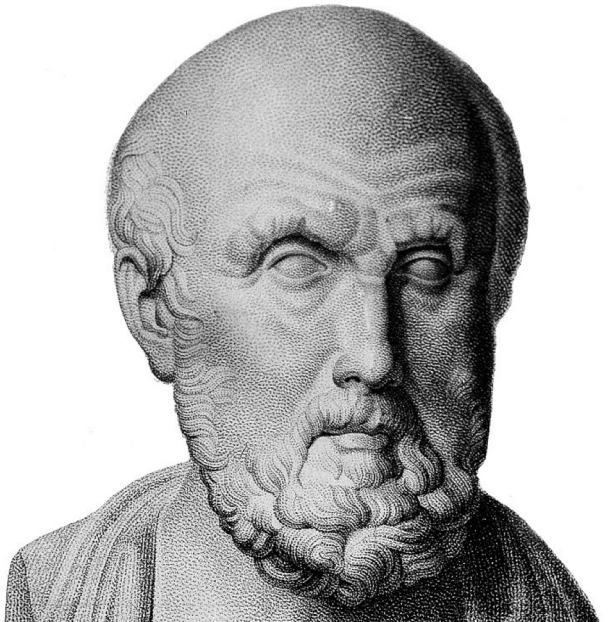


Cognitive abilities. Intelligence and personality

PART 1

Lecture 9



. . . from the brain, and from the brain alone, arise our pleasures, joys, laughter and jokes, as well as our sorrows, pains, griefs and tears. Through it, in particular, we think, see, hear, and distinguish the ugly from the beautiful, the bad from the good, the pleasant from the unpleasant . . . all the time the brain is quiet, a man can think properly.

Attributed to Hippocrates, 5th century BCE (quoted by Kandel et al. , 1991).

Outline

- Neurophysiology of cognitive processes
- Brief historical tour in cognitive neuroscience
- Basic cognitive processes
 - Sensations and perceptions
 - Attention
 - Memory

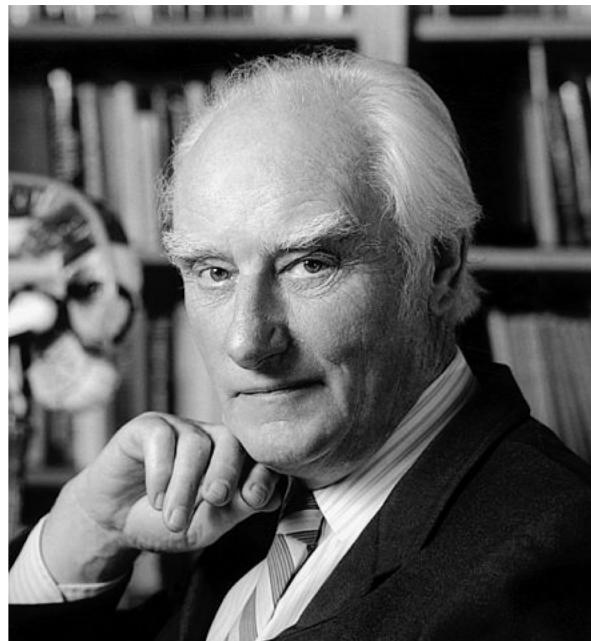
Neurophysiology of cognitive processes

- The science of the relationship of the brain and the psyche (in other words, how the brain makes the mental abilities)
- Currently tests of human mental abilities are modeled by cognitive constructs such as
 - attention,
 - working memory,
 - speed of information processing.

'You, your joys and your sorrows, your memories and ambitions, your sense of personal identity and free will, are in fact no more than the behavior of a vast assembly of nerve cells and their associated molecules.

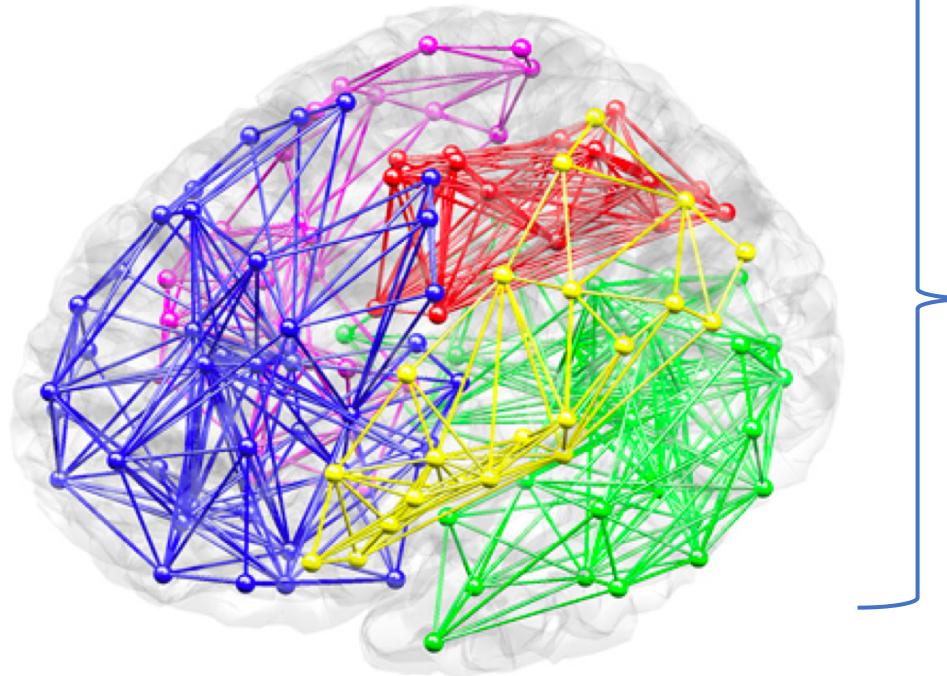
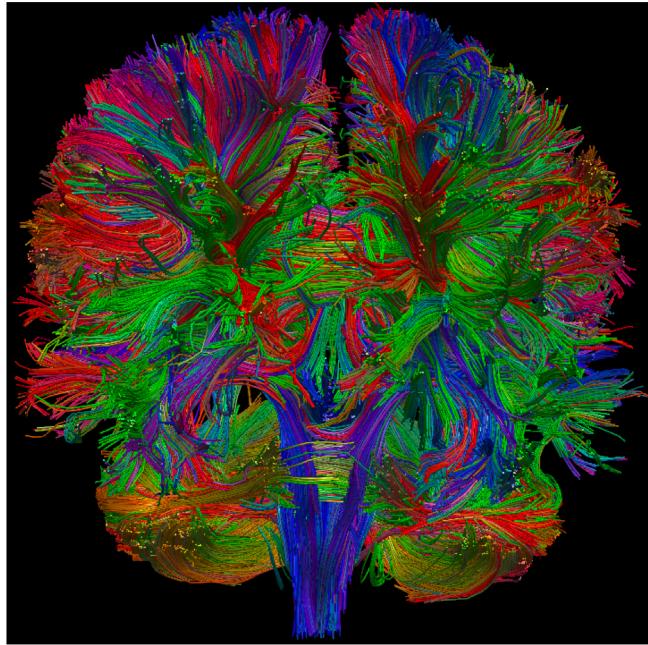
Francis Harry Compton Crick

