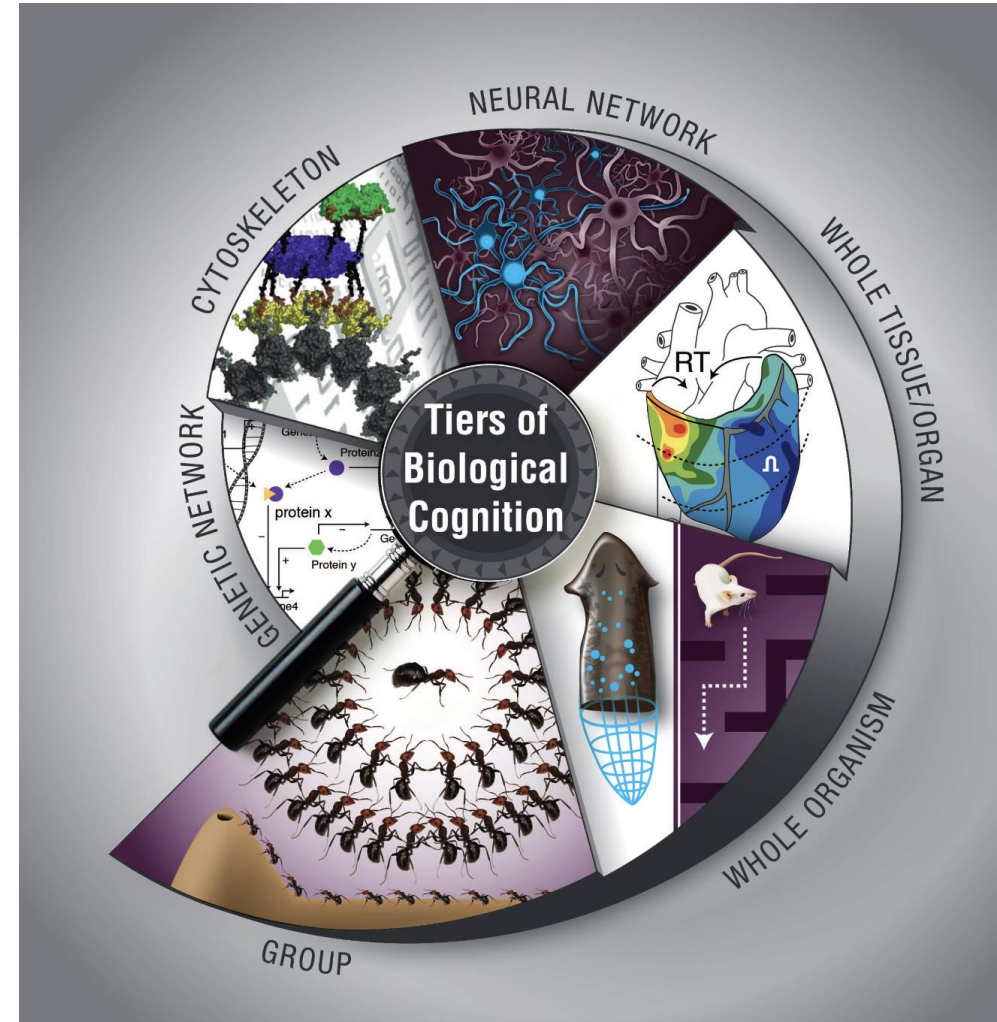


Strange Agents

HPS208

Emma Sigsworth





Last week

- The Living and Nonliving
- Anishinaabeg Animism(s)
- What does it mean to be alive, what kinds of things are alive, and how should we treat them because they are alive?



This week: Cognition and Life

- František Baluška & Michael Levin, "On Having no Head: Cognition Throughout Biological Systems", 2016
- Central thesis: all biological systems—at any level of organization—are cognitive agents
- Arguably, this is a wild claim ...
 - How do the authors defend this position?
 - WHY do the authors defend this position?



First Half

1. Introduce Baluška and Levin
2. Overview of Baluška and Levin's main claims in the paper
 - 'Neurons didn't invent cognition – they optimized it'
3. Levin on Bioelectricity
4. Cognition v/s Information-Processing
 - Do we agree with how the authors define 'cognition'?
 - What's the difference between cognition and information-processing?



Disclaimer

- I want to distinguish between Baluška and Levin's **philosophical claims** and the empirical, experimental work they both conduct.
- I can't evaluate the quality of their scientific work
- Focus on how Baluška and Levin discuss the nature of life and cognition — what are their philosophical positions? Do we agree/disagree, etc.

