



# **INTRODUCTION TO BIOPSYCHOLOGY**

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# **BIOPSYCHOLOGY**

- **is the study of the physiological, evolutionary, and developmental mechanisms of behavior and experience.**
- **emphasizes that the goal is to relate biology to issues of psychology**

# **BIOPSYCHOLOGY**

- **the study of the relationship between behavior, emotion, and cognition on the one hand, and brain function on the other.**
- **Examining the biological basis of thoughts, emotions and behaviors, including the electrical and chemical processes necessary for nervous system communication**
- **A Behavior is anything that an organism does that involves action and response to stimulation.**

# **BIOLOGICAL EXPLANATIONS**

## ***PHYSIOLOGICAL EXPLANATION***

- **relates a behavior to the activity of the brain and other organs.**
- **It deals with the machinery of the body**
- **for example, the chemical reactions that enable hormones to influence brain activity and the routes by which brain activity controls muscle contractions**

# BIOLOGICAL EXPLANATIONS

## *ONTOGENETIC EXPLANATION*

- describes how a structure or behavior develops, including the influences of genes, nutrition, experiences, and their interactions.
- For example, males and females differ on average in several ways. Some of those differences can be traced to the effects of genes or prenatal hormones, some relate to cultural influences, many relate partly to both, and some await further research.

# BIOLOGICAL EXPLANATIONS

## *EVOLUTIONARY EXPLANATION*

- reconstructs the evolutionary history of a structure or behavior. The characteristic features of an animal are almost always modifications of something found in ancestral species.
- For example, bat wings are modified arms, and porcupine quills are modified hairs.

# BIOLOGICAL EXPLANATIONS

## *FUNCTIONAL EXPLANATION*

- describes why a structure or behavior evolved as it did. Within a small, isolated population, a gene can spread by accident through a process called genetic drift.
- For example, a dominant male with many offspring spreads all his genes, including some that may have been irrelevant to his success or even disadvantageous.

# Human consciousness

- Awareness of our thoughts, reason, perceptions, memories, and feelings.
- Ability to communicate our thoughts and intentions



# Human consciousness

- Ability to think and to be aware of our existence.
- A Behavior is anything that an organism does that involves action and response to stimulation.

# Philosophy of consciousness

“So neuroscience is allowing us to take the study of consciousness from the metaphysical realm to the empirical realm. And we can now study the actual physical mechanisms that give rise to consciousness instead of just sitting in an armchair and making up theories about it.”

*Christof Koch*



# Historical origins

Monism -The idea that there is only one underlying reality - the body and the mind are inseparable

Dualism -The idea that both body and mind exist as different entities.

# Historical Origins: The Location of the Mind



Galen (130 – 200 AD)

- Ancient Egyptian, Indian, and Chinese cultures believed the heart to be the source of thought and emotions as did Aristotle.
- Galen proposed that mental activities originated in the ventricles of the brain.
- This became the accepted view of the Christian Church until the 14<sup>th</sup> century.

# Historical Origins: The Location of the Mind

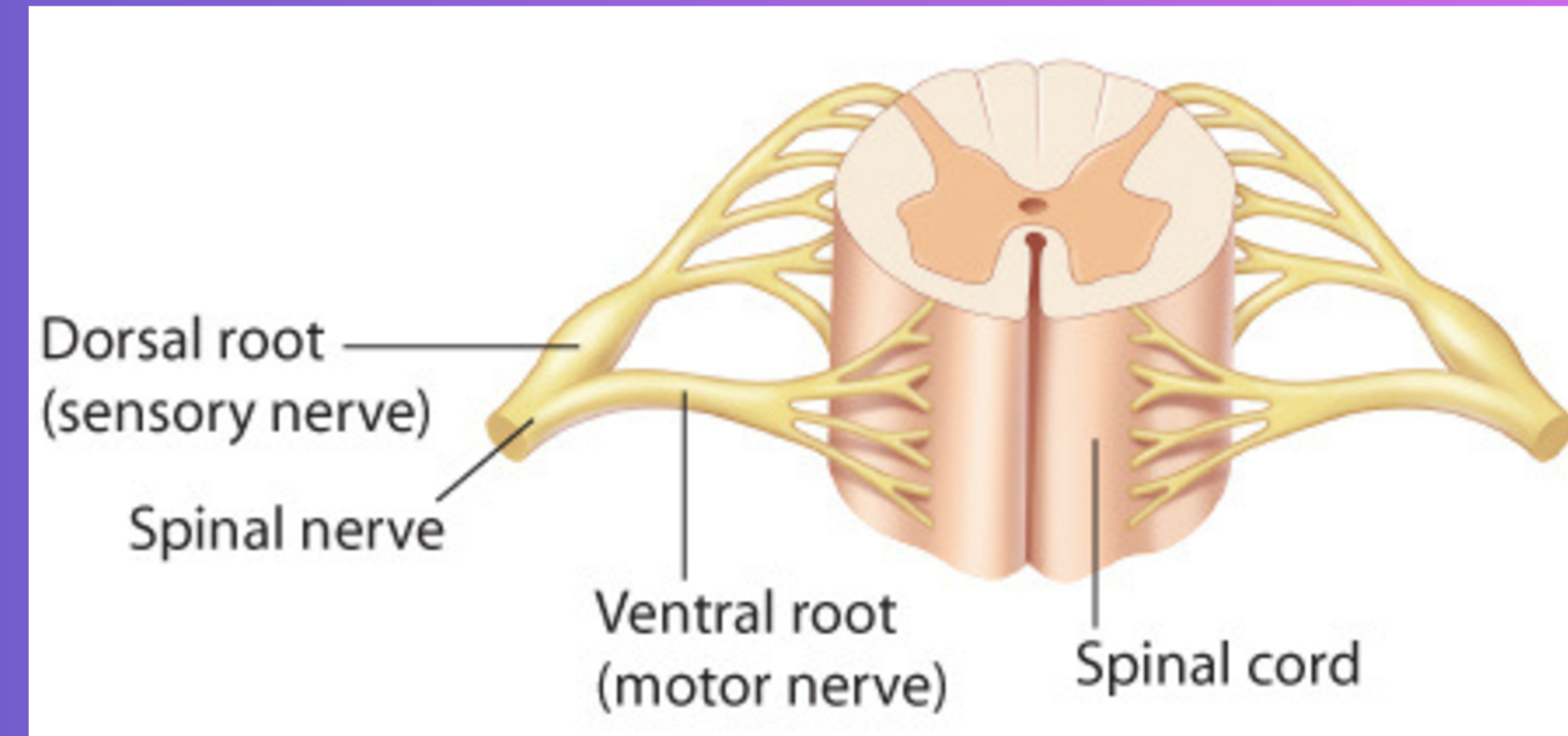
- Descartes was a dualist
  - proposed a hydraulic model of the nervous system controlled by pineal gland
- Disproved by Galvani, who demonstrated that even when a muscle and motor nerve were removed from a frog, it still twitched in response to electrical stimulation. TED



Descartes (1596 –  
1650)

## Historical Origins:

- Reflex – An involuntary response to a stimulus, caused by a direct connection between a sensory receptor and a muscle.
- Bell–Magendie Law – The principle that the dorsal root of a spinal nerve carries sensory information to the spinal cord and the ventral root carries motor information to the muscles.



