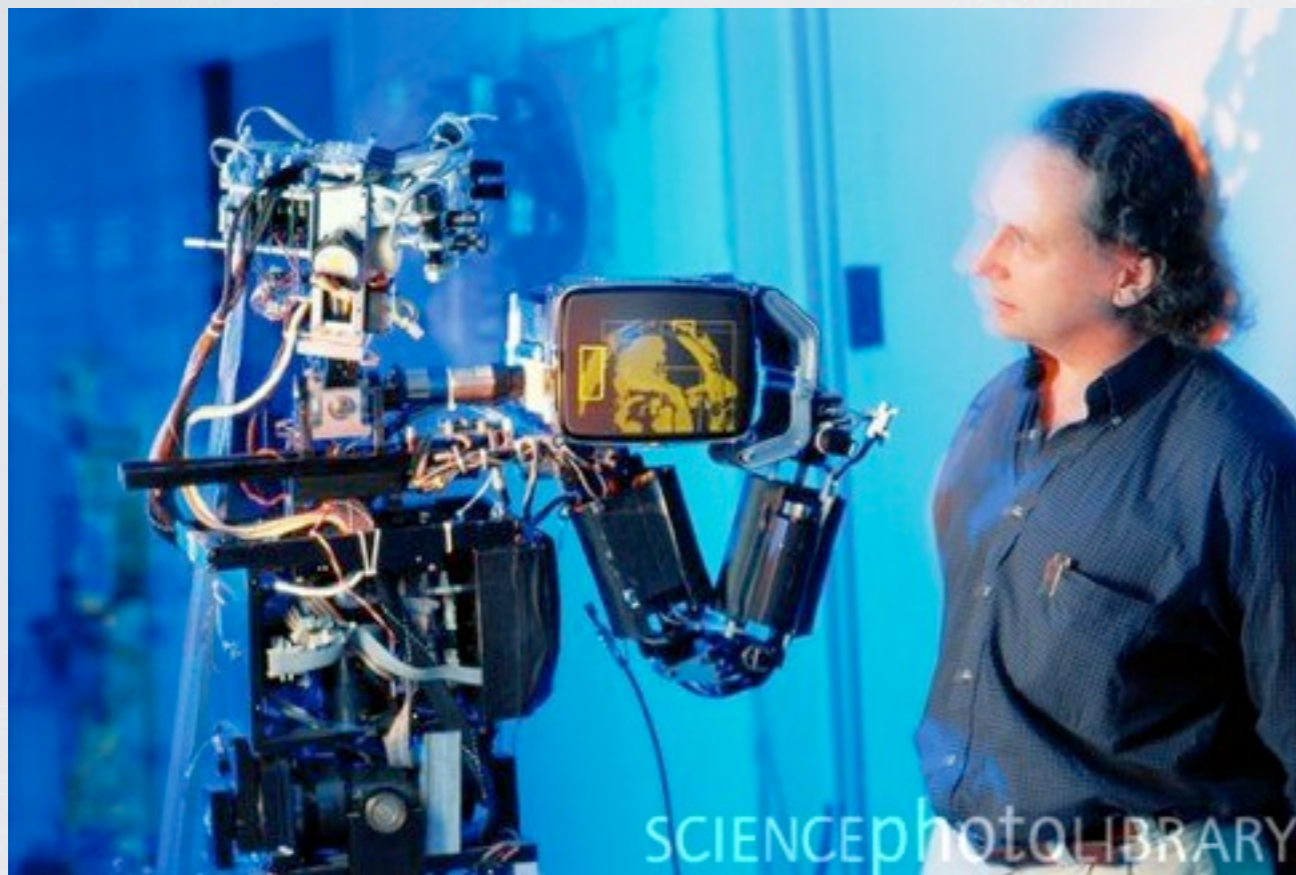


EMBODIED COGNITION

foundations of artificial intelligence
bruno lara

rodney brooks mit ai lab



intelligence without representation
artificial intelligence. 1991

human intelligence

- too complex and too little understood
- so it can not be decomposed into the right subproblems
- even if we know, we still wouldn't know the interfaces

suggestion

- incrementally build up capabilities having **complete systems** at every step to assure the functioning of the interfaces
- let them loose in the **real world** with real sensing and real action

after some robots

conclusion

explicit representations and models get on the way

use the world as its own model

hypothesis

representation is the wrong unit of abstraction

elephants



6 thousand million years -> age of the universe
4 thousand million years -> first signs of life
2 million years -> *humans*