František Baluška

- Slovakian plant cell biologist
- Undergraduate and doctoral degrees on plant cell biology at Comenius University, in Bratislava, Slovakia
- Institute of Cellular and Molecular Biology, University of Bonn, Germany (recently retired)
- 2005: Helped found the Society for Plant Signaling and Behavior (F.K.A. the Plant Neurobiology Society)
- Plant intelligence week crossover!



Michael Levin

American synthetic + developmental biologist

BS, Computer Science and Biology, Tuft University, 1992

PhD, Genetics, Harvard Medical School, 1996

2000-2008: Lab at the Forsythe Institute, Harvard

- Dental/oral health institute; lab members had affiliations at Harvard Medical School

2008-present: Lab at Tufts University, housed in Biology Department

- Lab members founded the Tufts Center for Regenerative and Developmental Biology





Baluska & Levin's Definition of Cognition

Cognition: "the total set of mechanisms and processes that underlie information acquisition, storage, processing, and use, at any level of organization"

On this definition of cognition, any biological system that processes information is a cognitive system.

Cytoskeleton of a single cell = information-processor = cognitive system

Human heart = information-processor = cognitive system

Neurons didn't invent cognition — they optimized it

What they wrote

"... [Central Nervous System] neurons do not embody cognition due to any magical, unique property.

[The computational powers of neurons] derive from the dynamics of networks of linked elements that propagate and integrate signals, and the ability to alter connectivity among those elements (network topology) based on prior activity [...]

[T]hese basic properties are present in biological systems at many complexity scales. [...] Indeed, neurons did not invent their special tricks — they merely optimized them for speed to drive adaptive behavior" (p. 2)

What they mean

Neurons do not 'produce' cognition simply *because* they are neurons, or because they are part of a brain/CNS.

A brain/central nervous system has cognitive capacities because it is a system that can transmit and integrate signals and update its configuration based on prior activity.

This kind of signal-integrating and configuration-updating capacity is present throughout biological systems. While neurons might be the 'best' at cognition, they didn't 'invent' it.



Bioelectricity

- A brain/central nervous system has cognitive capacities because it is a system that can transmit and integrate signals and update its configuration based on prior activity.

Developmental bioelectricity = processes through which electrical signals regulate the development of cells

For Levin, bioelectricity = a unifying principle in biology

'Bioelectricity' as an Interdisciplinary Scientific (sub)Field
- *Bioelectricity* (Academic Journal, co-founded by Levin in 2019)



Bioelectricity: Two Claims

(1) Theoretical claim about the nature of biological cognition

- Cognition in *living* systems can be 'boiled down' to bioelectricity
- Cognition = information-processing, and information-processing occurs via bioelectric signals

(2) Disciplinary Hypothesis — A better understanding of bioelectricity will dissolve disciplinary distinctions between brain sciences and biology

- "Thus, firm conceptual (and disciplinary) distinctions between the science of the brain and the those of the body are largely artificial hold-overs from past limitations of technology and evolutionary understanding..." ("Bioelectric Networks", p. 1883)



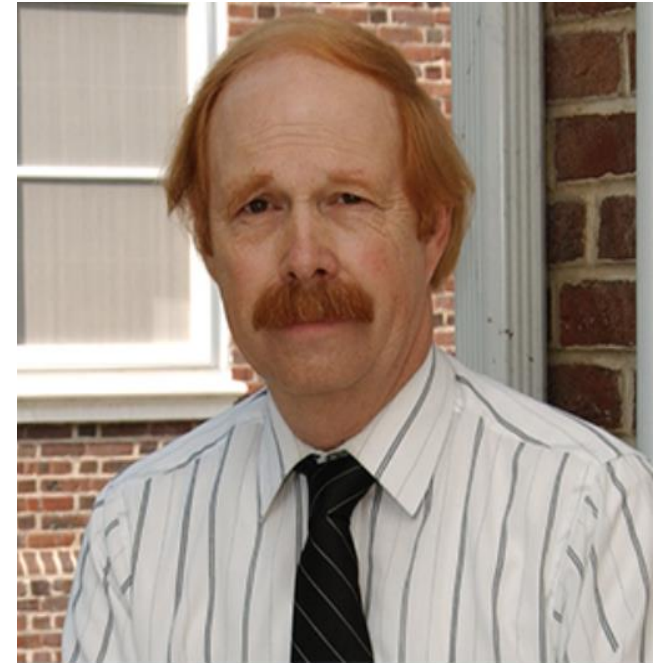
Information-processing and Cognition

- Baluška and Levin suggest that information-processing is *sufficient* for cognition
- In order to be a cognitive system, all a system needs to do is process-information; information-processing is 'enough', or sufficient for, cognition.
- Is this true?

