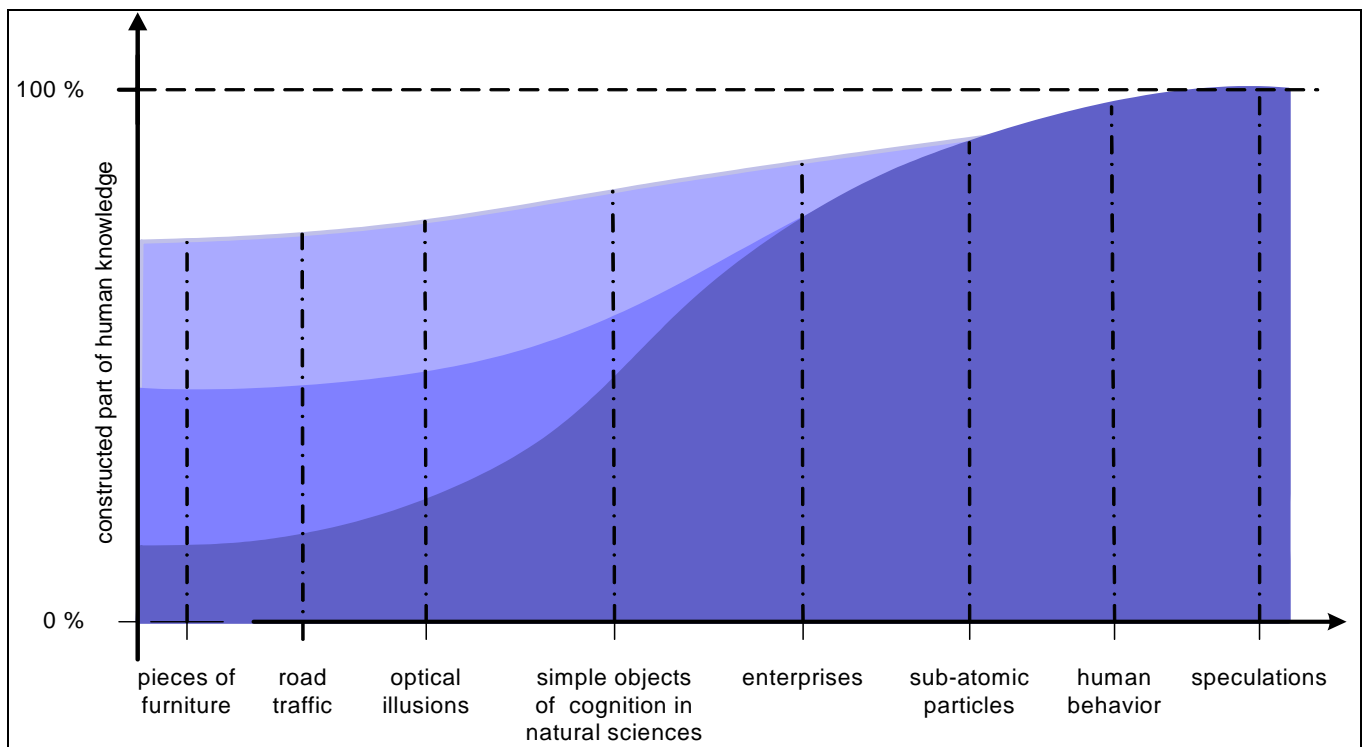
Every (re-)construction (interpretation) of reality is determined by **biological and social norms of perception** and, therefore, always contains some **constructed part**.

**Example: color blindness**



**Ishihara table**

**The size of the constructed part can only be determined relatively.**



**(Holl / Maydt, Epistemological foundations of RE, 2007, 47)**

## **8 References**

pdf-files of my own publications: see my homepage.

**Holl, Alfred:**

**Empirische Wirtschaftsinformatik und evolutionäre Erkenntnistheorie.**

**In: Becker, Jörg et al. (ed.): *Wirtschaftsinformatik und Wissenschaftstheorie. Bestandsaufnahme und Perspektiven.***

**Wiesbaden: Gabler 1999, 163-207, ISBN 3-409-12002-5.**

**English translation on my homepage.**

**Holl, Alfred; Krach, Thomas:**

**Ubiquitäre IT – ubiquitärer naiver Realismus.**

**In: Britzelmaier, Bernd et al. (ed.): *Der Mensch im Netz.***

***Ubiquitous Computing. - 4. Liechtensteinisches***

***Wirtschaftsinformatik-Symposium an der FH Liechtenstein.***

**Stuttgart: Teubner 2002, 53-69, ISBN 3-519-00375-9.**

**Holl, Alfred; Maydt, Dominique:**

**Epistemological foundations of requirements engineering.**

**In: Erkollar, Alptekin (ed.): *Enterprise and business management. A handbook for educators, consultants and practitioners.***

**Marburg: Tectum 2007, 31-58;**

**short version = contribution to Requirements Days 2006,**

**Nuremberg / Germany.**