

Intro to Perception



Instructor: Jonathan Pillow
Sensation & Perception (PSY 345 / NEU 325)
Spring 2019, Princeton University

Sensation and Perception

Spring 2019

(PSY 345 / NEU 325)

Time: Tues / Thurs 10-10:50am.

Location: Guyot 10

Instructor: Dr. Jonathan Pillow (pillow@princeton.edu)

Office: PNI 254 Office Hours: Tues. 11-12pm and by appt.

Als: **Aaron Kurosu** (akurosu@princeton.edu)

Shruthi Ravindranath (shruthi@princeton.edu)

Office Hours: by appt., and TBA during pre-exam and post-exam weeks

course website: <http://pillowlab.princeton.edu/teaching/sp2019/>

piazza page: <https://piazza.com/princeton/spring2019/psy345neu325/home>

Syllabus

Course Description

This course will provide an introduction to the scientific study of sensation and perception. We tend to think of the ability to perceive the world around us as an automatic process that happens ‘for free’ whenever we use our eyes, ears, nose, and other sense organs. But sensation-and-perception is an *active* process that relies on exquisitely sensitive receptors and powerful computational machinery housed in the brain, spinal cord, and peripheral nervous system. Our perceptual capabilities have been honed by evolution over many millions of years to arrive in their current form. The central focus of this course will be to examine how these sensory systems work and why. We will undertake a detailed study of the major senses (vision, audition, touch, smell, taste), using insights and methods from a variety of disciplines (philosophy, physics, computer science, neuroscience, psychology). We will begin with a study of the physical basis for perceptual information (e.g., light, sound waves), and proceed to the biological and psychological processes by which such information is converted to percepts in the brain.

Learning Objectives

The objective of this course is to provide a thorough introduction to the biological and psychological study of the senses, and the computational and neural mechanisms that underlie sensation and perception.

Textbook

Sensation & Perception, 5th ed. Wolfe, Kluender, et al. Sinauer 2018.

The textbook has a companion website with overviews, study aides, essays on select topics, as well as some nice demonstrations of perceptual illusions we'll discuss in class:

<https://oup-arc.com/access/sensation-and-perception-5e-student-resources>

Precepts

Additional readings from the primary scientific literature will be assigned weekly, to be discussed during precepts. List available at:

<http://pillowlab.princeton.edu/teaching/sp2019/readings.html>

Expectations:

- lead presentation of 1 article
- reviewer for 2 other articles
- participate in discussion of other articles

Sign up sheet coming soon!

Grading

- two mid-term exams (25% each)
- cumulative final exam (35%)
- precept participation (15%)

Attendance at precepts is mandatory. All students will be allowed 2 unexcused absences. For every additional absence, 2% will be deducted from the student's participation grade.

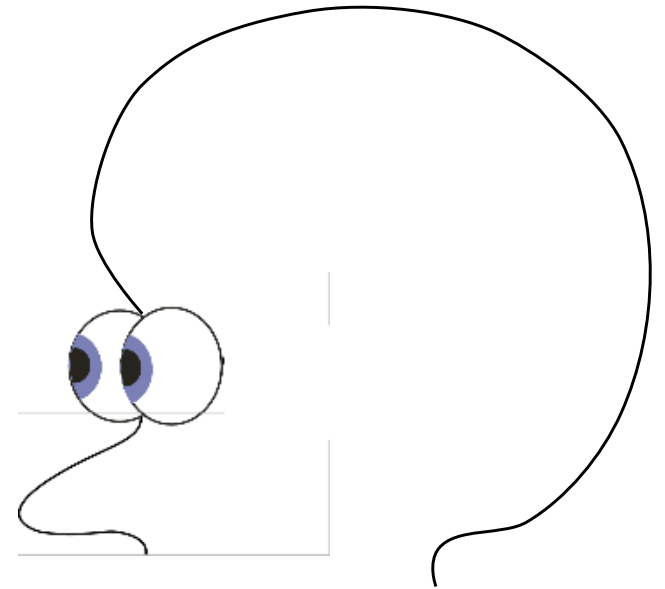
Note also (very important!): all students must complete a *Research Participation Assignment* to receive credit for this course (see final page of syllabus).

