The California State University
WORKING FOR CALIFORNIA

Mark Van Selst

San Jose State University

COGNITION

Chapter 1: Introduction

Fundamentals of Cognitive Psychology

(Kellogg)

Fall 2013

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Psychology 135, Cognition
Section 3, Fall 2013

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(sjsu.edu → Psychology → Faculty → Van Selst → …)

Class Days/Time: Monday and Wednesday 9:00 – 10:15 PM
Classroom: DMH 359

Office Hours: Monday and Wednesday 10:30 – 11:45
Office Location: DMH 314 ("Jump the Advising Line")

(also advising Tuesday 10-12 and 2-4 so will be around)

Prerequisites: PSYC 1 (General Psychology)
Class ID Number: 42693

What is COGNITION ?

… and where have you seen the term outside of this class?

Syllabus (Green Sheet)

Course Scope: an INTRODUCTION to the general topic of "how people think" (this course is an overview of a broad range of topics)

Memory: The *mental processes* of acquiring and retaining information for later retrieval, and the *mental storage system* in which these processes operate.

Cognition: The collection of mental processes and activities used in perceiving, learning, remembering, thinking, and understanding, and the act of using those processes.

More Definitions of Cognition

Cognition: (People Think)

- cognito = "to know"
- co = "together"
- gnoscere = "know“

- The collection of mental processes and activities used in perceiving, learning, remembering, thinking, understanding, and the act of using those processes.

- The study of how people perceive, learn, remember, and think about information.

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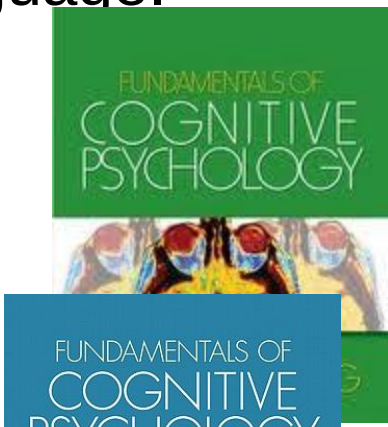
Catalog Description and Required Text

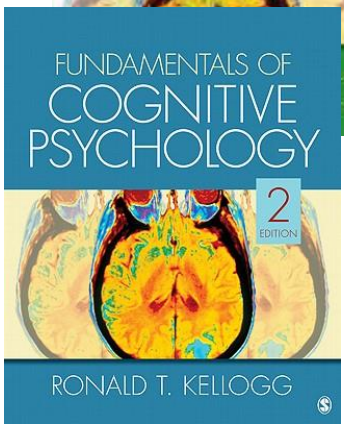
Course Description

- The activity of knowing: acquisition, organization and use of knowledge. Processes involved in that activity, including perception, memory, thinking, and language.

Required Textbook

- Kellogg, R.T. (2007). *Fundamentals of Cognitive Psychology*. Sage. ISBN 978-1-4129-3692-7.
- **The Second edition (1st edition mostly ok…)**





Course topics

Chapter 1:	Introduction to Cognitive Psychology
Chapter 2:	Perception
Chapter 3:	Attention and Consciousness
Chapter 4:	Memory systems
Chapter 5:	Remembering events
Chapter 6:	Memory distortions
Chapter 7:	Knowledge Representation
Chapter 8:	Language
Chapter 9:	Problem Solving
Chapter 10:	Reasoning and Decision making

Core Concepts (Kellogg)

- Mental representations
  - hierarchical systems
  - cognitive architecture
- Stages of processing
- Serial vs. parallel processing
- Memory stores
- Consciousness
- Emotion

Finding Course-Relevant Materials

www.sjsu.edu → PSYCHOLOGY

www.sjsu.edu/psych → Faculty and Staff

www.sjsu.edu/psych/contact/ → Van Selst (http)

http://www.sjsu.edu/people/mark.vanselst/courses/p135/

- You WILL need access to SJSU library resources

  Bernd.becker@sjsu.edu

Course Goals

Goal 1. Knowledge Base of Psychology:

- Students will demonstrate familiarity with the major concepts, theoretical perspectives, empirical findings, and historical trends in cognitive psychology.

Goal 2. Research Methods in Psychology:

- Students will understand basic methodological approaches used in cognitive psychology, including research design, analysis, and interpretation.

Goal 3. Critical Thinking Skills in Psychology:

- Students will understand and be able to use critical and creative thinking, skeptical inquiry, and a scientific approach to address issues related to behavior and mental processes.

Goal 4. Application of Psychology:

- Students will understand and be able to apply psychological principles to individual, interpersonal, group, and societal issues.

Goal 5. Values in Psychology:

- Students will value empirical evidence, tolerate ambiguity, act ethically, and recognize their role and responsibility as a member of society.

Evaluation

11 assignments (see schedule, 3-5% each [49%])

- Wednesday, Sept 4 Asst 1 (Scope and Concepts) [3%]

4 mostly non-cumulative exams [51%]

- Wednesday Sept. 18th [10%, chapter 1-2]
- Monday Oct. 21st [15%, chapter 3-5]
- Wednesday Nov 6th [6%, chapter 7-8]
- Wednesday Dec 11th (7:15AM) [20% (final), chapter 9-10]

The course will be graded out of 100 (60% for a D- pass)

Introductions

ME

UBC, Waterloo, NASA-Ames, SJSU

Dual-Task, Alcohol, Decision Making, Visual Cognition, Consciousness

(and sailboat racing)

YOU

name, program, when do you expect to graduate? future plans?

