



# Introduction to cognitive science

## Session 9: Enactivism

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# Enactive approach

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- Autonomy
- Sense-making
- Emergence
- Embodiment
- Experience

# Philosophical roots

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- Phenomenology: Edmund Husserl (1859-1938), Maurice Merleau-Ponty (1908-61)



# Philosophical roots

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- Radical constructivism: Jean Piaget (1896-1980), Ernst von Glasersfeld (1917-2010)

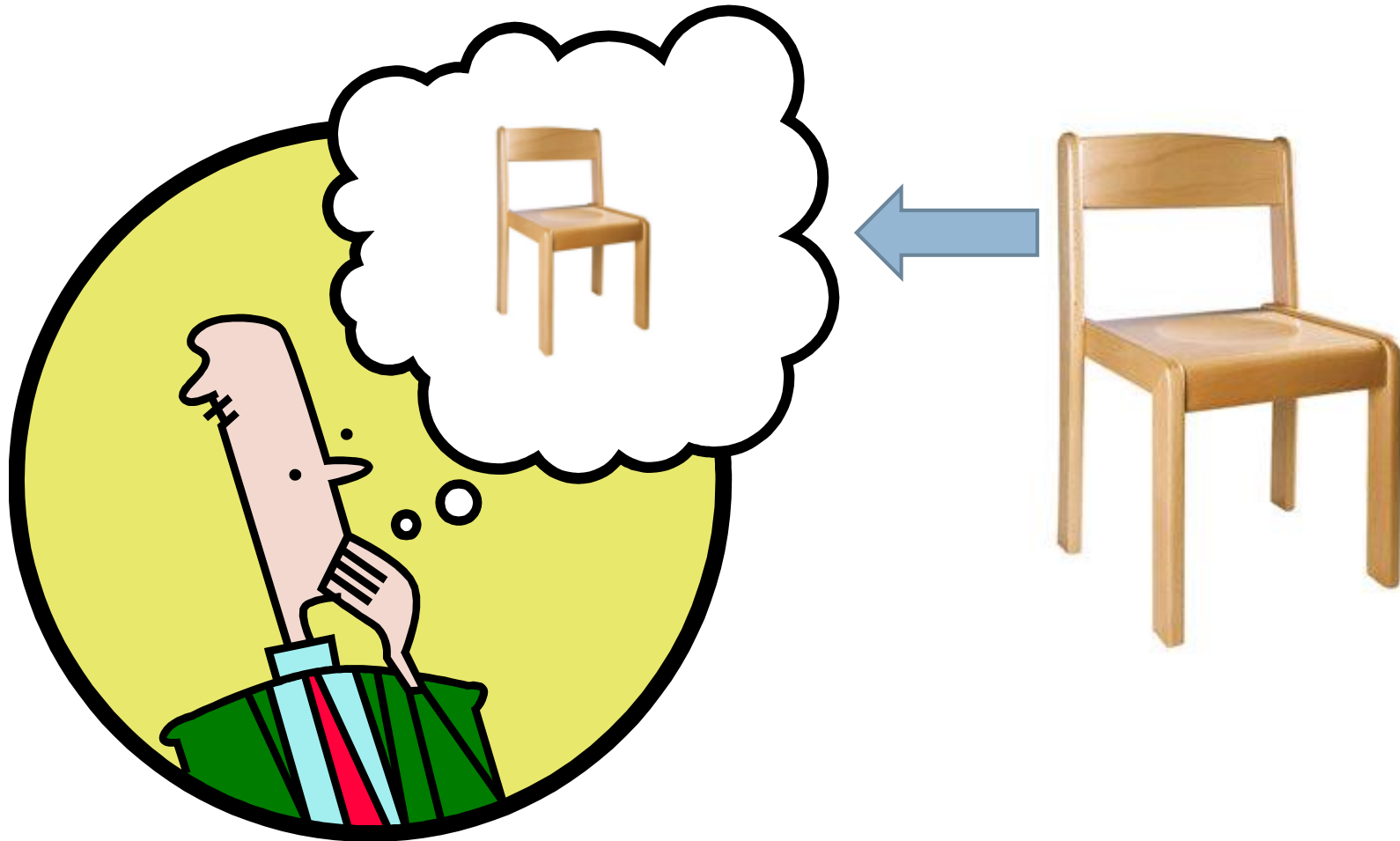


# Non-representationalism

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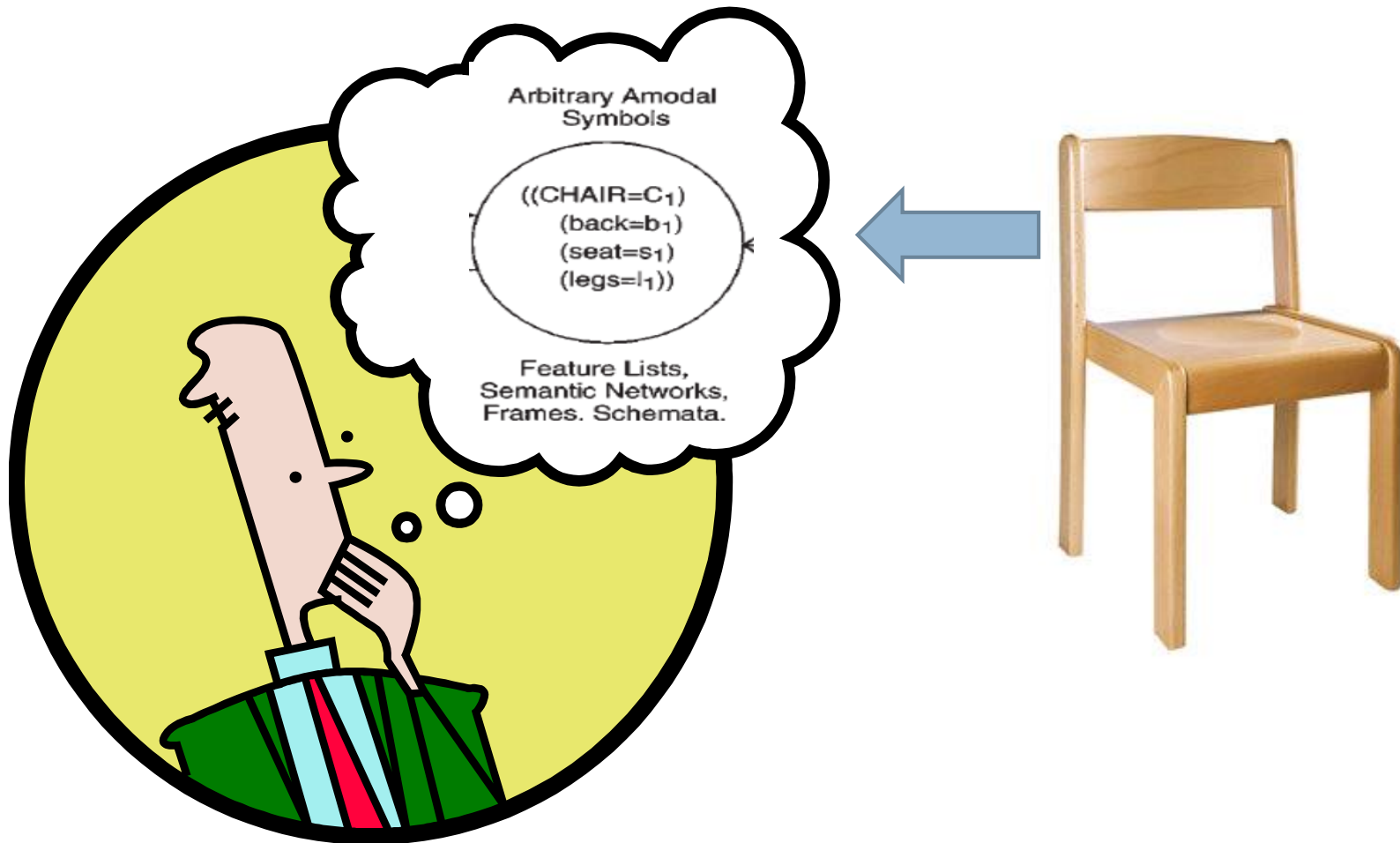
- Vs. previous paradigms

