

# What is exploration?

# Readings for today

- Braitenberg, V. (1986). Vehicles: Experiments in synthetic psychology. MIT press.

# Topics

- The innate drive to discover
- Defining exploration
- Our approach

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# The innate drive to discover

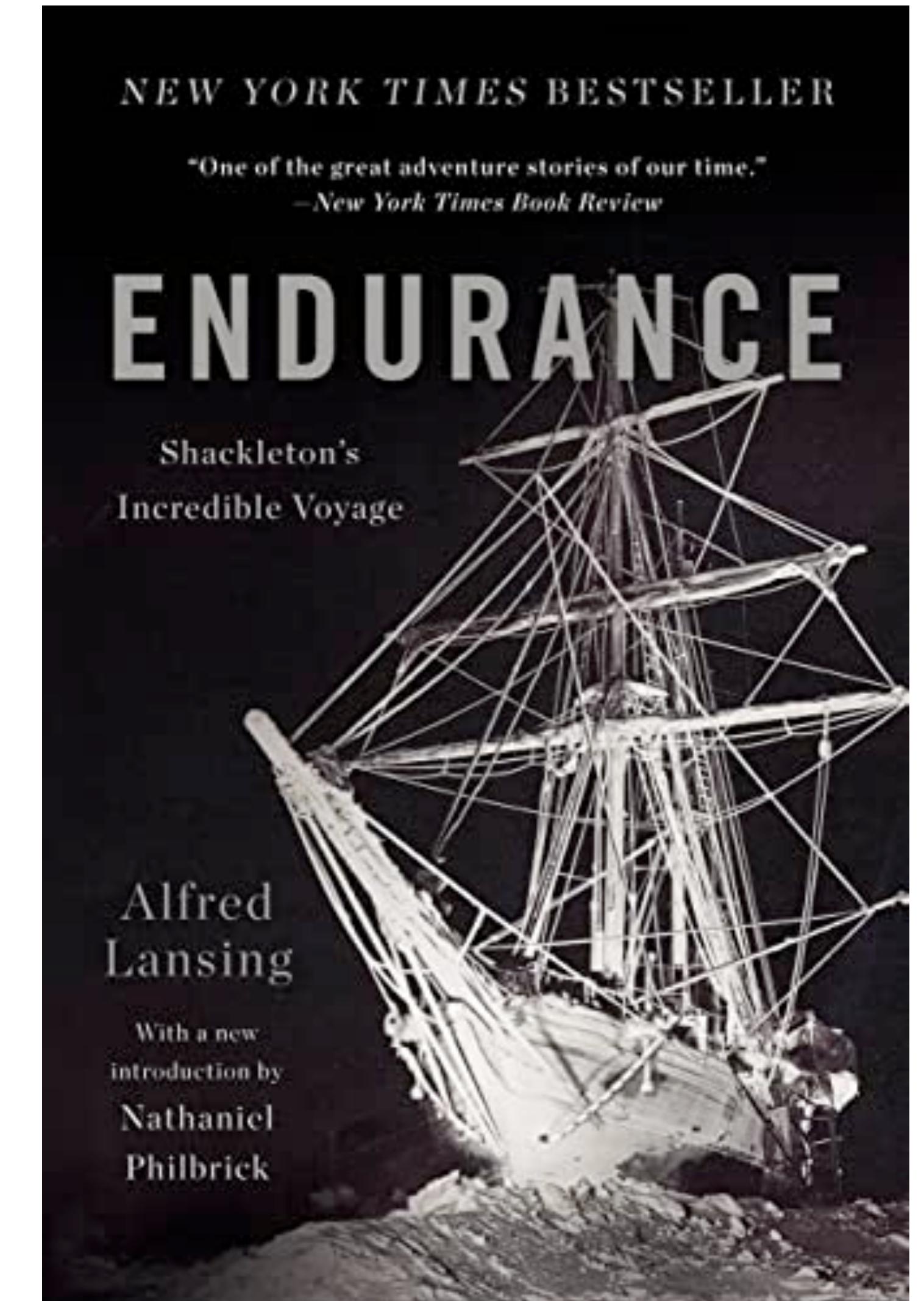
# The tale of the Endurance



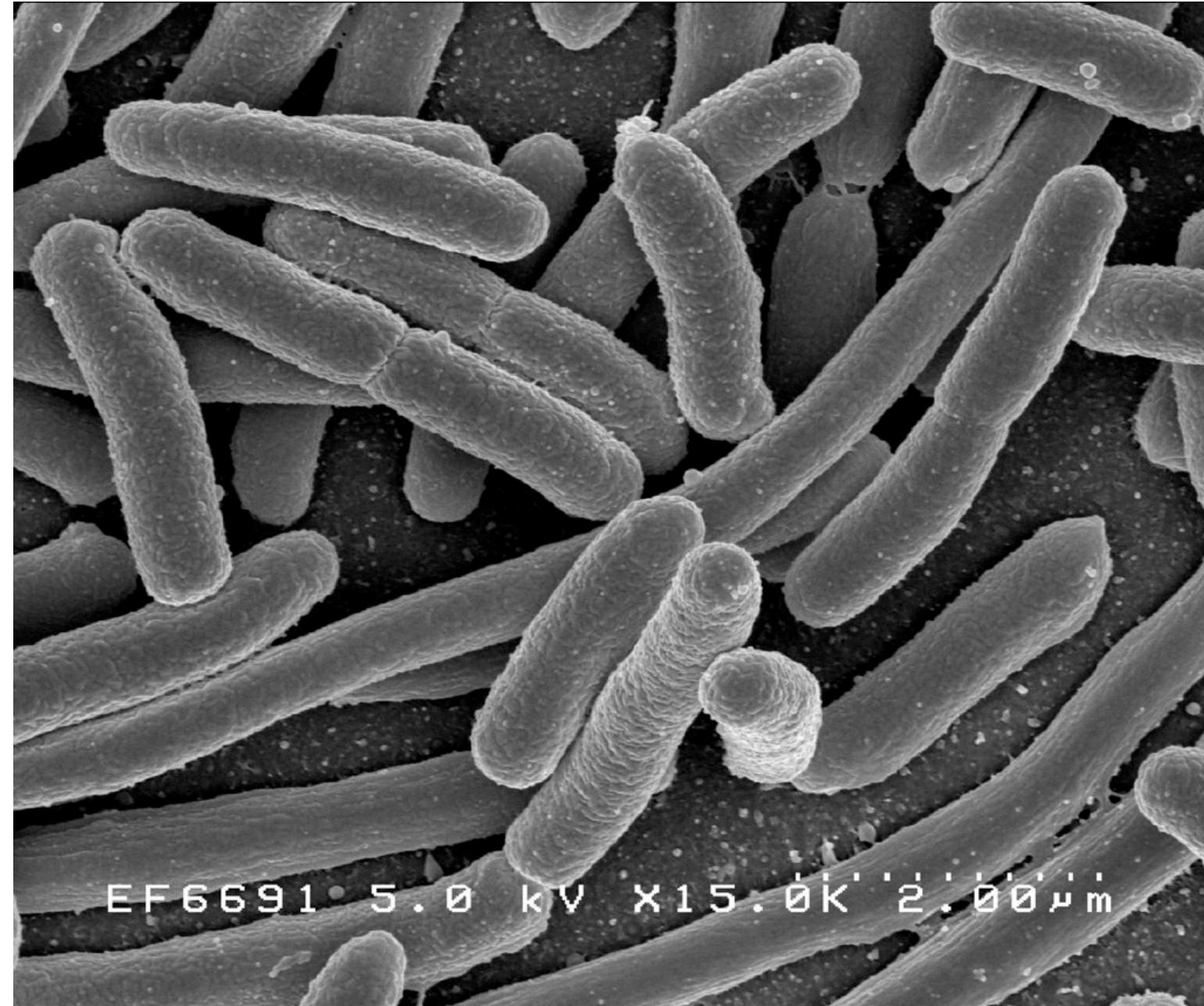
Ernest Shackleton (1874-1922)