# Historical Origins: *Doctrine of Specific Nerve Energies*

- The theory that the message detected by the nervous system is **determined by which nerve carries the message**, not how it is stimulated.
- Johannes Müller (1835) – each sensory nerve carries specific information about the quality and location of sensory events.
  - Optic nerves → images
  - Auditory nerves → sounds





# Historical Origins: Localization of Function—Evolution

- Charles Darwin's (1859) *The Origin of Species* posits the idea that evolution occurs by means of natural selection.
- Changed the current view that animals had no mind (or soul), opening the door for the idea that research on animals could generate knowledge relevant for humans.



1809 –1882

## Historical Origins: Localization of Function—Evolution

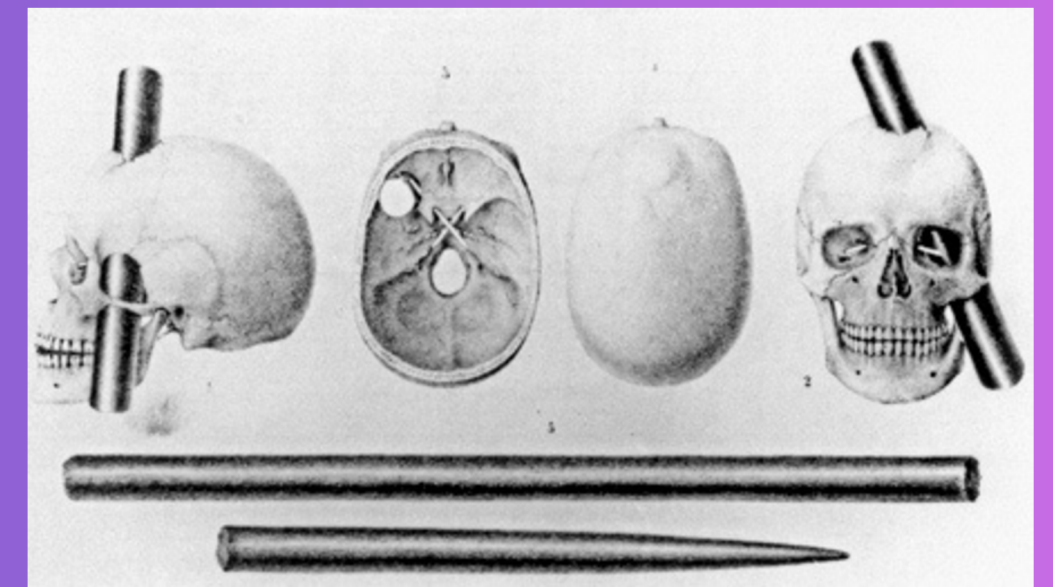
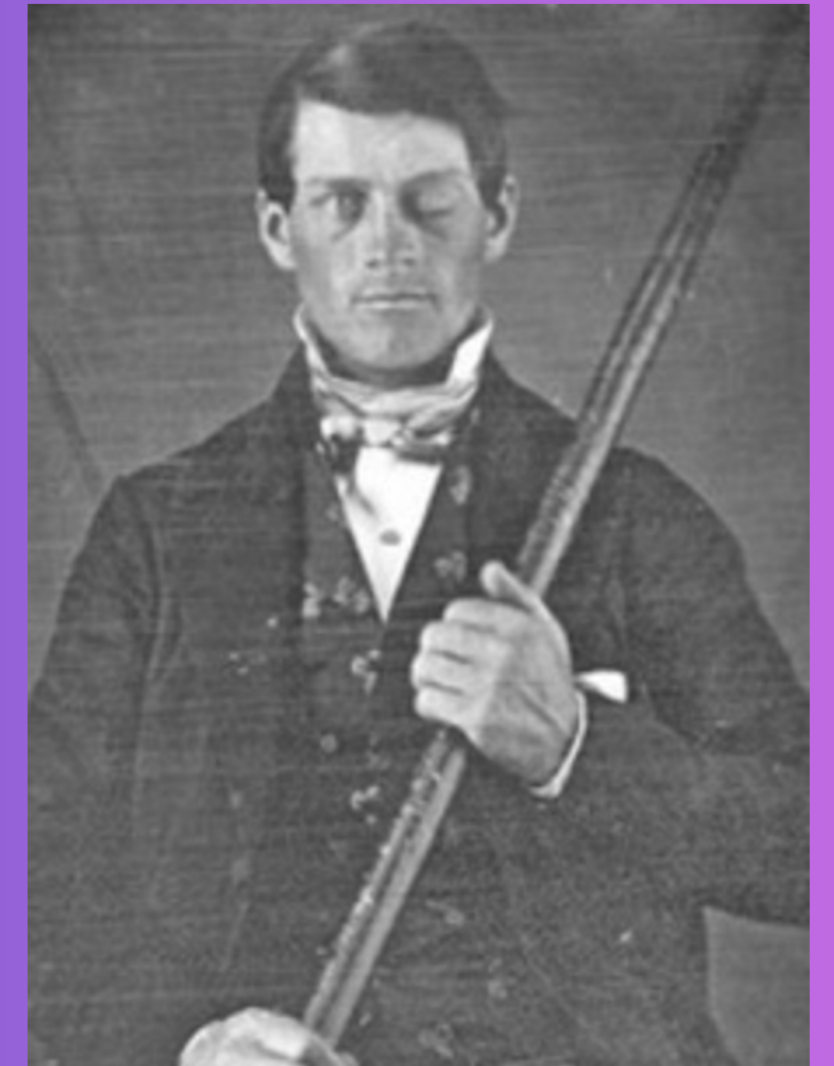
- ***Pierre Flourens*** – Experimental ablations on animals, he was the first to prove that the **mind was located in the brain, not the heart.**
- Led to the founding of ***comparative psychology*** by **George John Romanes** (1883) which postulates the cognitive processes of animals and humans are the same.