# Representacionalism



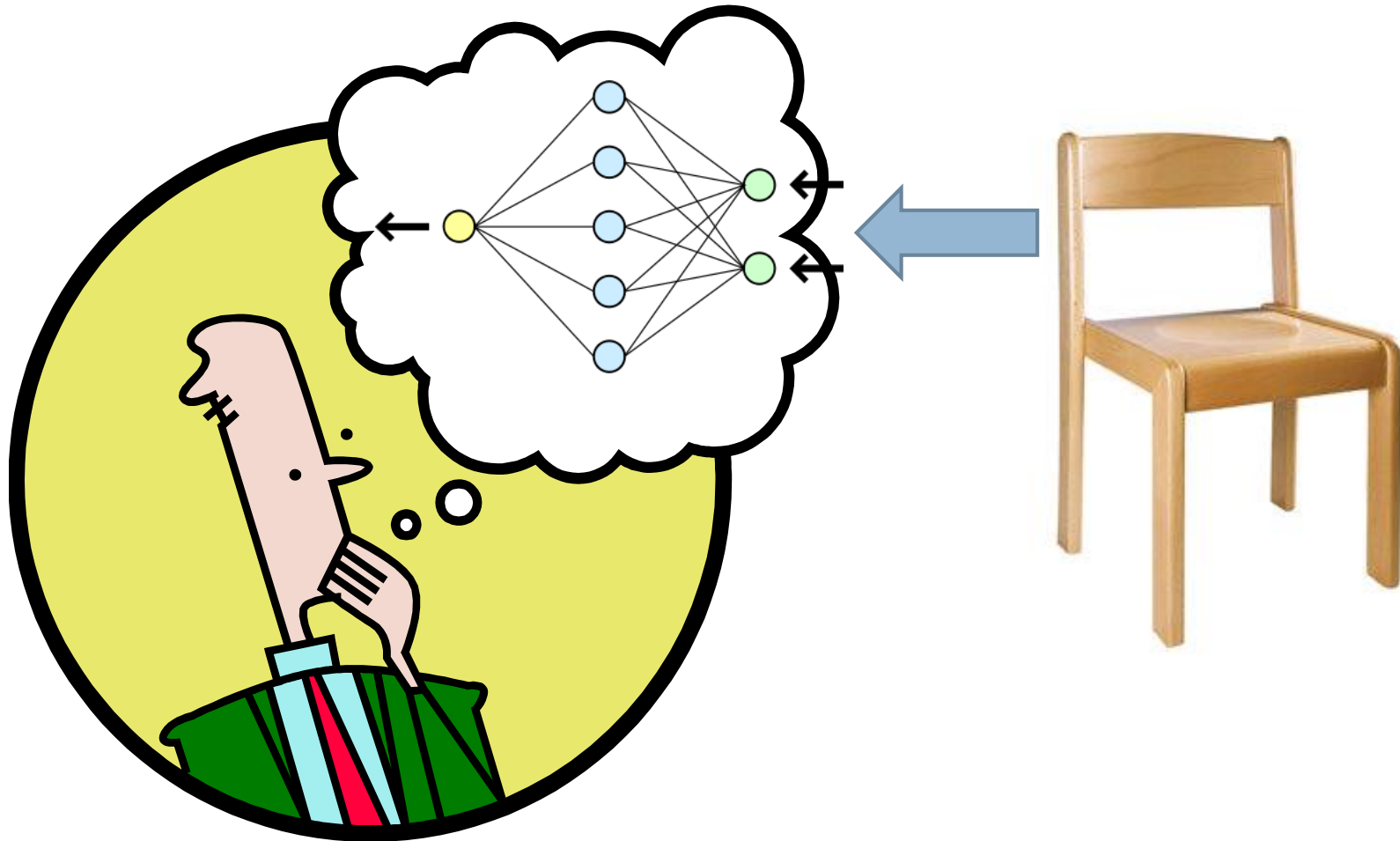
# Representationalism

## □ Cognitivism



# Representationalism

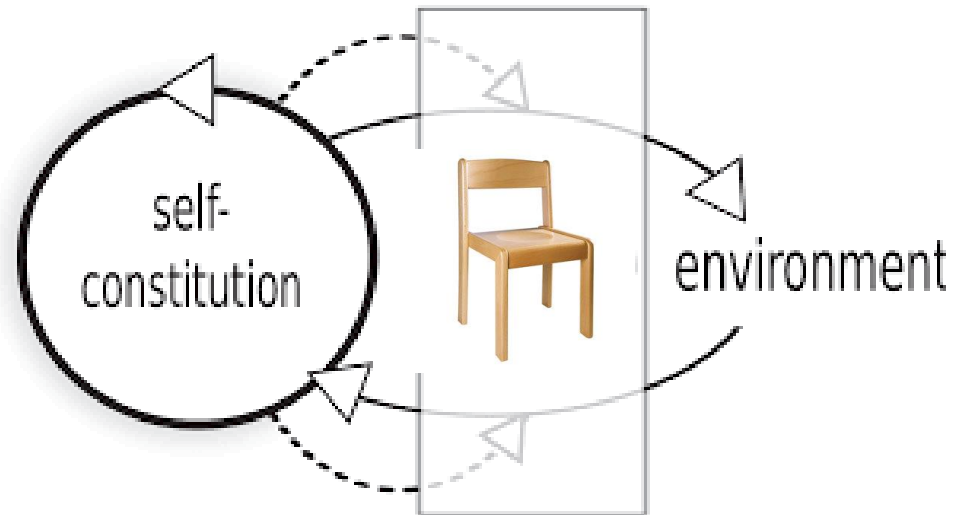
## □ Connectionism





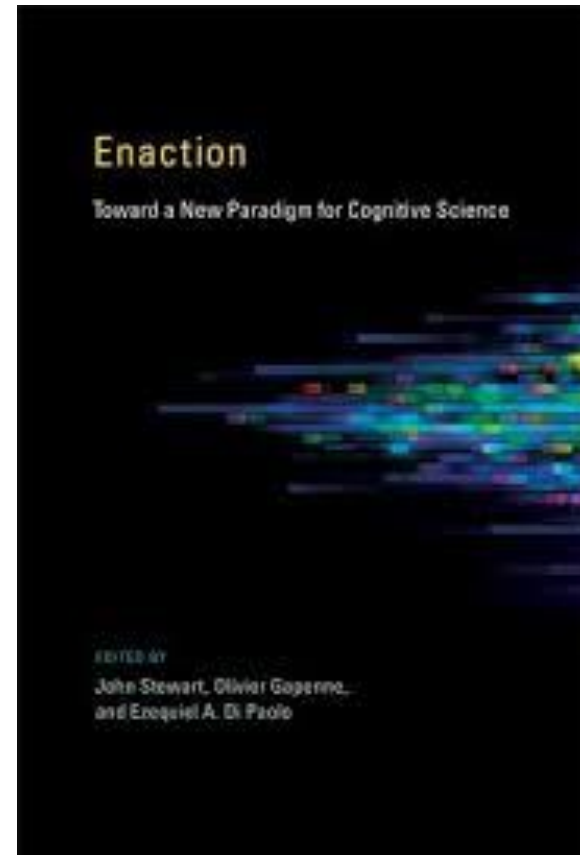
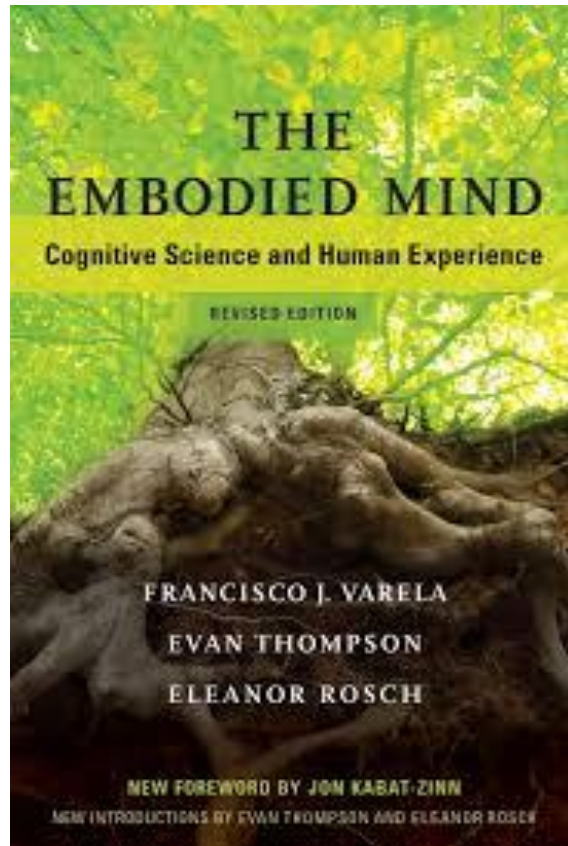
# Non-representationalism

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# From *The embodied mind* (1996) to Enaction (2010)

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# Prehistory of enactivism:

## Jakob Johann von Uexküll (1864-1944)

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- Shift away from mechanistic or anthropocentric views
- Biology as epistemology
- focus on meaningful responses which enable every organism to actively realise its own life-world — its unique *Umwelt*.
- based on empirical physiological studies of the movements of invertebrate animals



# Jakob Johann von Uexküll

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- Biology should study organisms not as objects, but as active subjects.
- Umwelt = subjective world of an organism
- individual organism is always *actively creating its individual Umwelt*
- this creative process is related to meanings determined by the animal's
  - ▣ internal states
  - ▣ needs
  - ▣ design
  - ▣ etc.