The sinking of the *Endurance*



# Exploration is universal in biology



*e. coli* bacteria



honeybee



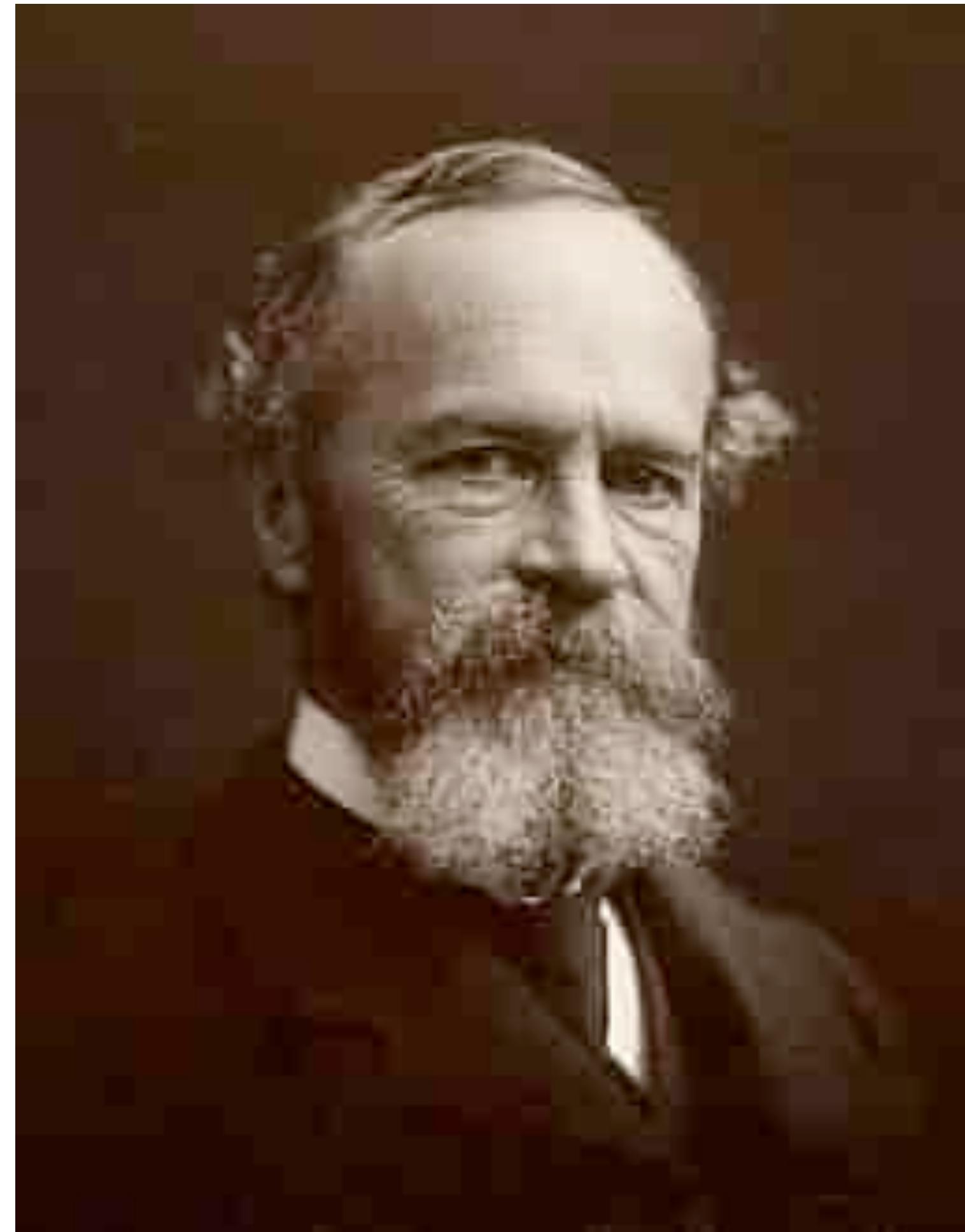
humans?

# The purpose of exploration

- Exploration is fundamentally about knowledge.

- Resources?
- Threats?
- Opportunities?

Curiosity



“the impulse towards better cognition”  
- William James (1842-1910)

# Defining exploration

# What is exploration?

**Exploration:** An action made without knowledge of, but in order to observe, the subsequent outcomes.

*Action* → change in the environment implemented by some agent in the world

*Behavior* → an action that is the result of a complex interplay between the environment and internal processes of the agent

# Complete vs. optimal exploration

**Complete Exploration:** the process of taking every available action in a given context at least once.

**Optimal Exploration:** Balancing the need for complete exploration against the costs and expected consequences of actions.