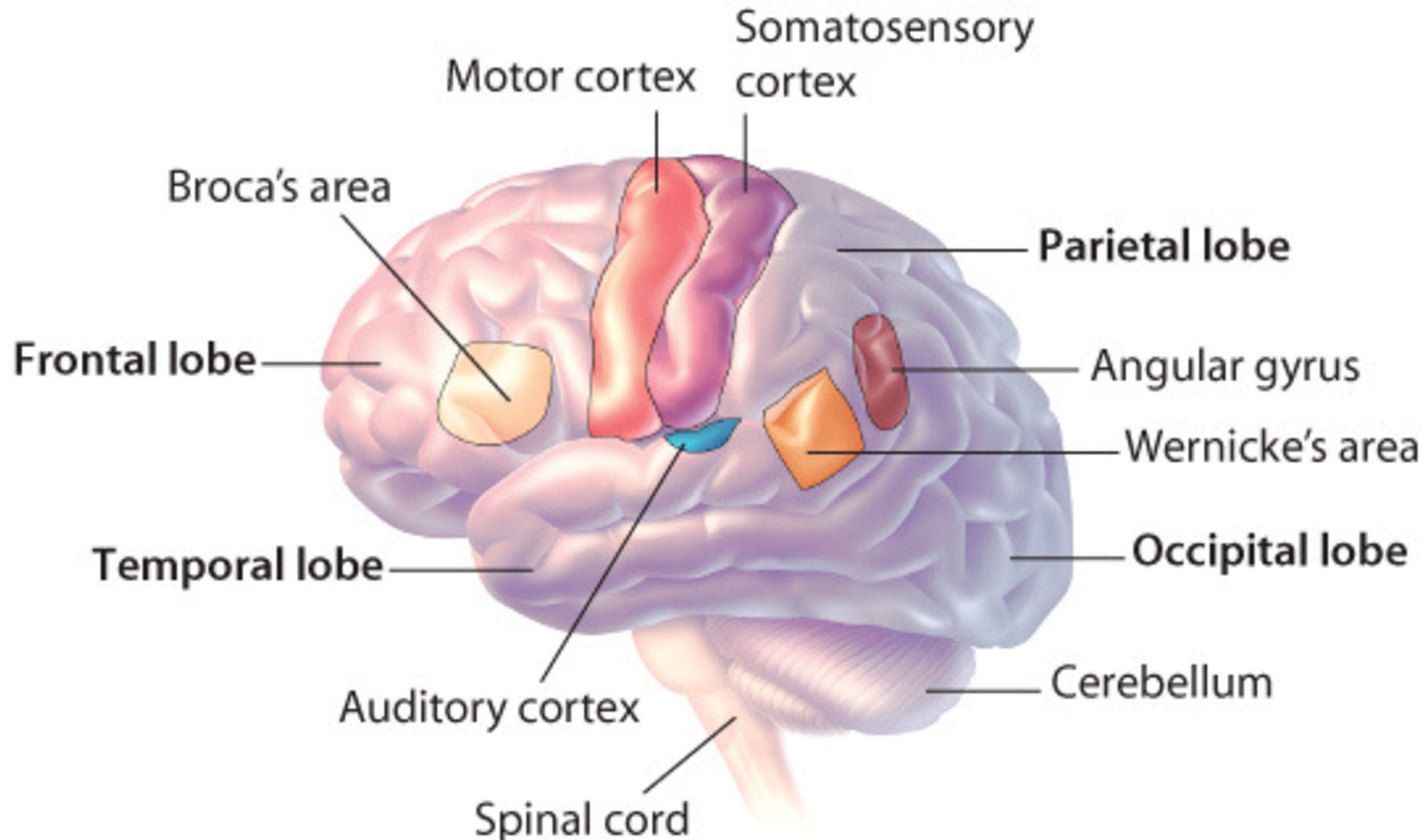
# Historical Origins: Localization of Function

- Phineas Gage (1848)

- Explosion sent a tamping rod through his left cheek and out the top of his head.
- Damasio (1994) confirmed the location of the damage was in the prefrontal cortex, which controls the ability to make rational decisions and processes emotional information.



# Historical Origins: Localization of Function The Four Lobes of the Cerebral Cortex



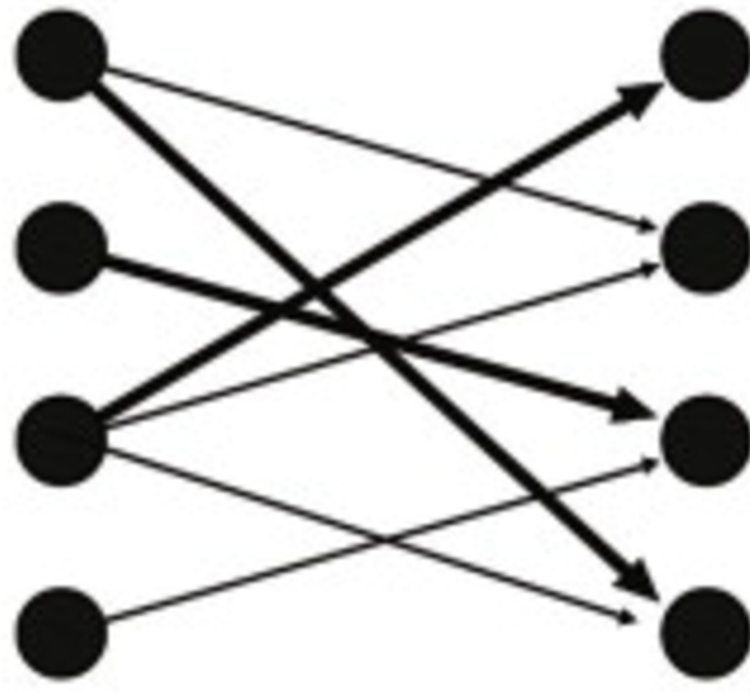
# Historical Origins: Localization of Function

- **Karl Lashley** searched for the physical location of specific memories

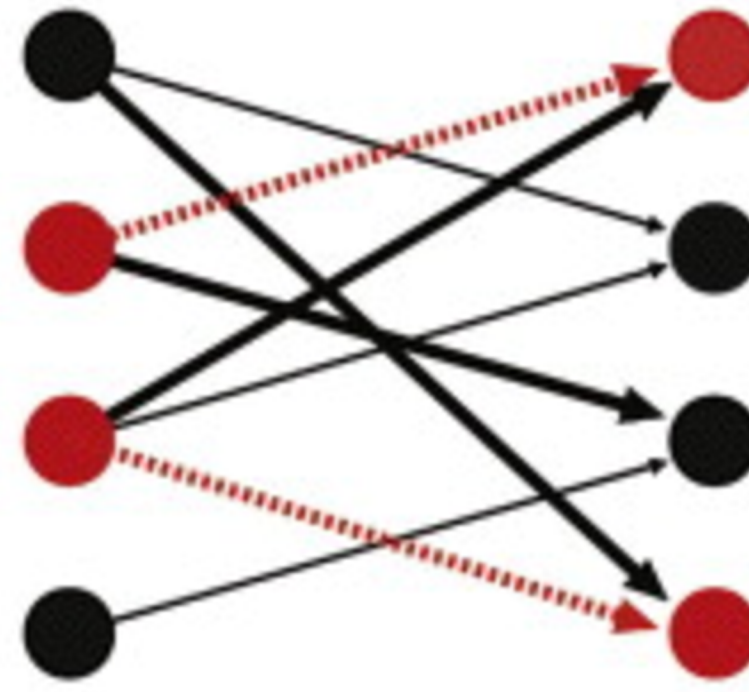
Engram – a memory trace or the physical location of specific memories (biophysical or chemical change in the brain in response to external stimuli produces memory)