EXPECTATIONS

Social Expectations: you are adults, I am human

- Etiquette
- Disability / Modifications
- Exam Rescheduling (exam early)

Academic Expectations:

- Lateness is bad (be sure to keep current work on time)
- Plagiarism is worse
- Poor grammar, illegible text, or unintelligible writing will hurt your grade

Assignment 1: Concepts

GOAL: To have you demonstrate your grasp of one (or more) of the concepts that will be covered under the broad umbrella of cognitive psychology (if there is any question: ask me…).

This assignment is deliberately "exploratory," I expect you to think about what information or insights cognitive psychology might provide rather than necessarily having you do the research to reveal the current status of our full understanding of the phenomena from the literature.

I do expect you to have verified that the concept is one that is appropriate for treatment from a cognitive psychology perspective. Other than perceptual and procedural errors, many other issues related to memory, language, or processes of object recognition are all central to cognitive psychology and would be fruitful for you to consider prior to our in depth treatment of the underlying scientific knowledge.

Assignment 1 (Continued)

- Preview the text chapters
- come up with a “real world” situation that *you have personally encountered* that relates to Cognitive Psychology.
  - E.g., bank machine, a BART ticket dispenser, a cell phone, a fuel pump, a poorly organized textbook)
    - A simple example of a cognitive "design-facilitated error" is pulling on a door equipped with a pull-handle that you are supposed to push – the user of the device is cued by the shape of the handle [the affordance] to “push” rather than “pull” based upon prior learning.
- To help you think about the problem, you may want to think about what would be required to fix the problem.
- Use appropriate technical terms (with definitions) and cite your sources.
  - It is often useful to check text definitions (even if from later in the text – it is ok and even recommended to read ahead into the appropriate chapters) to ensure that you are using technical terms correctly.
- Since so many of the examples use automatic versus controlled processes as a starting point, I will mention that differences between automatic and controlled processes are discussed on Page 77 of the text.

Due Date: start of class, Wednesday, August 28th.

Assignment 1 (Continued)

Two pages, double-spaced, 12 point or larger typeface for each of the assignments. I will not grade beyond the first two pages.

1. describe the event and the underlying difficulty
2. define the relevant cognitive process or phenomena
3. clearly tie the two together

Note: It is always a good idea to include the definitions (and page numbers) from the textbook.

Assumptions & Foundations of Cognitive Psychology

1. Mental Processes Exist
   - Why say this? History of **Behaviorism** (struggle in the mid-50s in proving that thought and mental processes could be subject to scientific empirical research)
2. Firm Commitment to Objective Observational Methods
   - Why say this? History of **Introspection**
3. Information Processing Approach
   - Why say this? This **metatheory** (overall approach) captures the philosophy of Cognitive Psychology

History of the Cognitive Approach

The history of what we now call cognitive psychology is largely the history of whether or not we can infer the existence what we cannot directly measure with additional flavoring by the ‘current’ view of knowledge.

RATIONALISM (PLATO)

Plato (ca. 428-348 B.C, *The Republic*): Plato posits a tripartite division within the self:

- the ***rational soul*** (mind or intellect),
- the ***spirited soul*** (will or volition),
- the ***appetitive soul*** (emotion or desire)

- ***Rationalism:*** Knowledge is acquired through logical analysis.

EMPIRICISM (Aristotle)

Aristotle(384-322 B.C.):

- ***Empiricism:*** Acquisition of knowledge through experience and observation → (Locke) "*tabula rasa" (blank slate).*

Rationalism vs. Empiricism

Rationalism

- Phenomena can be understood through careful thought and logical proof
- reason is the best route to knowledge
- logical deduction
- Knowledge comes from intellectual effort (logical proof derived from the basic 'fact' of thought - Descartes)
- Logic/Rationalism led to *Descartes* (1596-1650) "Cogito, ergo sum" [I think, therefore I am]

Empiricism

- Phenomena are to be investigated by careful objective observation
- Methodological Prescription: rely on observation & measurement
- "Straight from the horses mouth“
- *Aristotle*’s (384-322 BC) Empiricism *(‘unscripted tablet’)* led to *John Locke’s* (1632-1704) "*tabula rosa*" [blank slate] view of human experience

Immanuel Kant brought Descarte and Locke’s views together in arguing that both must function together in the quest for truth.

Historical Approaches to Understanding Phenomena

Rationalism

Empiricism

Structuralism – elementary units of thought / consciousness ("IS") ; seeks to understand the configuration of the elements of the mind and its perceptions by analyzing the perceptions into their constituent components (mode, form, quality, duration, etc.)

Functionalism – Organism in Environment ("IS FOR")… a very pragmatic approach… knowledge is useful in that it can be applied to things (e.g., William James)

Associationism – The study of the linking together of two events, objects or ideas because they tend to co-occur (Paul Broca: 1861). **Mental processes** operate by the association of a mental state with its successor states. **Behavior** occurs because of trial and error. Knowledge come from experience (e.g., British Associationists: John Locke, David Hume, John Stuart Mills; the related *Empiricism* is the doctrine of the superiority of experience over innate factors [this also influenced the development of Darwinian Evolution]) … "*the law of effect*" (Thorndike)

Behaviorism: (extreme version of *Associationism*: only can examine "observables")
[see next slide]

Nativists – Biology/Genetics largely determines abilities and tendencies. This is the classic "Nature" side of the Nature/Nurture Debate