# Our approach

# Levels of analysis

Our focus

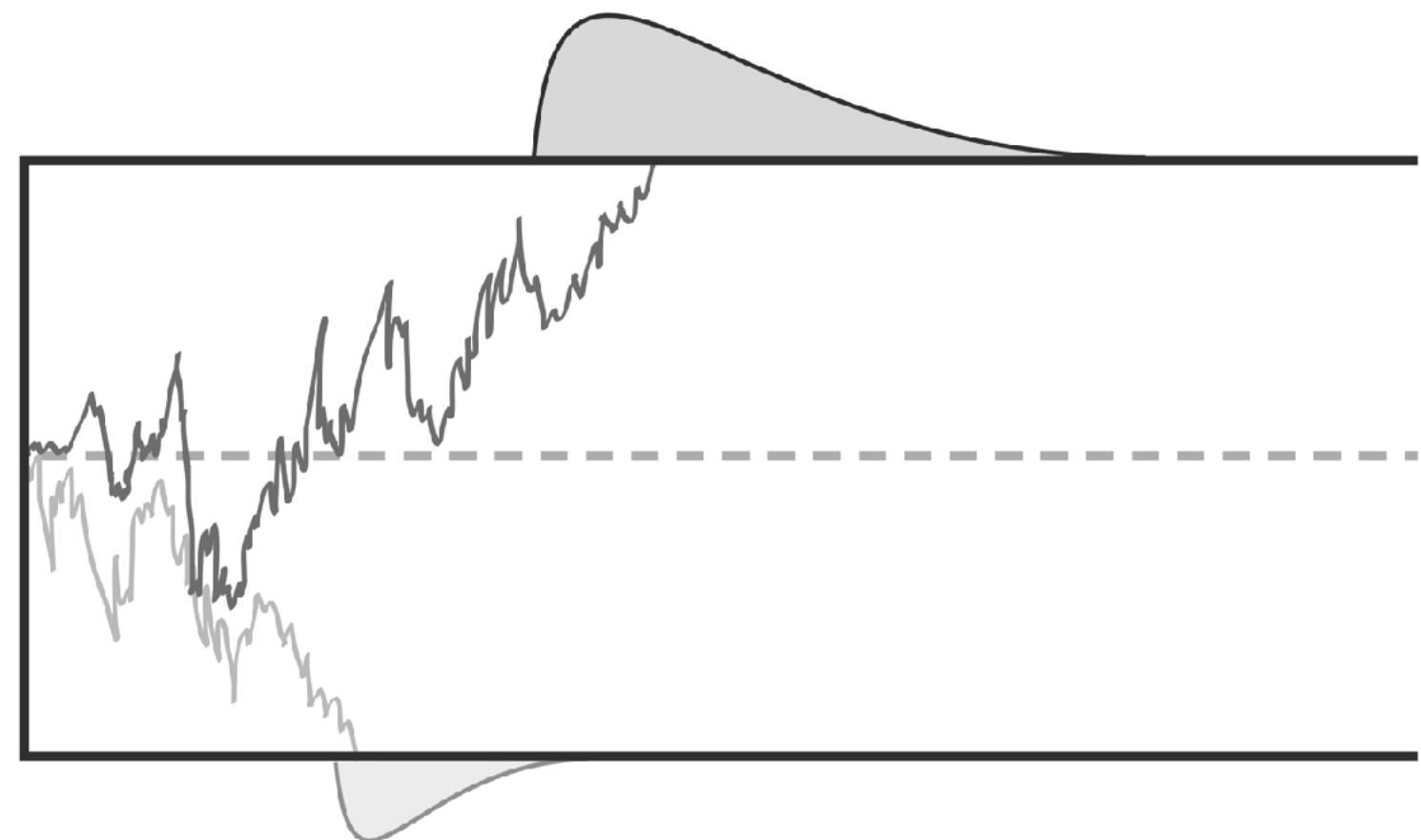
Behavioral  
Goal



Computation

1

Cognition



Algorithm

2

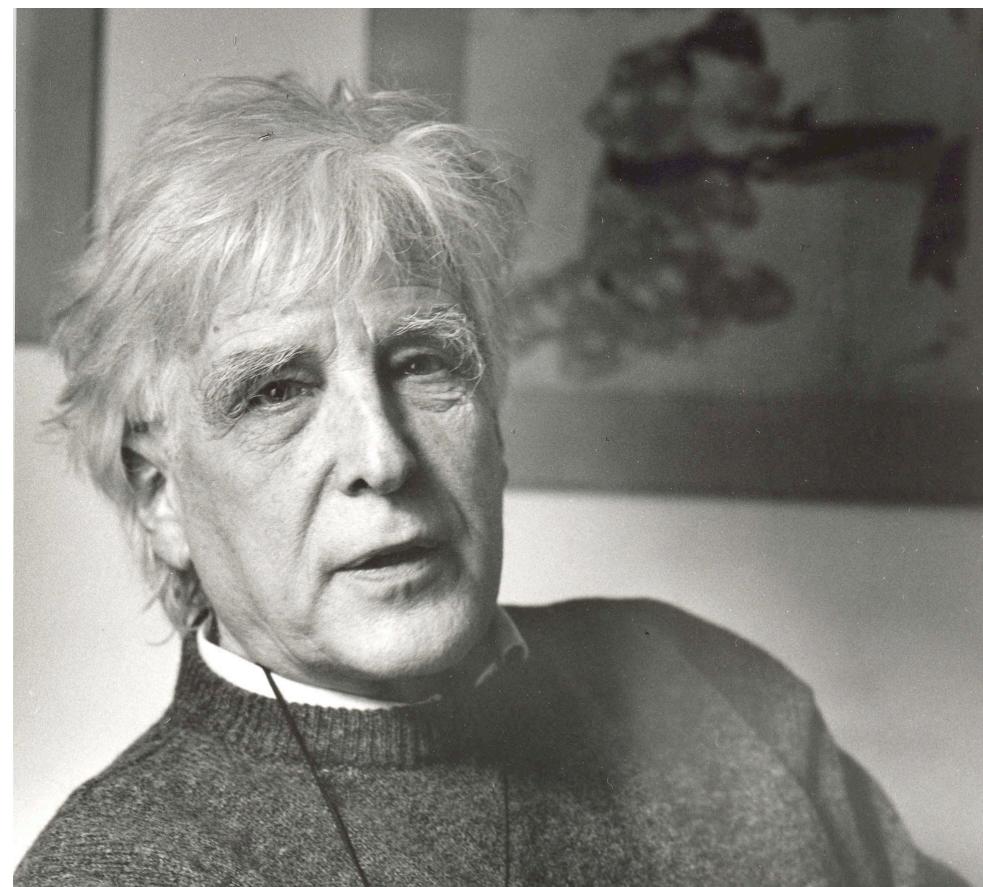