Fred Adams, "Information and Cognition" (2016); "Cognition Wars" (2018)

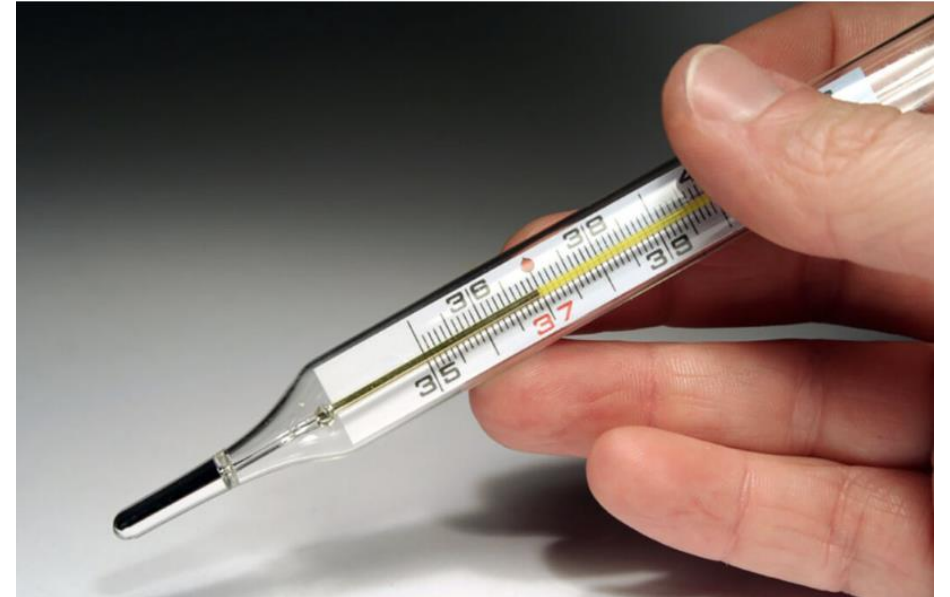
"...the mere fact that a metabolic process or type of behavior is information-driven is not sufficient for it to be cognitive" (2018, p. 27)

"If being a conduit of information were sufficient for cognition, then the whole universe would think. Despite a few proponents of this view, it seems highly implausible to most" (2016, p. 323).



Adams, "Information and Cognition", 2016

- "Consider a mercury thermometer. When used to take a child's temperature, it contains information about the body temperature of the child. The level of mercury rises or falls in perfect variation with the rise or fall in body temperature of the child. But the thermometer does not have any cognitive states, despite being a perfect carrier of information about the child's temperature." (p. 324)