Behaviorism

- Behaviorism can be seen as an extreme extension of Pavlov's work
- Antimentalistic (Mental Activity is seen as Epiphenomenal at best; mental processes do not exist or are unimportant)
- Nomothetic (defining the "typical" or "average" process)
- Replicable / Cumulative
- Experimental
- Development of the experimental method
- Use of rigid definitions (Operational Definition)
- Use of postulated mechanism of operations
- Testable claims

BEHAVIORISM

- John B. Watson (1878-1958): banishment of consciousness from scientific study
  - Observation
  - Measurement
  - Repeatability
- BEHAVIORISM: It is only appropriate to study observable responses and their relation to observable stimuli
- *"S-R psychology: (Stimulus Response)": We don't eat because we feel hungry, eating is an observable response that occurs in the presence of a verifiable stimulus, i.e. low insulin levels or viewing a plate of croissants*
- *Behaviorism was the dominant approach in the US for the first half of the 20th century before being rejected for its inability to accommodate cognitive influences.*

PEOPLE IN HISTORY

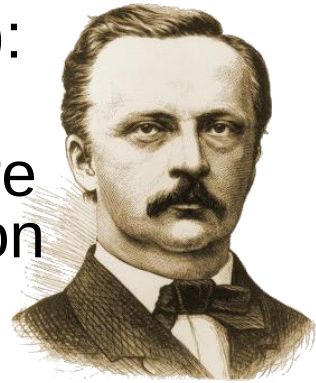
Note that this is only one possible history; others could focus on the changing perspective of memory across time (Aristotle's aviary model through serial models, the Von Neumann digital architecture (localized on/off) to the current holographic / distributed models.

It is important to recognize that the central issues of cognitive psychology – such as the nature of the mind and nature of the information within the mind – have only recently (125 years) been seen as amenable to scientific investigation

(Psycho-)Physiological History

Hermann von Helmholtz (1821-1894)

- Physician & Physicist (Physiology and Psychology):
- Measured the speed of neural impulses: this early work suggested that it might be possible to measure psychological phenomena (also contributed to vision research)



Gustav Fechner:

- Measured Sensation – "How much of a stimulus must there be in order to experience it" (Weber-Fechner's law)
- established a connection between the measured physical magnitude of a stimulus input and the psychological sensation associated with it.

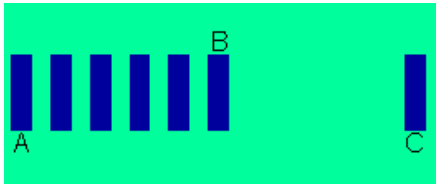
Christian Wolff

- The German philosopher Wolff (1679-1754) argued for a duality of both RATIONAL and EMPIRICAL Psychology (as later by Wundt, Wolff considered empirical psychology to be limited to introspection)

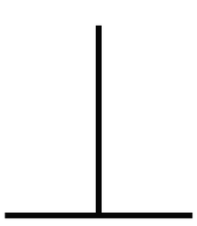
- Before Wolff, the study of the manifestations of the so-called soul, mind, thinking, memory, etc. was assimilated to the study of the nature of the soul (Psyche).

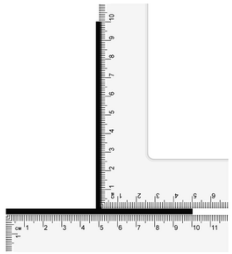
PEOPLE IN HISTORY
Wilhelm Wundt: (1832-1920)

- Scientific study of the mind is possible.
- Initial interest after reading Oppel's paper on regularity in illusions:
  - Oppel-Kundt Illusion



  - Horizontal-Vertical Illusion





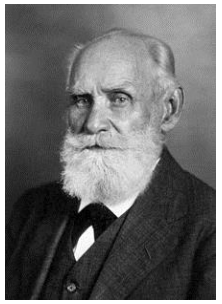
  - Vertical Stripes make you look fat

- Advocate of a *science of the mind* to create laws to explain mental events
- cannot measure higher order cognition
  - Basic elements of consciousness:
    1. ***Sensations*** (basic sensory dimensions that we encode from a stimulus)
    2. ***Feelings*** (emotions aroused by a stimulus)
    3. ***Images*** (purely mental expressions that seem sensory in nature)
- We need to measure sensation since only sensations can be studied: [Introspection: mode, quality, intensity, & duration]
- produced a student **Edward Titchener** (1982 to USA). Wundt used introspection to advance a Structuralist view with the investigator as the final authority (conflicts over "erroneous" introspections led to the behavioral revolution)

PEOPLE IN HISTORY

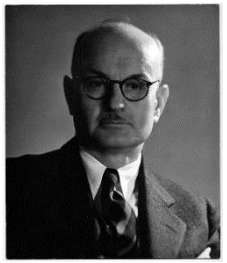
Ebbinghaus:

- Wanted to find an objective measure of association formation (measure of higher order cognition - partly because the structuralist view was that higher order cognition could not be studied scientifically)
- used the Method of Savings (savings during relearning relative to intitial learning episode) to assess strength of residual connection between ostensibly meaningless stimuli (CVC nonsense syllables). How many fewer repetitions to re-learn?