How to do well in this course

- **Come to class!**
 - Ask questions
 - Answer questions
- Read the textbook before class
- Take good notes + review them
- Form study groups
- If you have questions, please don't wait until the night before the exam—ask on piazza or come to office hours

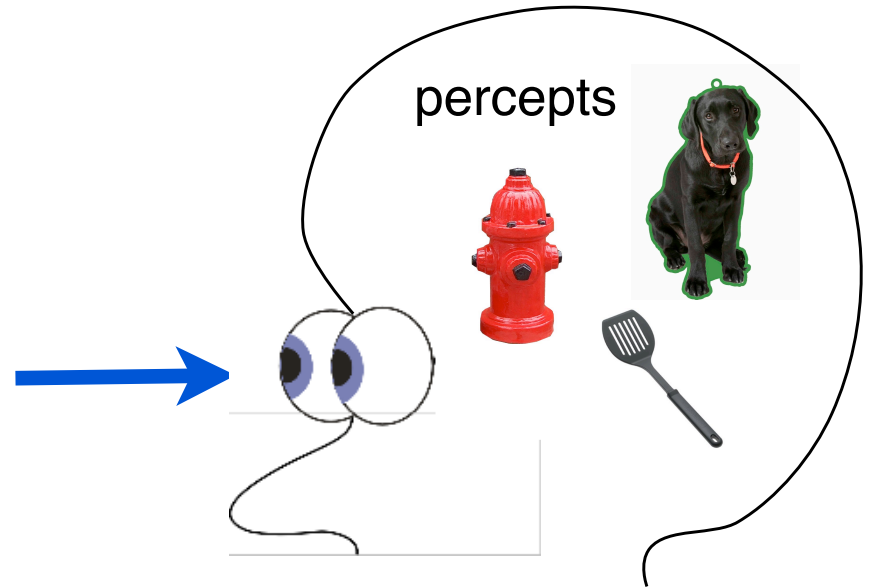
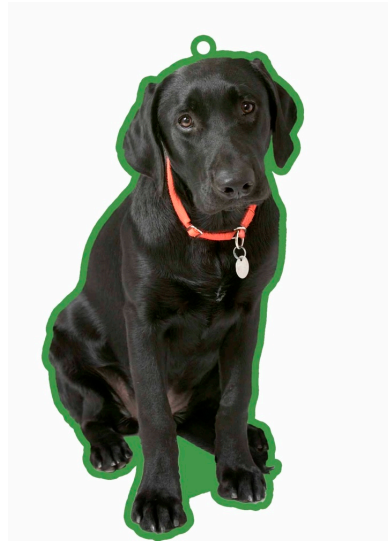
What is Perception?

stuff in the world



What is Perception?

stuff in the world



process for:

- extracting information via the senses
- forming *internal representations* of the world

Outline:

1. Philosophy:

- What philosophical perspectives inform our understanding and study of perception?

2. General Examples

- why is naive realism wrong?
- what makes perception worth studying?

3. Principles & Approaches

- modern tools for studying perception

Epistemology = theory of knowledge

- Q: where does knowledge come from?

Answer #1: Psychological Nativism

- the mind produces ideas that are not derived from external sources

Epistemology = theory of knowledge

- Q: where does knowledge come from?

Answer #1: Psychological Nativism

- the mind produces ideas that are not derived from external sources

Answer #2: Empiricism

- All knowledge comes from the senses

Proponents: **Hobbes, Locke, Hume**

- newborn is a “blank slate” (“tabula rasa”)

Epistemology = theory of knowledge

- Q: where does knowledge come from?

Answer #1: Psychological Nativism

vs.

Answer #2: Empiricism

- resembles “nature” vs. “nurture” debate
- extreme positions at both ends are a bit absurd

Metaphysics

Metaphysics = theory of reality

- Q: what kind of stuff is there in the world?

Answer #1: Dualism

- there are two kinds of stuff
- usually: “mind” and “matter”

Answer #2: Monism

- there is only one kind of stuff

“materialism”
(physical stuff)

“idealism”
(mental stuff)

“Meditations On First Philosophy”, 1641

- undertook a program of “radical skepticism”: decided to discard any idea that can be doubted
- senses can be fooled
- all sense data could be caused by an “evil demon”
- concluded that the only thing he *could* be certain of was that he existed. (“cogito ergo sum” = “I think, therefore I am”)



- Descartes: “Dualism” - there are two kinds of stuff
- mental stuff (non-spatial, non-physical)
 - physical stuff (possesses no mental properties)

Problem: how can the physical and mental stuff interact?