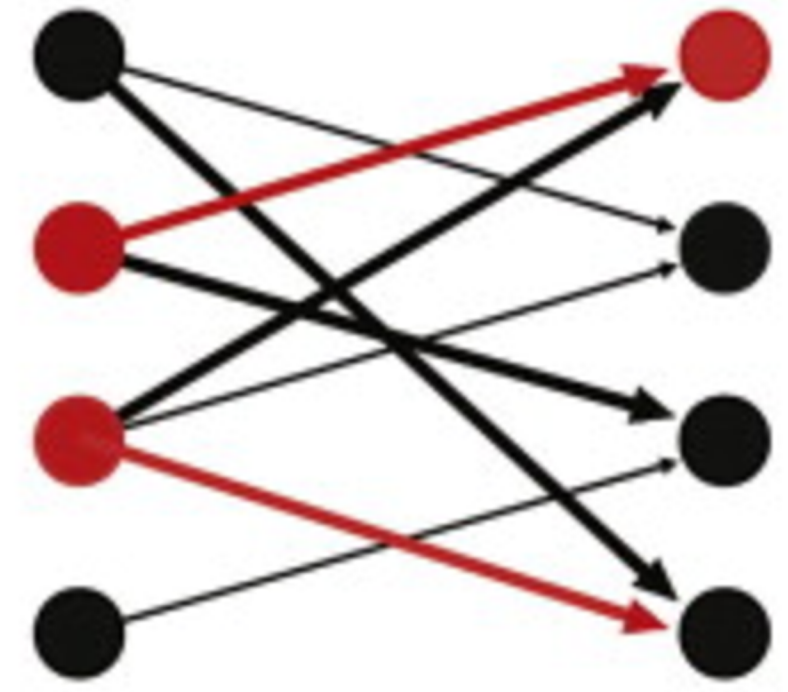
### Before learning









### Encoding

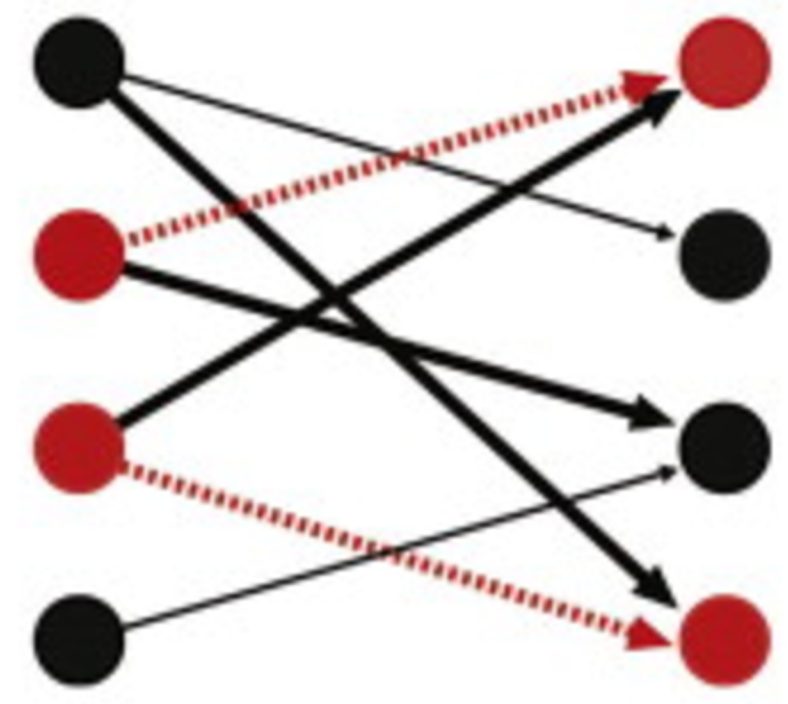


### Consolidation



-  Non Engram Cell
-  Engram Cell
-  Unpotentiated synaptic connection
-  Potentiated synaptic connection
-  New unconsolidated synaptic connection
-  Consolidated synaptic connection

### Amnesia



Current Opinion in Neurobiology

# Historical Origins: Localization of Function

- Developed the concepts of:
  - Mass action – the greater the brain area destroyed, the more severe impact on learning
  - Equipotentiality – the theory that the brain has the capacity (in the case of injury) to transfer functional memory from the damaged portion of the brain to other undamaged portions of the brain. (all areas of the brain are equally able to perform a task.)

# OTHER BRAIN THEORIES

# OTHER BRAIN THEORIES

## '2. MODULARITY

- Different areas of the brain function together in an integrated manner.

## '3. LEVEL OF INTERACTION

- The sensory and motor component of the brain interacts with each other.

# OTHER BRAIN THEORIES

## 4. LATERALIZATION/ BRAIN DOMINANCE THEORY

- A particular hemisphere of the brain corresponds to set of functions.
- 1981: Dr. Roger Sperry conducted a study for epilepsy, which gave him, the 1981 Nobel Prize for Physiology or Medicine.

# OTHER BRAIN THEORIES

## 4. LATERALIZATION/ BRAIN DOMINANCE THEORY

- Explained that the brain has two hemispheres that perform tasks differently from each other.
- Our behavior is a function of the heightened activity of either the left or right brain.
- People have dominantly a part of their body, like a more dominant leg, eye or arm, which a person often prefers to use.

# OTHER BRAIN THEORIES

## 5. Triune Brain Theory

- Dr. Paul MacLean came up with a theory that identified three distinct parts of the brain namely : neocortex, limbic system and reptilian complex (Triune Brain Theory)
- Neocortex – also called as the rational brain
  - responsible for intellectual tasks such as language, planning abstraction and perception.