Pavlov:

- classical Conditioning

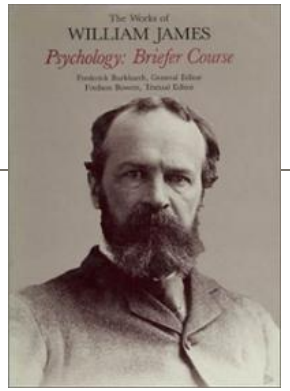


Tolman:

- understanding behavior requires taking into account the purpose of behavior (goal-directedness)

Hebb:

- cell assemblies as the basis for learning in the brain



William James

- Critical of the “atomist” Structuralist approach
- was interested in the stream of consciousness and the continuous ever-changing nature of our experience
- Wanted to understand the functions of the mind with an emphasis on mental processing rather than on mental structures

Functionalism: the Functions of Mental Experience

The development of scientific psychology: merging of the influences

Natural Sciences:

- Charles Robert Darwin:*On the origin of* Species (1859).

Physiology:

- Hermann von Helmholtz:*Treatise on Physiological Optics*Wilhelm Wundt:Principles of Physiological Psychology (GrundzügederphysiologischenPsychologie) 1873 and 1874.
- **William James: *The Principles of Psychology* 1889: Psychology as "the Science of Mental Life, both its Phenomena and their conditions"**
- Ivan Petrovich Pavlov: Physiologist, Psychologist: Behaviorism: "Classic conditioning", "conditional reflexes"
- Charles Scott Sherrington(1857-1952): synapses, reflexes and lengthy studies in spinal reflexes. Contributions to the physiology of perception, reaction and behavior. 'The Integrative Action of the Nervous System"(1904).

Physics: Gustav Theodor Fechner: psychophysics. *Elementeder Psychophysik*.

Medicine: Sigmund Freud: neurologist, founder of psychoanalysis

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"Modern" Psychological Perspectives (and their antecedents)

Gestalt Psychology:

- Strongly critical of the behaviorist viewpoint.
- The whole idea of gestalt (Gestalt = Figure / Form / Shape) psychology is to examine RELATIONS rather than elements
  - *"the whole is different than (and often not predictable from) the sum of parts"* (e.g., your computer)
- ASSUMPTIONS:
  - Psychological phenomena are not reducible (anti-atomism)
  - Understanding components will not automatically lead to understanding whole processes or systems
  - Psychological phenomena have to be studied in their entirety (perceiver & environment)
- "Stimuli Crave Organization" (but how…)

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Gestalt Psychology:
"Stimuli Crave Organization"

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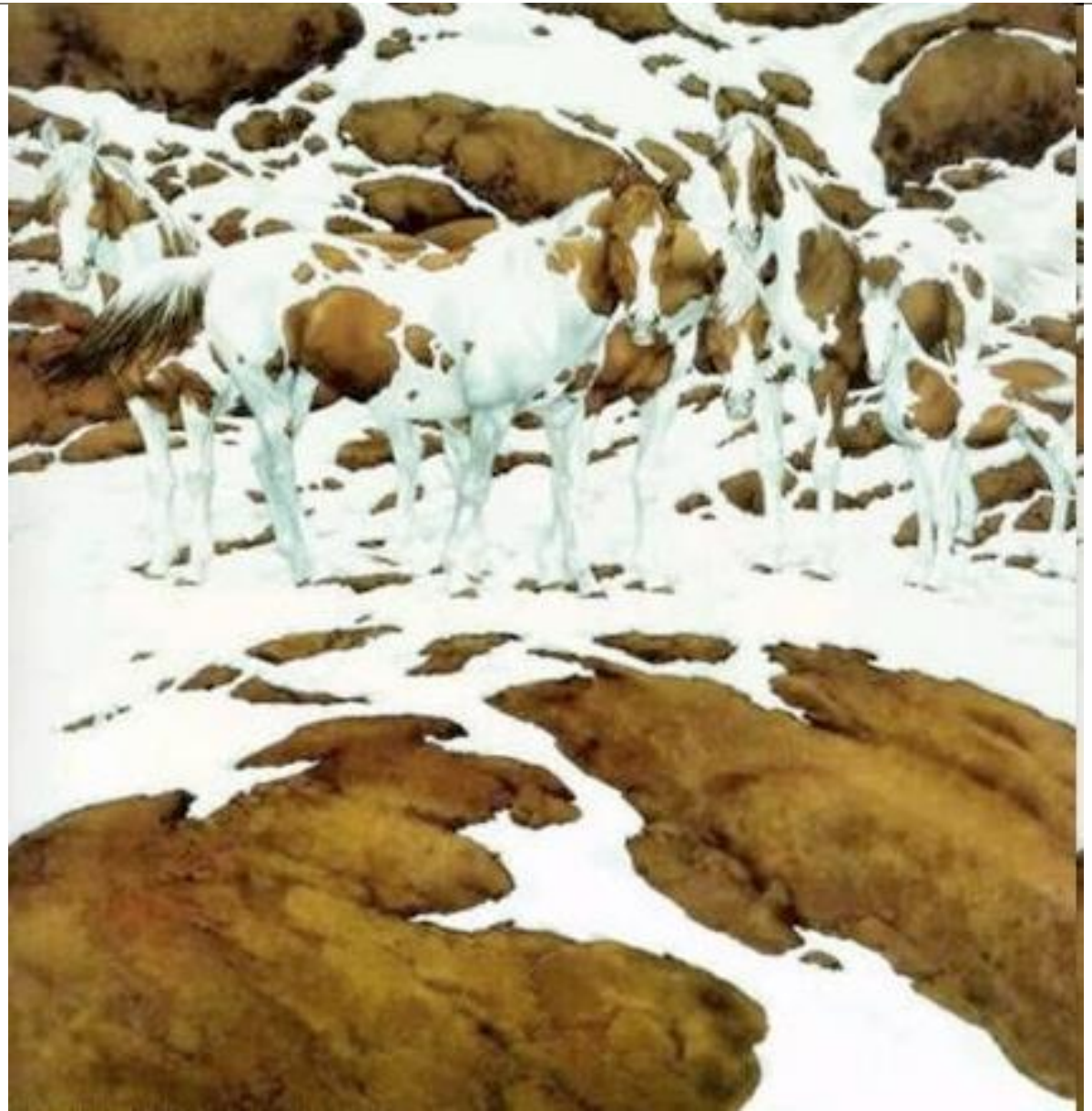
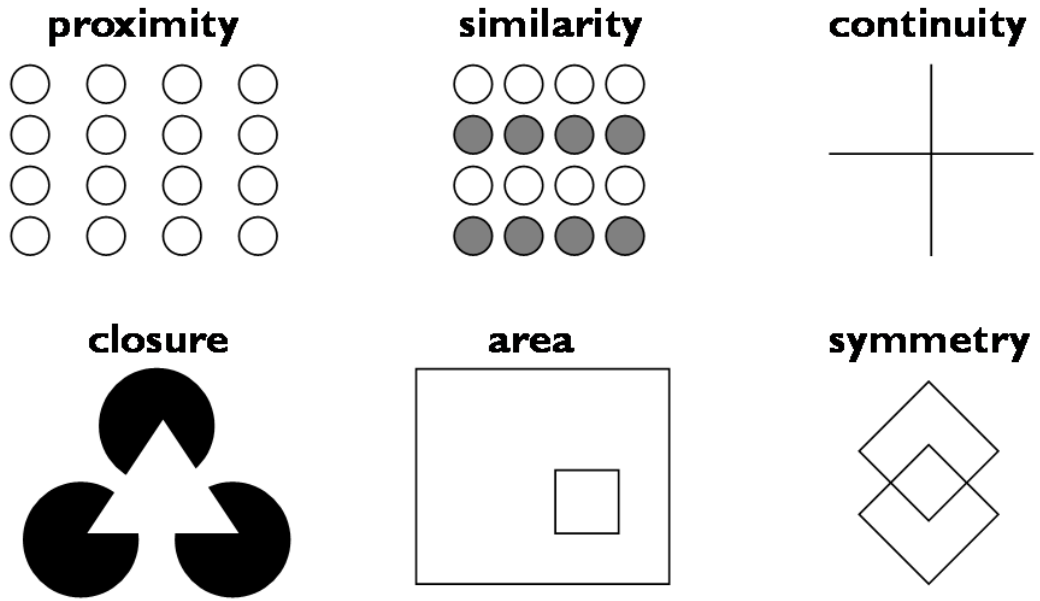
Gestalt Psychology:
"Stimuli Crave Organization"