Modern versions of dualism

“homunculus” - little man

The person who sits inside our head and is responsible for “perceiving” what we see.



www.jollyon.co.uk

Prevalent conception, even in neuroscience today.

Alternative theory: “Monism” - only one kind of stuff

Specifically: “**Materialism**” - physical matter and energy is all that exists

- challenge is to come up with a story that explains how physical stuff can have “mental” properties (consciousness, awareness, etc)

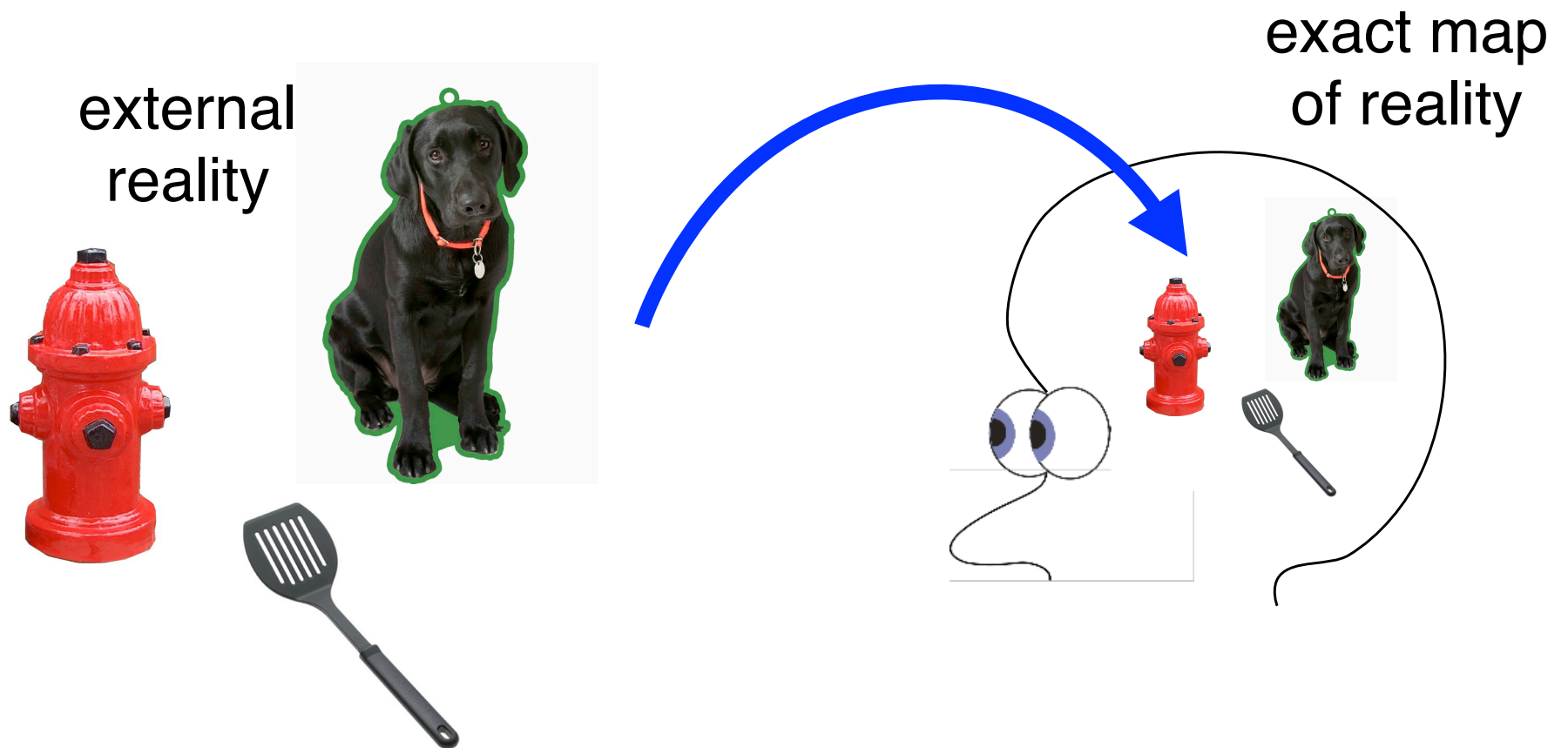
Philosophy of Mind

Q: what is the relationship between “things in the world” and “representations in our heads”?