# OTHER BRAIN THEORIES

## 5. Triune Brain Theory

- Limbic System – also called as intermediate brain.
  - motivation and emotion involved in feeding, reproductive behavior and parental behavior.
- Primitive Brain or reptilian complex– self preservation and aggressive behavior of humans similar to survival instincts of animals.

# OTHER BRAIN THEORIES

## 6. Whole Brain theory

- The brain is divided into 4 quadrants, each responsible for particular abilities.
- All brain functions are interconnected and inseparable from memory functions.
- Proposed by Ned Hermann

# OTHER BRAIN THEORIES

## 6. Whole Brain theory

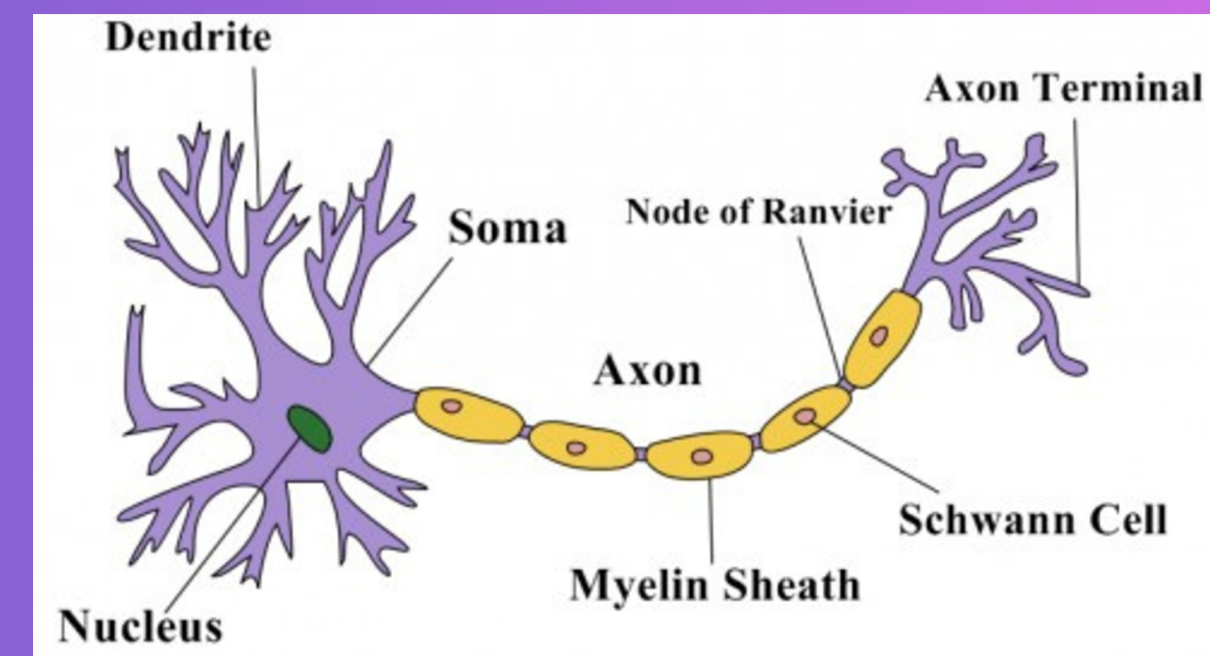
### **Herrmann's Four Dominant Quadrants :**

- 'Upper Left (A) Cerebral Mode – ANALYTICAL
- 'Lower Left (B) Limbic Mode – ORGANIZED
- 'Lower Right (C) Limbic Mode – INTERPERSONAL
- 'Upper Right Cerebral Mode (D) – IMAGINATIVE

QUADRANT	DESCRIPTION	
A	Analyzes data Critical Understands money	Down – to – earth Logical thinker Works with numbers
B	Get things done Creates procedures Neat and organized	Submits on time Plans and organizes Reliable in getting things done
C	Tactile Emotional Expressive Uses physical movements	Sensitive Sociable Shares knowledge
D	Vivid imagination Experiments Uses visuals to learn	Explores Flexible Curious Conceptualizes Risk – taker