# Umwelt and negative feedback

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- Umwelt - formed by perceptual and effector worlds together
- Organism is embedded in the world through *functional cycles*
- modeling of functional cycles should help to conceptualise the functional organisation of behaviour as an ongoing process of regulation

# Umwelt of a tick

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- Tick: 3 successive reflexes:
  1. Butyric acid as perceptual cue – tick let go and drops
  2. Tactile cue of hair – move around
  3. Skin's heat – suck



# Functional circle – receptor and effector cues

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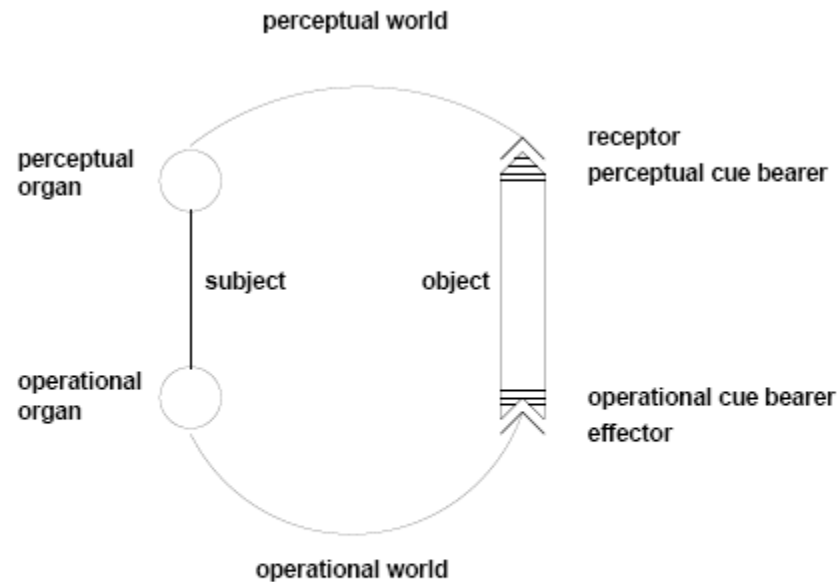


Figure 1: The functional circle according to Jakob von Uexküll. Adapted from von Uexküll (1957).



# Umwelt

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- Out of hundreds of stimuli radiating from the qualities of the mammal's body, only 3 become the bearers of receptor cues.
- The whole rich world around the tick shrinks to 3 receptor cues and 3 effector cues – her Umwelt



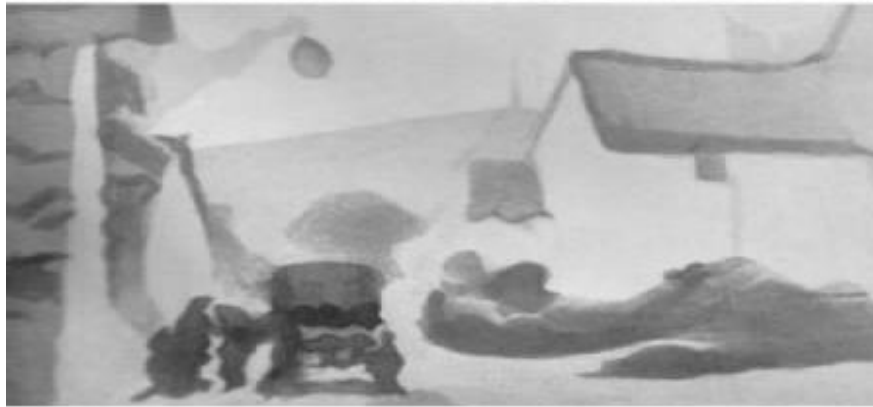
# Umweltforschung

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- T. von Uexküll: “The approach of *Umweltforschung* aims to reconstruct creative nature’s process of creation”
- Sensory physiology - investigation of the capacity of the sense organs
  - ▣ Investigating the animal’s ability to perceive and discriminate different physical stimuli
  - ▣ First ideas about the signs that possibly constitute the animal’s *Umwelt*.



A street in a town,  
seen through the  
eyes of a human



The same street  
seen with the eyes  
of a fly



The same street  
in the eyes of a  
mollusc

Illustrations of the different visual Umwelten of a human, a fly and a mollusc (Uexküll, Brock 1927).

# Lißmann (1932)

- Use of fish dummy to identify the physical features that function as signs of rivalry
- counted the attacks that were elicited by dummies with different body marks.
  - their significance as signs (*Merkzeichen*) in the functional cycle of rivalry

Diagram showing the frequency of aggressive reactions to dummies with different signal cues (Lißmann 1932: 89).