From: "The Astonishing Hypothesis - The Scientific Search for the Soul» London, Simon and Schuster, 1994

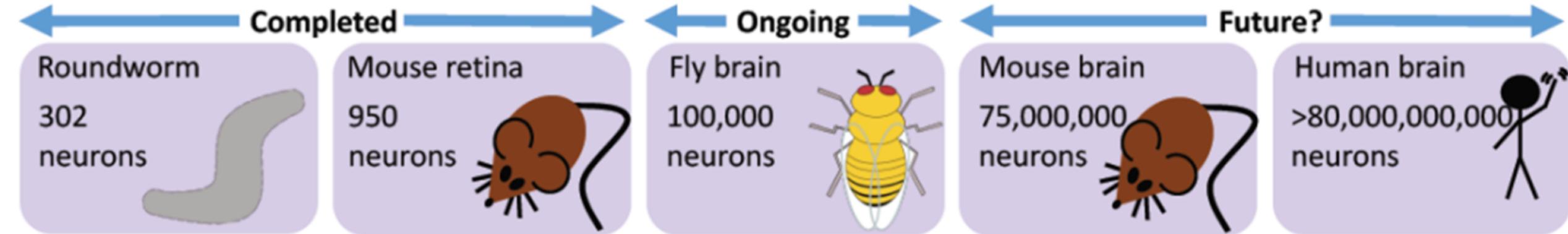


Francis Harry Compton Crick (8 June 1916 – 28 July 2004) was a British molecular biologist, biophysicist, and neuroscientist. In 1953, he co-authored with James Watson the academic paper proposing the double helix structure of the DNA molecule. Together with Watson and Maurice Wilkins, he was jointly awarded the 1962 Nobel Prize in Physiology or Medicine "for their discoveries concerning the molecular structure of nucleic acids and its significance for information transfer in living material"