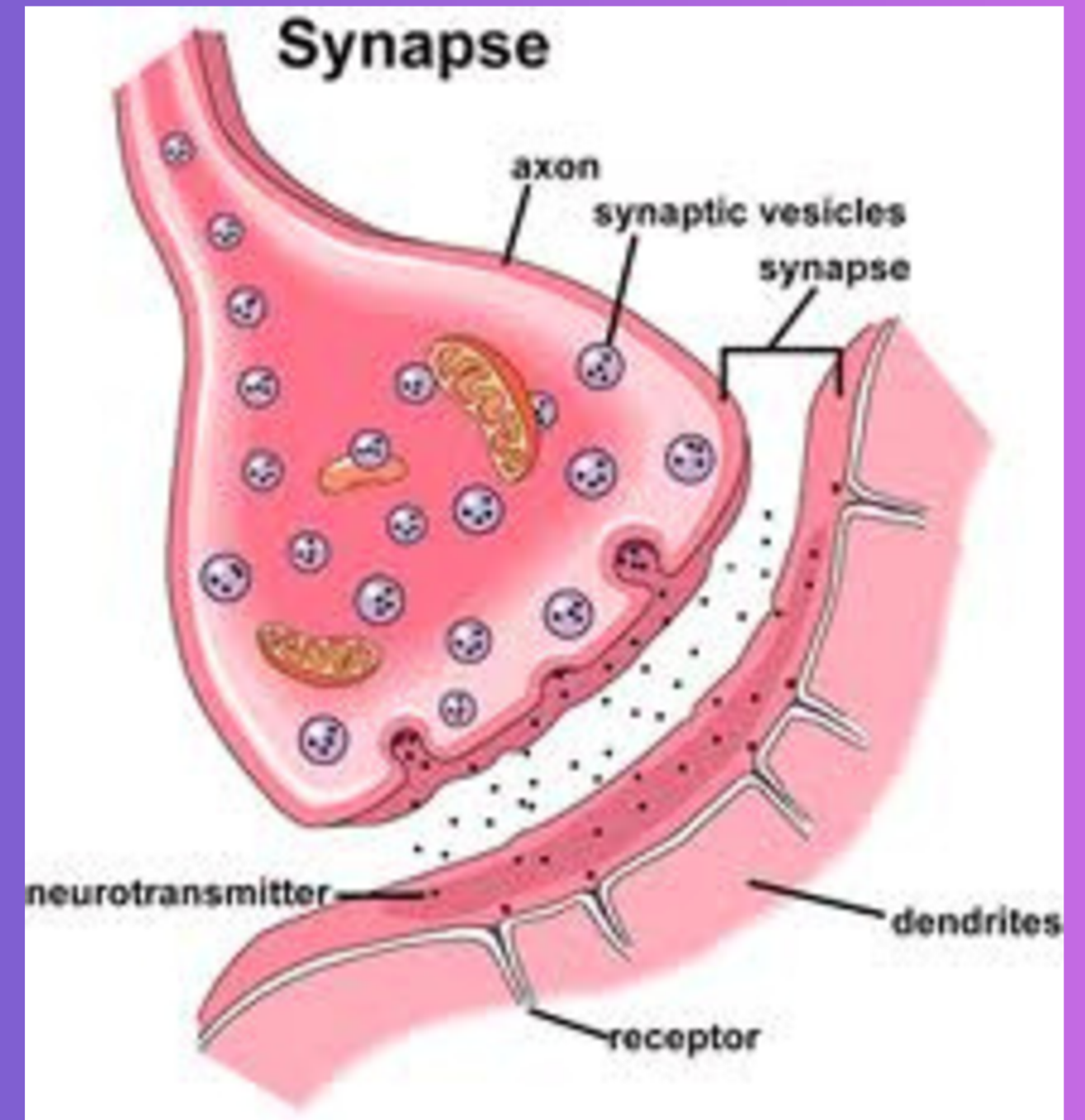
# The Neuron

- Neuron –The structural unit in the brain responsible for the functioning of the brain.
- Nerve net theory –The idea that the nervous system consists of a network of connected nerves.
- Neuronal theory –The idea that the nervous system is made up of individual nerve cells.



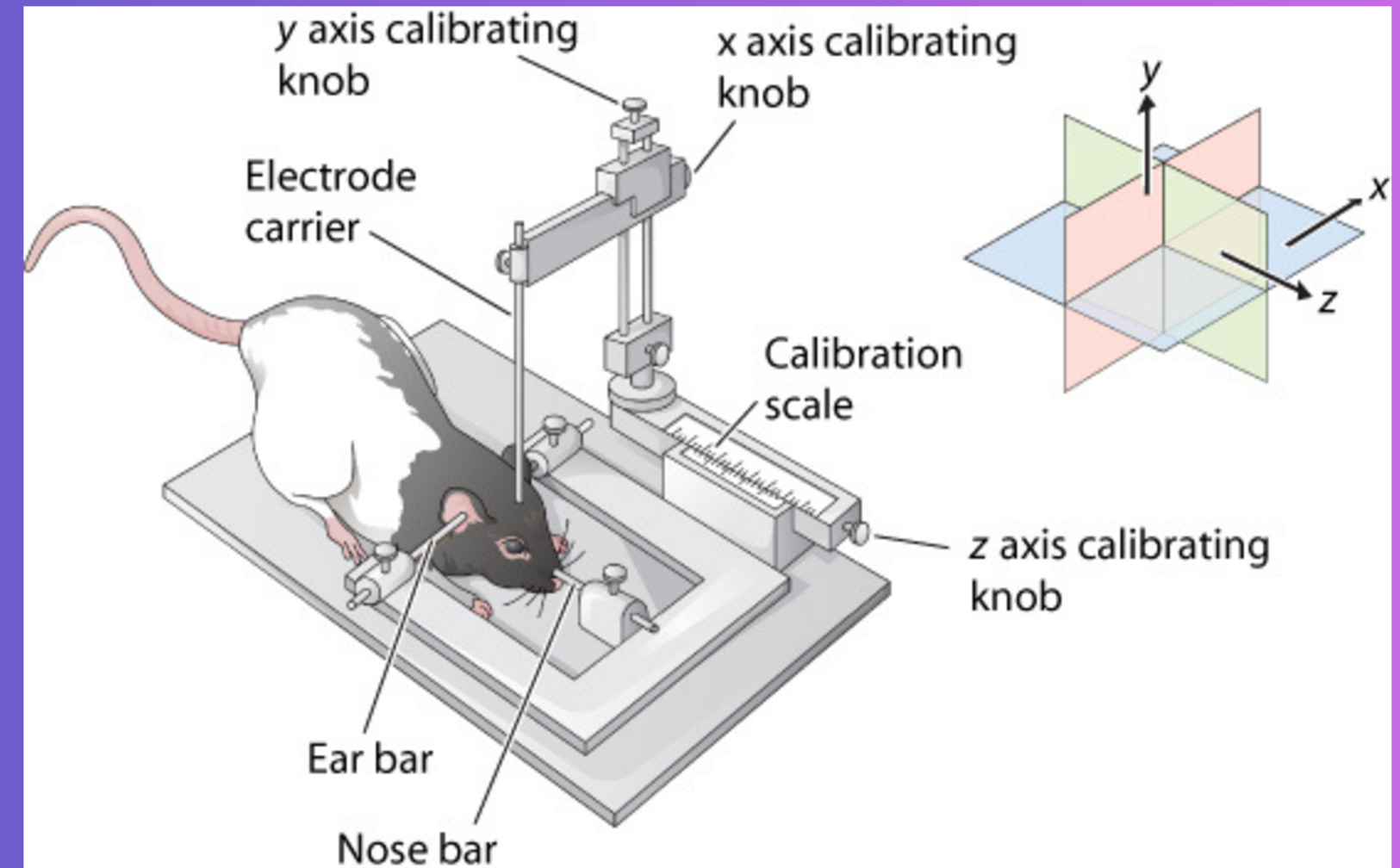
# The Synapse

- Synapse –The point of functional contact between a neuron and its target.
- Sherrington studied reflexes and the interaction of neurons. He coined the terms synapse.
- Loewi demonstrated that neurons contain chemicals (neurotransmitters) that are released into the synapse and act to stimulate the target neuron.



# Techniques for Studying Brain Function: Ablation of Neural Tissue

- Ablation (lesioning) –The experimental destruction of neurons or the surgical removal of a part of the brain which may suggest the functioning of a brain area.
- Stereotaxic apparatus –  
A surgical instrument that allows a neuroscientist to create a lesion in a specific region of the brain.



# Techniques for Studying Brain Function: Static Images of the Nervous System

- Computerized axial tomography (CAT scan) – produces an image of the brain by shooting a narrow beam of x-rays from all angles to produce a cross-sectional image.
- Magnetic resonance imaging (MRI) – produces a 3D image of the brain by passing a strong magnetic field through the brain, followed by a radio wave, to measuring the radiation emitted from hydrogen atoms.



# Techniques for Studying Brain Function: Static Images of the Nervous System

- Diffusion Tensor Imaging – technique using specific radio frequencies and magnetic field pulses to reveal bundles of myelinated axons in the living human brain



# Techniques for Studying Brain Function: Recording Nervous System Activity

- Macroelectrode – An electrode designed to record from many neurons at once.
- Microelectrode – An electrode designed to record the activity of one or a few neurons.
- Electroencephalogram – EEG; a graphical record of the electrical activity of the cerebral cortex.