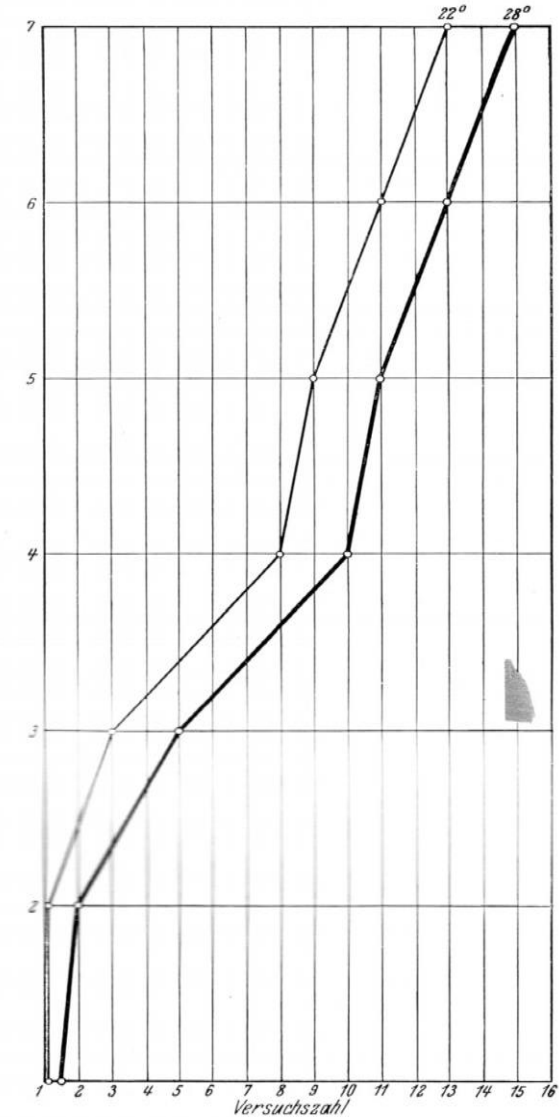
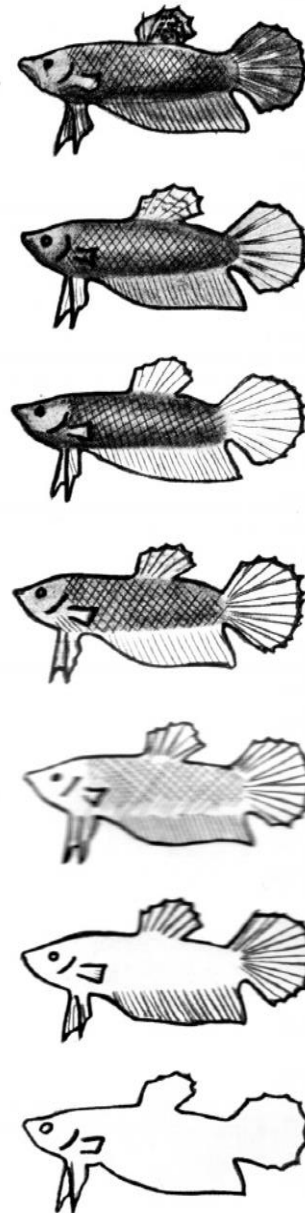
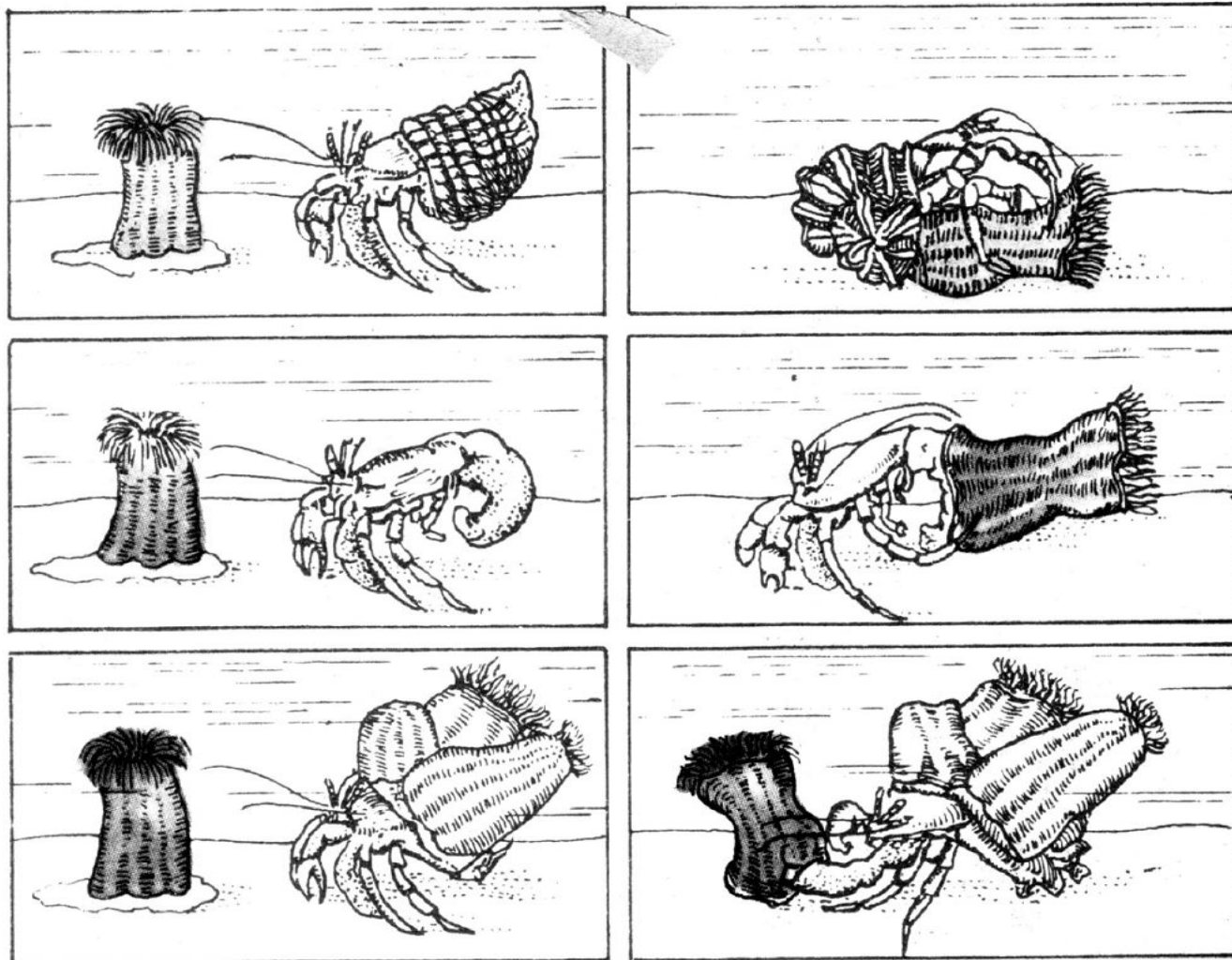


Abb. 8. Bildserie mit steigender Ähnlichkeit. Mit jedem Bild wurden bei 22° und 28° je 16 Versuche gemacht (Abszisse). Auf der Ordinate sind die Bilder mit steigender Ähnlichkeit aufgetragen. Die Kurven geben die Anzahl der Erregungen an, die das betr. Bild bei 16 maligem Zeigen beim Kampffisch auslöste.

# Hermit crab & sea anemone

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- Friedrich Brock (1927)
- investigated the complex interplay necessary before the crab could find the right anemone, induce it to leave its place and let itself be planted onto the crab's shell, where it would serve as protector against octopuses, while the anemone would profit from the leftovers of the crabs meals



Farbbild 1 Seerose und Einsiedlerkrebs

The interaction of the hermit crab and the sea anemone, changing according to change in meaning (Uexküll, Kriszat 1934: 55).