Psychological processes and functional brain networks

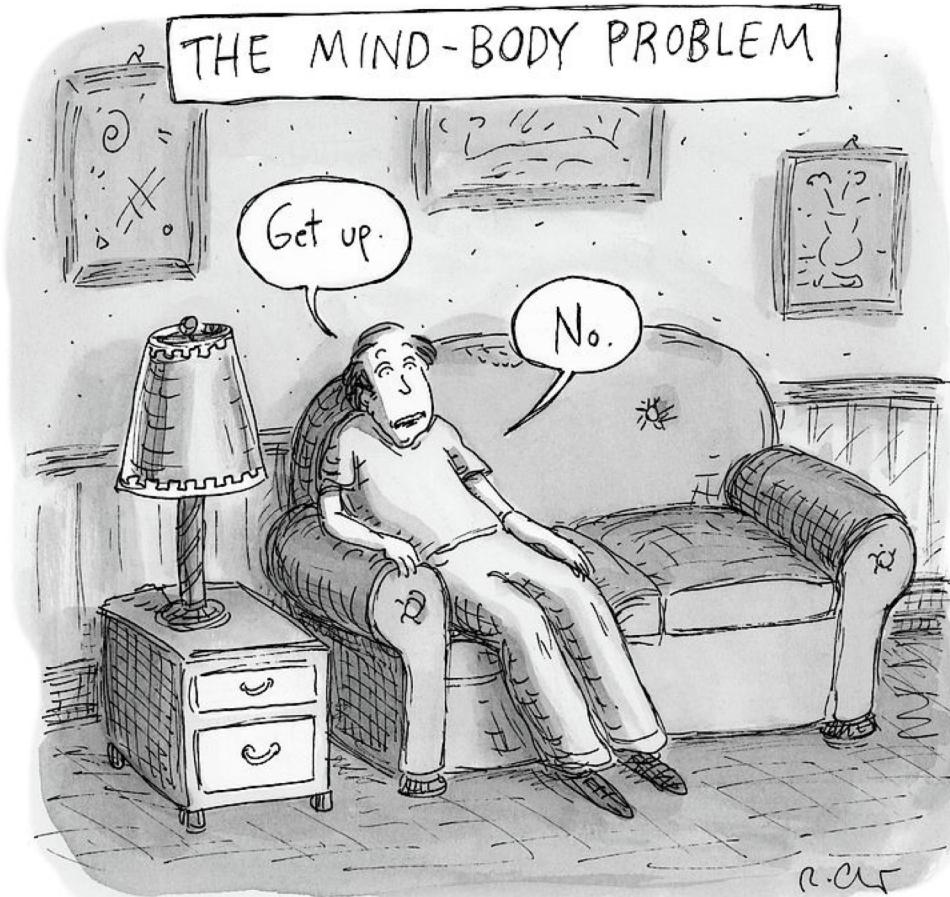


- perception
- attention
- decision
- executive control



Mind-body problem

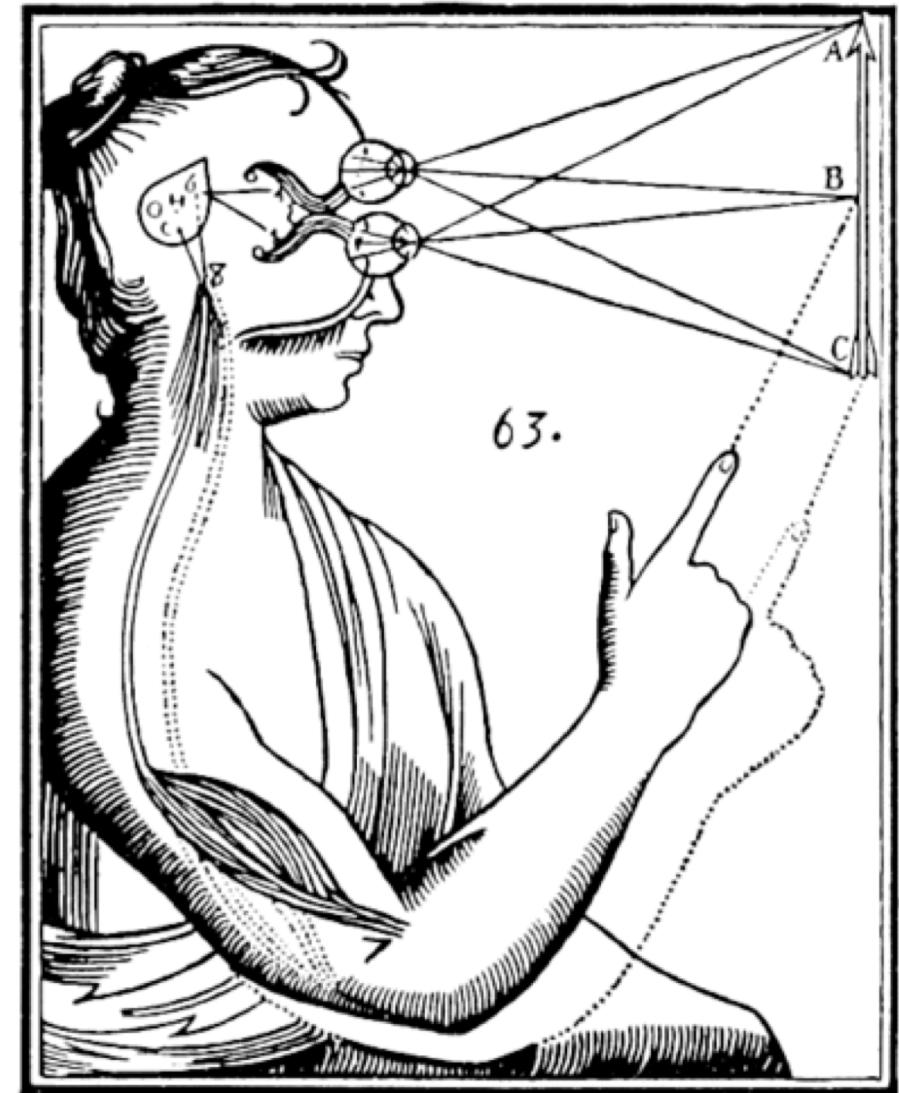
- The problem of explaining how a mind is **connected** to and **interact** with a body whose mind it is, or the problem of explaining how a body is **connected** to and **interacts** with a mind whose body it is



Mind-body problem

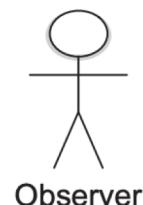
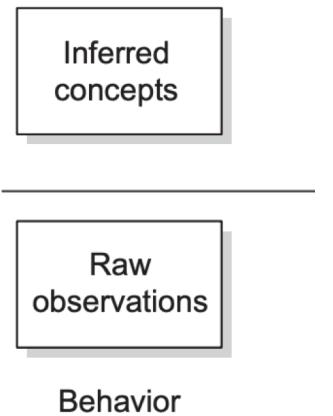
- The problem was addressed by René Descartes in the 17th century

René Descartes' illustration of mind/body dualism. Descartes believed inputs were passed on by the sensory organs to the epiphysis in the brain and from there to the immaterial spirit.



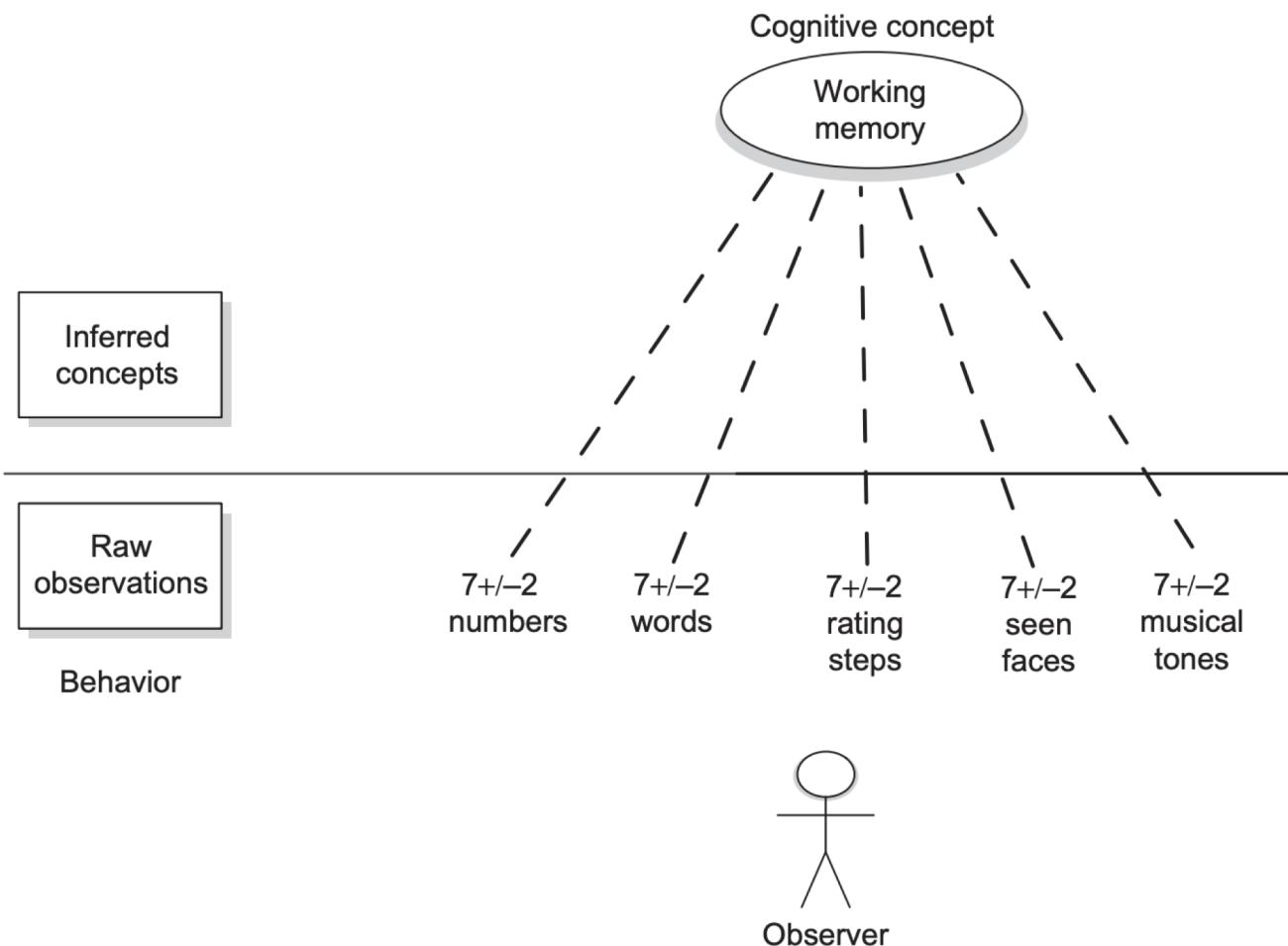
Method of cognitive neuroscience

- Cognitive concepts are based on consistent behavioral observations.