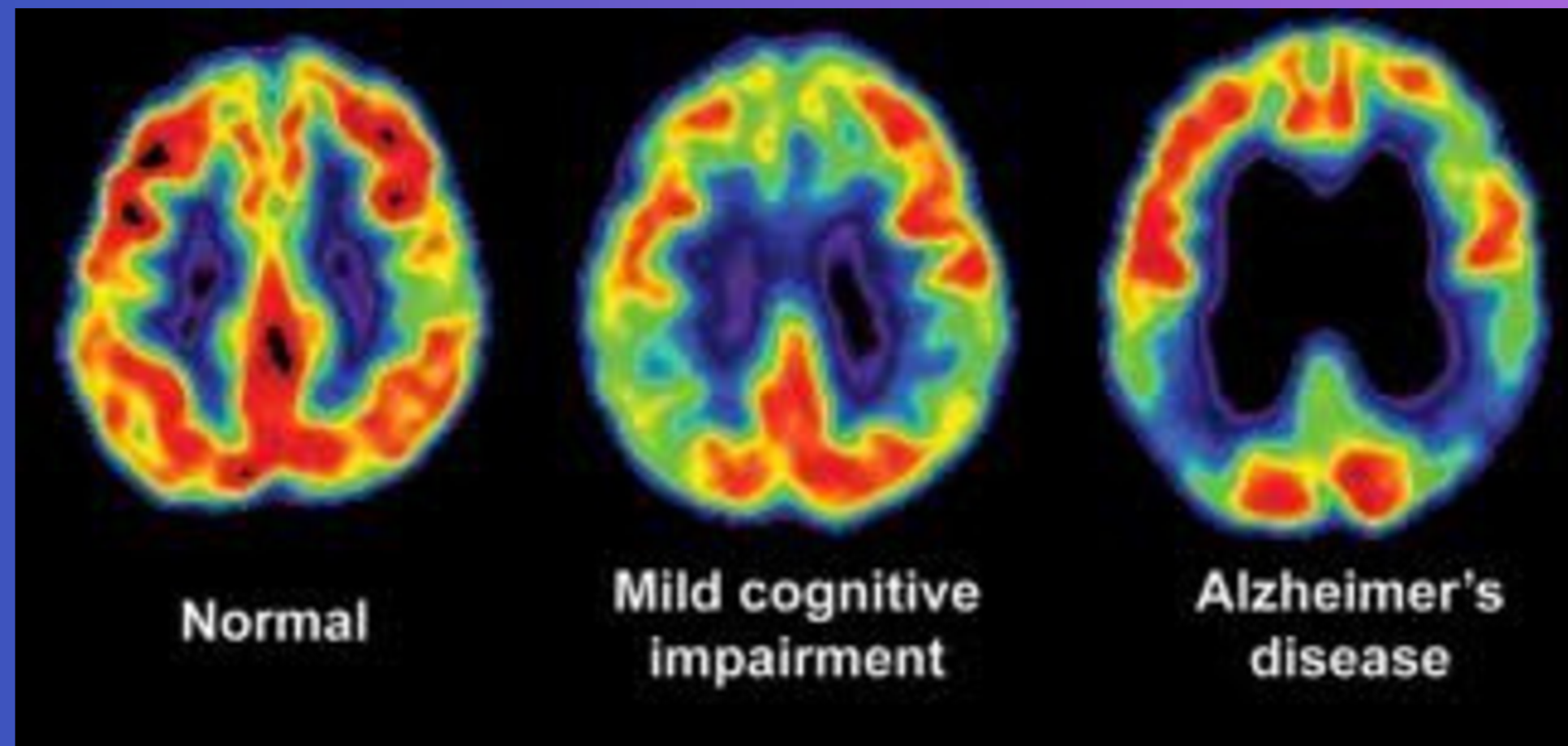
# Techniques for Studying Brain Function: Recording Nervous System Activity

- Evoked potential – A neural response to sensory stimulation introduced by an experimenter.
  - Determine specific brain areas that respond to sensory input
  - Identify the types of sensory stimulation different people respond to.



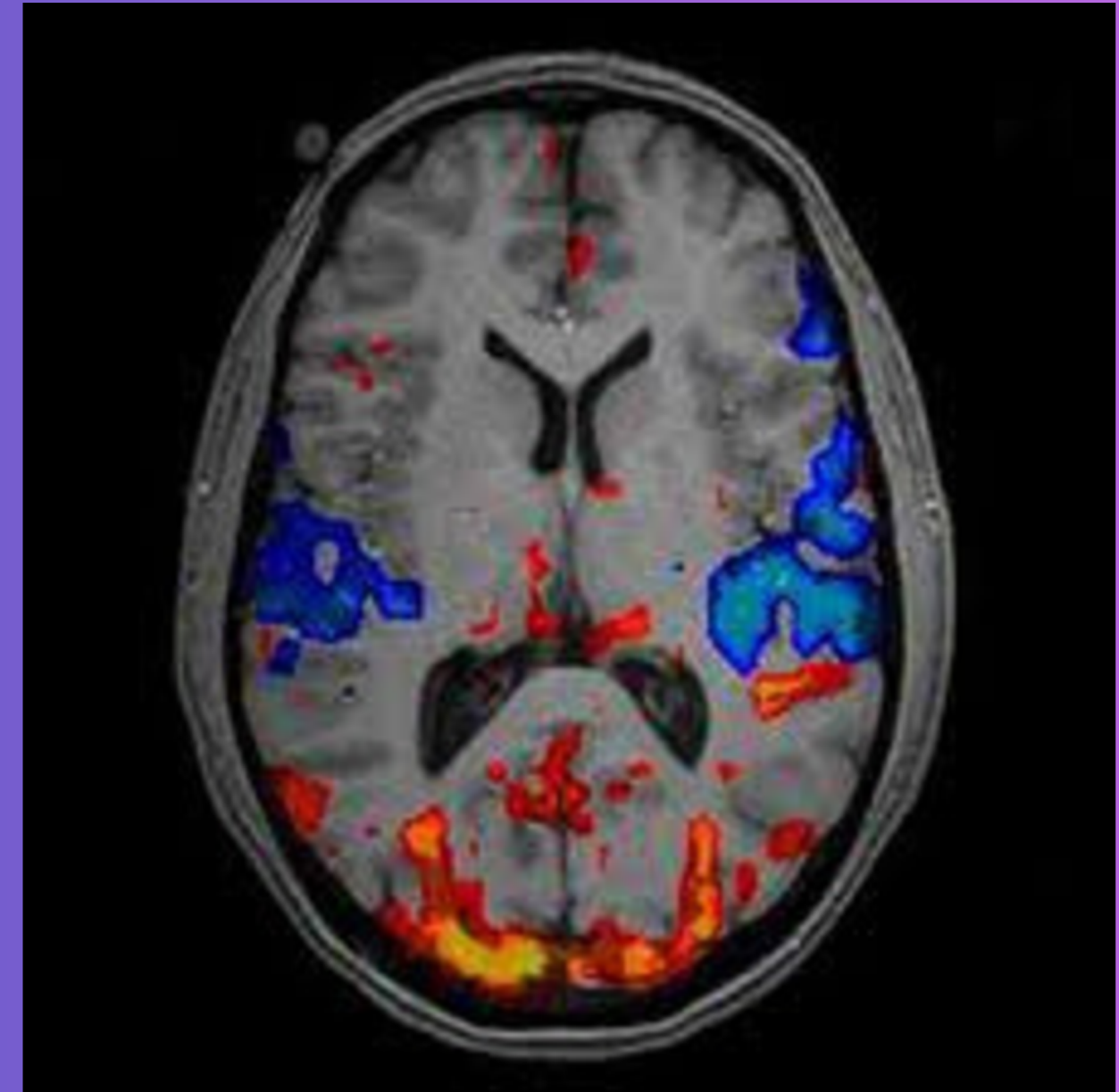
# Techniques for Studying Brain Function: Recording Nervous System Activity