# Change of meaning of the sea anemone to the hermit crab

- (1) Upper row: if the crab inhabits snail shell without an anemone, an anemone is seen as a welcome partner for symbiosis. The anemone is “hugged” and forcefully persuaded by rhythmic drumming to loosen its hold and then put upon the crab’s house.
- (2) Middle row: if the crab is naked it will try to use the anemone as substitute for the protecting shell.
- (3) Lower row: if the crab is already in symbiosis with anemones, then it interprets the appearance of another anemone as a welcome prey and starts to feed on the animal.
  - The perceived signs are marked with different meanings: depending on the subject’s needs they are either made a part of the protection functional cycle or of the food cycle.

# Dogs, human language and the effect world (*Wirkwelt*)

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- Emanuel Sarris (1931), “*Sind wir berechtigt vom Wortverständnis des Hundes zu sprechen*” (“Can we talk about the dog’s understanding of words”)
  - ▣ trained his dogs to react to command sentences in German and Greek.
  - ▣ tried to show that dogs understand the meaning of words.
- The dogs jumped on a chair, when he said “chair”.
- they would also jump on a sofa or small table
- Sarris stated that dogs could indeed recognise words out of a mixture of sounds and assign meaning to them.
- “But the understanding of words by the dog is always appropriate to the dog’s Umwelt”



A room as a human *Wirkwelt*, with objects of a sitting-, an eating-, a drinking and a reading-tone



The same room as a *Wirkwelt* of a dog, showing no reading tone



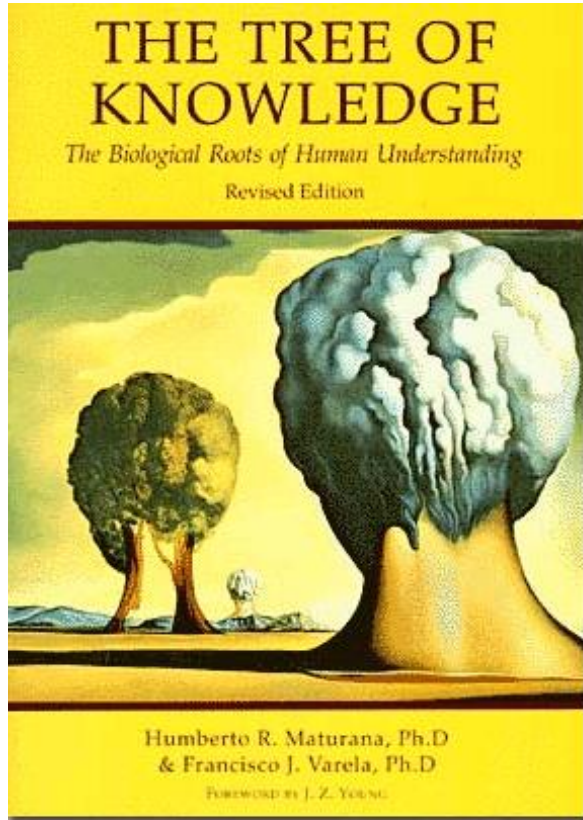
The same room as a flies *Wirkwelt*, showing even no special sitting-tone

The different *Wirkwelten* (effect worlds) of a human, a dog and a fly (Uexküll, Kriszat 1934: 56–58).



# Biological roots of human knowing

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Francisco Varela (1946-2001)



Humberto Maturana (1928)

# Central question: What is knowing?

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- search for biological roots of knowing/understanding
- Knowing is the action of the knower.
  - ▣ it is rooted in the manner of his **living being**, his **organization**
  - ▣ **all knowing depends on the structure of the knower.**
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# Living beings

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- characterized as self-producing
- their organization is such that their only product is themselves, with no separation between producer and product
- **autopoiesis**