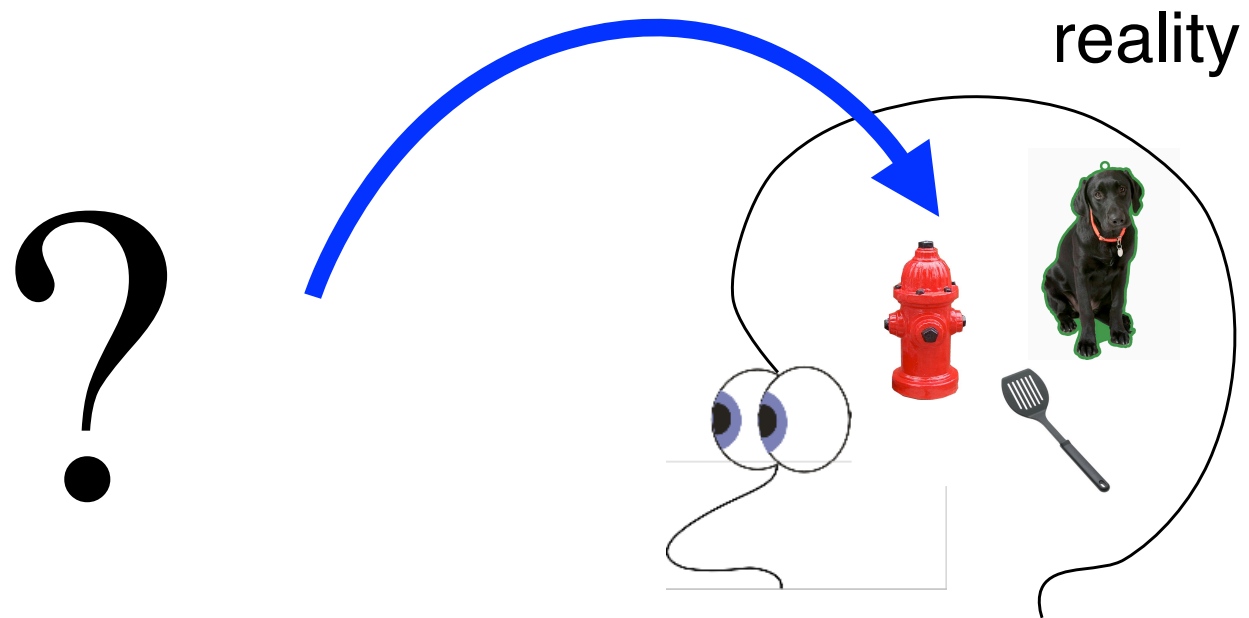
1. Naive Realism (or “common sense realism”)