Gestalt Principles of Grouping (not tested in this chapter)

The Gestalt Principles of Grouping

- Gestalt principles explain how eye creates a whole (*gestalt*) from parts



"Modern" Psychological Perspectives (and their antecedents)

Cognitive Psychology

- Advancing our understanding of people through Nomothetic Explanation (vs. ideographic)
- Empirical
- Experimental Approach
- Operational Definitions
  - + use of mental constructs
  - + humans as active information processors
  - + Information Processing Approach

THE "COGNITIVE REVOLUTION"

Developments in engineering, computer Science, and linguistics helped focus new research on the process of information storage, representation, and transformation.

- Rejection of the behaviorist tradition
- Emergence of HUMAN FACTORS ENGINEERING as a discipline during WWII
  - e.g., brake lever / landing gear
    - Redesign = different arm movements
- Man-machine interaction
- Borrowed terminology and concepts from communications engineering (signal detection theory)
- Humans as limited capacity information processors
  - e.g.,
    - Hicks Law
    - magical number 7 ± 2 (George Miller, 1956)
    - Sperling (iconic memory)

THE INFORMATION PROCESSING APPROACH

Central Analogy:

- The digital computer

Cognition is information passed through a system.

- People's cognitive abilities are "systems" of interrelated capacities.

People, like computers, are general purpose information manipulators. (note influx of computer terms into common language).

What is RESEARCH?

- **Theory**: organized body of explanatory principles
- **Hypotheses**: generated by theory, tentative proposals regarding expected empirical results
- **Statistical hypothesis testing**: inferential statistical analysis
- **Approaches to Research**
  1. laboratory (or other controlled environments)
  2. psychobiological research (including laboratory work)
  3. self-report
  4. case studies
  5. naturalistic observation (field observation)
  6. computer simulation (and artificial intelligence)

Windows into Cognitive Function / Structure

- Verbal Report (epiphenomenal?)
- Introspection (epiphenomenal?)
- Reaction Time (inference or leap?)
- Accuracy (inference or leap?)
- Brain imaging (inference or leap?)
- Neuroscience (inference or leap?)