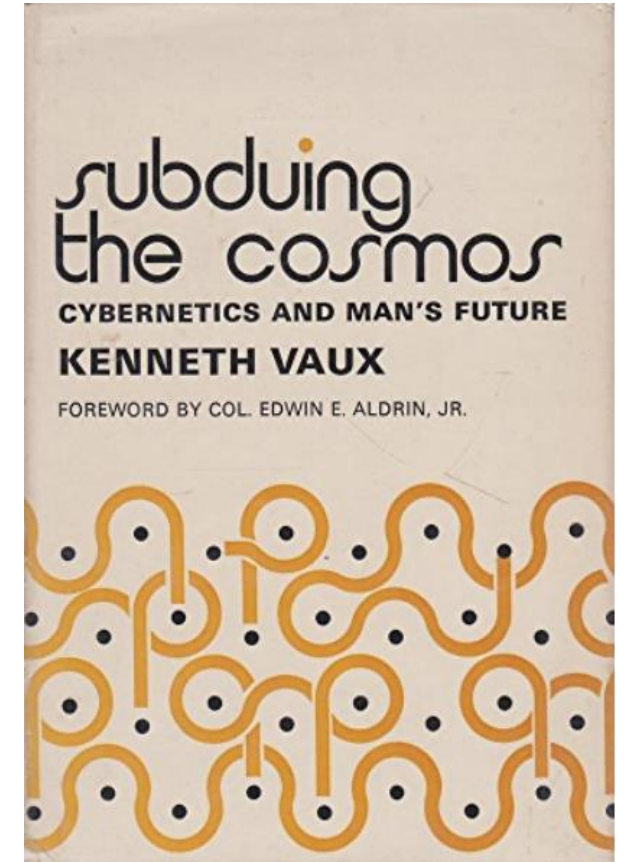
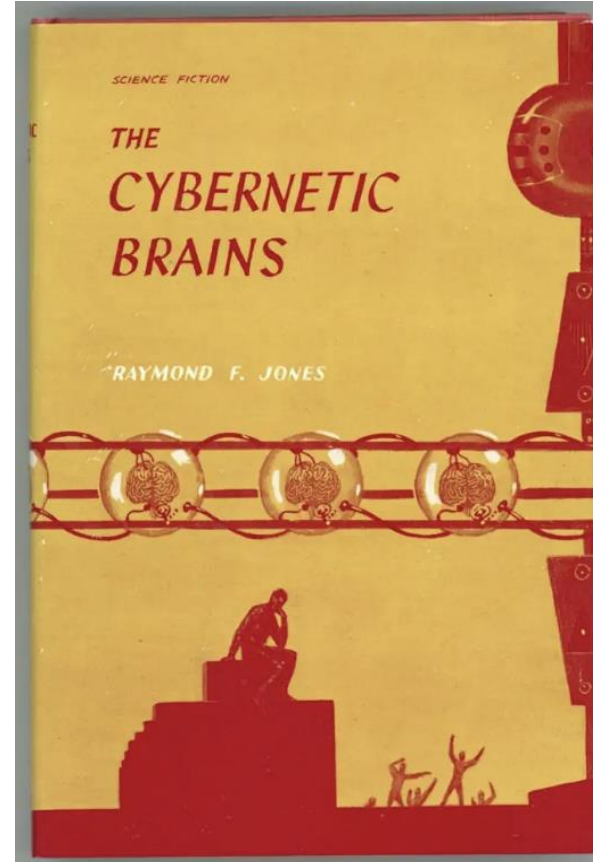
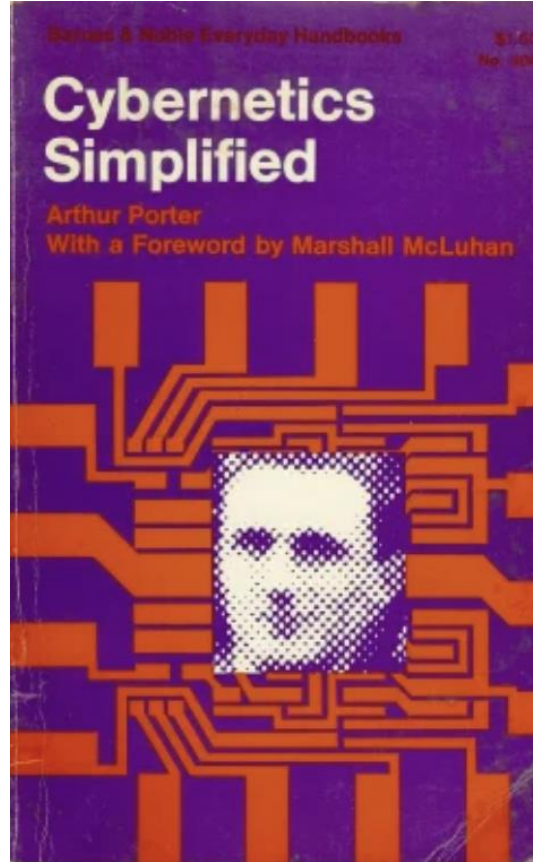
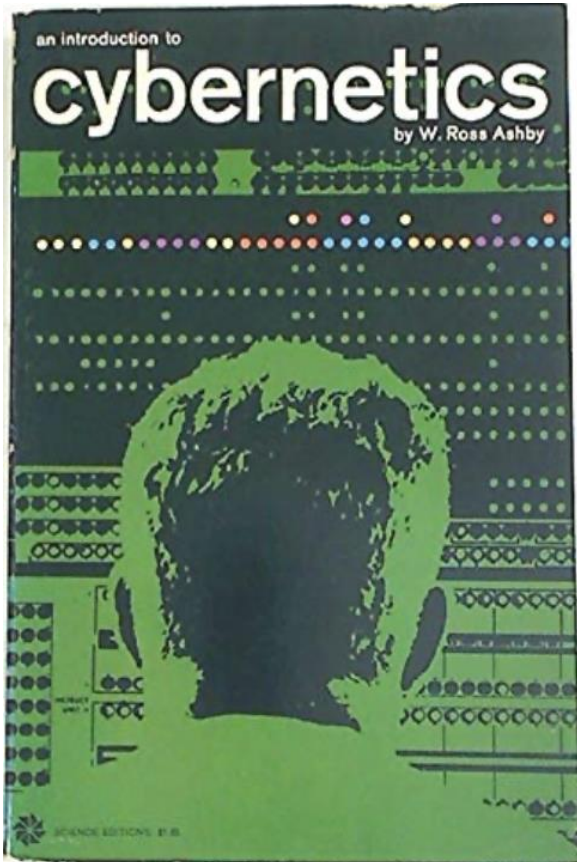




