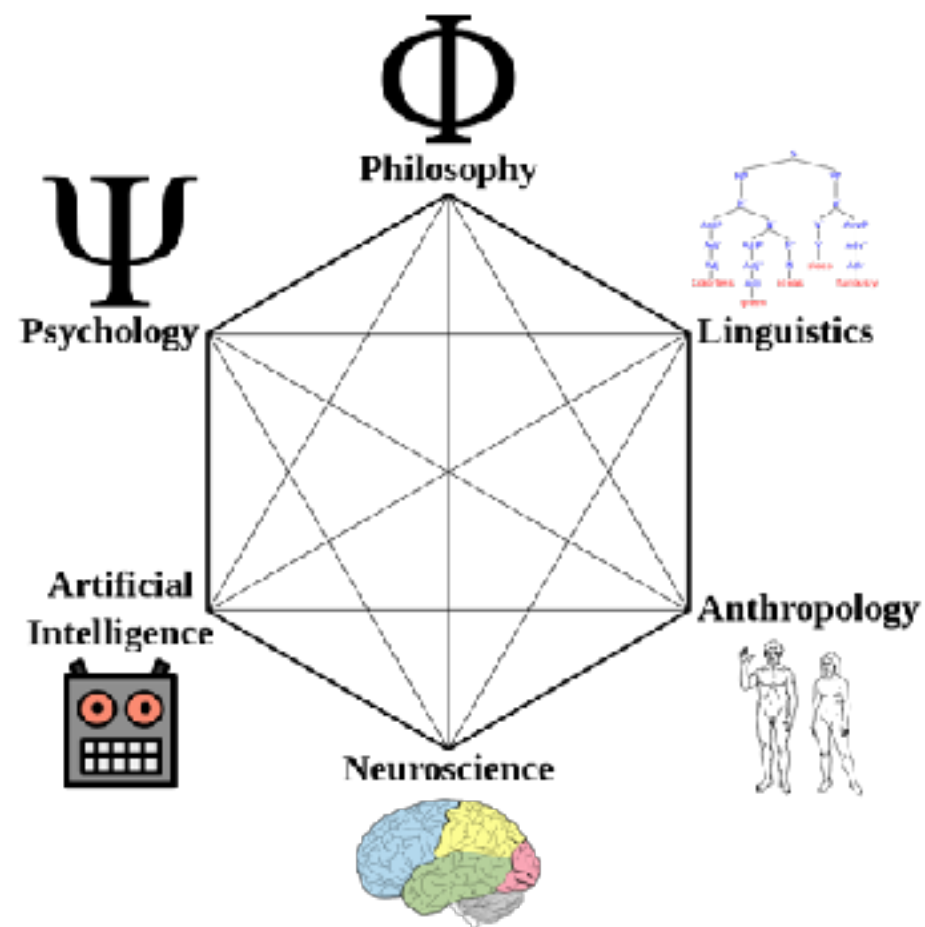
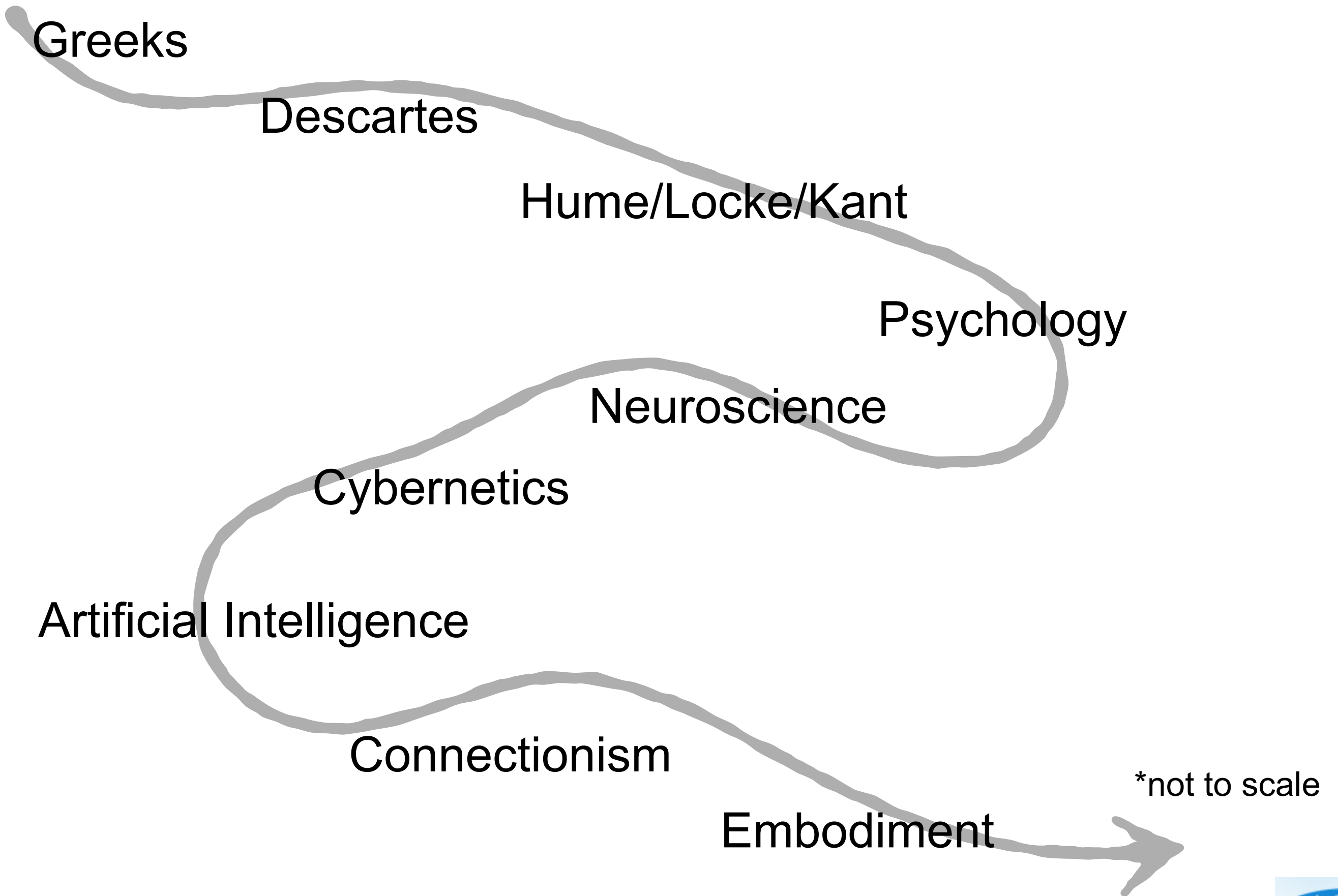
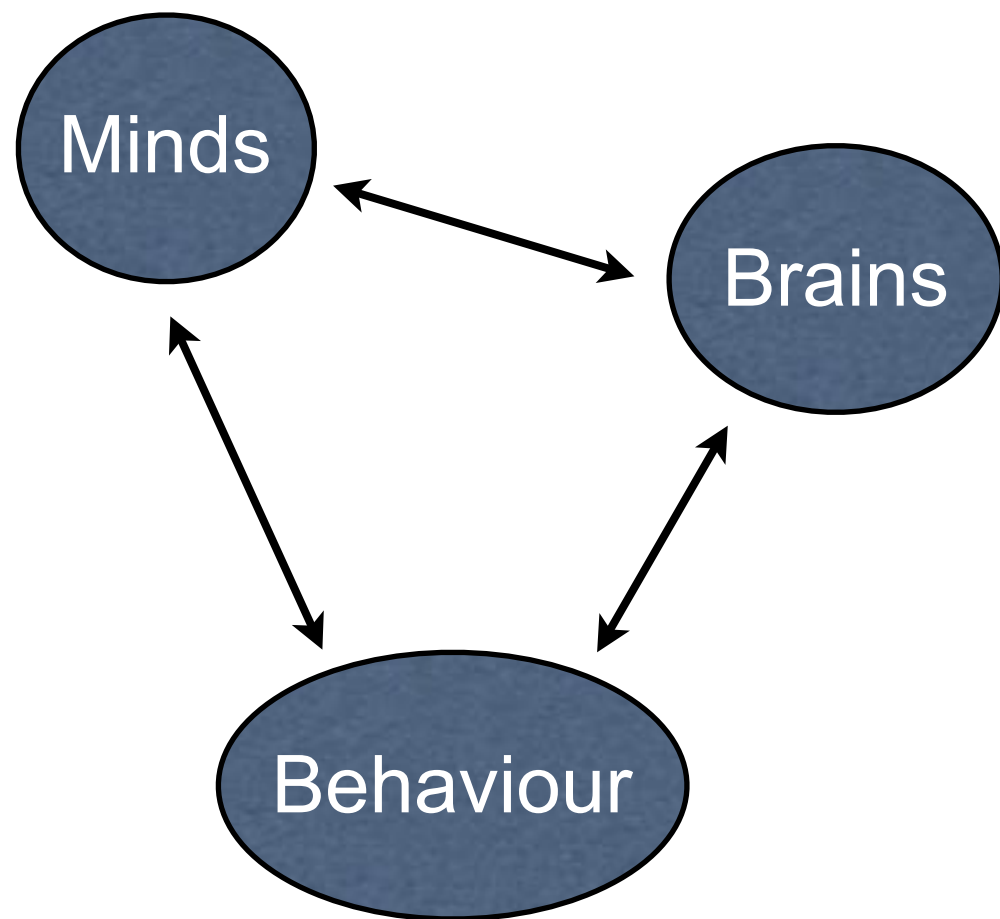


History of Cognitive Science







Spirit
Consciousness
Intellect
Soul
Psyche
Anima
Atman
Dasein
Experience

cognition

. . . is about *knowing*

. . . hence about the **relationship** between the *knower* and the *known*

“Subject” $\leftrightarrow$ “World”

Practical epistemology?

Some recurring themes

Dynamist ~ Eternalist

Process ~ State

Rationalist ~ Empiricist

Representationalist ~ Anti-representationalist

Individualist ~ Collective/Social

Monist ~ Dualist (~ Pluralist/Pragmatic)

This is the landscape. These are not questions with answers



The pre-Socratics



Heraclitus



Parmenides

What does it mean to say that something exists? How is this related to time and the present? What is it to persist in time? What is the relation between the world as it appears to us, and as it is?

The pre-Socratics



Heraclitus

All is change/dynamism
You never step in the same
river twice
Non-determinism

Parmenides



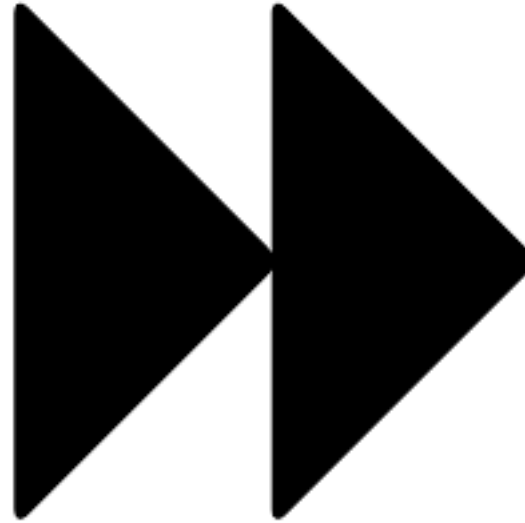
Eternalism
State-based description
Determinism

The surviving works of Heraclitus and Parmenides are mere fragments of poems. We know little of their actual philosophy.

For us, they will serve as landmarks, to distinguish fundamentally different ways of coming at things.

Heraclitus: the indubitable reality of the lived now

Parmenides: that which indubitably exists



We skip about 2,000 years.

*Ancient
Greece*

*Modern
Science*



René Descartes (1596-1650)

Strongly *rationalist*

The further the mind is taken away from its proper objects – **logic and pure reason** – the more likely it is to fall into error.



The purpose of philosophy is to direct the mind away from the confusing images of the senses towards the indubitable truths contained within the mind itself.