- Positron emission tomography- (PET scan) is a technique that measures the metabolic activity of a specific structure in the nervous system in order to determine neural functioning.



# Techniques for Studying Brain Function: Recording Nervous System Activity

- Functional MRI – technique that uses high-powered, rapidly oscillating magnetic fields and powerful computation to measure cerebral blood flow in the brain and obtain an image of the neural activity in a specific brain area.



## Techniques for Studying Brain Function: Measuring Chemical Activity

- Autoradiography – The injection of radioactive chemicals into the bloodstream and subsequent analysis of neural tissue to determine where a specific chemical is found in the nervous system.
- Microdialysis – A technique for identifying the neurotransmitter in a specific area of the nervous system by measuring the chemical constituents of fluid from neural tissue.

# Genetic Methods

- Twin studies
- Adoption studies
- Genomic studies
- Targeted mutations

26



# Areas of Study within Biological Psychology

- Physiological psychology – investigation of the relationship between the nervous system and behavior by altering specific nervous system structures and then observing the effects on behavior.
- Psychophysiology – study of the relationship between physiology and behavior by analysis of the physiological responses of human subjects engaged in various activities.
- Psychopharmacology – investigation of the effects of drugs on behavior, focusing mostly on psychoactive drugs
- Comparative psychology – comparative study of the behavior of different species of animals, focusing on the influence of genetics and evolution on behavior.

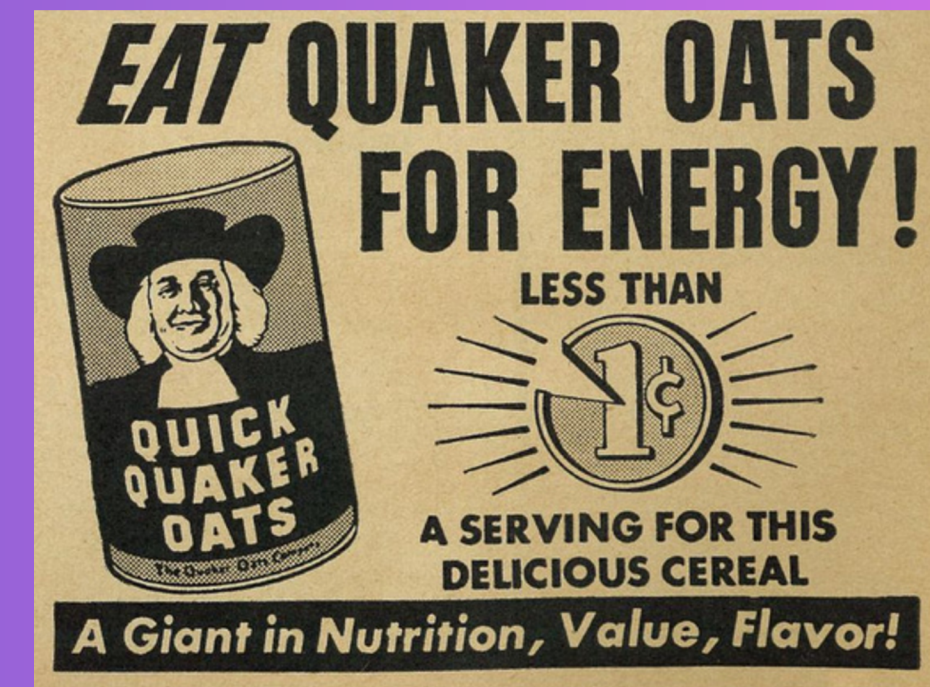
## Table 1.2

### Specializations Within Neuroscience

Specialization	Area of Investigation
Behavioral neuroscience	Impact of the nervous system on behavior
Cognitive neuroscience	Relationship between the nervous system and mental processes
Developmental neurobiology	Development of the nervous system
Neuroanatomy	Structure of the nervous system
Neurochemistry	Chemical basis of neural activity
Neuroendocrinology	Influence of hormones on the nervous system and of the nervous system on endocrine (hormone) function
Neuropathology	Disorders of the nervous system
Neuropharmacology	Effects of drugs on the nervous system
Neuropsychology	Behavioral consequences of disorders of the nervous system

# Ethics of Conducting Human Research

- Guidelines established by:
  - U.S. Dept. of Health and Human Services
  - American Psychological Association
- These guidelines require a researcher to demonstrate that the study maximizes potential gain in knowledge and minimizes potential risks to its participants.



# Ethics of Conducting Research: Research on Human Subjects

- The following guidelines must be adhered to when using human participants:
  - Subject is participating of their own free will.
  - Participant must provide informed consent after being given information regarding the general purpose of the study and the potential risks of participating.
  - Anonymity and confidentiality must be guaranteed.
  - After the study is completed, information about the results must be made available to the participant.
  - Participant is free to withdraw from the study at any time.

# Ethics of Conducting Research: Research on Nonhuman Subjects

- Federal laws, such as the Animal Welfare Act, protect nonhuman animals and ensure their proper care when used in research.
- Animal research can only be conducted when approved by a committee, such as the Animal Care and Use Committee (IACUC), which ensures that animals are used humanely and in strict accordance with local, state, and federal regulations, imposing penalties for any violations.
- Guidelines are also provided by the APA, specifying how such research is to be conducted and how research animals are to be cared for.