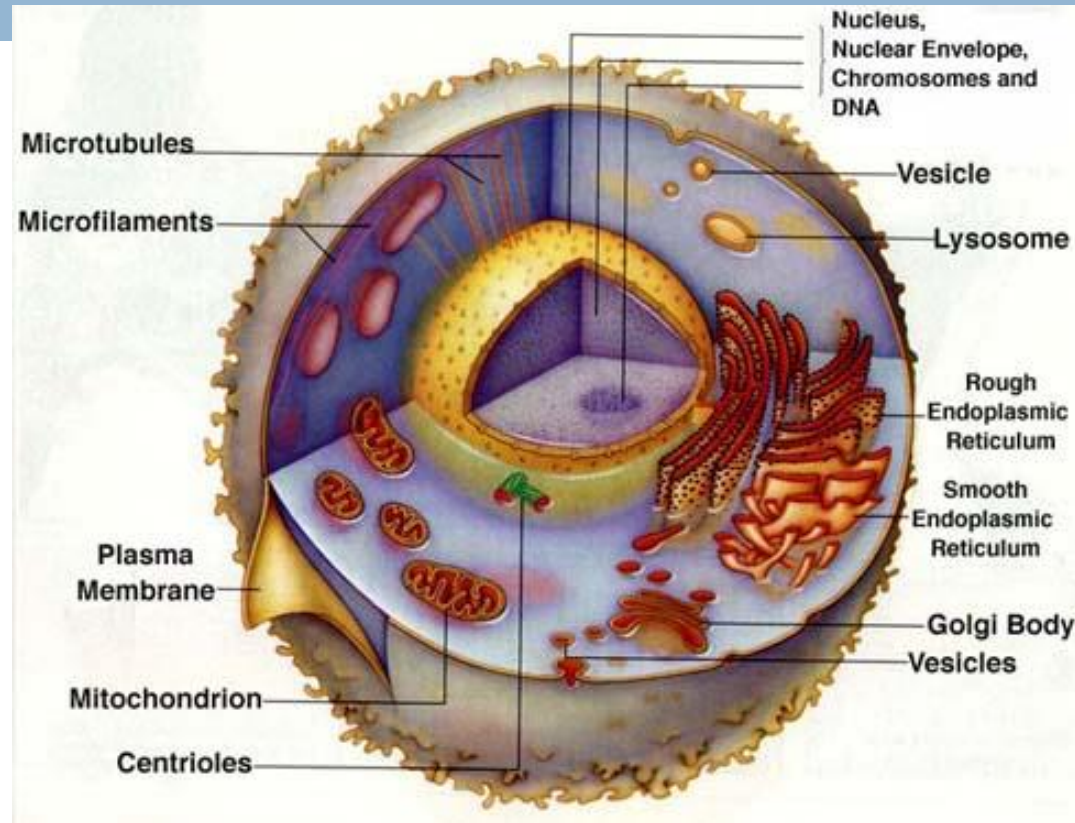
# Autopoietic and allopoietic systems

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- **Autopoiesis:** literally means "auto (self)-creation"
- Autopoietic system – its components are produced by the interaction and transformation of themselves, they continuously regenerate and realize the network processes
- Allopoietic system – its components are produced by other processes that are independent of the organization of the machine.
- Similar to Uexkull's centripetal/centrifugal distinction

# Autopoiesis and living cell

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- System creates and maintains itself
- System creates its own border

# Organization vs. structure

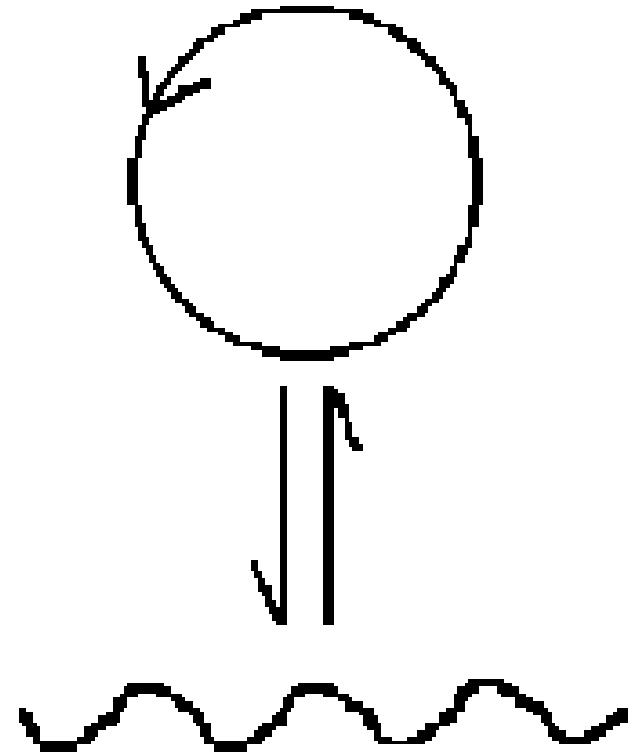
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- **organization** - denotes those relations that must exist among the components of a system for it to be a member of a specific class
- **structure** - denotes the components and relations that actually constitute a particular unity and make its organization real.

# Structural coupling

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- Ontogeny is the history of structural change in a unity without loss of its organization.
- This structural change is
  - ▣ Triggered by interactions coming from environment
  - ▣ Result of its internal dynamics
- The result is mutual congruent structural changes =>  
**STRUCTURAL COUPLING**



# Organizational closure

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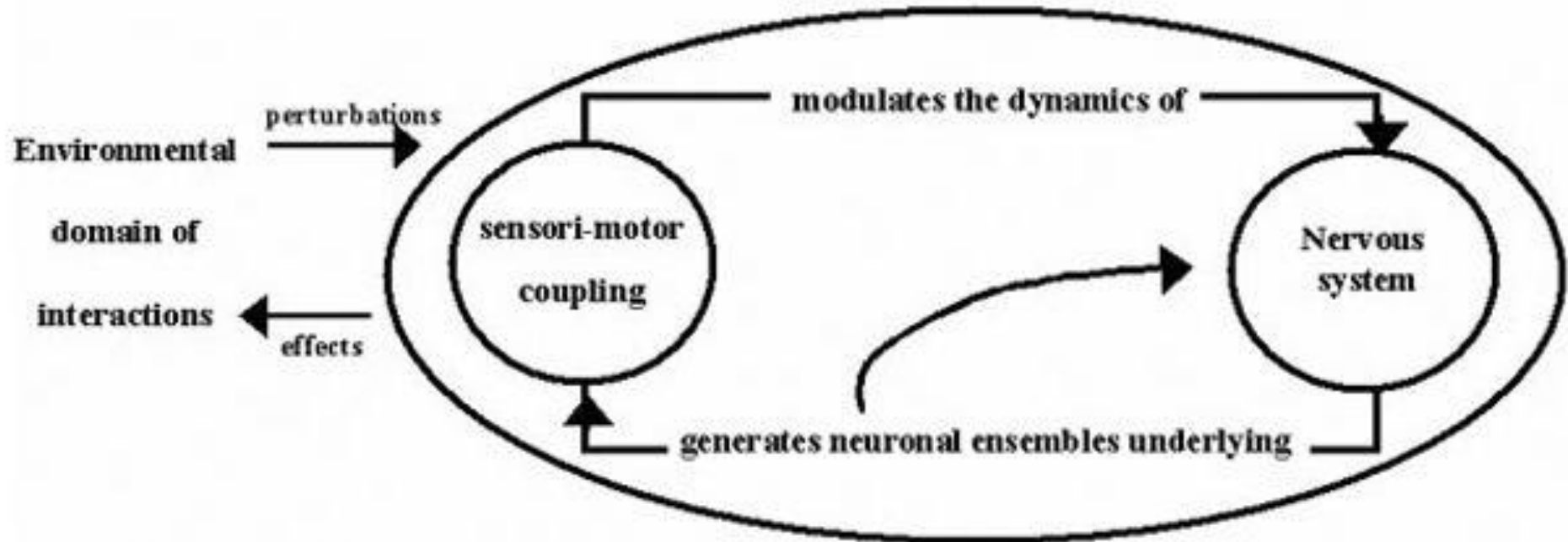
- [Systems exhibit organizational closure if...] "...their organization is characterized by processes such that
  - ▣ the processes are related as a network, so that they recursively depend on each other in the generation and realization of the processes themselves, and
  - ▣ they constitute the system as a unity recognizable in the space (domain) in which the processes exist."