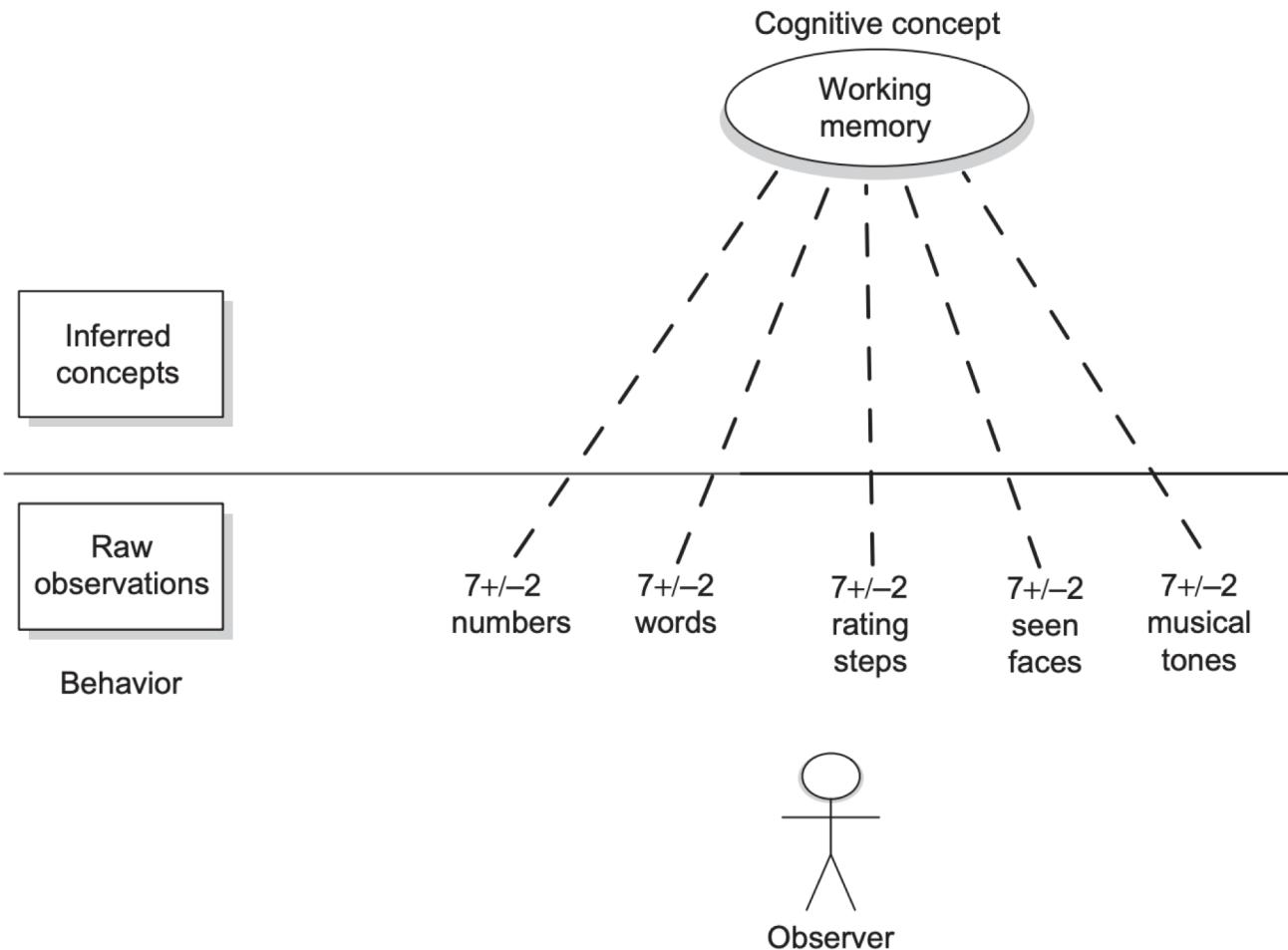
FROM:
BERNARD J. BAARS NICOLE M. GAGE,
COGNITION, BRAIN, AND
CONSCIOUSNESS (Introduction to
Cognitive Neuroscience)

Method of cognitive neuroscience



- Concepts like **working memory** are not given in nature. They emerge after many years of testing, when a large body of evidence seems to be explained by an inferred concept.
- Working memory was proposed in 1974 after two decades of study of immediate memory. Today it has expanded in scope, so that visual, verbal, and other temporary buffers are called working memories..

Method of cognitive neuroscience



- In cognitive neuroscience, we infer conclusions from observations of behavioral responses and brain activity. We cannot directly observe attention or working memory

Cognitive neuroscience

- Cognitive neuroscience is the scientific field that is concerned with the study of the biological processes and aspects that underlie cognition, with a specific focus on the neural connections in the brain which are involved in mental processes. It addresses the questions of how cognitive activities are affected or controlled by neural circuits in the brain.
- Cognitive neuroscience is a branch of both neuroscience and psychology, overlapping with disciplines such as behavioral neuroscience, cognitive psychology, physiological psychology and affective neuroscience.

Brief historical tour

- For many years, a human being was considered as something special (MATTER + something else)
- MATTER (physical) obeys the law of nature, and science can study these laws
- SPIRIT (psyche) is not matter and does not obey the laws of nature, therefore it is not subject to study

Brief historical tour

- Rene Descartes: Cartesian dualism
- Animals are the machines
- Nerves are hollow tubes through which animal spirits are transmitted to the muscles from the reservoir of the soul (brain)