Some ideas relevant to understanding cognitive psychology

1. Data in Cognitive Psychology can be fully understood in the context of an explanatory theory, but theories are empty without empirical data
    - An empirical generalization does not (in the absence of an underlying theory) provide an explanation
    - An important goal of science is PREDICTION (Description, Explanation, Prediction, Control)
2. Cognition is generally adaptive but not in all specific instances
    - Consider the functionalist question of "What For?"… why does the cognitive process exist? What situation or constraints produced the pattern of processing as a desirable consequence?
3. Cognitive processes interact with each other and with non-cognitive processes
    - Mental processes depend on perceptual processes.
    - It has been demonstrated that learning produces biological changes in the brain; thus, just as biological structures can impact cognitive operations, cognitive operations can impact biological structures.
4. Cognition needs to be studied through a variety of scientific methods
    - There is no "right" way to study cognition.
    - Recall the earlier presentation of thesis/antithesis/synthesis and the rationalist/empiricist discussion
5. All basic research can lead to applications and all applied research can lead to insight into basic understandings.

Seven Recurrent Themes in Cognition

1. **Attention**
   - This is the all important but poorly understood process that can act to limit and affect our cognitive processing. It is essential to most cognitive processing but only partially under our control. Is it a mechanism? a pool of resources? an epiphenomenon?
2. **Automatic vs. controlled processing**
   - The study of consciousness and control.
3. **Data-Driven vs. Conceptually driven processing.**
   - Processing driven by environment (data-driven) or existing knowledge (conceptually-driven)
4. **Representation**
   - How is information represented? same memory codes or different?
5. **Implicit vs. Explicit Memory**
   - Aware vs unaware; can information for which you have no conscious awareness affect your behavior?
6. **Metacognition**
   - o Our own perceived awareness of our own cognitive systems and capabilities
7. **Brain**

Evolution of the Human Brain

Australopithecus
(4 million years ago)

The brain capacity ranges from 450 to 650 cubic centimeters (cc).

Homo erectus
(1.6 million to 100,000 years ago)

Further development of skull and jaw are evident and brain capacity is 900 cc.

Neanderthal
(350,000 to 28,000 years ago)

The human skull has now taken shape: the skull case has elongated to hold a complex brain of 1,450 cc.

Homo sapiens
(200,000 years ago to present)

The deeply convoluted brain reflects growth in areas concerned with higher mental processes. (1,300 cc)

Regions of the Brain

Forebrain

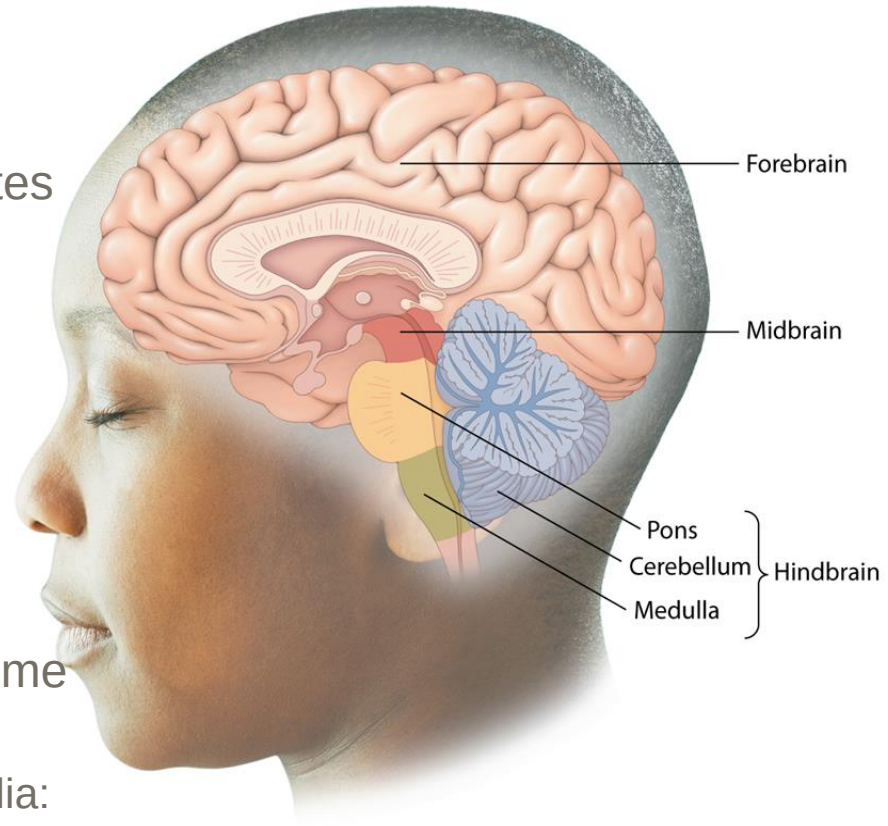
- Cerebrum (higher order processing)
- Thalamus (relay)

Midbrain

- Reticular formation (sleep & arousal; gates signals by importance [attention])

Hindbrain

- Medulla (breathing, heart rate, blood pressure, vomit, gag, salivate)
- Pons (bridge; sleep & arousal)
- Cerebellum (balance, coordination of complex voluntary movement (has some role in learning & memory)
  - adjoining region holds the basal ganglia: coordinates slower deliberate movement