Would you 'side' with Adams or Baluška and Levin on this topic?

- Do you think cognition = information processing?
- Is cognition something 'more' than information-processing? Does cognition involve something like belief, or knowledge? Do you think cognition 'needs' a brain?

10 Minute Break



Next: Cybernetics (and more)



The cure for everything?

Michael Levin





Thoughts?



How hacking our biology could revolutionize healthcare

"If we were able to communicate to a set of cells exactly what we want them to build, we would have the solution for birth defects, lost organs of various kinds and limbs, we could reprogram tumours back to normal. All of this could we solved if we could communicate with the collective intelligence of cells."

- Focus on manipulation and control of biological systems
- 'communication' via bioelectric signals
- Goal = Biomedical advances



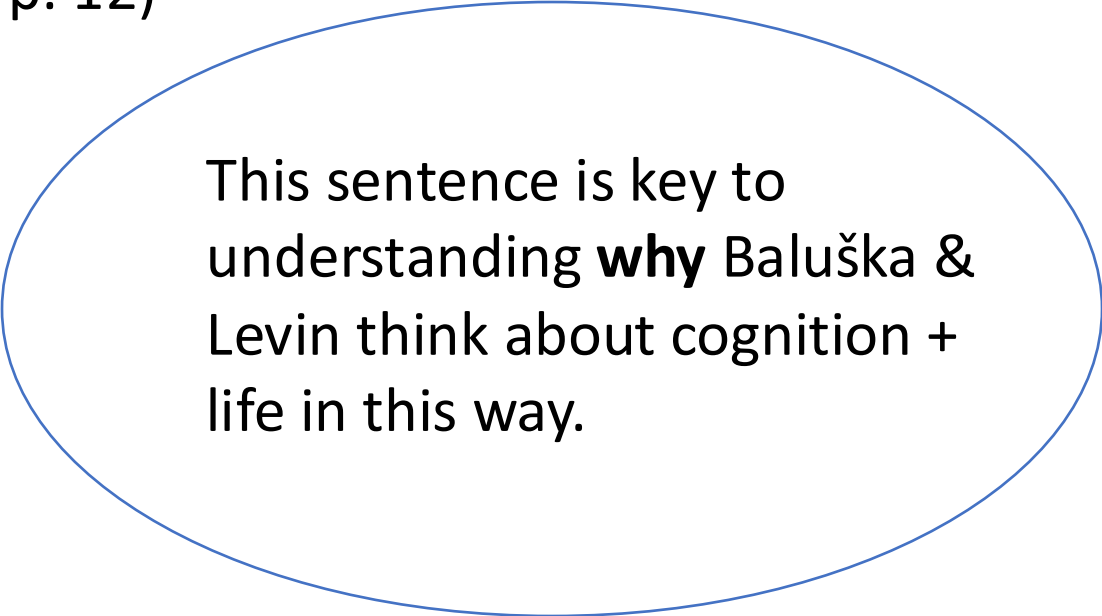
How might Levin (and Baluška) respond to the charge that their definition of cognition is too broad?