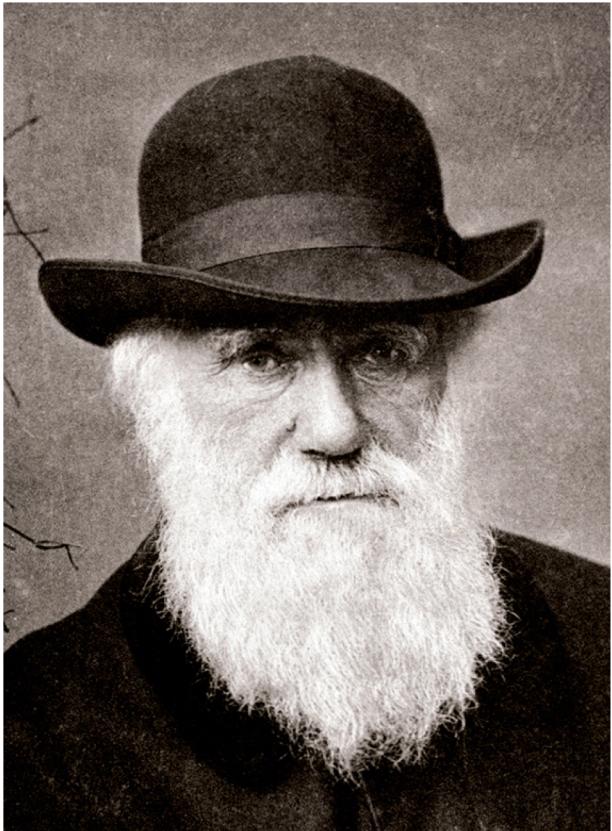


Brief historical tour



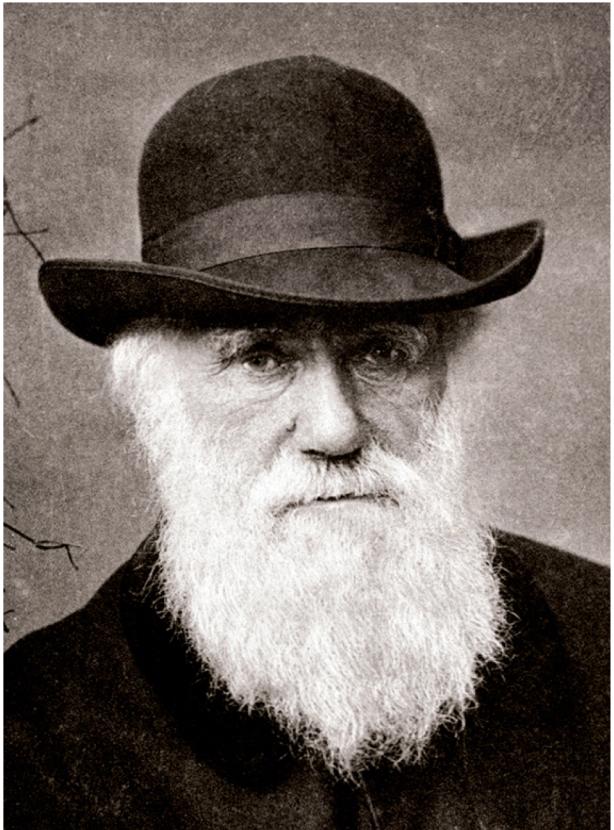
- **John Locke** (29 August 1632 – 28 October 1704) : mind is also a mechanism
- Physical and mental are not two independent substances, but two forms of our conscious experience - external or sensation and internal (reflection)

Brief historical tour



- **Charles Robert Darwin** (12 February 1809 – 19 April 1882) : contributed to the biological rationale of the psyche
- Human emotions are of a biological nature (at that time such an idea was completely odious)

Brief historical tour



- **Ivan Pavlov** (26 September 1849 – 27 February 1936) : mental and physiological are one and the same
- All the forms of behavior can be explained through elementary behavioral acts based on the theory of reflexes.
- Thus, Investigating the nervous activity, we study the psyche

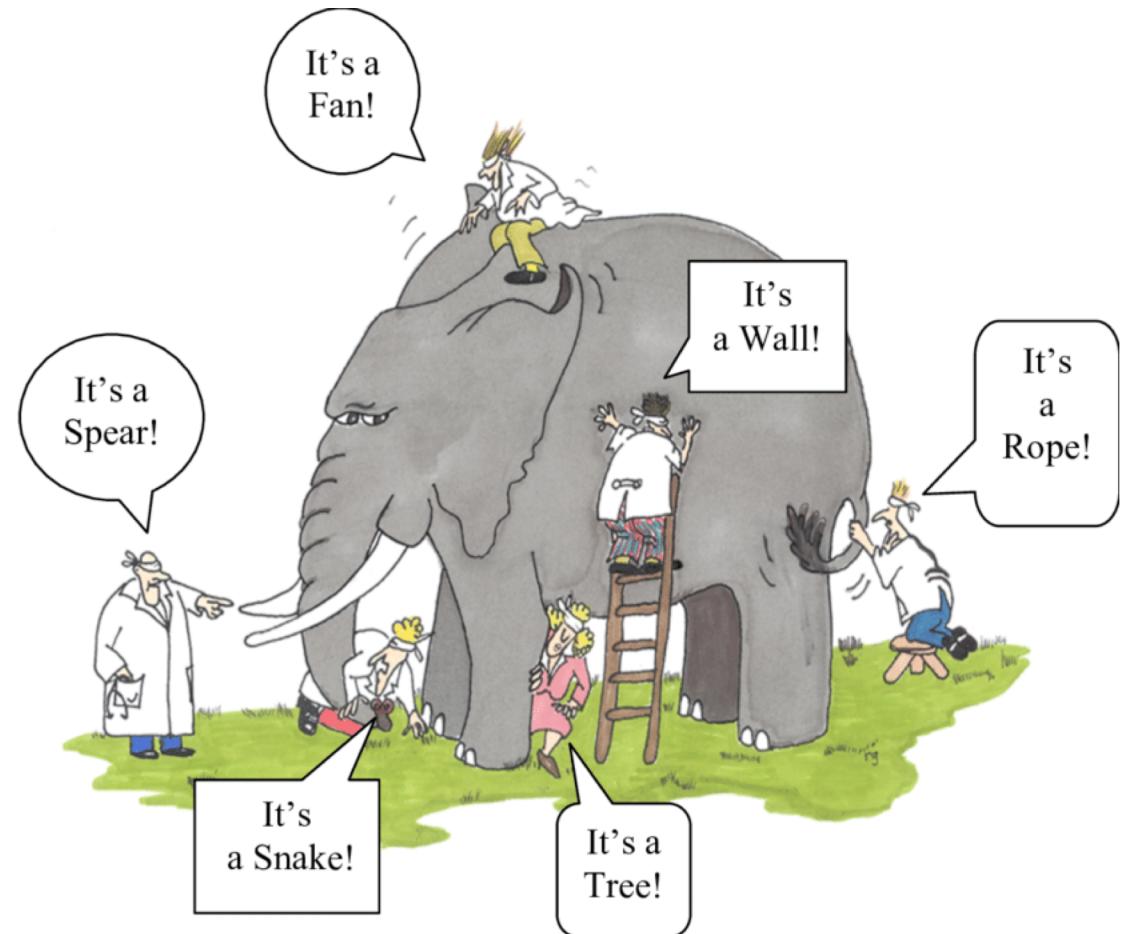
Brief historical tour



- **John Broadus Watson** (January 9, 1878 – September 25, 1958) : Watson's **behaviorism** rejected the studying of consciousness.
- Any mention of consciousness is unlawful, since we can observe in explicit form only real behavior and the brain as a physical object