A sceptical philosopher, wishing to establish a foundation for true and certain knowledge, recognises that the world of appearances, mediated by the senses may be illusory. He considers what remains after denying the testimony of the senses, and reasons thus:

“So after considering everything very thoroughly, I must finally conclude that this proposition, *I am, I exist*, is necessarily true whenever it is put forward by me or conceived in my mind.” (Meditation 2, AT 7:25)

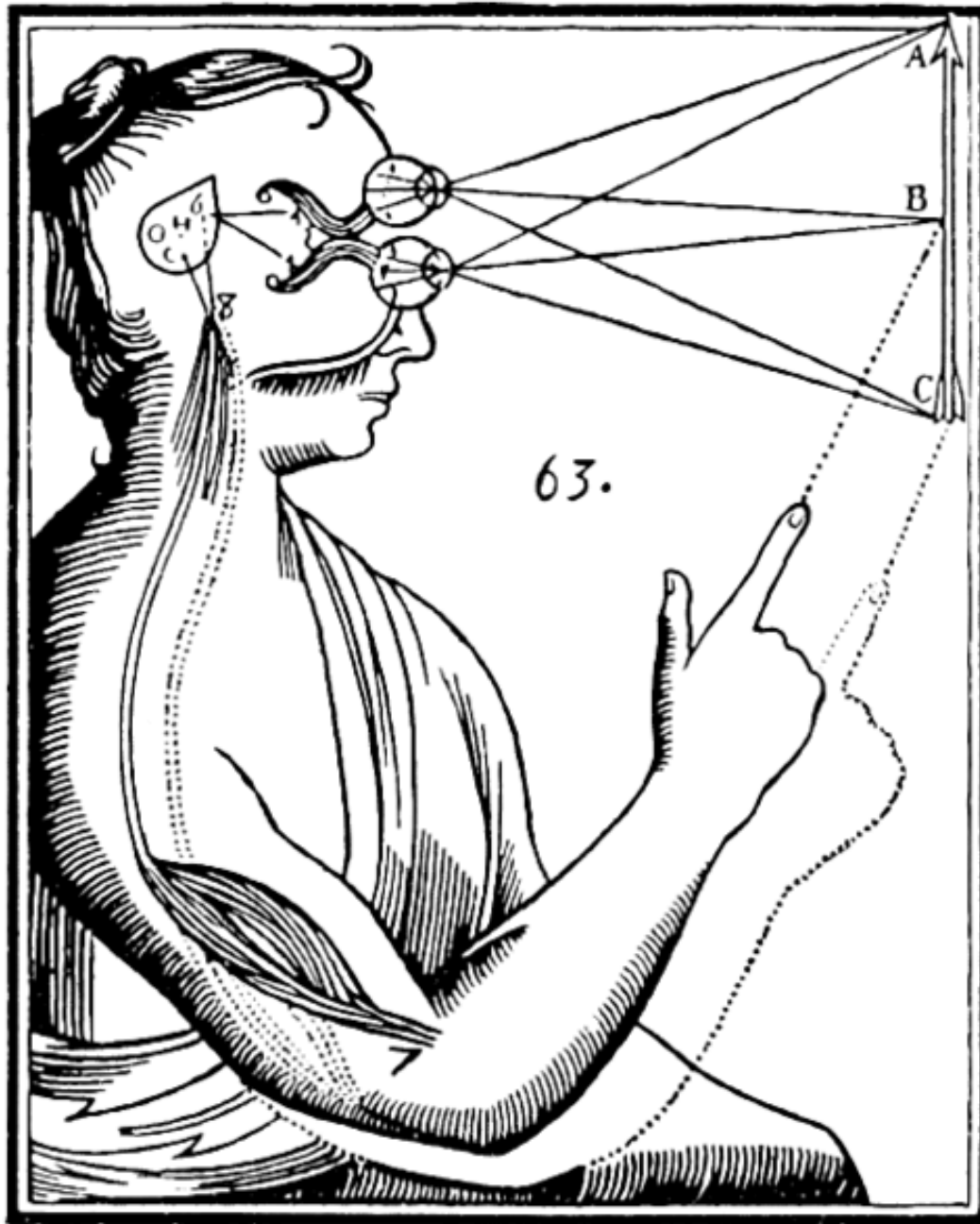
Descartes gave us the ***cogito***: the domain of mind considered as if it were independent of everything else (and hidden, private, unobservable)

Soul

Cogito

Mind

These terms are contested. No surprise there. But remind yourself that the body is also a highly contested domain.



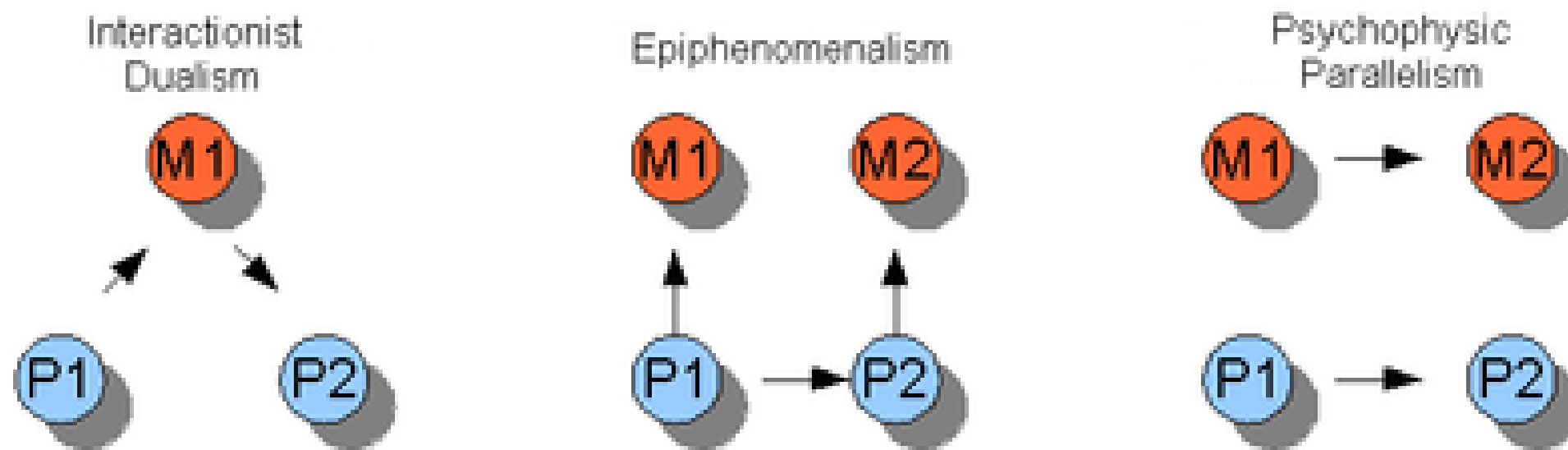
The **mental** (*res cogitans*) and the **physical** (*res extensa*) are seen as different kinds of things.

How they interact is one big problem for ***substance dualism***. Descartes suggested the pineal gland. That satisfied nobody.

Shades of Substance Dualism

Descartes couldn't make substance dualism work. Nor, it seems can anyone else, but not for lack of trying . . .

- Interactionism
- Epiphenomenalism
- Psychophysis Parallelism

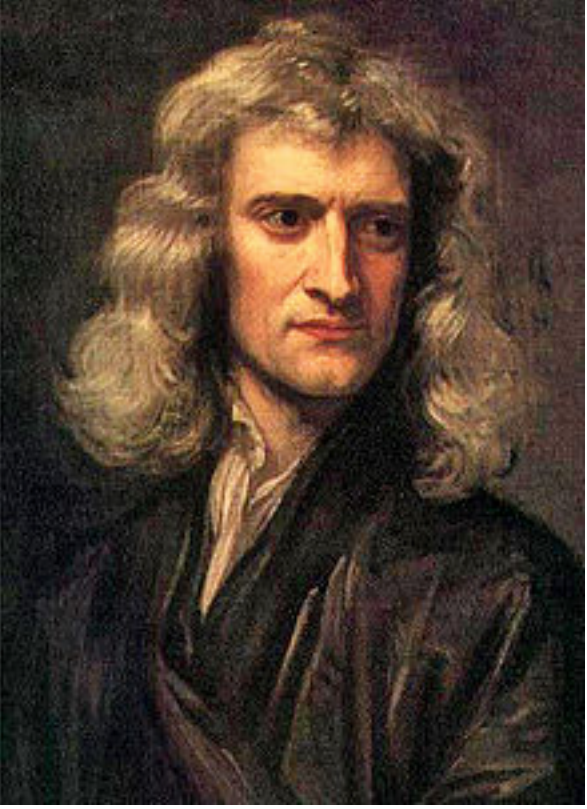


Source: wikipedia



The body, for Descartes, was an *automaton*, subject to the laws of mechanics (pre-Newton)

All animals were likewise 100% mechanical. Note the strong theological commitment: Humans are fundamentally different from animals. Descartes was not a secular philosopher



Isaac Newton (1642 - 1727) provided a superior account of mechanics, with his three laws of motion.

His view of Natural Law became a foundation stone of the Enlightenment

To this day, many scientists appeal to the notion of a *mechanism* as the archetype of scientific understanding.

But mechanics has its limitations.

Mechanics is the best physics for accounting for the motion of inanimate rigid matter at spatial and timescales appropriate to the human body.

It doesn't account for animate motion (all living things),
It treats space and time as simple coordinate dimensions,
Caution ought to be applied when appealing to mechanics
or mechanical explanation



Descartes' *cogito* places the mind outside of things.

It can lead to the bizarre notion of *solipsism*

Solipsism is the belief that you are the only person with a mind, as you have direct knowledge of your mind and only indirect circumstantial evidence of anyone else's

Solipsism is not a position anyone wants to defend.

Placing the experiencing agentive mind outside nature leads to a view of the world as deanimated, passive, mechanical.

Q: What do people mean when they say something is *physical*?

Q: What role should mechanics play in any account of behaviour?

Q: What is mechanics incapable of dealing with? What are its limitations?

Mind/Brain and Mental/Physical is
not a simple distinction

Not all languages distinguish two classes here.

When discussing “reality”, or attempting to be
scientific, it is wise to remember that much of
the language one uses is determined, not by
facts, but by the culture around one.

If you think about it, are you clear what you mean by “mental” or “physical”?

When Doubting Thomas put his fingers in the wounds, what kind of proof was he looking for?

Many everyday uses of the term “physical” seem to mean something more like “experiential”





brigette @lillbizzle

4m

it's **physically** impossible for me to pay attention during class

Expand

← Reply ↻ Retweet ★ Favorite ... More

Discuss the many meanings of the word “physical” here.



Inside Higher Ed @insidehighered

2h

Physically attractive high school students are more likely to complete college: insidehighered.com/news/2013/12/1...

Expand

← Reply ↻ Retweet ★ Favorite ... More



Imran Sheik @imranbsheik

6h

Have you ever missed someone so much you feel **physically** sick?

Expand

← Reply ↻ Retweet ★ Favorite ... More



♡ **bambi** ♡ @bbambz

6h

i **physically** cannot sleep with pants on

Expand

← Reply ↻ Retweet ★ Favorite ... More



Julia @JuJuJukebox

10h

I AM **PHYSICALLY** HURTING OMG"@KaylaDz: LOOK AT BRUNO 
pic.twitter.com/iDHoYZApAL

 Hide photo

← Reply ↻ Retweet ★ Favorite ... More



jenna coleman @Imp0ssible_Girl

21h

10/10 agree that it is **physically** impossible to say "No" to this face.
pic.twitter.com/h6OD2Jx2gl

 Expand

← Reply ↻ Retweet ★ Favorite ... More

British Empiricists



John Locke



Bishop Berkeley



David Hume

Contra Descartes, all knowledge is seen as grounded in the experience of the world mediated by the senses.

Beginning of *embodied* cognitive science?
The questions raised have a Heraclitian flavour.

Example: Molyneux's Question, posed to Locke:

Suppose a Man born blind, and now adult, and taught by his touch to distinguish between a Cube, and a Sphere of the same metal, and nighly of the same bigness, so as to tell, when he felt one and t'other; which is the Cube, which the Sphere. Suppose then the Cube and Sphere placed on a Table, and the Blind Man to be made to see. Quaere, Whether by his sight, before he touch'd them, he could now distinguish, and tell, which is the Globe, which the Cube.

Amenable to empirical investigation. Rare example of a productive thought experiment.