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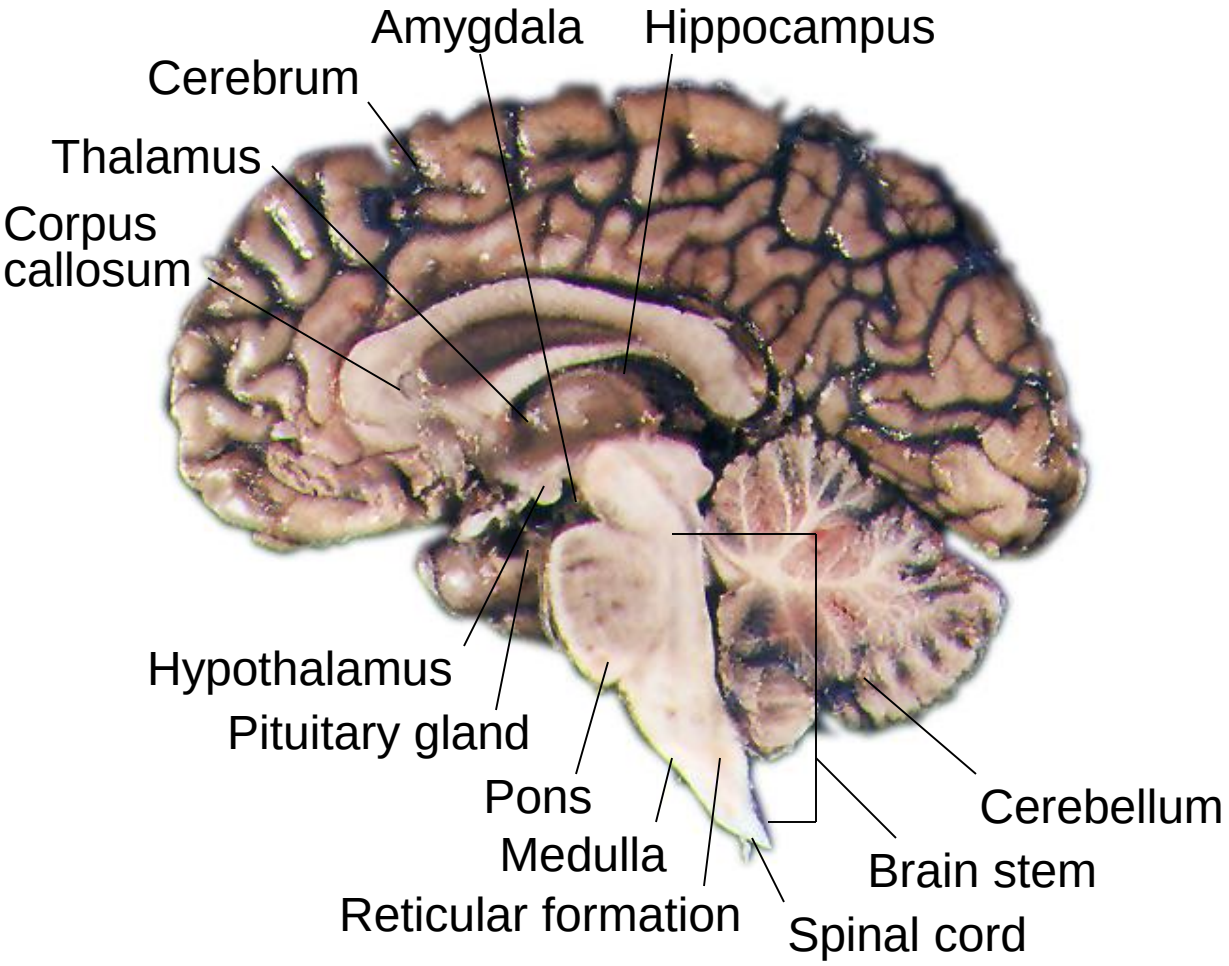
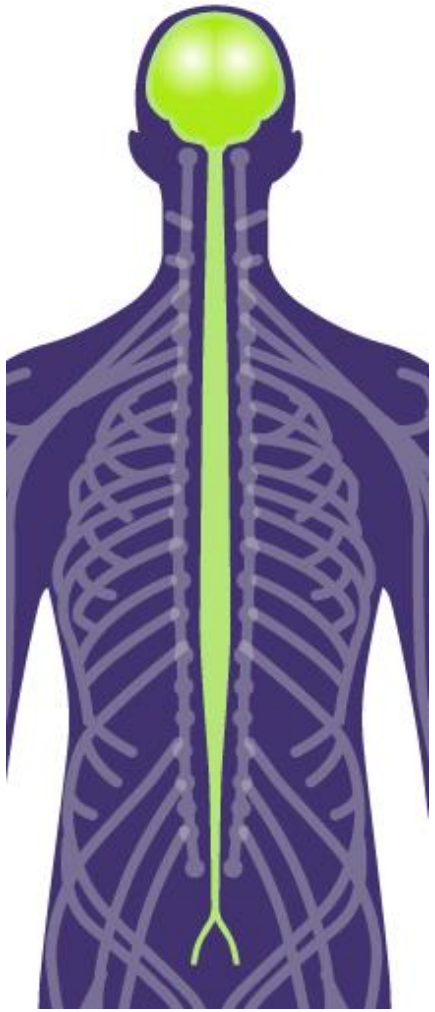
Regions of the Brain