- We perceive the world “as it is”
- Our minds have direct access to reality



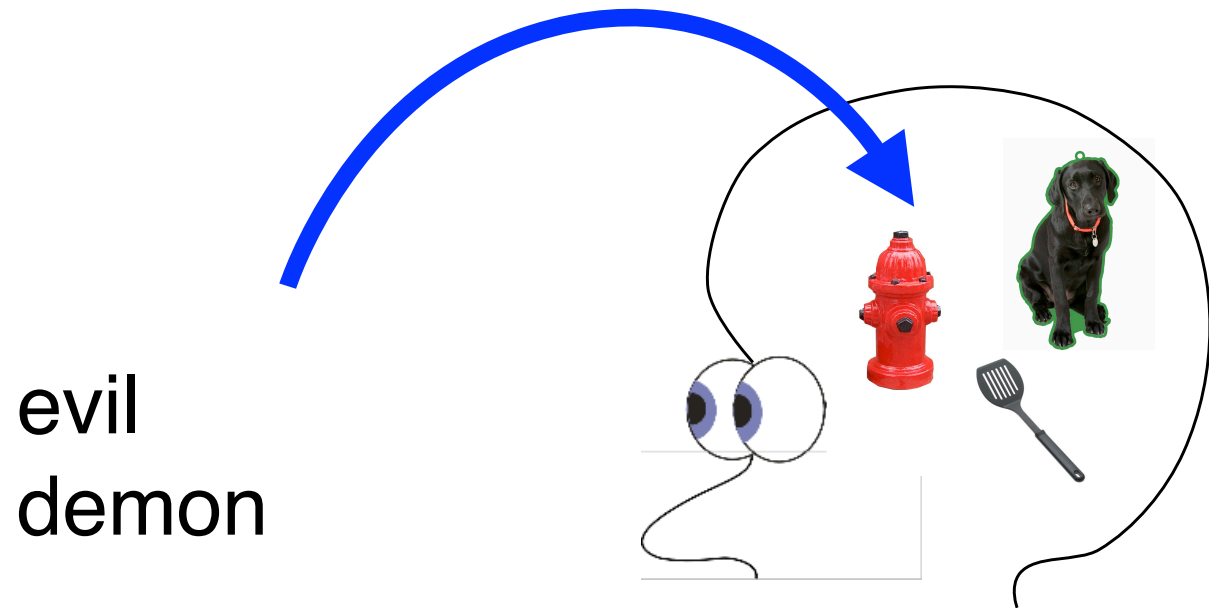
2. Idealism

- The only reality is that of mind / ideas
- There is no evidence for / reason to believe in an external world



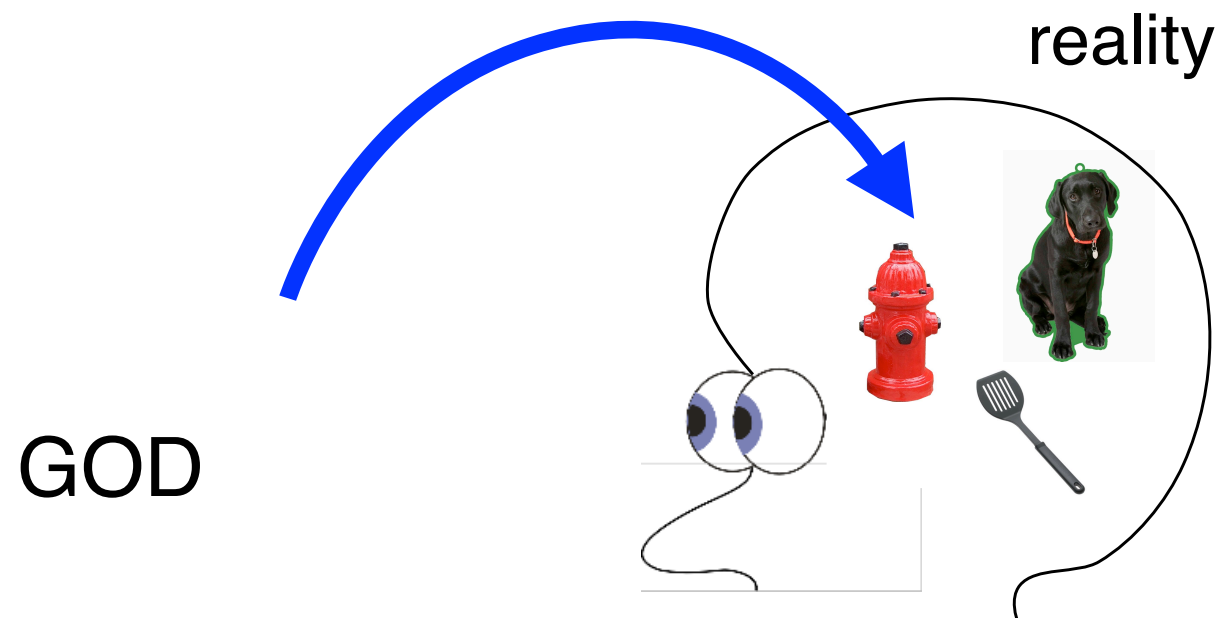
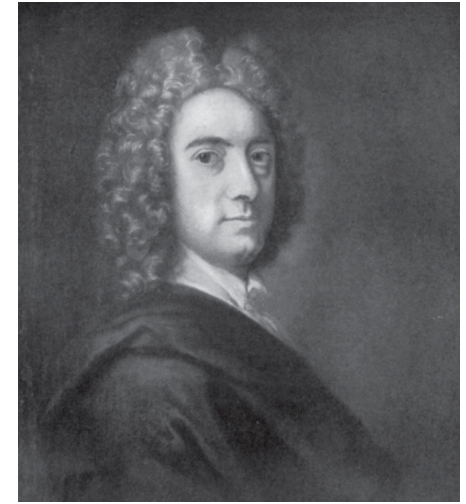
2. Idealism