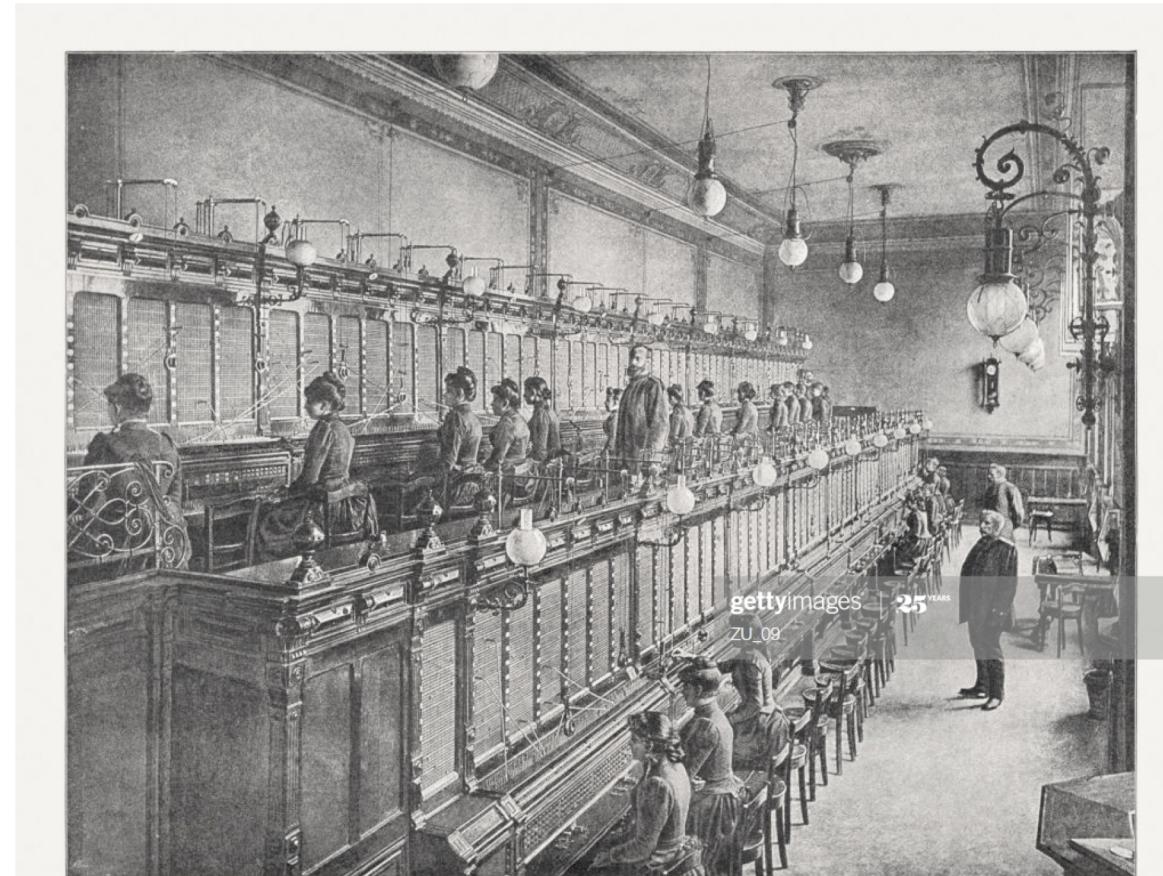
Double-aspect theory

- Mental (phenomenal) and physiological (physical) are two sides of the same single process
- *It is unclear what kind of a single process that we can characterize on both sides.*