Rationalism

Innate knowledge

Reason & Deduction

Certainty

a priori

Empiricism

Tabula rasa

Inference & Induction

Tentative knowledge

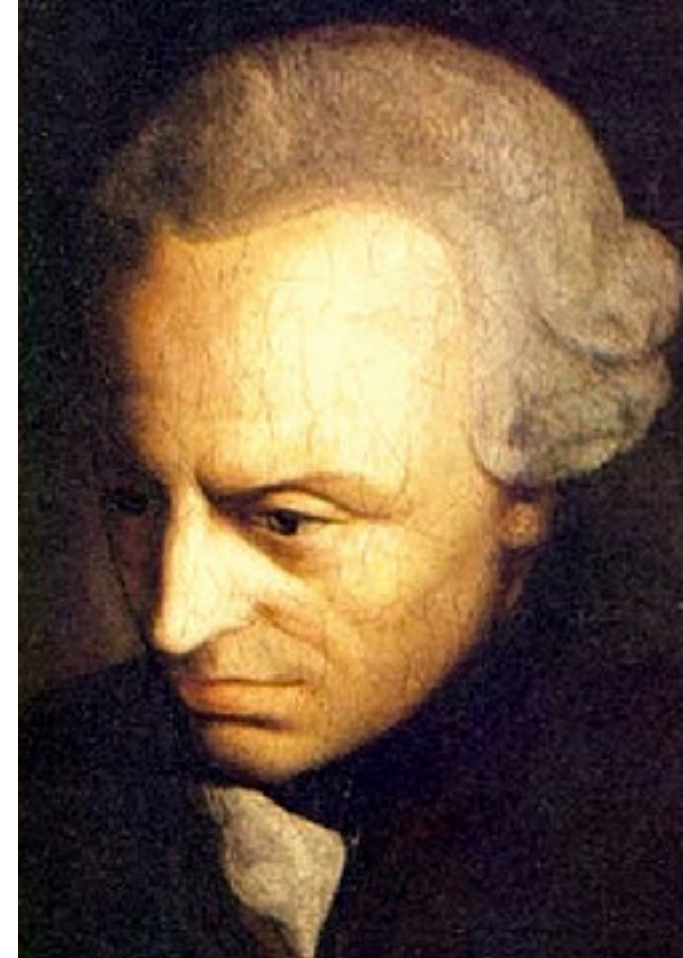
a posteriori

The debate is clouded by a persistent dichotomy between physical and mental, and the problematic nature of the *cogito*

Immanuel Kant

Attempted to synthesise the insights of the rationalist and empirical traditions

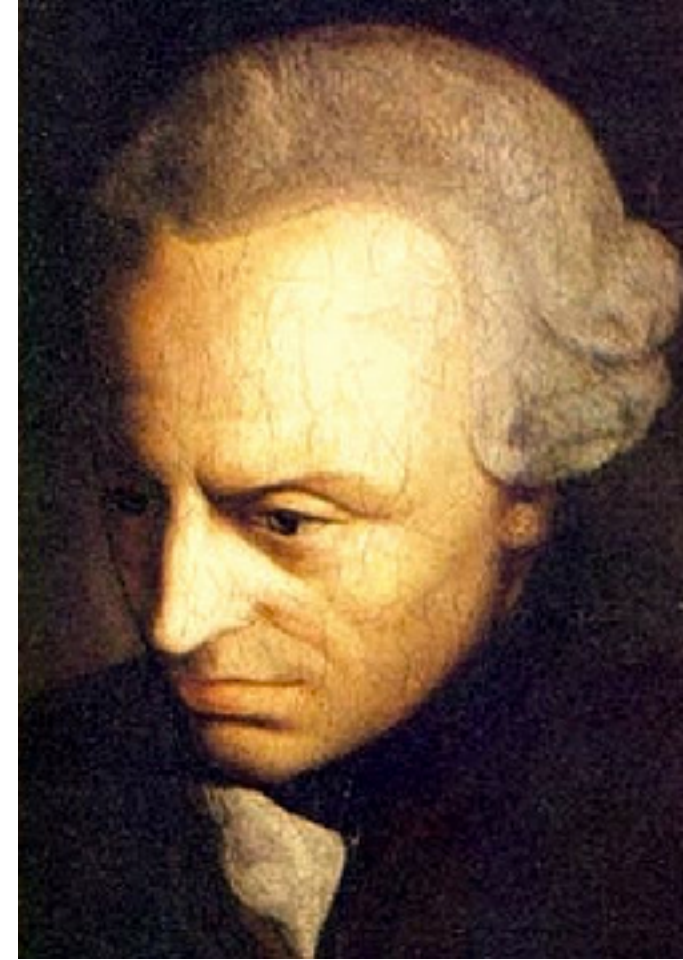
Regarded *space* and *time* as *a priori* of experience. Likewise, *cause and effect* must be assumed to make sense before anything empirical is learned.



Had Newton's physics and concept of Natural Law to work with, but recognised that the apparent agency of the living would not admit of a mechanical description

Recognised that a finite being has finite epistemological limits, and that we meet the world on human terms

To Kant we owe the notion of the *transcendental subject*. Psychology, in particular, seems wedded to this notion, which is a little odd as Kant thought a science of psychology to be impossible.



Kant's legacy is complicated.

To some, he provided the framework for establishing a science of the mental

To others, he set up metaphysical confusion from which we are still liberating ourselves.

Kant's *transcendental subject* can be thought of as

1. Descartes' *cogito*, private and unobservable

wedded to

2. The empiricists' insistence that concepts and the patterns of thought are grounded in sensorimotor experience, here and now.

In this framing of things, the subject's relation to the world is necessarily mediated through representations

After Kant

Representational Approaches

Transcendental
Subject in
contact with a
transcendental world
through the medium
of representations

A single fixed
subject/object divide

Non-representational Approaches

Direct perception

Phenomenological
insights

Various approaches to
subject/object relations

The birth of the science of Psychology

Towards the end of the 19th Century, the scientific method was being applied in very many domains, with enormous success in both understanding and in practical spin offs (technology).

Why not apply it to study of the human condition?

The ground in which psychology was born

17th - 18th C.

Mechanical
Universe



Newton

Transcendental
Subject



Kant

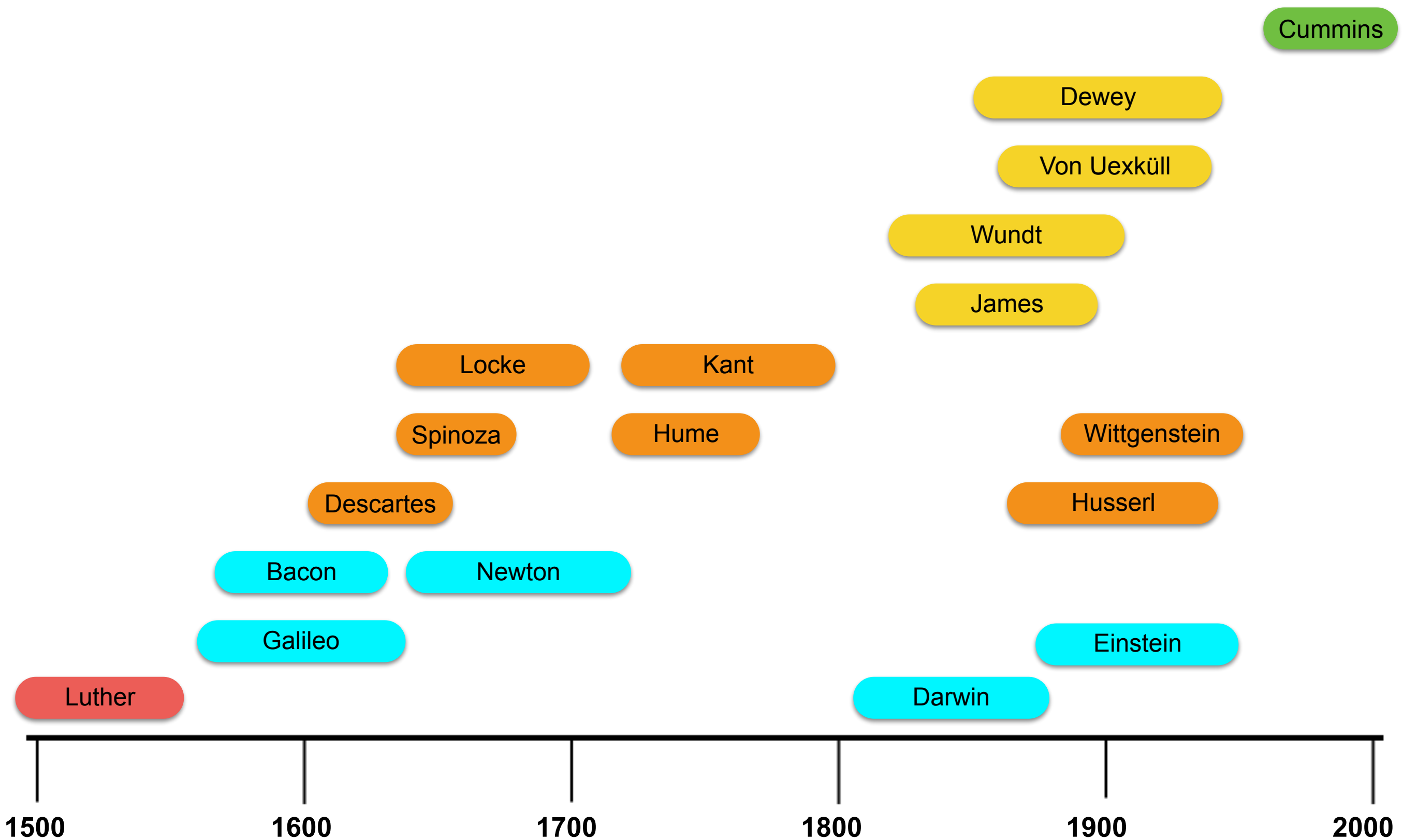
Cogito



Descartes

19th C.

- Kelvin
 - Darwin
 - Maxwell
 - Mendeleev
 - Boltzmann
 - Planck
-
- James
 - Wundt
 - Fechner
 - Dewey



Q: What is Psychology a Science of?

Experience

Behaviour

A few selected dates

1849: Hermann von Helmholtz first measures the speed of neural signal transmission (ca 30 m/sec)

1860: Gustav Fechner publishes *Elemente der Psychophysik*, seeking to quantitatively relate measurable physical quantities to sensations

1879: Wilhelm Wundt establishes the first experimental psychology laboratory in Leipzig, Germany.

1890: William James publishes the *Principles of Psychology*

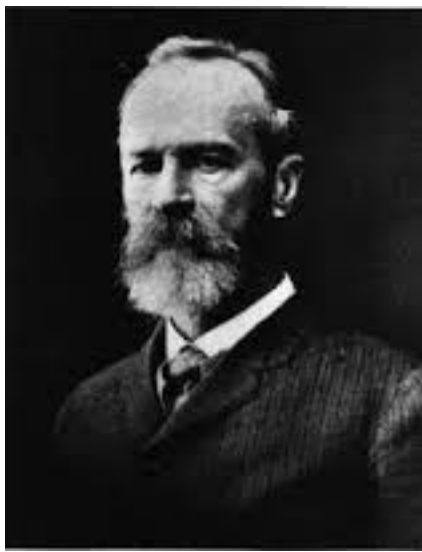


William James (USA, 1842 - 1910)

Brother of Henry James (novelist)

In a famous passage he says "Consciousness ... does not appear to itself chopped up in bits. ... it flows. A 'river' or a 'stream' are the metaphors by which it is most naturally described. In talking of it hereafter, let us call it the stream of thought, of consciousness, or of subjective life." (James, 1890, i, 239). He referred to the stream of consciousness as "... the ultimate fact for psychology." (James 1890, i, p 360).

The “stream of consciousness” idea has been more influential in literature (Joyce, Wolff, etc) than in science, though recent theories of consciousness may refer to it as a starting point.