Descartes' supposition:



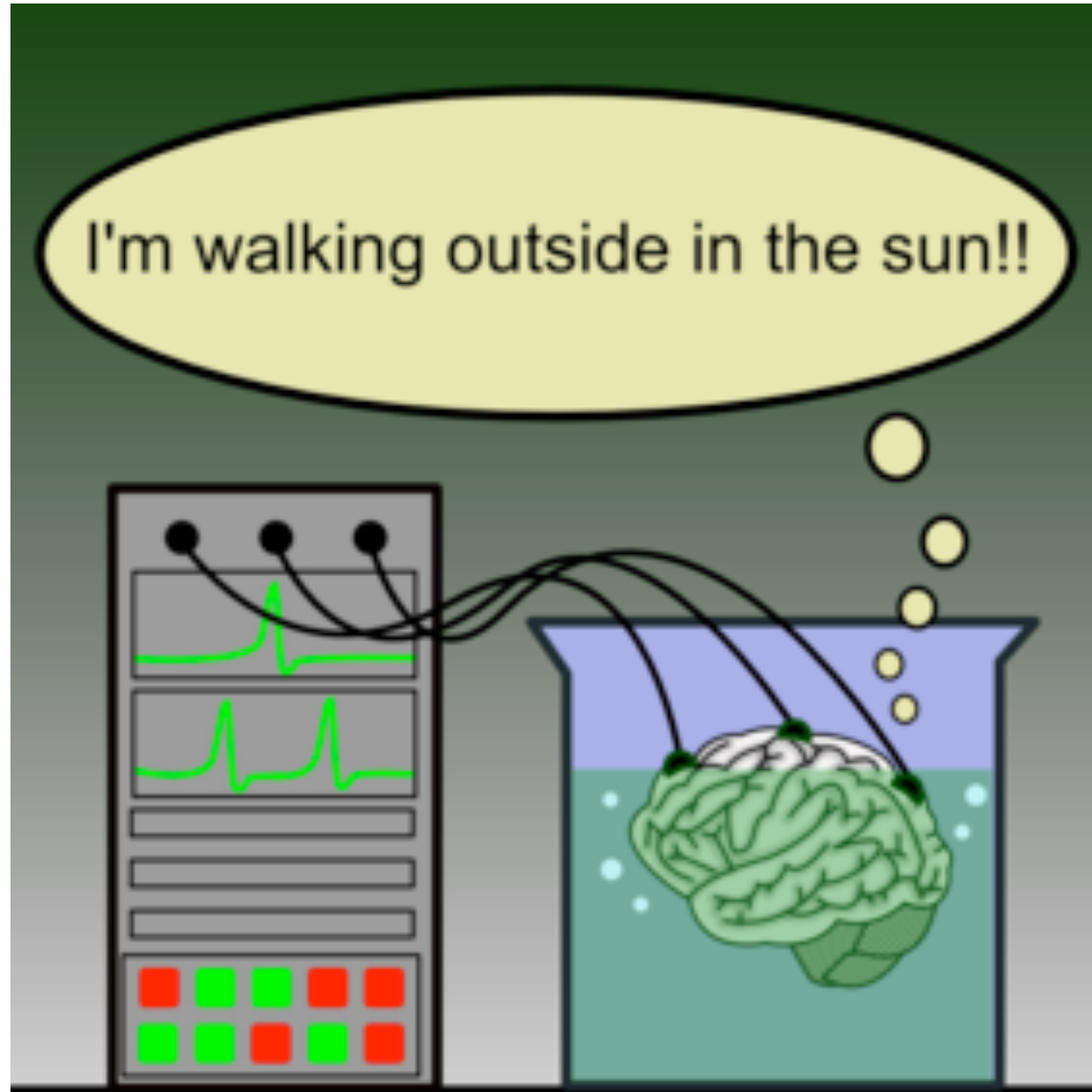
2. Idealism

Bishop Berkeley (1685–1753)
- idealist, empiricist



Modern variants:

- Brain in a vat



Brain in a vat paradox

“What is real? How do you define real? If you’re talking about what you can feel, what you can smell, what you can taste and see, then real is simply electrical signals interpreted by your brain. This is the world that you know.”