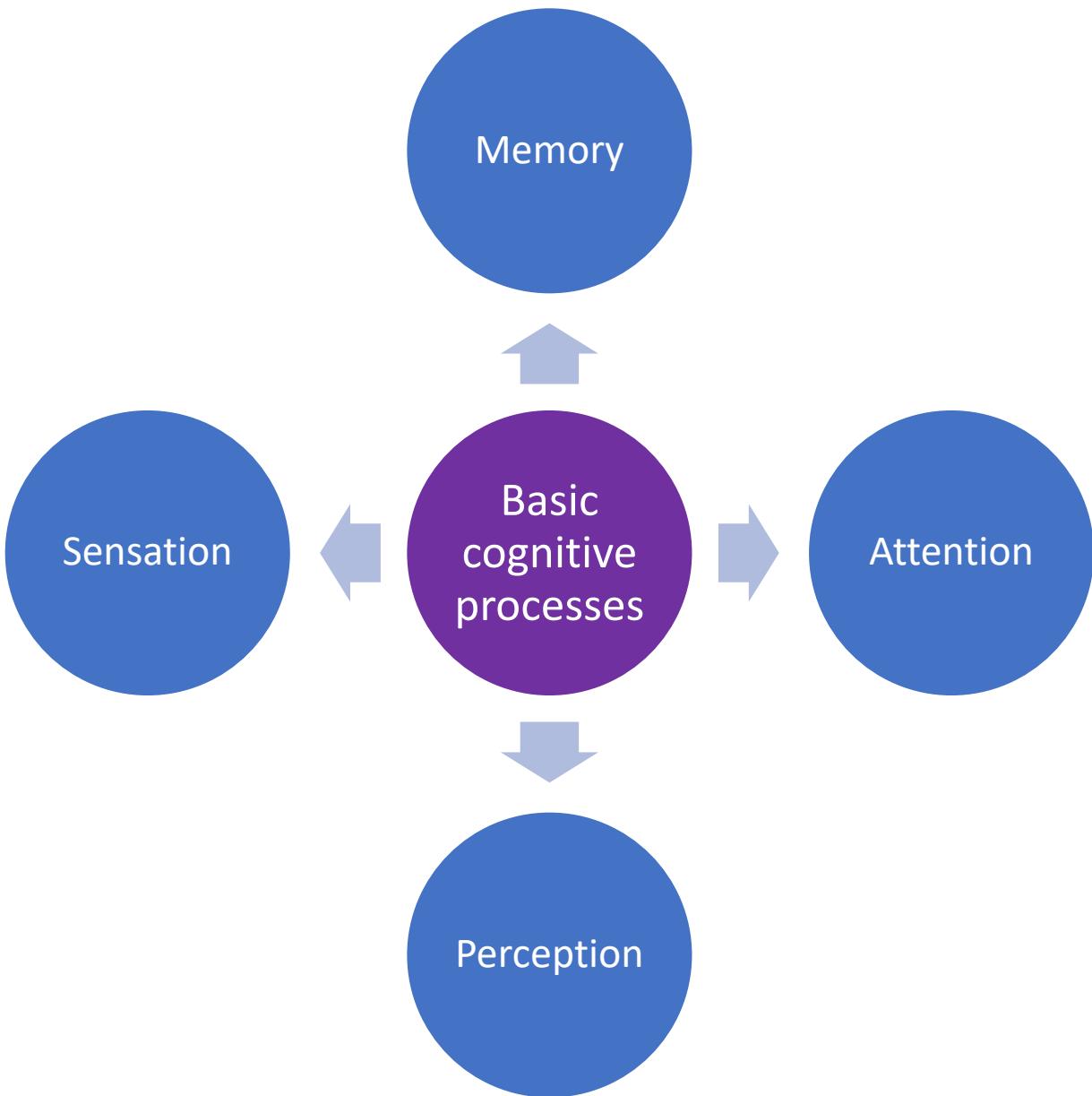
Wire brain concept

- The brain as a telephone exchange
- The brain is like a computer



930005986

Eine Hälfte des Vermittlungsamtes I der Berliner Fernsprechanstalt.



Sensory and perceptual processes

- **Sensation** is the simplest form of mental activity.
This is a product of processing the central nervous system of irritants (stimuli) that arise in the internal and external environment.
- Sensations are characterized by the reflection of the individual properties of objects and phenomena of the objective world with their direct impact on the senses.

- **Perception** is a cognitive process that forms the subjective picture of the world. Unlike sensation, perception is a reflection of an object or phenomenon as a whole.
- The result of perception is a subjective holistic image of an object acting on analyzers through a combination of sensations.

Classification of human sensations

interoceptive

- signaling about the state of internal processes of the body, arise due to receptors located on the walls of the stomach and intestines, heart and circulatory system and other internal organs

proprioceptive

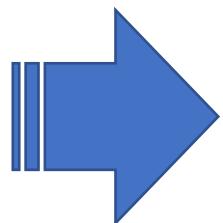
- relating to stimuli that are produced and perceived within an organism, especially those connected with the position and movement of the body

exteroceptive

- relating to stimuli that are external to an organism
- **create the basis for conscious human behavior**