William James (USA, 1842 - 1910)

Principles of Psychology
Varieties of Religious Experience

Strong interest in subjective experience
Influenced by Buddhist and Hindu philosophy as well as
Western Science

Philosophically a *pragmatist*: rather than arguing for
ever, let's see if a given idea or position can actually
help us. (The start of the tradition of “self-help” in
popular psychology)

Early Approaches

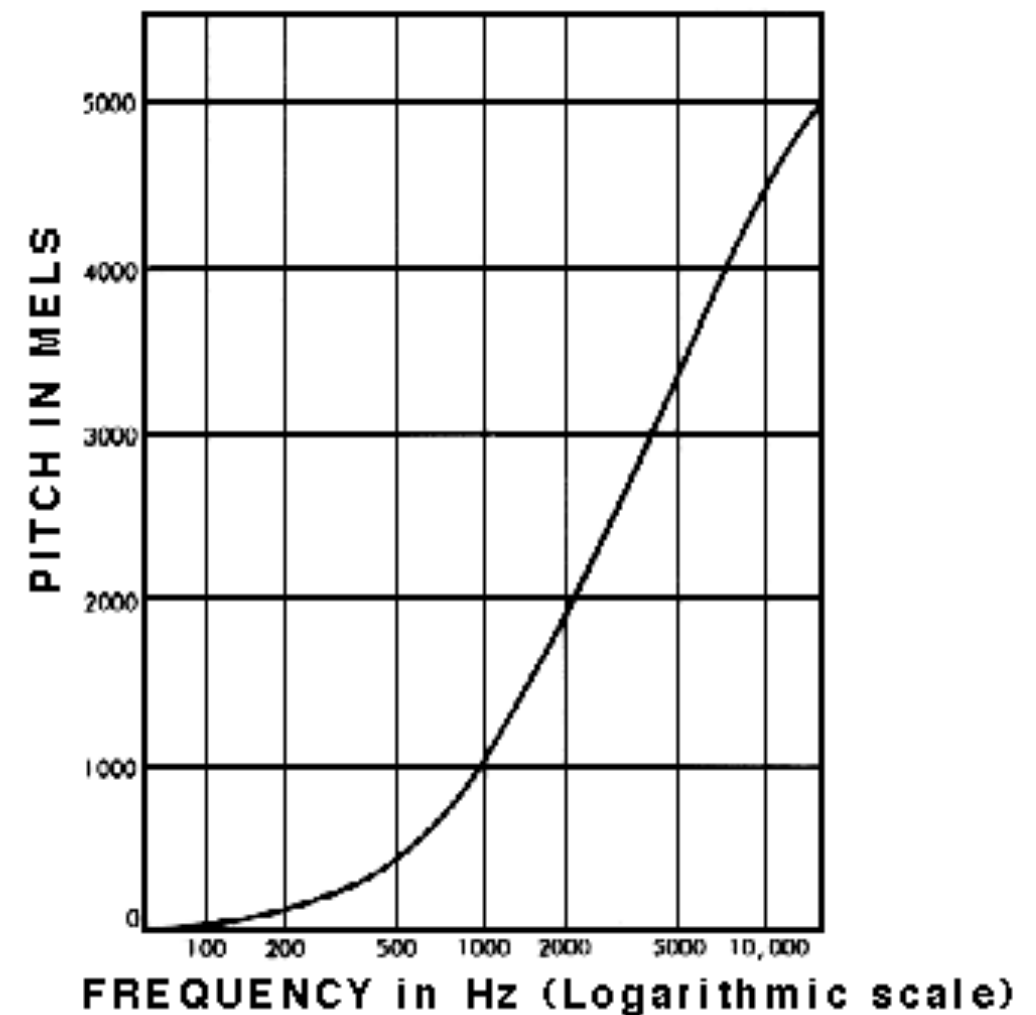
- Analysis (reason)
- **Psychophysics**
- Experiments (e.g. hypnosis)
- Introspection

A little illustration of psychophysics

200 Hz	We know how to measure the physical properties of things like sounds and light. But more work is required to understand how the physical properties relate to our perception. For example, we know that sounds of different frequencies are heard as different pitches, but we need to do experiments to find the relation between measured frequency and perceived pitch
300 Hz	
400 Hz	
800 Hz	
1600 Hz	

We seek to establish the lawful relation between measurable properties such as frequency and perceived properties such as pitch.

How do you find out what someone perceives?



- * ask them!
- * judge if 2 stimuli are identical or not
- * find just noticeable differences
- * adjust two stimuli until they appear to be equal
- * etc.

Measured Physical Property

Frequency

Amplitude

Luminosity

Chemical composition

Pressure

etc

Perceived Property

Pitch

Loudness

Brightness

Scent/Taste

Perceived pressure

So psychophysics introduces us to many of the conundrums of cognitive science.

Are we establishing a mapping between two distinct domains?

What are the background assumptions about the nature of the *subject*?

Introspection

- One method among many
- Attempts to develop protocols that would allow for a degree of rigour
- Massively criticised later
- Still employed by almost everyone



A Fairy Story we tell Undergraduates

Methodological cornucopia including introspection



Behaviorism: no appeal to ghostly mental entities or processes

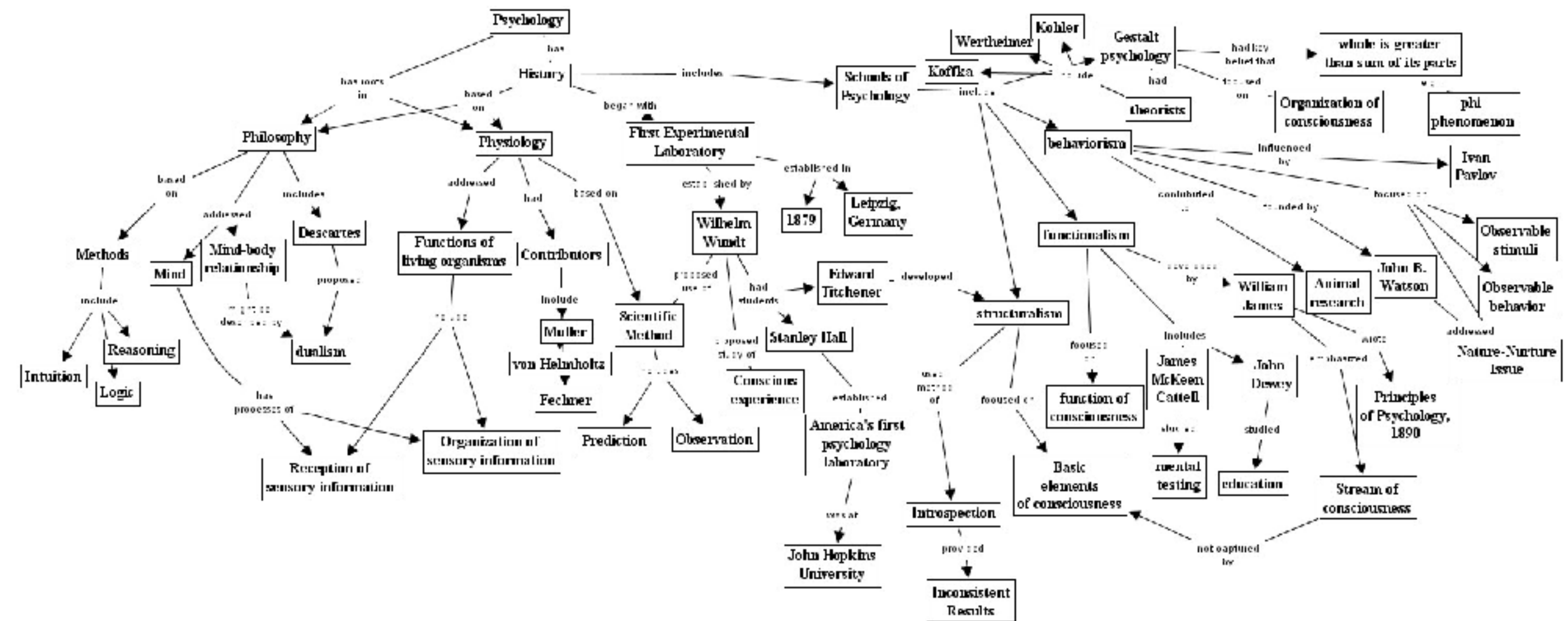


Cognitivism: mind as information processing

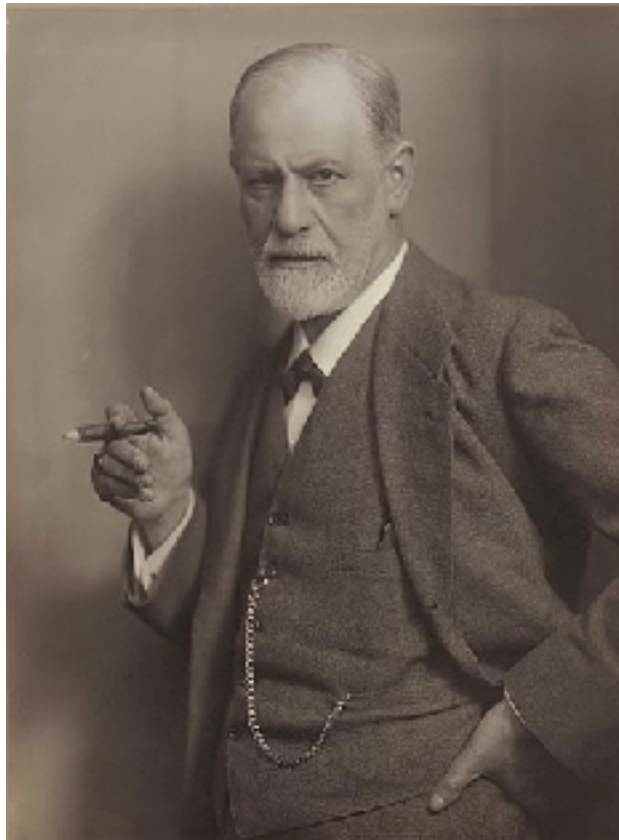


. . . Embodied approaches, etc

It's a lot more complicated than that



Psychoanalysis

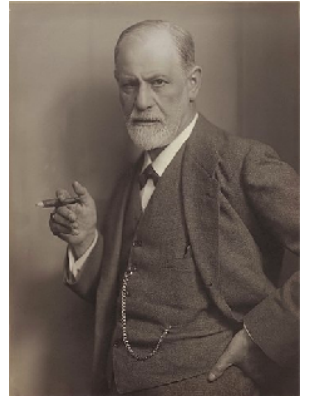


Sigmund Freud
(1856 - 1939)



Carl Jung
(1875 - 1961)

Freud was a pioneer who developed radically new ways of thinking about psychology



He introduced the notion of the *unconscious mind*

He saw behaviour and experience as arising from a dynamic interplay of forces, no one of which is to be equated with the person

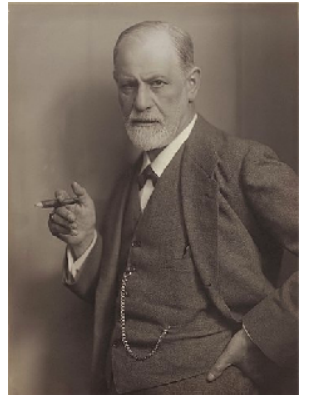
The ***id*** (brute, animal);

The ***super-ego*** (socially informed conscience) and

The ***ego*** (the public self image that tries in vain to keep things in order)

He was notoriously obsessed with sex and its role in personal development

Freud developed *psychoanalysis*, a new form of therapeutic relationship that has since mutated into thousands of variants, most of which depend critically on the personality of the therapist.



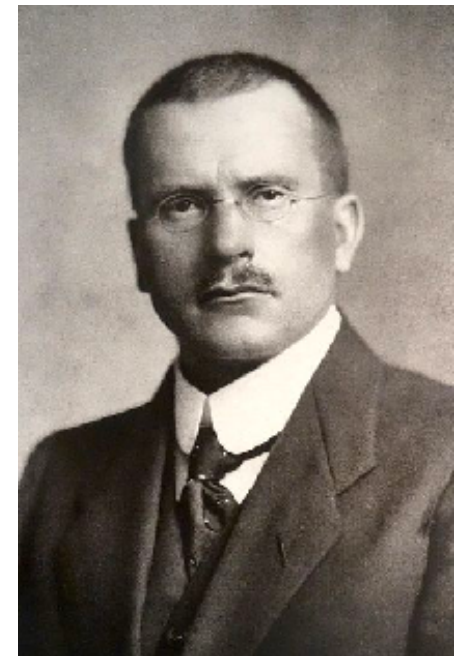
Psychoanalysis never became a respectable scientific process, but it remains popular.

Freud understood his own work as proto-scientific. The territory was so new, that brave imaginative leaps were necessary.

This is also his gift to us: he provided a rich set of concepts and metaphors with which we can think about our selves, our development, our attachments, and our relationships.

Jung worked with Freud for about 7 years

He took psychotherapy in very different directions, and he disagreed with Freud and his obsession with understanding the person in sexual terms



He introduced the notion of the *Collective Unconscious* through which cultural *Archetypes* resonate. His view of our cultural embedding and make up is not consistent with most accounts of individual minds.