Neural Substrate



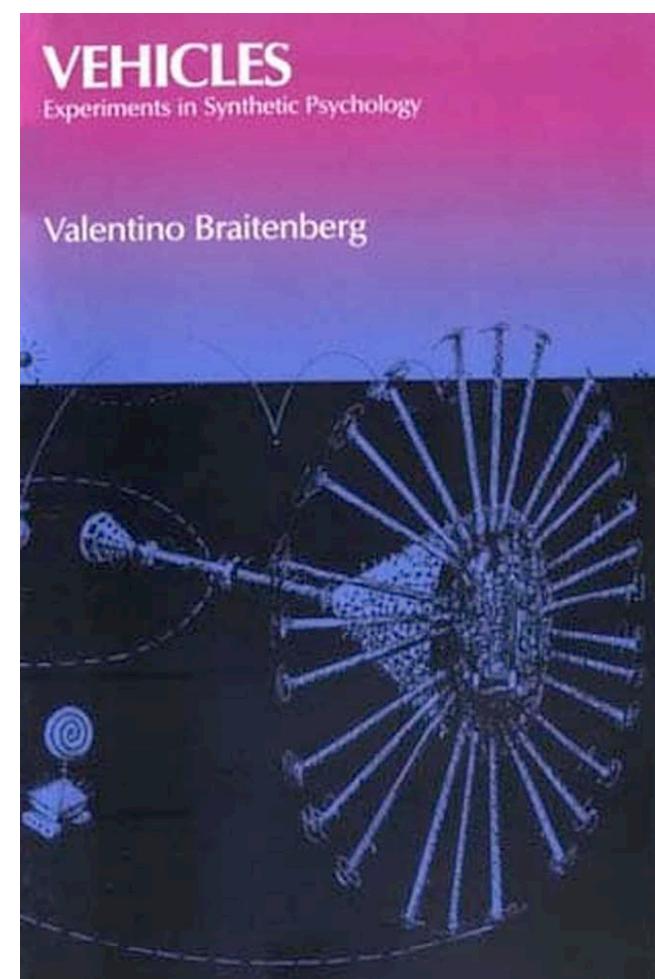
Implementation

3

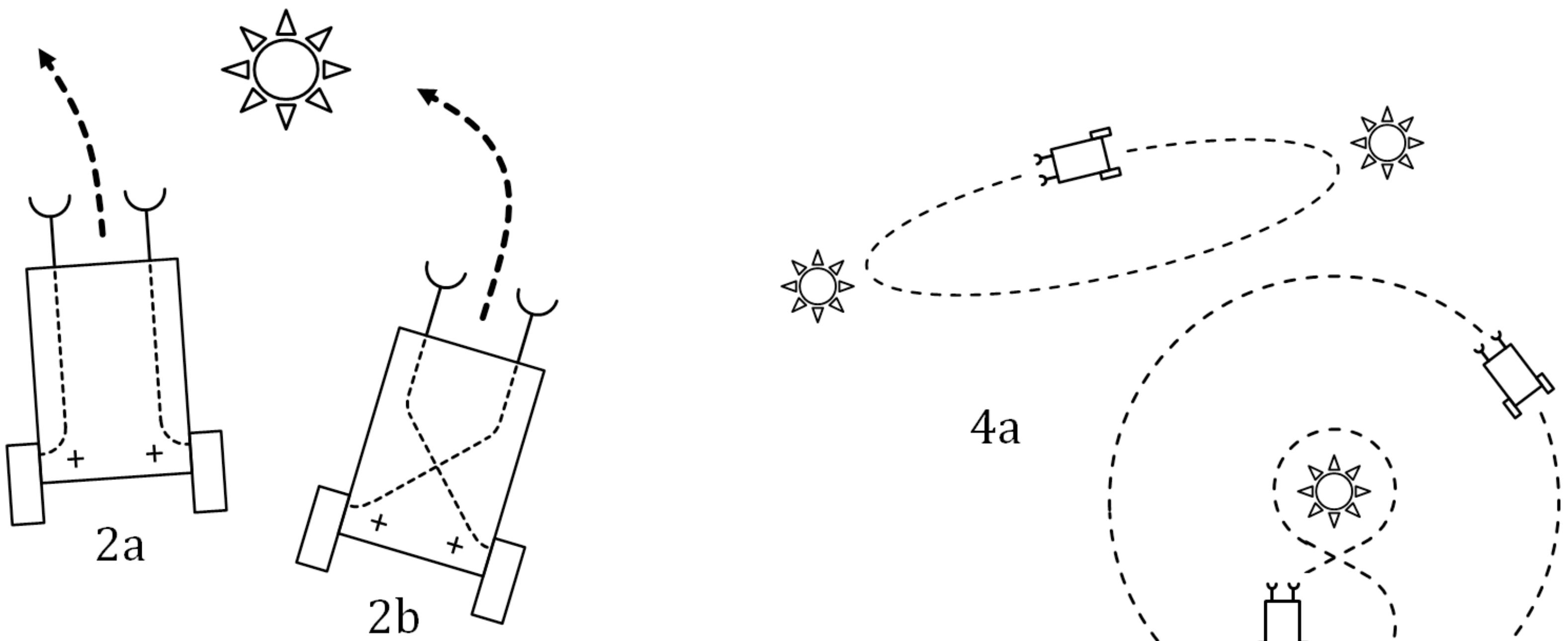
# The art of synthetic psychology



Valentino Braitenberg  
(1926-2011)



**Synthetic psychology:** the study of artificial systems, like simulations or robots, to understand the origins and mechanisms of behavior.