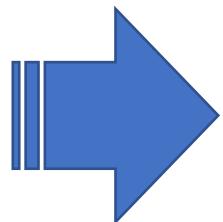
Sensor system functions

- signal detection
- their distinction
- transformation



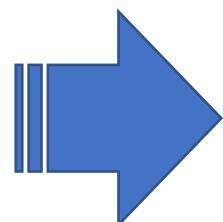
- receptors

- transmission
- coding
- detection



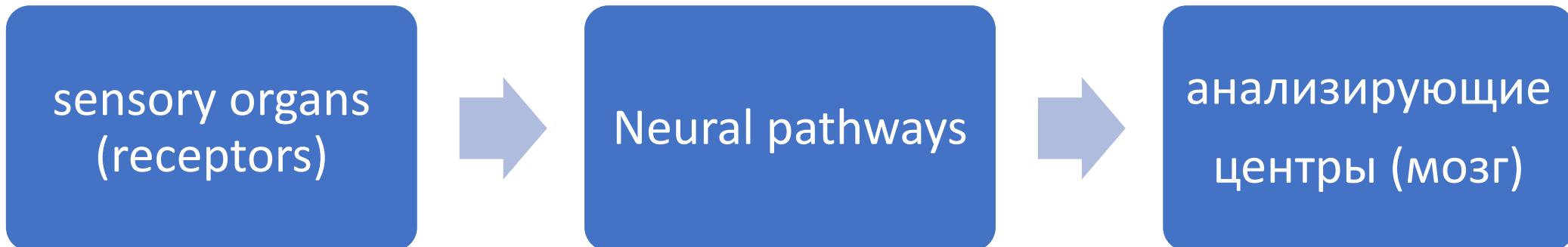
- neural pathways

- recognition sensor image



- cortical neurons

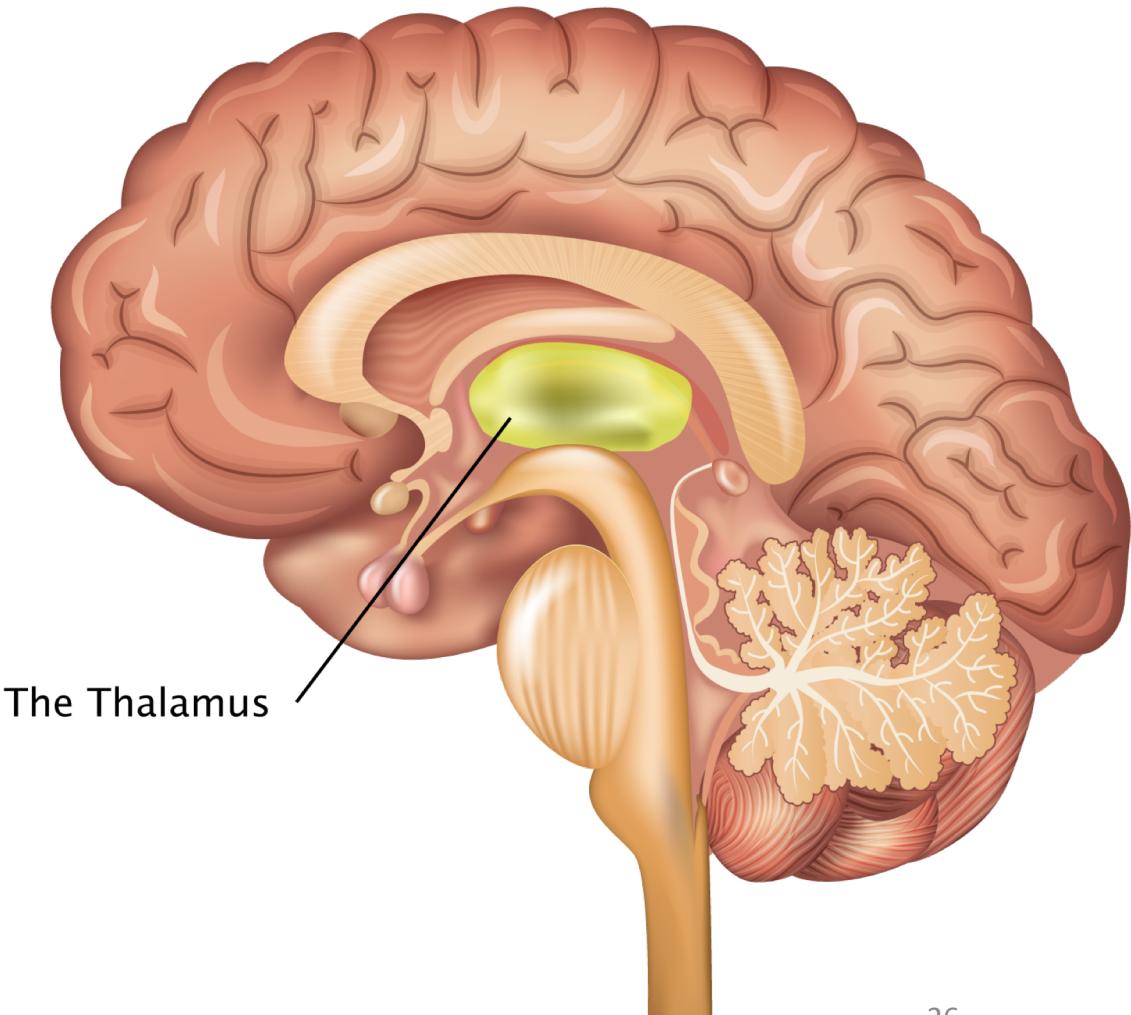
Sensor systems



every sensory system (with the exception of the olfactory system) includes a thalamic nucleus that receives sensory signals and sends them to the associated primary cortical area

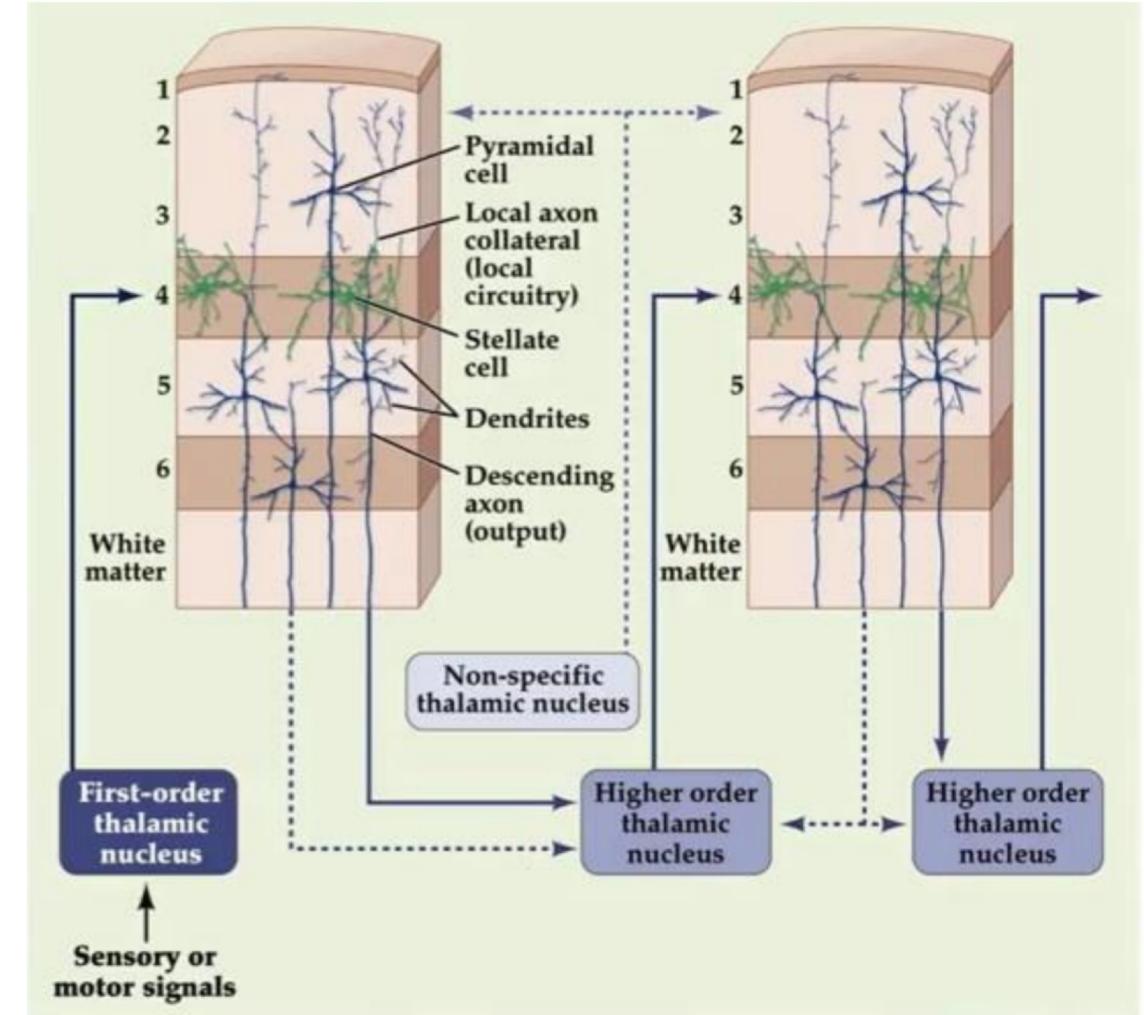
Location of thalamus and connections

- Thalamus is a midline symmetrical structure of two halves (left and right), within the vertebrate brain, situated between the cerebral cortex and the midbrain
- The spinothalamic tract is a sensory pathway originating in the spinal cord. It transmits information to the thalamus about pain, temperature, itch and crude touch. There are two main parts: the lateral spinothalamic tract, which transmits pain and temperature, and the anterior (or ventral) spinothalamic tract, which transmits crude touch and pressure.
- The thalamus is connected to the cerebral cortex via the thalamocortical radiations.



Functions of thalamus

- The thalamus has multiple functions, generally believed to act as a relay station, or hub, relaying information between different subcortical areas and the cerebral cortex.
- In particular, every sensory system (with the exception of the olfactory system) includes a thalamic nucleus that receives sensory signals and sends them to the associated primary cortical area
- The thalamus is believed to both process sensory information as well as relay it—each of the primary sensory relay areas receives strong feedback connections from the cerebral cortex



Thalamo-cortical network