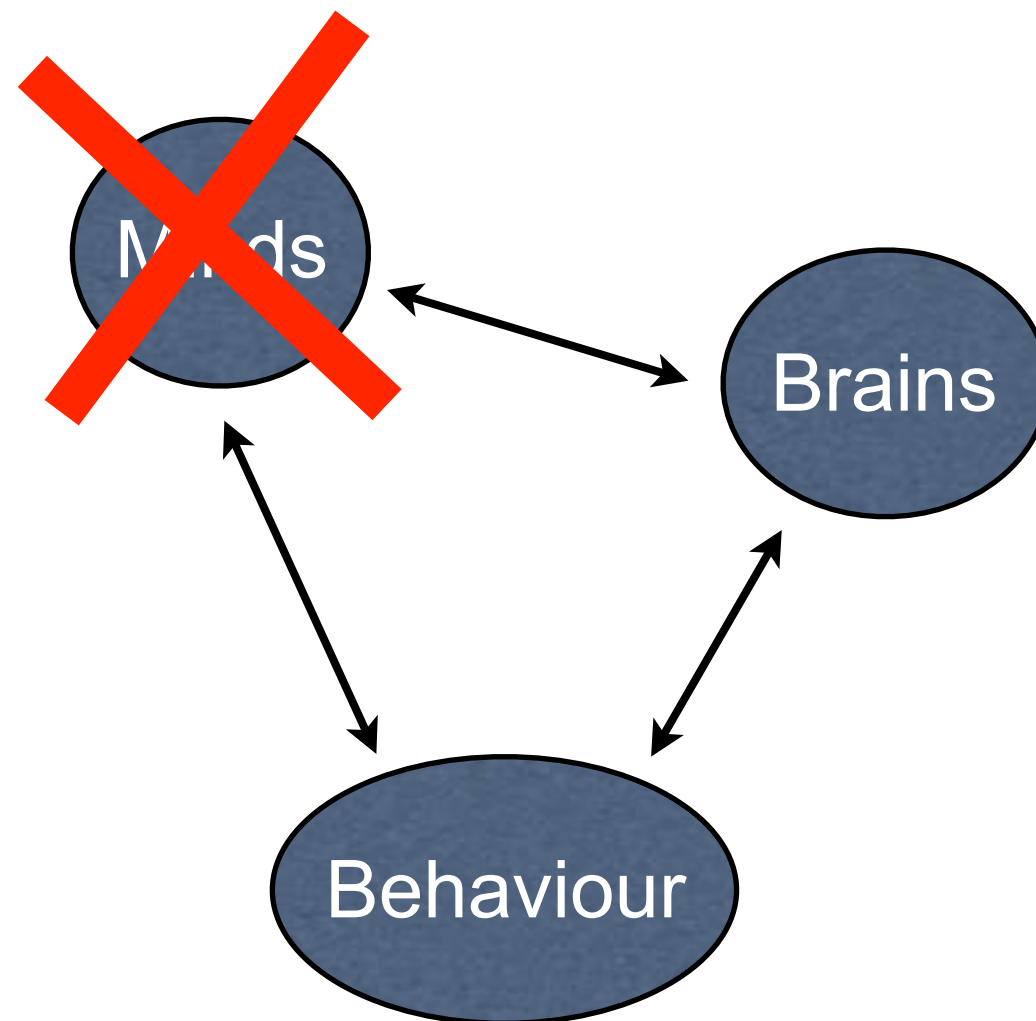
His work is deeply spiritual, mystical, and imaginative.

But it too has not become part of the scientific end of psychology

Behaviorism

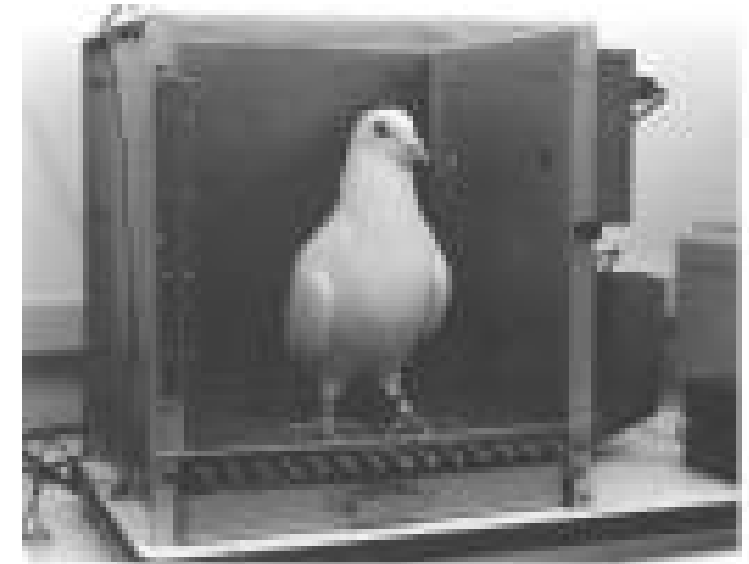
- Outlawed appeal to unobservable mental states
- Attempted to be rigorous and scientific
- Comes in a variety of forms and extremes
- Most famous: B. F. Skinner





- Skinner introduced “**Operant Conditioning**”
- Behaviour is modified as a result of its consequences (reward/punishment)
- You burn yourself: you avoid fire
- Pigeons were kept at 2/3 of their normal weight -> starving
- By providing food at unpredictable times, pigeons preferentially reproduced the behaviour that ‘seemed’ to produce food.



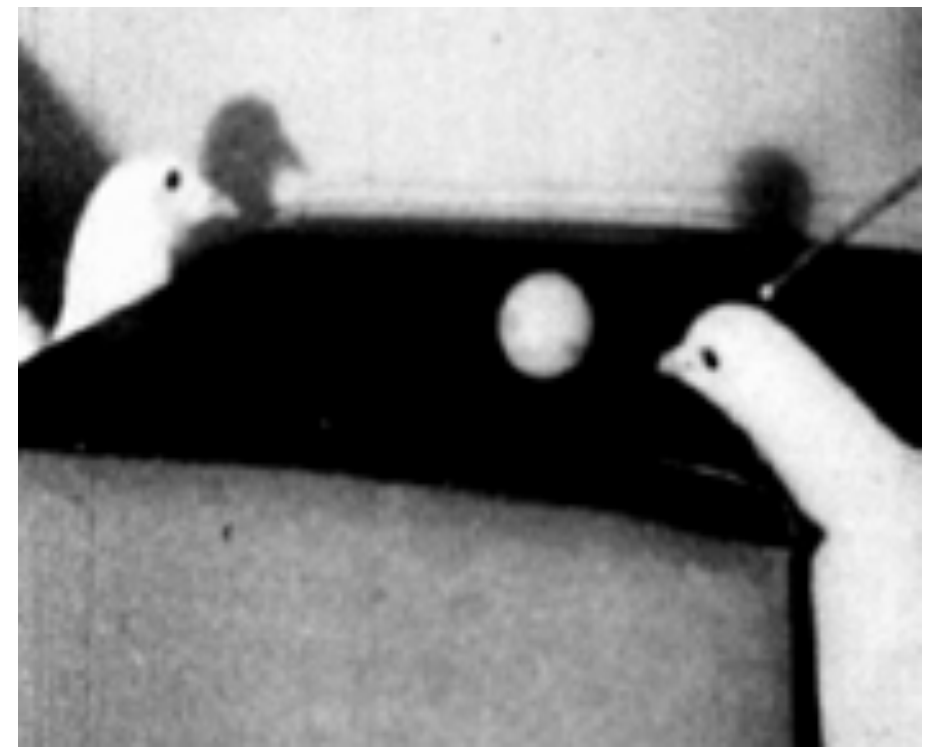


One bird was conditioned to turn counter-clockwise about the cage, making two or three turns between reinforcements. Another repeatedly thrust its head into one of the upper corners of the cage. A third developed a 'tossing' response, as if placing its head beneath an invisible bar and lifting it repeatedly. Two birds developed a pendulum motion of the head and body, in which the head was extended forward and swung from right to left with a sharp movement followed by a somewhat slower return. (see readings...)

Skinner's approach to understanding behaviour emphasized that any behaviour unfolds in a specific context.

This spreads the explanatory load over subject and world.

This insight is worth hanging onto.



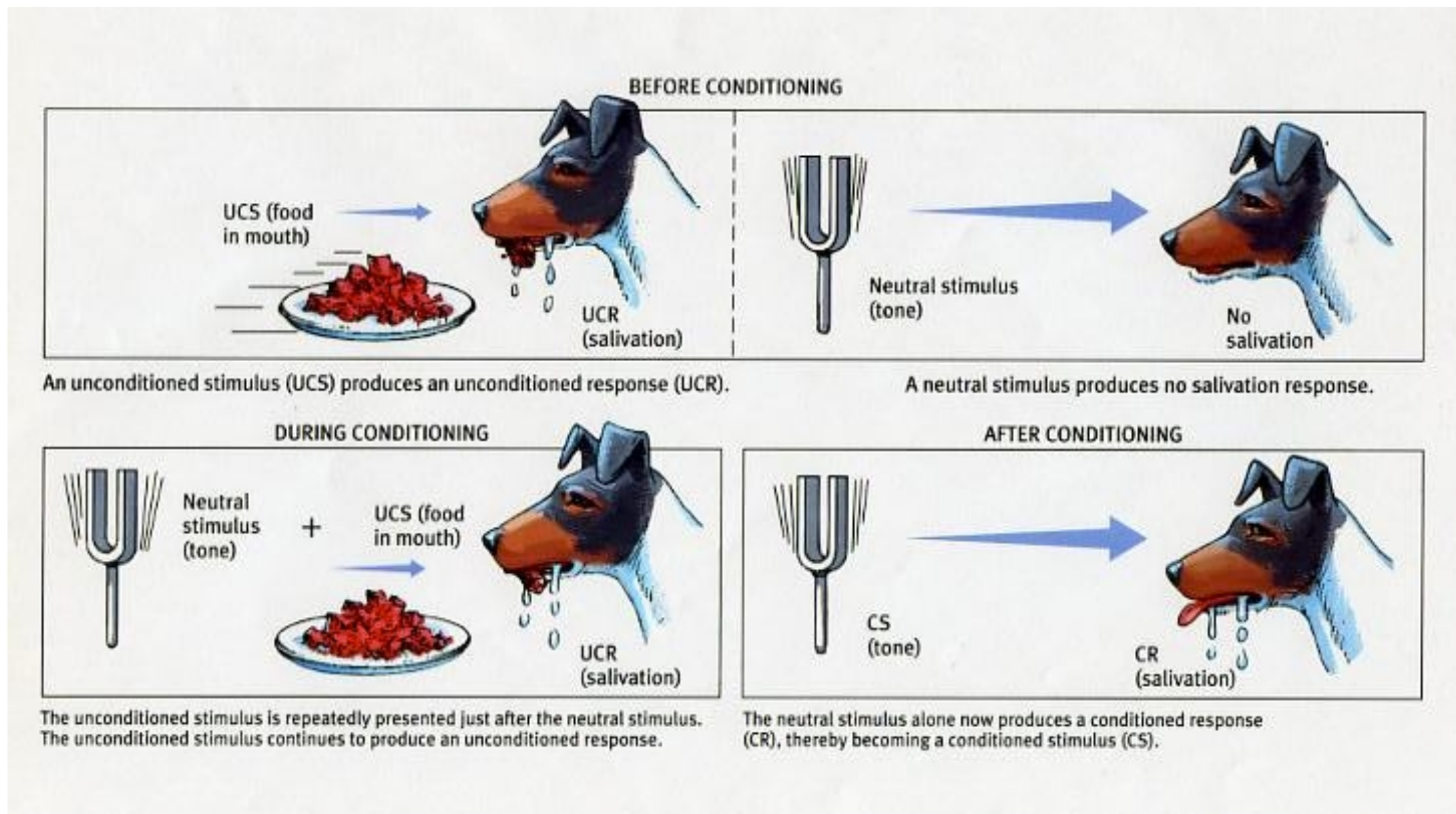
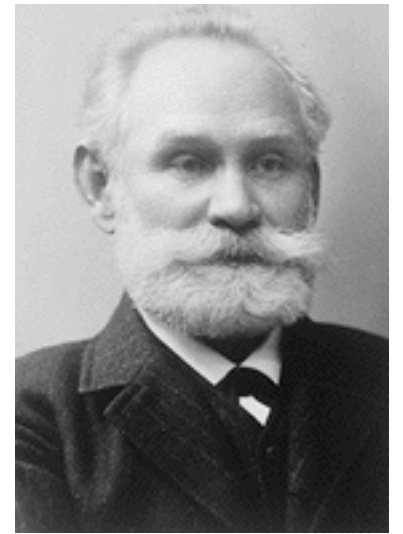
Behavioral shaping is effective in animal training