- They likely wouldn't be too worried about our philosophical concerns
- Their philosophical framework is not trying to clarify the 'true' nature of life and cognition
- In another paper: "Our goal ... is not to [define cognition], but to present tools that can help with research" (Manicka & Levin, 2019)
- A research tool, or 'useful fiction'

"On having no head", Baluška & Levin, 2016

- "[We favour] an intentional stance-like pragmatic, engineering approach grounded in cybernetics" (2016, p. 12)

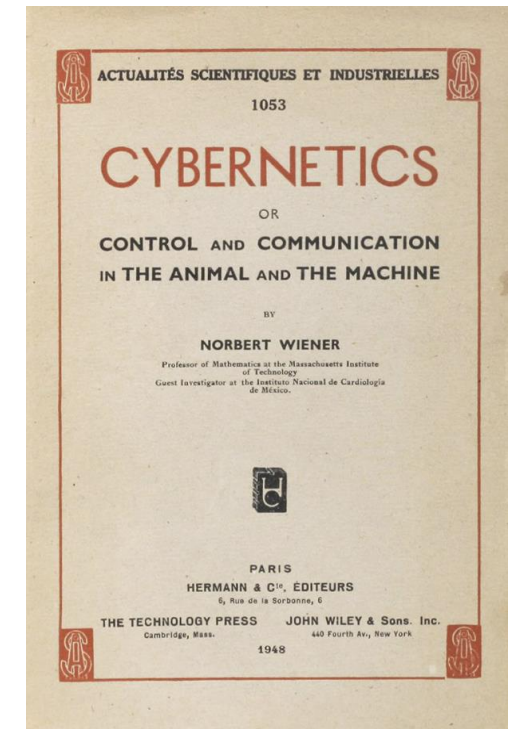
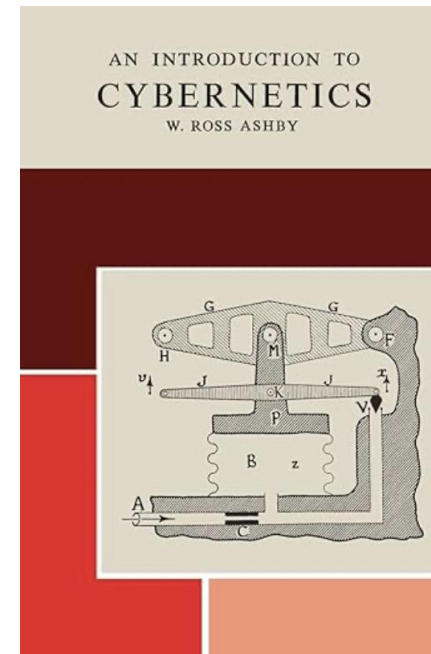
- Intentional stance?
- Pragmatic approach?
- Grounded in cybernetics?



This sentence is key to understanding **why** Baluška & Levin think about cognition + life in this way.

Cybernetics

- Norbert Wiener: "the science of control and communication, in animals and machines" (1948)
- Ross Ashby (1956): cybernetics is a theory of 'all possible machines'; the field studies "all forms of behaviour in so far as they are regular, determinate, or reproducible" (p. 1).





Levin: an approach 'grounded in cybernetics'

- Focus on manipulation/control of the system in question
- Recall video: communicate with cells to control growth
- Similarities in objects of study -- "all forms of regular, determine, or reproducible behavior"
- Thinking about 'unconventional' biological systems as information-processors, and thus cognitive agents, is theoretical perspective that can help scientists control and manipulate the system they study