(Varela, 1979, p. 55)



# Organizational closure of embodied systems

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# Autopoietic unities

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- First-order
  - ▣ autonomous cellular unities
- Second-order
  - ▣ multicellular unities / metacelular unities

# Second-order unity

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- metacellular
- has structural coupling and ontogeny adequate to its structure as a composite unity

# Organisms

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- adaptation
  - maintenance of the organisms as dynamical systems in their environments, centered on the compatibility with the env.
- conservation of autopoiesis and adaptation are necessary conditions for the existence of living beings

# Nervous system

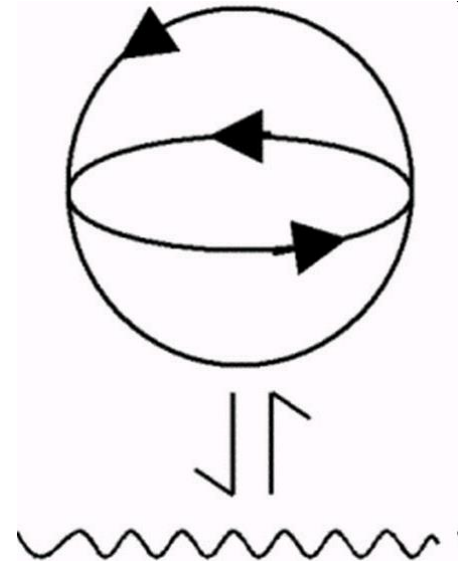
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- network of special cells which is embedded in the organism in such a way that it couples points in the sensory surfaces with points in the motor surfaces.
- With a network of neurons coming between this coupling, the field of possible sensorimotor correlations of the organism is increased and the realm of behavior is expanded.
- (Behavior: description an observer makes of the changes of state in a system with respect to an environment with which that system interacts)

# Nervous system

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- The nervous system brings forth a world by specifying what patterns of the environment are perturbations and what changes trigger them in the organism.



# Learning

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- **Plasticity:** We human beings in particular are modified by every experience, even though at times the changes are not wholly visible.
- **Learning:** the neurons, the organism they integrate and the environment in which they interact operate reciprocally as selectors of their corresponding structural changes and are coupled with each other structurally: the functioning organism, including its nervous system, selects the structural changes that permit it to continue operating, or it disintegrates.

# Autopoietic unities

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- First-order
  - ▣ autonomous cellular unities
- Second-order
  - ▣ multicellular unities / metacelular unities
- Third-order
  - ▣ societies



# Organisms vs. human societies

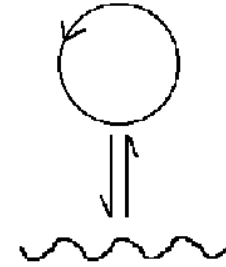
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- both belong to the class of metasystems - aggregates of autonomous units that can be cellular or metacellular.
- **Organism** - metasystems of components with minimum degree of autonomy (components have very little independent existence), requires stability
- **Human societies** - max. autonomy, components with many dimensions of independent existence, requires plasticity
- The organism restricts the individual creativity of its component unities, as they exist for that organism. The human social systems amplifies the individual creativity of its components, as the systems exists for them.

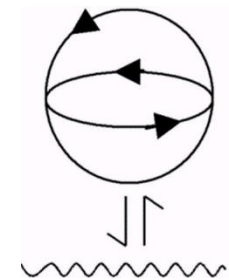
# Structural couplings

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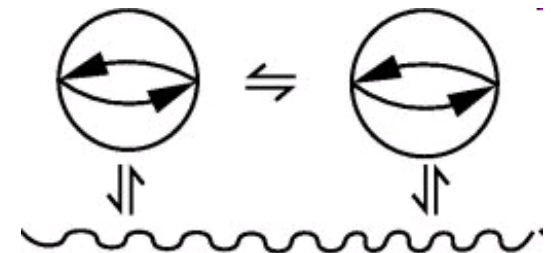
□ ontogeny of an auto-poietic unit



□ organism with a nervous system



□ society (3<sup>rd</sup> order structural coupling)



# Communication

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- **communication** - the coordinated behaviours mutually triggered among the members of a social unity.

# Knowing

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- The evaluation of whether or not there is knowledge is made always in relational context.
- **To live is to know** (living is effective action in the realm of existence)
  - ▣ View on knowledge that is not based on representationalism.
  - ▣ Knowing based on sense-making capacity of an autonomous living system is not picking or processing information, but specifying of what counts as relevant.

# Cognition

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- Effective action, an action that will enable a living being to continue its existence in a definite environment as it brings forth its world.
- The world everyone sees is not THE world but A world which we bring forth with others

# Enactive cognitive science

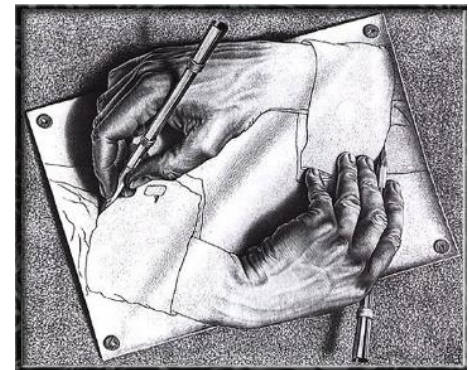
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- Generalisation of autopoiesis on other living organisms – multicellulars and societies
- Enactive cognition – self-creation and self-maintenance.
- Cognition equals to processes in living body
- Cognition is always embodied

# Enactive approach - consequences

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- Knowing system is a part of the environment it is bringing forth.
- Thus, it creates/modifies itself.
- The ability of self-modification has no limits in principle.
- Thus, the ability to modify the environment has no limits in principle.



# Enactive approach

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- existence of an external world independent of the knowing process is just an ontological assumption
- Knowing is not a passive re-presentation, but a permanent active mutual creating of the knowing system and its environment.
- Knowing means enacting (negotiating, bringing forth) of a world.



# Applications

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- Intersubjectivity
- Participatory sense-making (Hanne de Jaegher)