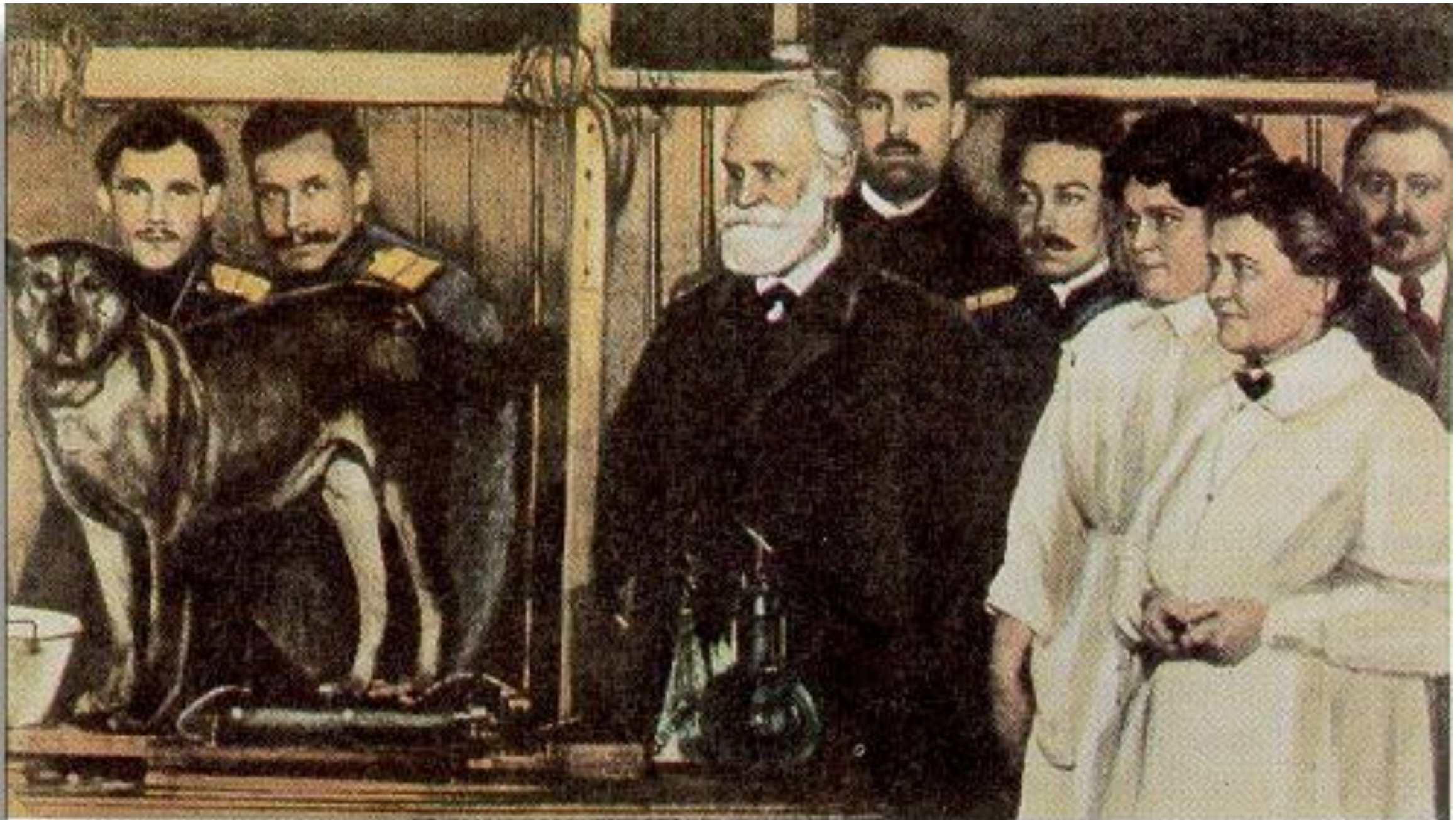
Classical Conditioning

Stimulus.....Response

Involuntary learning

Ivan Pavlov





Pavlov(center) shown demonstrating classical conditioning to students at the Military Academy in Russia. © The Granger Collection



Umberto Maturana

Heinz von Förster

<https://www.youtube.com/watch?v=KM85u4AZpOU>

Consider von Foerster's argument carefully.

How sure can you ever be that a “stimulus” plays the role you think it does?

What does the notion of stimulus & response assume about the endogenous activity of the nervous system?

An Ointment Full of Flies?

- Mechanistic view of the human spirit
- Denied much of the mental richness we all know
- Impoverished theory of learning
- Has nothing to say about *experience*



Not all behaviourists shared one world view.

Skinner was very aware of the importance of the context in which behaviour happened

Watson and Pavlov largely ignored context, hence stuffing responsibility into the head(?) of the subject

The Cognitive Turn

1943: McCulloch's *A logical calculus of the ideas immanent in nervous activity*

1945: Von Neumann architecture introduced

1946 - 1953: Macy Conferences to lay the foundations for a General Science of the Human Mind (Cybernetics)

1948: Claude Shannon "A mathematical theory of communication" Bell Labs

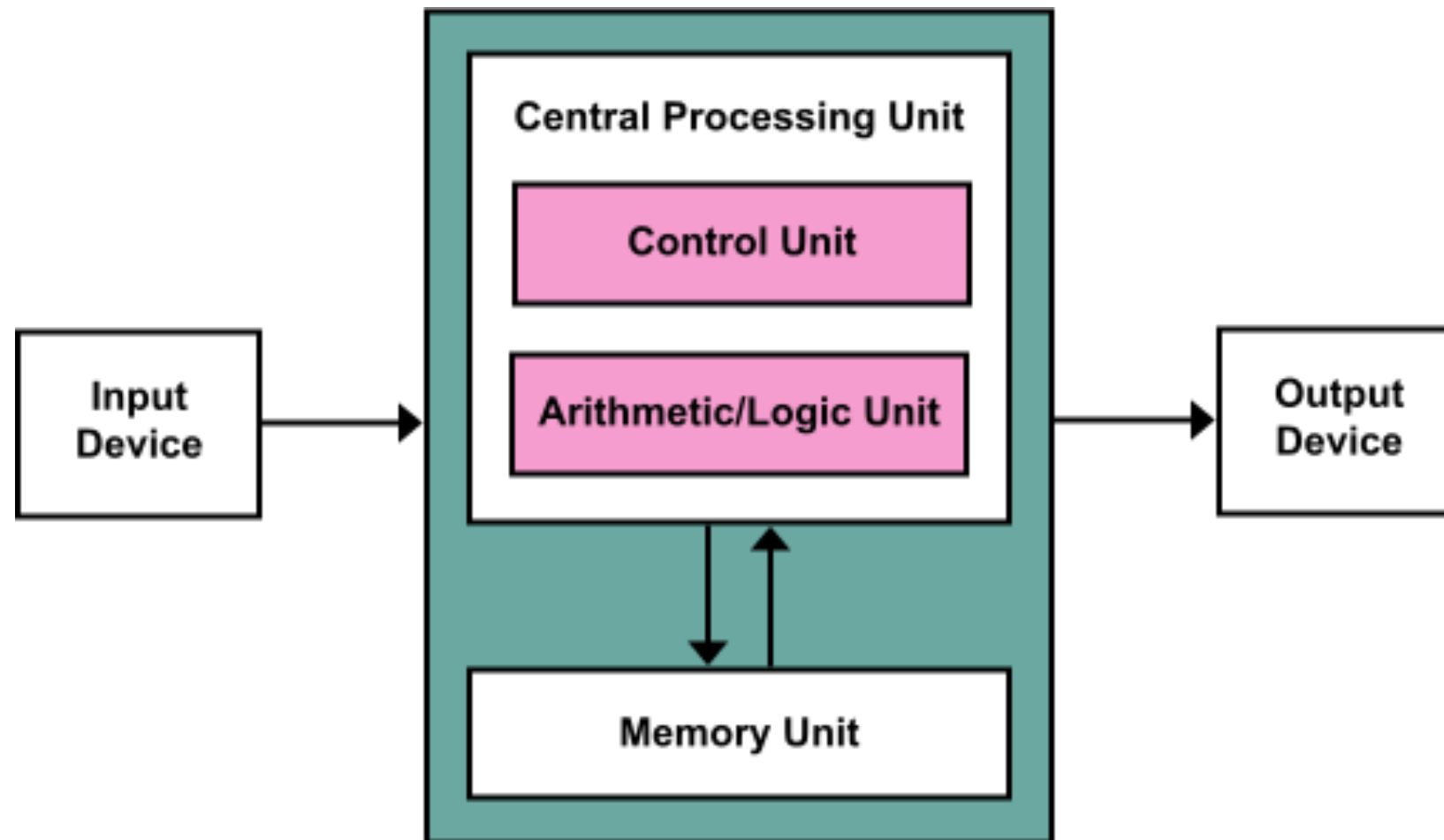
1950: Turing introduces the Turing Test

1959: Chomsky's review of Skinner's *Verbal Behavior*. 1957: *Syntactic Structures*

1967: Neisser's *Cognitive Psychology*

1973: Birth of the term *cognitive science* (Christopher Longuet-Higgins)

1945: Von Neumann architecture introduced



Basic architecture of the modern computer

1946 - 1953: Macy Conferences to lay the foundations for a General Science of the Human Mind (Cybernetics)

Norbert Wiener defined cybernetics in 1948 as "the scientific study of control and communication in the animal and the machine."

"A branch of mathematics dealing with problems of control, recursiveness, and information, focuses on forms and the patterns that connect."—Gregory Bateson



10th
conf.

1953

1st row
(left to right)

T.C. Schneirla, Y. Bar-Hillel, Margaret Mead, Warren S. McCulloch, Jan Droogleever-Fortuyn, Yuen Ren Chao, W. Grey-Walter, Vahe E. Amassian.

2nd row
(left to right)

Leonard J. Savage, Janet Freed Lynch, Gerhardt von Bonin, Lawrence S. Kubie, Lawrence K. Frank, Henry Quastler, Donald G. Marquis, Heinrich Kluver, F.S.C. Northrop.

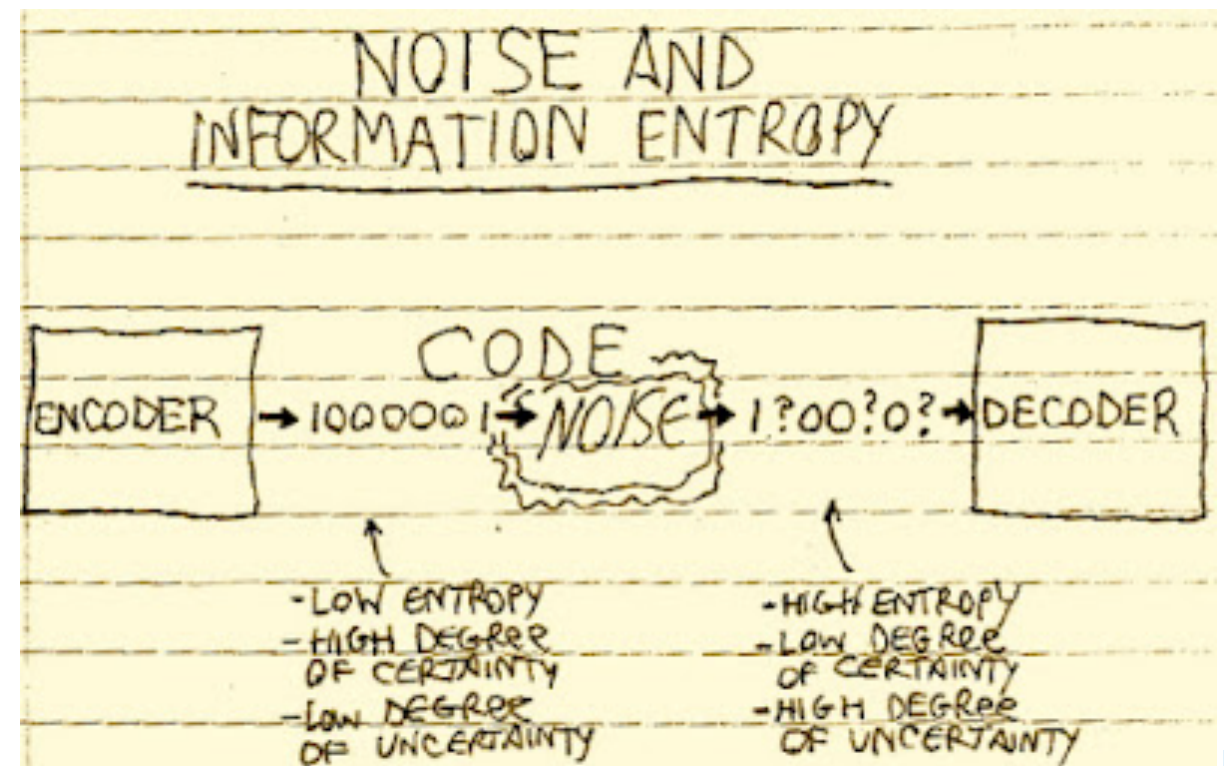
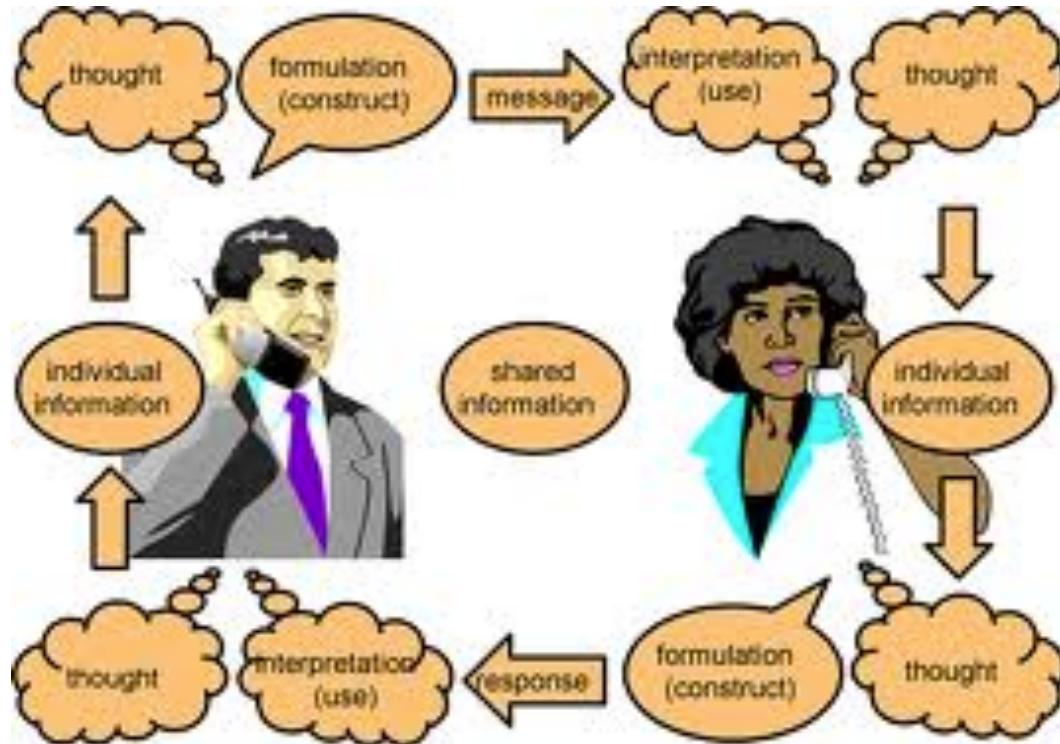
3rd row
(left to right):