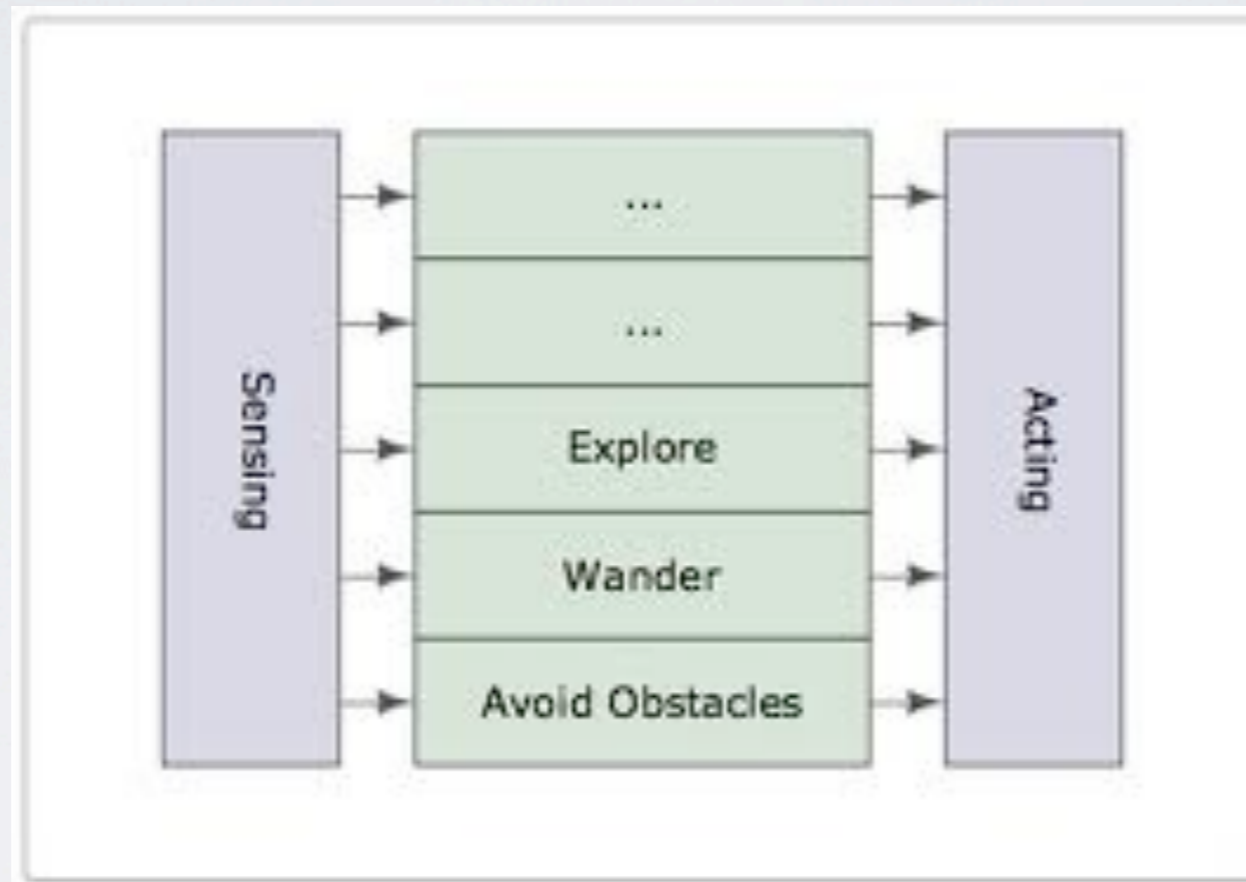
abstraction - dangerous weapon

- represent the world completely and explicitly
- search processes could then be use for planning
- block worlds with representations as the best interfaces