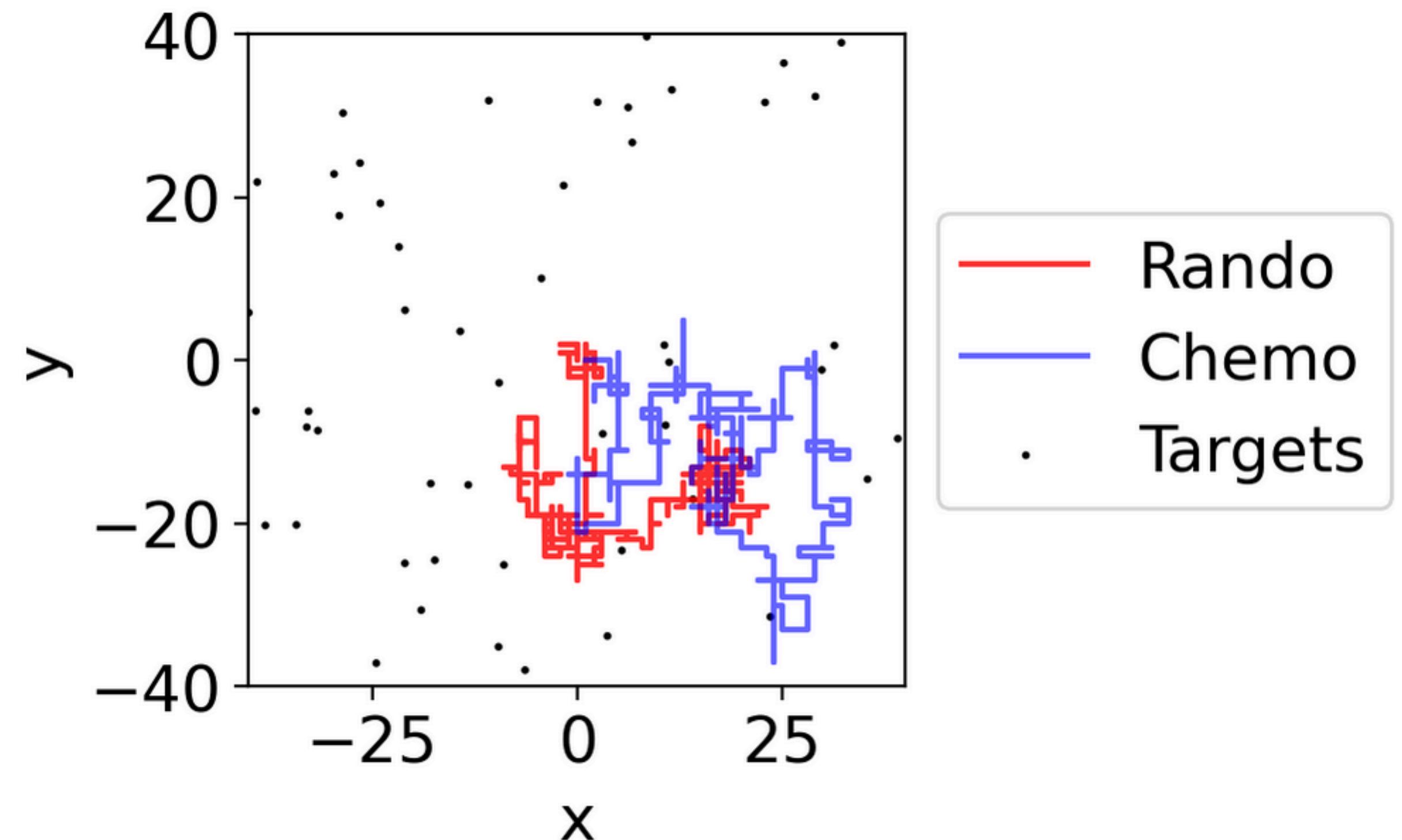


# Towards a neo-synthetic psychology

<https://coaxlab.github.io/BIX-book>

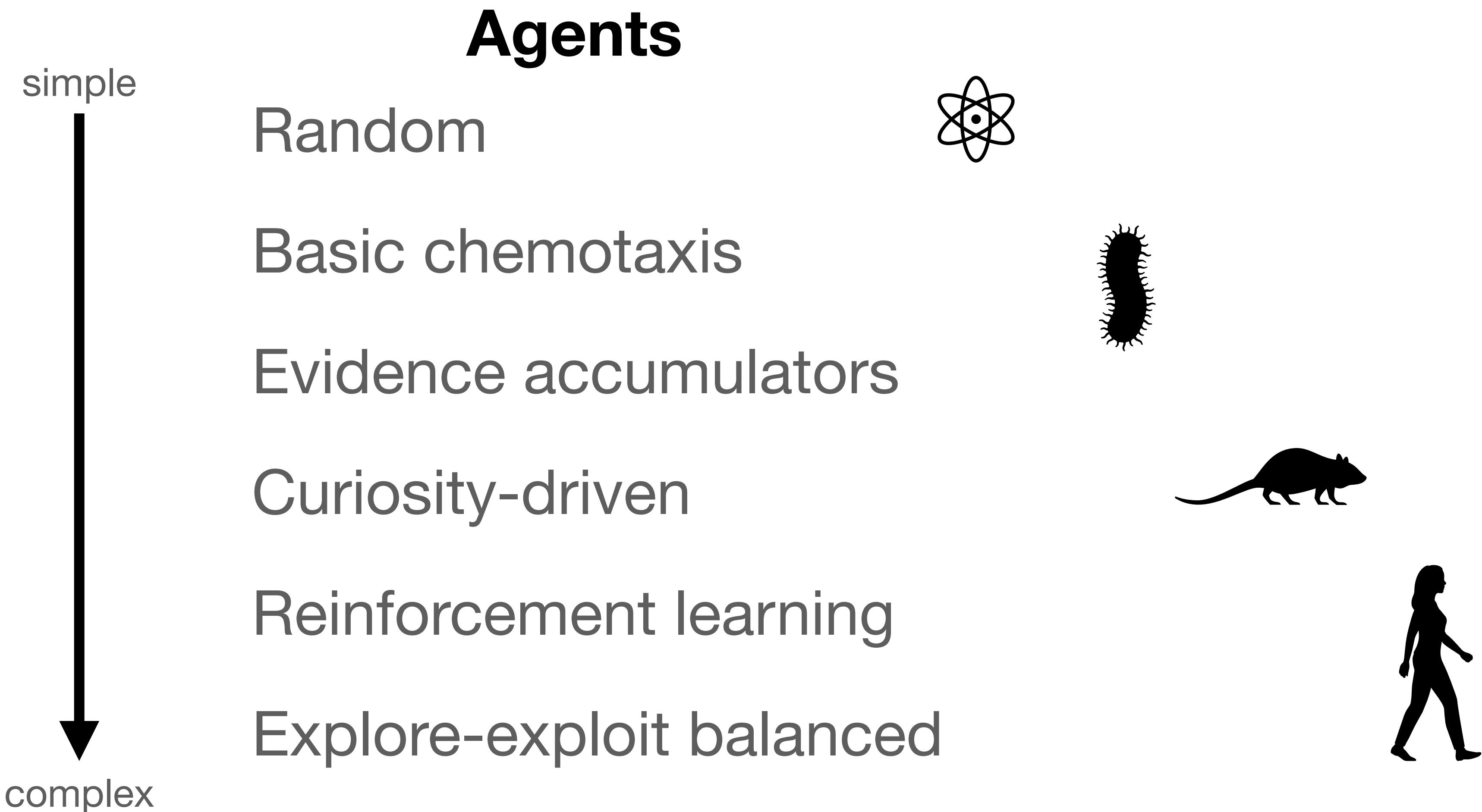
The screenshot shows a web browser window for the URL <https://coaxlab.github.io/BIX-book/intro.html>. The main content area displays the title "Biologically Intelligent eXploration (BIX)" and a welcome message. A sidebar on the left contains a fractal logo, the title "Biologically Intelligent eXploration (BIX)", and a list of ten lab sections: "Getting started", "Introduction to python", "Labs", "Lab 1 - Random exploration", "Lab 2 - Simple Chemotaxis", "Lab 4 - Evidence Accumulation", "Lab 5 - CBGT pathways", "Lab 6 - Information theory", "Lab 7 - Infotaxis", "Lab 8 - Patch foraging", "Lab 9 - Reward seeking", and "Lab 10 - Exploring vs. exploiting".

**Valentinos**



<https://github.com/CoAxLab/explorationlib>

# Types of agents



# Take home message

- Exploration is a fundamental process of all biological life
- Exploration is about taking actions without knowledge or certainty of the consequences.
- This class will adopt a synthetic psychology approach towards understanding the algorithms and mechanics of exploration.

# Break out group discussions

Ignorance is a fundamental feature of our definition of exploration. How much ignorance is necessary for an action to be considered exploratory?