Peggy Kubie, Henry Brosin, Gregory Bateson, Frank Fremont-Smith, John R. Bowman, G.E. Hutchinson, Hans Lukas Teuber, Julian H. Bigelow, Claude Shannon, Walter Pitts, Heinz von Foerster

1948: Claude Shannon “A mathematical theory of communication” Bell Labs

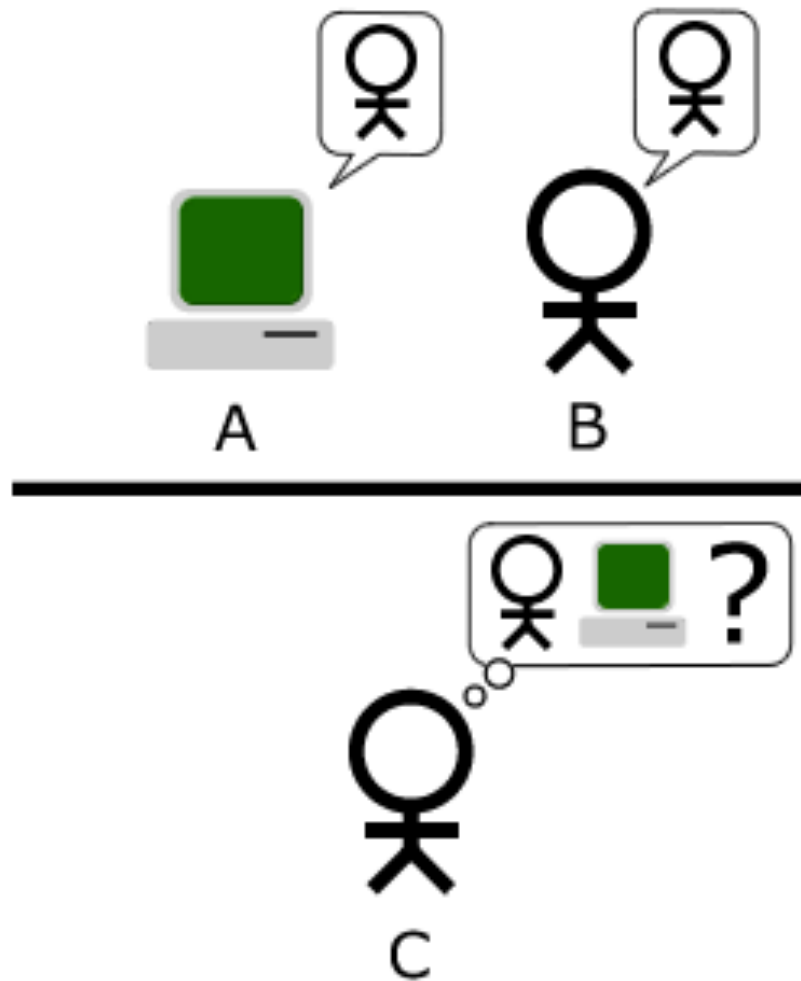
bits & bytes

entropy



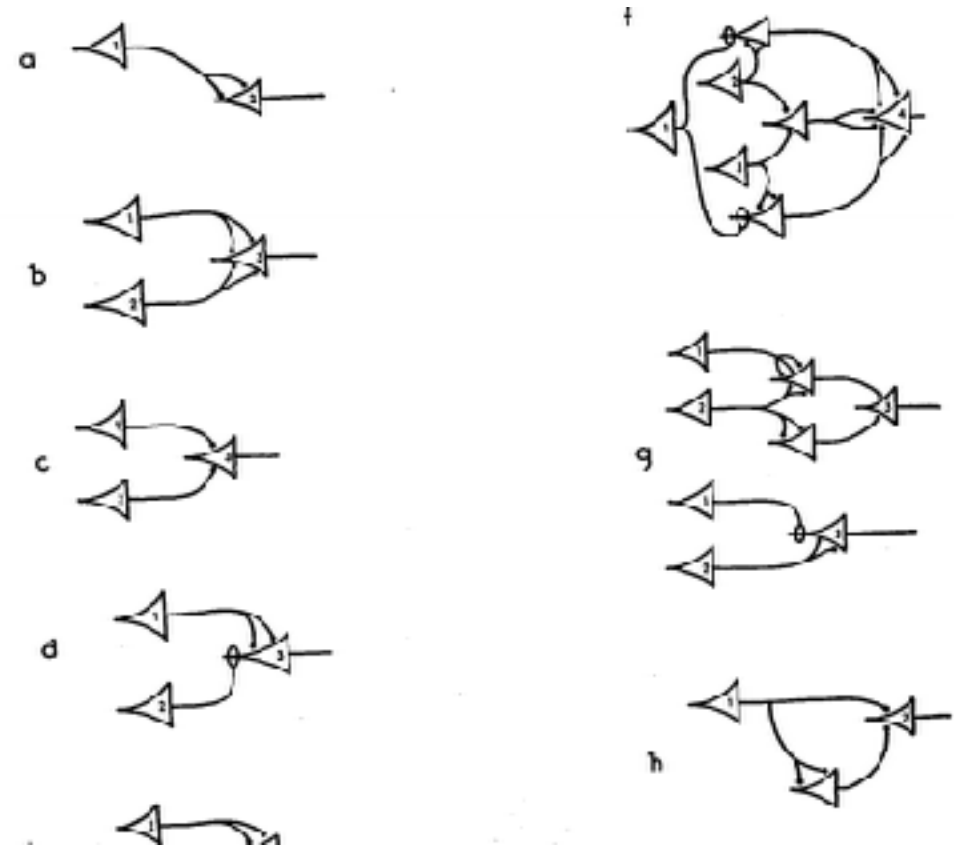
1950: Turing introduces the Turing Test

In 1980, this spawned the infamous Chinese Room argument by John Searle



1943: McCulloch's *A logical calculus of the ideas immanent in nervous activity*

Because of the “all-or-none” character of nervous activity, neural events and the relations among them can be treated by means of propositional logic. It is found that the behavior of every net can be described in these terms, with the addition of more complicated logical means for nets containing circles; and that for any logical expression satisfying certain conditions, one can find a net behaving in the fashion it describes. It is shown that many particular choices among possible neurophysiological assumptions are equivalent, in the sense that for every net behaving under one assumption, there exists another net which behaves under the other and gives the same results, although perhaps not in the same time. Various applications of the calculus are discussed.



Neurons as components in logical calculation

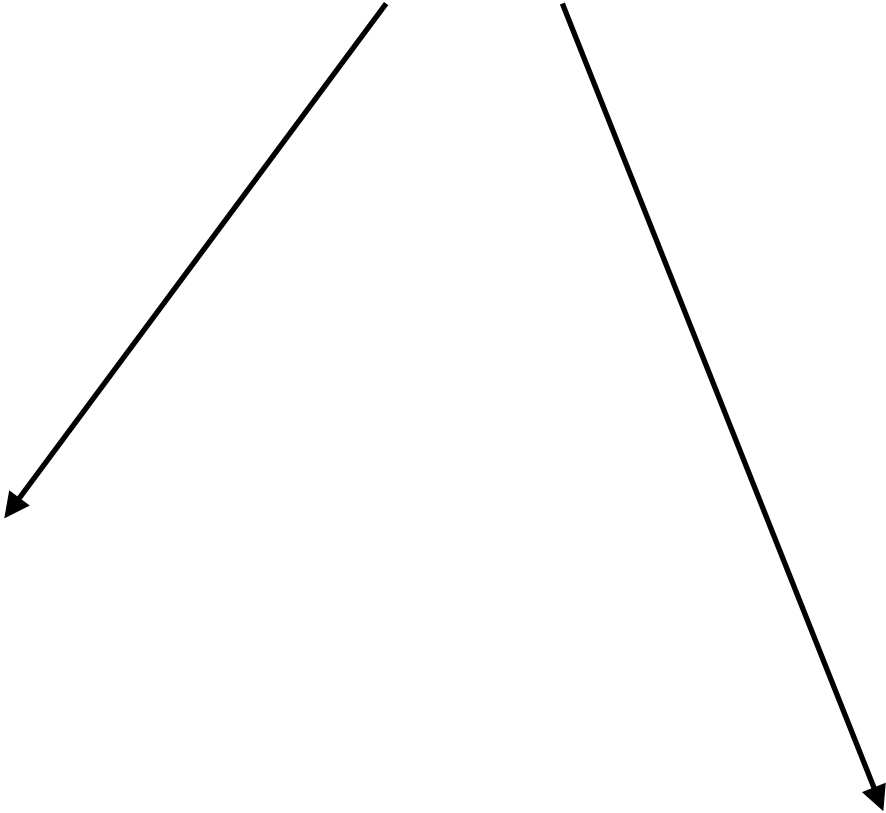
Out of all this emerged the
Computational Theory of Mind (CTM)

Human cognition can be described as a form
of *Information Processing*

Computation provides the necessary concept to
link neural activity (brains) and human cognition

Attempts to sidestep some of the philosophical
problems we have met

In most variants, cognition is viewed as the manipulation
within the system of representations generated from inputs
leading to outputs



Cybernetics

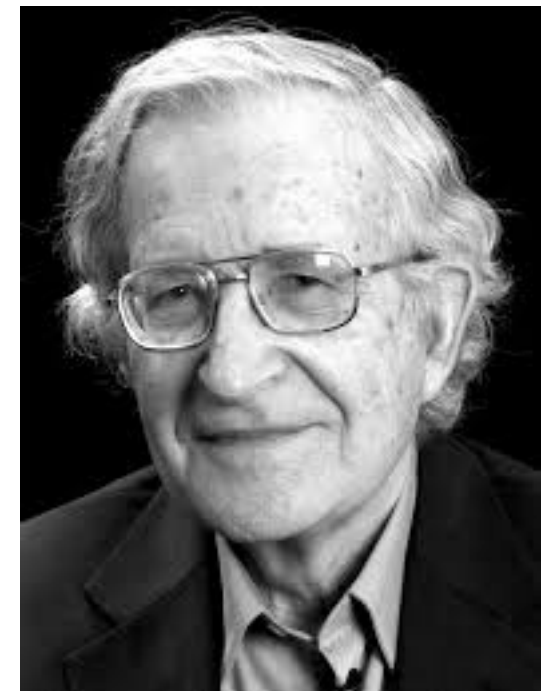
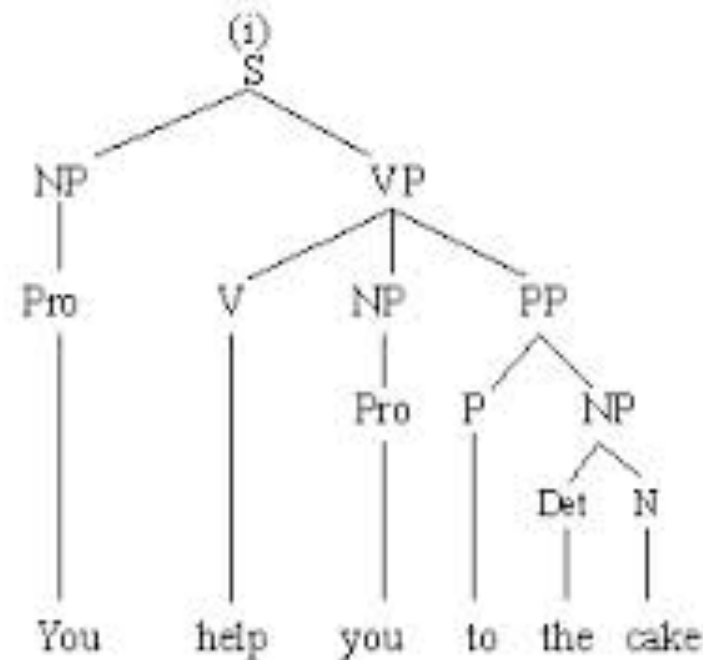
Artificial Intelligence

In the 1970s, funding
favoured MIT,
Marvin Minsky and AI.