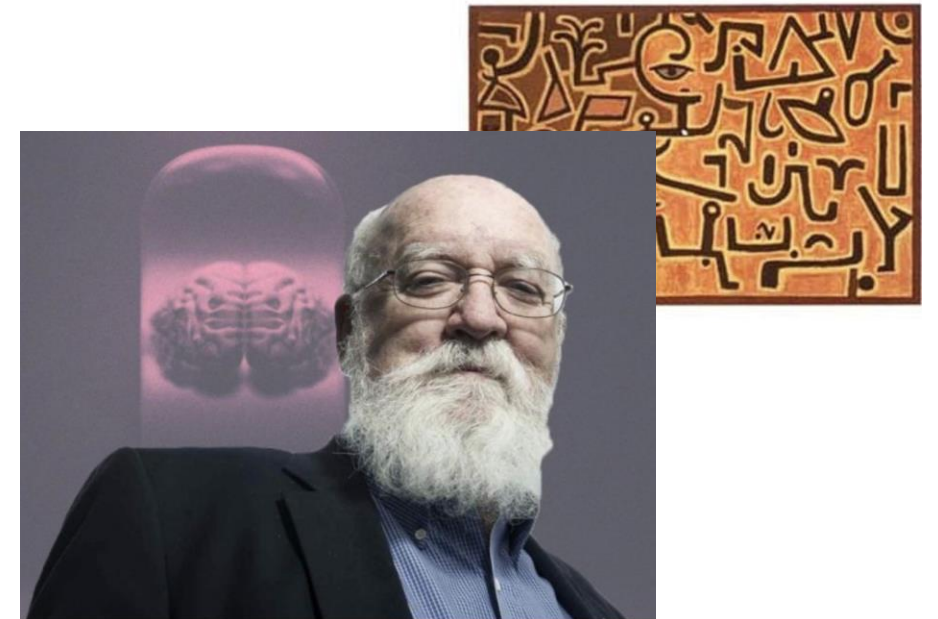
Daniel Dennett's Intentional Stance

Physical stance: predicts behaviour based on assumption that the object is under control of physical laws

Design stance: predicts behaviour based on assumption that the object has been designed for a specific purpose

Intentional stance: predicts behaviour based on the assumption that object/system has beliefs and desires

THE
INTENTIONAL
STANCE
Daniel C. Dennett

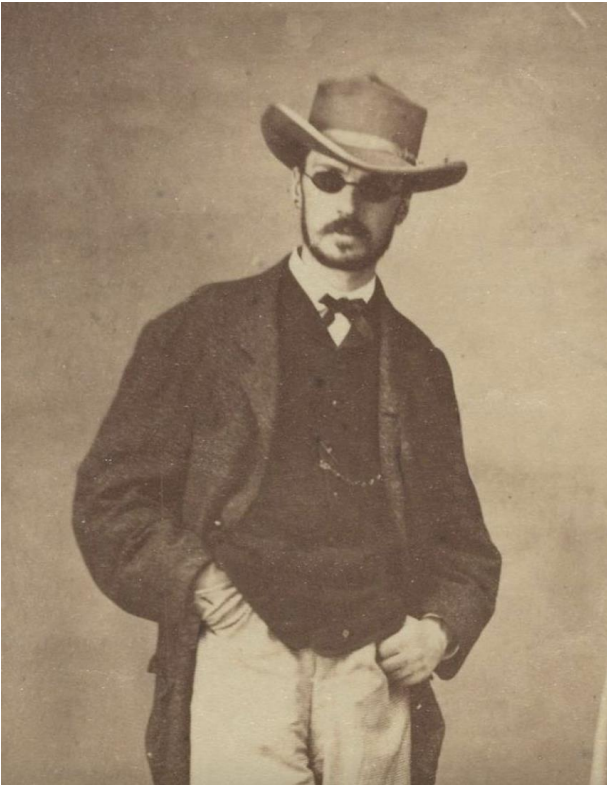




Baluška & Levin's 'cognitive stance'

- "intentional stance-like"
- Cognitive stance = predicts behaviour based on the assumption that a system is a cognitive agent.
 - If this gives us more predictive power, we are justified to call that system cognitive

Pragmatism




- American philosopher and psychologist, 1842-1910
- Pragmatic method in philosophy: "*the attitude of looking away from first things, principles, 'categories,' supposed necessities; and of looking towards last things, fruits, consequences, facts*" (James, Lecture II, Pragmatism (1907))
- Less metaphysics, more action



Baluška and Levin's pragmatism

- No interest in metaphysical speculation about abstract concepts, such as being, time, knowledge, existence, etc.
- Prioritizing a theoretical framework that (1) reflects contemporary scientific work (2) can actually *help scientists conduct this work*
- Their thesis that cognition = information-processing = bioelectricity is intended to help stimulate scientific research
- Action-oriented

- 
- **Grounded in cybernetics:** focus on manipulation and control of systems in experimental research
 - Intentional stance-like ('**Cognitive Stance**'): predicts the behaviour of systems *as if they are* cognitive agents, with the expectation that this improves predictive power
 - **Pragmatic:** focused on the empirical consequences of adopting a particular theoretical perspective



Conclusions

1. Baluška and Levin (2016) employ a very broad definition of cognition. On their view, any system that processes information is a cognitive system.
2. Arguably, there is reason to claim that this is not a satisfactory definition of cognition (Adams' critique)
3. This type philosophical critique likely wouldn't bother Baluška and Levin.
 - Focus on biomedical research outcomes
 - Levin's 'cognitive stance' as a theoretical tool that (he argues) can *help advance* biomedicine