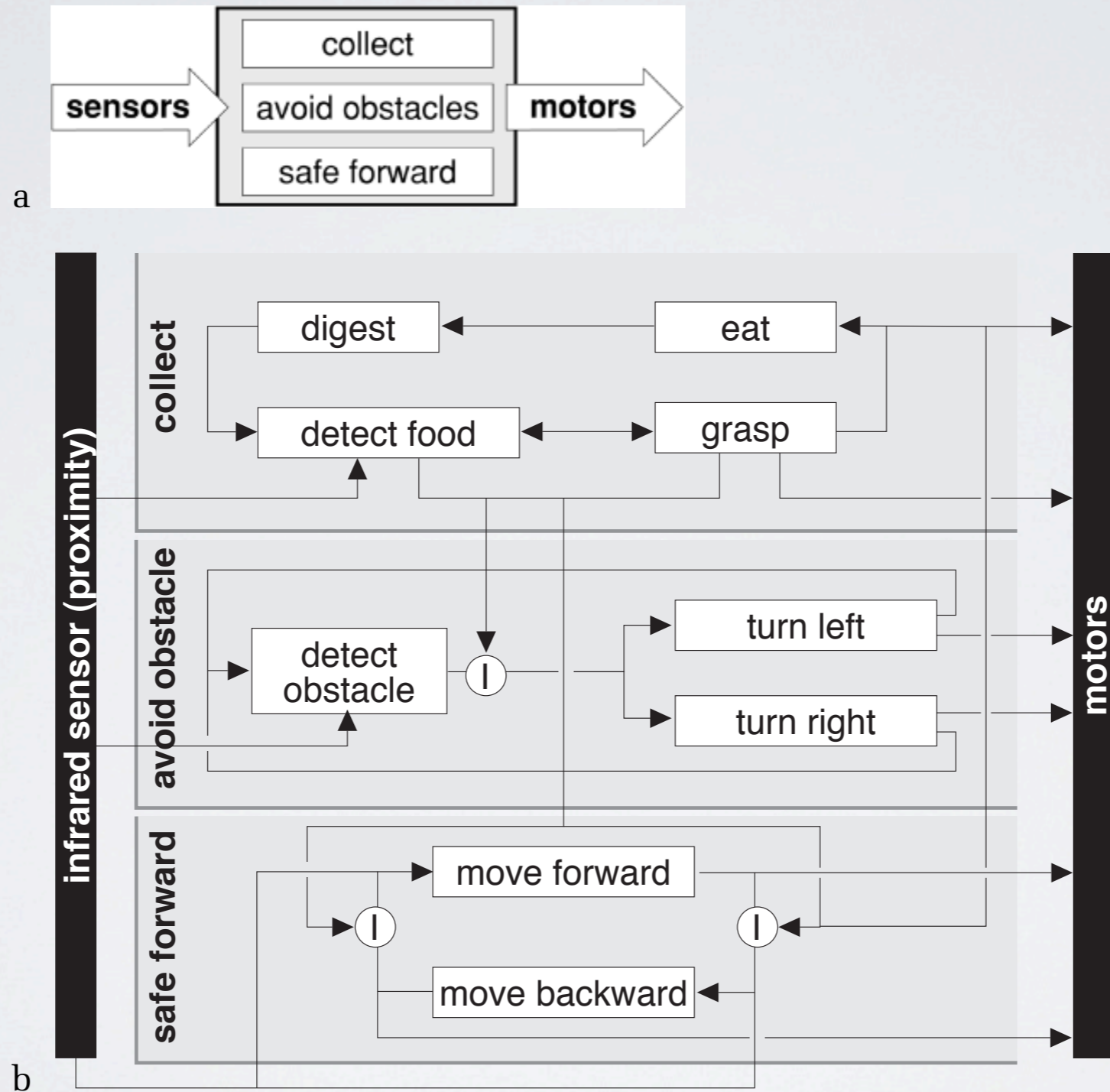
creatures

- must cope with a dynamic environment
- robust with respect to the environment
- maintain multiple goals and change and actively pursue them
- must have a purpose in being