—Morpheus in *The Matrix*,
1999

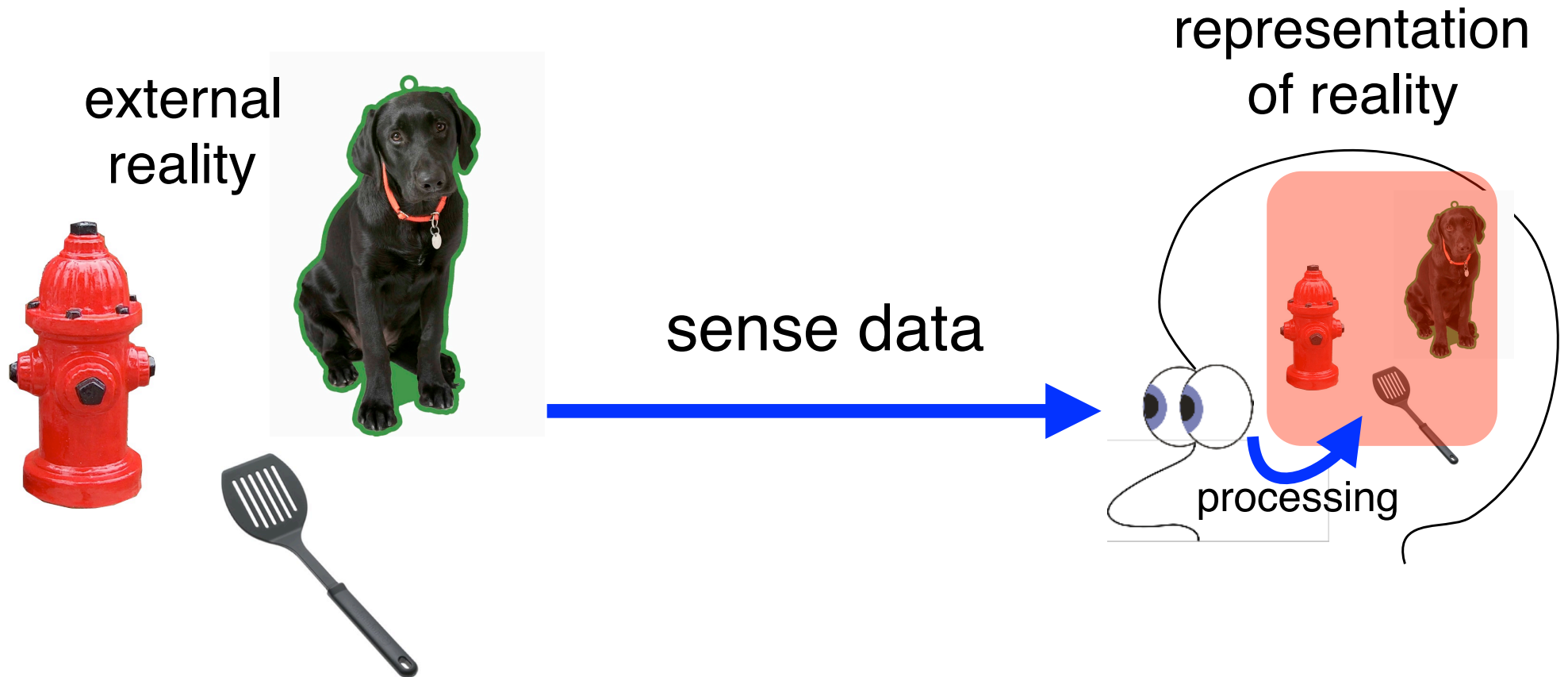
(movie clip)

<http://www.youtube.com/watch?v=WnEYHQ9dscY>



3. Representative Realism

- We perceive the external world indirectly & imperfectly, via intermediate “sense data”



Note: idealism is not testable or disprovable!

- science can't "prove" that the external world exists
- or that we have any kind of access to it

We need some pragmatic assumptions to get started:

- there is an external world
- we have (indirect) access to it via our senses

Philosophical position of this course:

- Empiricism - knowledge from senses (obviously!)
- Materialism - only one kind of stuff (matter/energy)
- Representative Realism - indirect knowledge of world, via the senses
- Functionalism - understanding the “function” of the sensory systems is all that we need to know to “understand” them.

In this course, “understanding” perception means:

1. We can write down an algorithm for how a perceptual task is performed

(i.e., we could design a computer / AI to perform the same task)

2. Knowing where and how the algorithm is implemented in the nervous system.