1959: Chomsky's review of Skinner's *Verbal Behavior*.

1957: *Syntactic Structures*

- (1) S → NP + VP
- (2) VP → Verb + NP
- (3) NP → Det + N
- (4) Verb → Aux + V
- (5) Det → *the, a, ...*
- (6) N → *man, ball, ...*
- (7) Aux → *will, can, ...*
- (8) V → *hit, see, ...*



Innateness

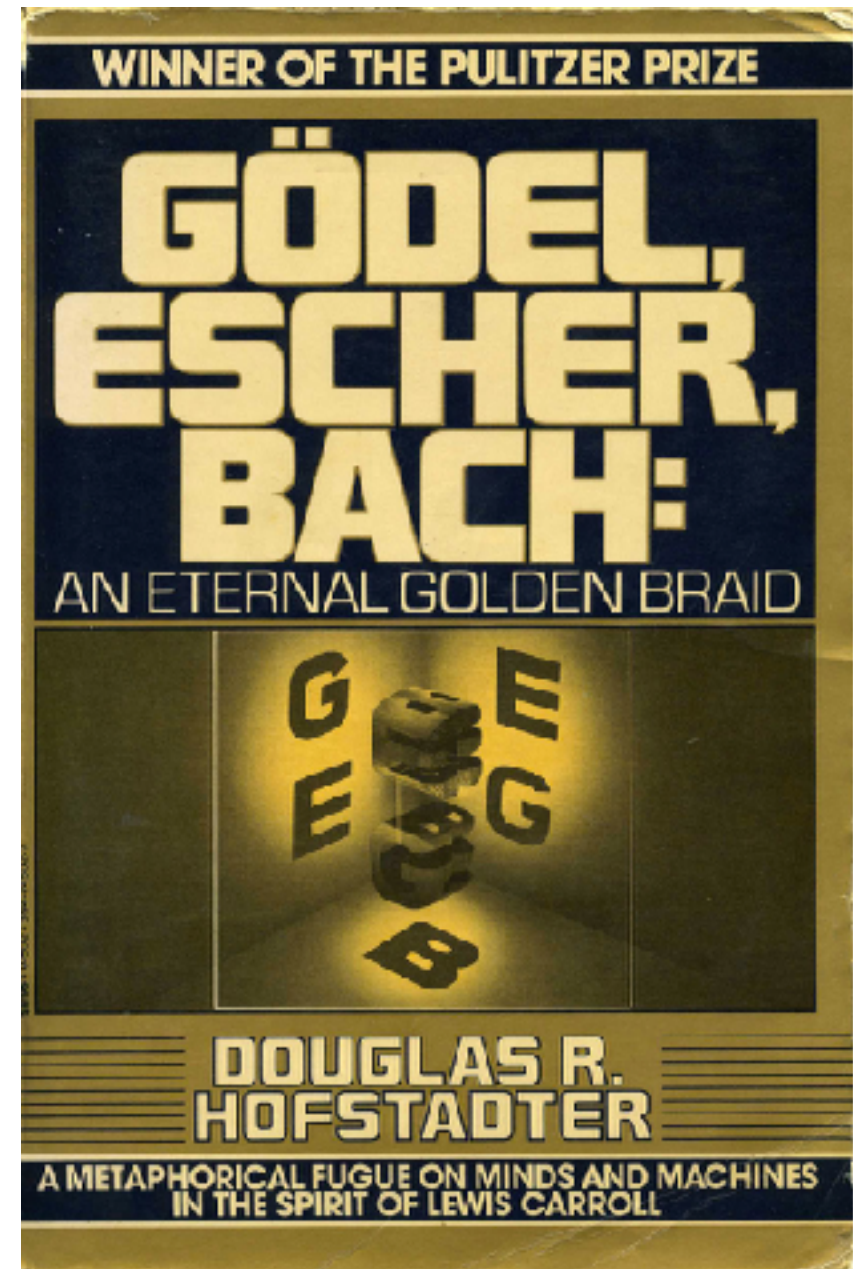
Poverty of the stimulus

Creativity/Generativity

Symbols

Sub-symbolic processing

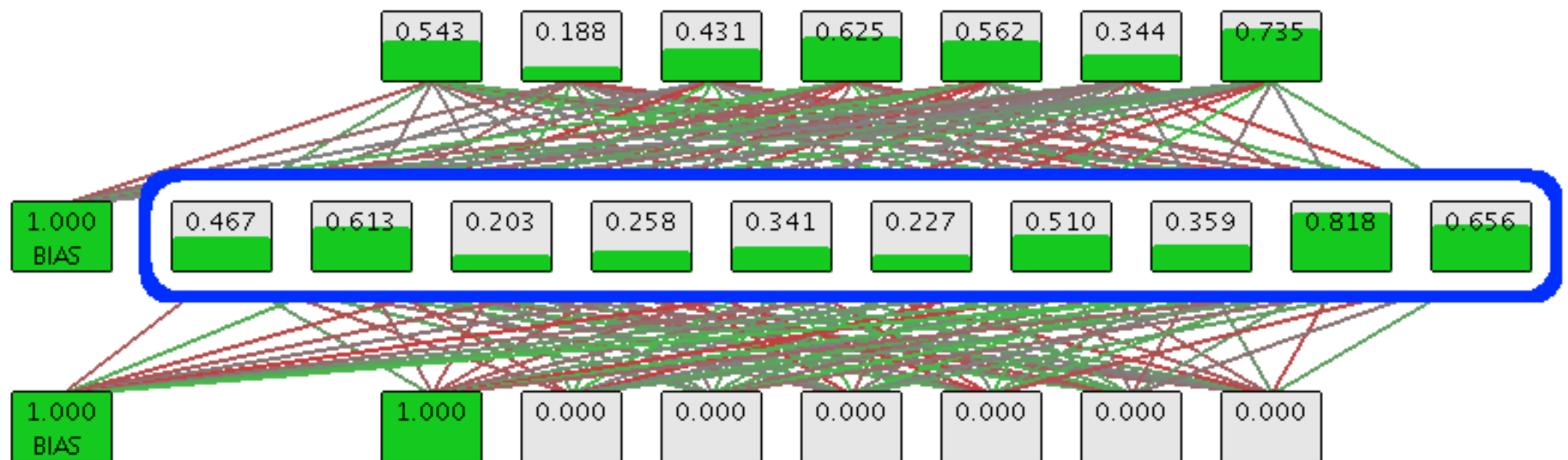
Connectionism



Mid 1980's: Connectionism - Artificial Neural Networks

1986: Back Propagation algorithm

Allowed artificial neural networks to learn functions automatically from data.



Connectionism

Numerical processing

Distributed representations

Associationism

Empirical push-back

Generic learning
mechanisms

New kid on the block:
Deep Learning

Computationalism

Word like symbols

Syntactic processing

Language of thought

Steeped in rationalist
concerns

Modular, domain-specific
architecture

The Embodied Turn

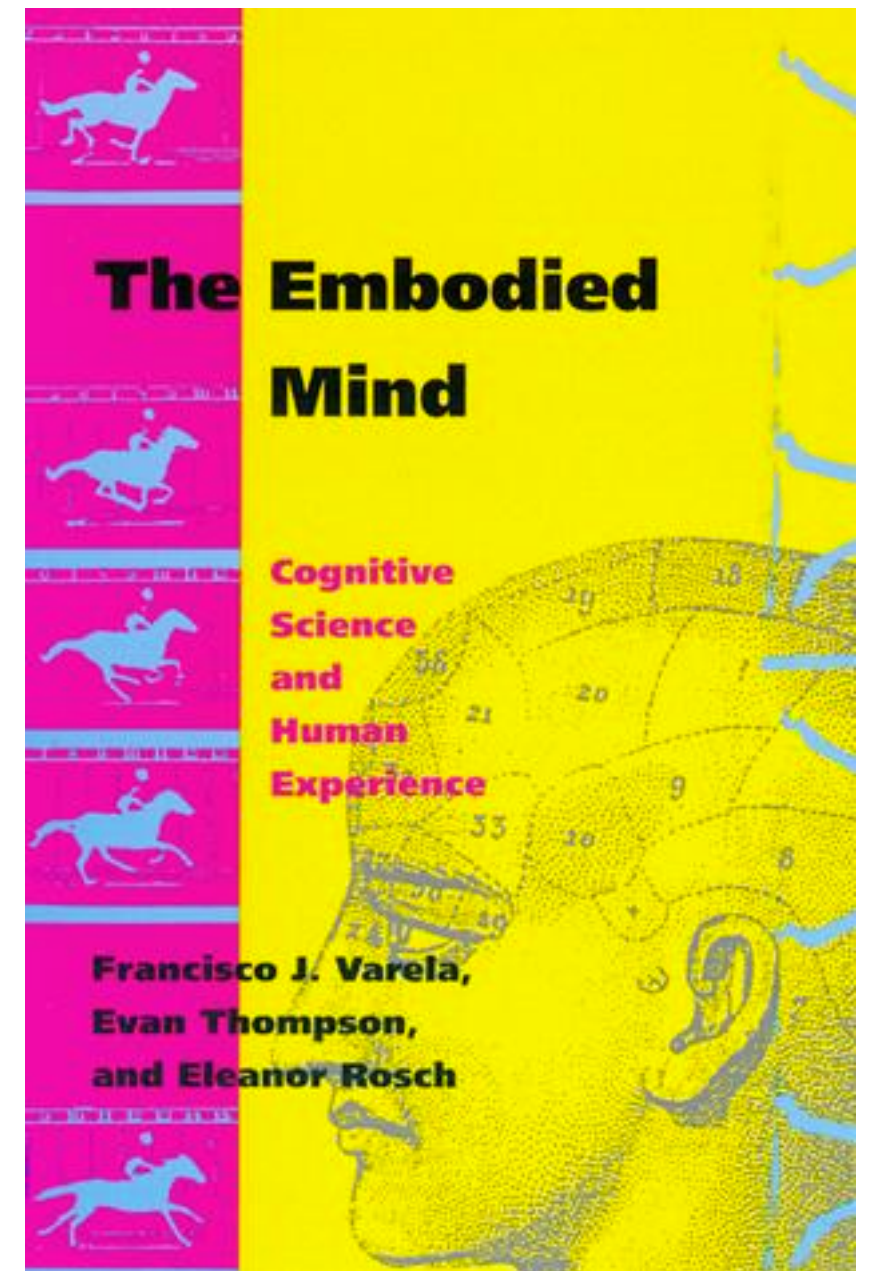
Convergence of many strands,
some very old, some new

Rejection of mind/brain identity

Centrality of phenomenological
concerns

Cognition as a form of activity

Strong *biological* basis



1991

4E as a cover term:

Embodied

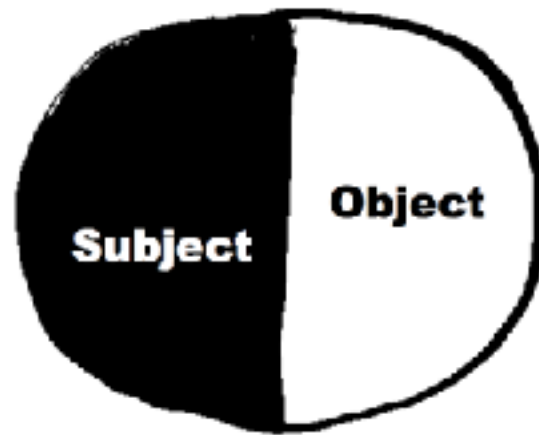
Extended

Embedded

Enactive

It is worthwhile noting how many of the most intractable human debates revolve around the body and what we think it means

Computational approaches



4-E approaches



Persistent Oppositions

Presentism

Eternalism

Presence

Representation

Becoming

Being

Senses & Experience

Reason & logic

Mind/Body/World

Mind vs World