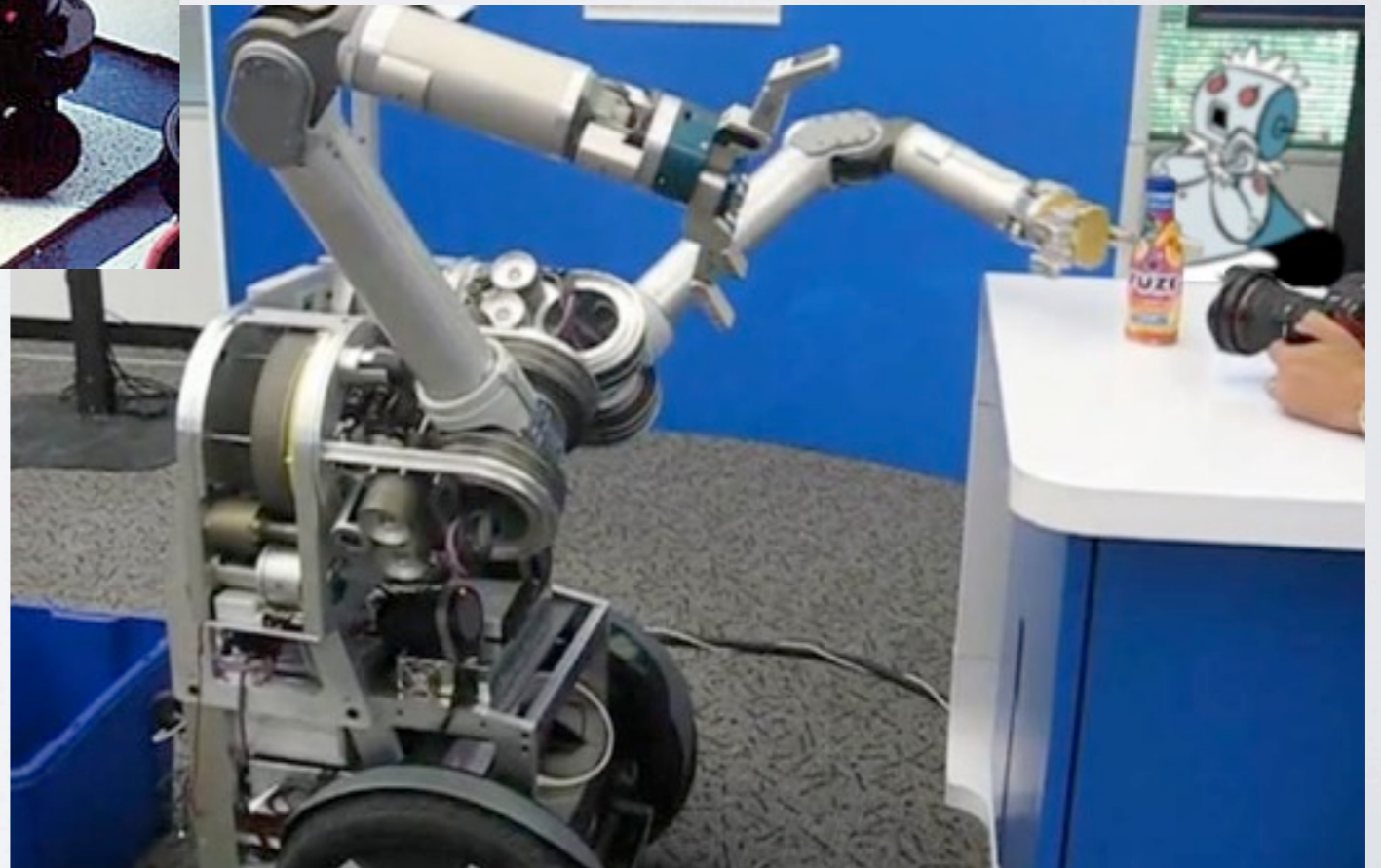
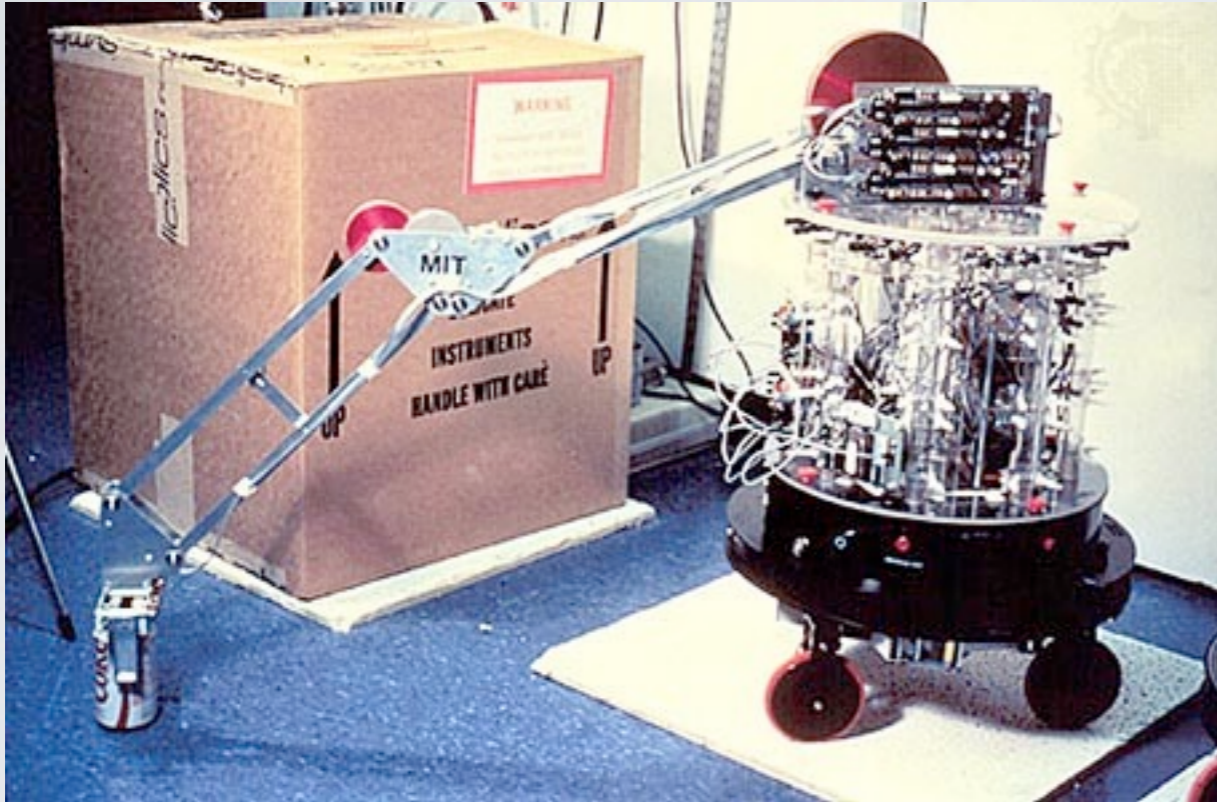
subsumption architecture



subsumption architecture



subsumption architecture



what this is not

- connectionism
- nn
- production rules
- blackboard
- german philosophy

limitations (?)

- number of layers before the interactions become too complex
- how complex can the behaviours be without central representations
- can higher-level functions, such as learning occur in this fixed topology

embodied cognition

to achieve something close to human intelligence we need agents that

- have a body
- interact with their environment
- learn through the interaction

j.j. gibson

affordance

we perceive objects according to their potential interaction

graspability of a handle

sittability of a chair

six views

six views of embodied cognition

margaret wilson

psychonomic bulletin

2002



six views

cognition is situated

cognitive activity takes place in the context of a real-world environment, and it inherently involves perception and action

cognition is time pressured

we are “mind on the hoof ” and cognition must be understood in terms of how it functions under the pressures of real-time interaction with the environment.

six views

we off-load cognitive work onto the environment

because of limits on our information-processing abilities (e.g., limits on attention and working memory), we exploit the environment to reduce the cognitive workload, we make the environment hold or even manipulate information for us, and we harvest that information only on a need-to-know basis

the environment is part of the cognitive system

the information flow between mind and world is so dense and continuous that, for scientists studying the nature of cognitive activity, the mind alone is not a meaningful unit of analysis

six views

cognition is for action.

the function of the mind is to guide action, and cognitive mechanisms such as perception and memory must be understood in terms of their ultimate contribution to situation-appropriate behavior

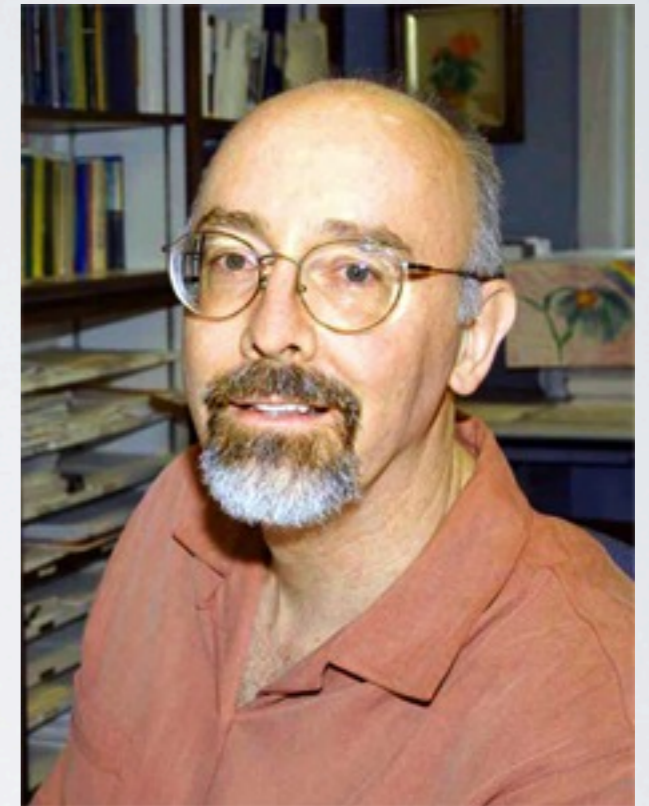
off-line cognition is body based

even when de-coupled from the environment, the activity of the mind is grounded in mechanisms that evolved for interaction with the environment—that is, mechanisms of sensory processing and motor control

grounded cognition

lawrence barsalou

professor of psychology
emory university



grounded cognition

rejects

cognition as computation on amodal symbols in a modular system

independent of the brains modal systems for perception, action and introspection

grounded cognition

based on evidence, is

- it is unlikely that the brain contains amodal symbols, if it does, they work together with modal representations to create cognition
- role of the body in cognition, ie. bodily states can cause cognitive states and be effects of them
- focus on the role of simulation in cognition

grounded cognition

simulation

reenactment of perceptual, motor and introspective states acquired during experience with the world, body and mind

grounded cognition

as an experience occurs (eg easing into a chair)

- the brain captures states across the modalities

- integrates them with a multimodal representation stored in memory

(eg how a chair looks and feels, the action of sitting, introspection of comfort and relaxation)

grounded cognition

later when knowledge is needed to represent a category (eg a chair)

□ multimodal representations captured during experience with its instances

□ become reactivated to simulate how the brain represented perception, action and introspection associated with it

a diverse collection of simulation mechanisms **across** diverse cog processes suggests that simulation provides a core form of computation in the brain