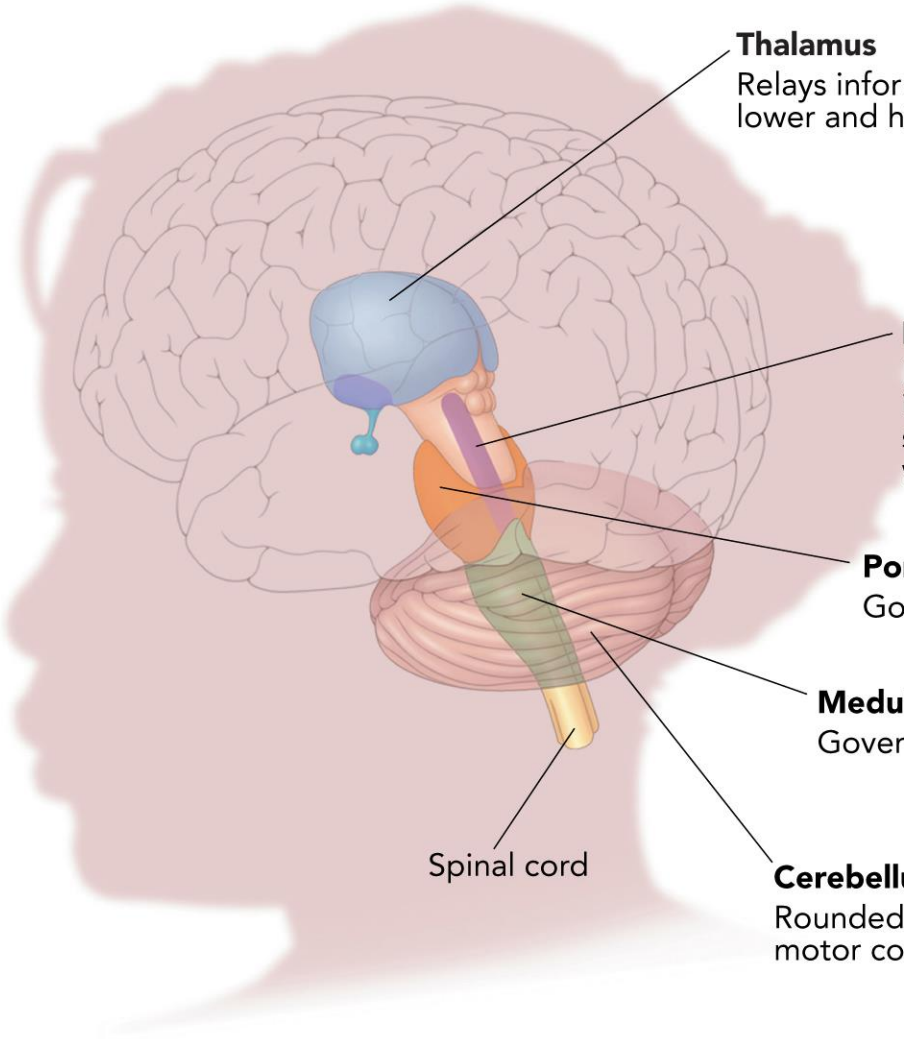
- Central Nervous System (CNS)
  - Brain
    - Forebrain
      - Thalamus
      - Hypothalamus
      - Cerebrum
      - Limbic system
      - Corpus callosum
    - Midbrain
    - Hindbrain
      - Cerebellum
      - Pons
      - Medulla
  - Spinal cord

Central Nervous System



3a Brain Stem Structures

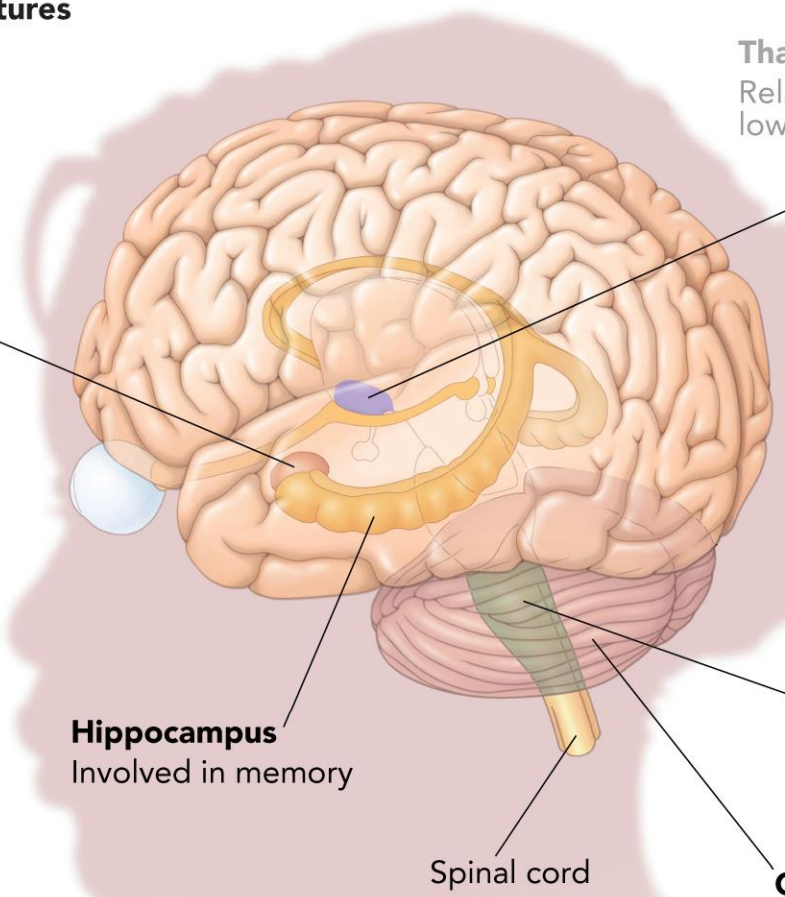
Identify the brain's key structures and functions.



Identify the brain's key structures and functions.

3a Brain Stem Structures

3b Limbic System Structures



Thalamus
Relays information between lower and higher brain centers

Hypothalamus
Governs eating, drinking, and sex; plays a role in emotion and stress

Amygdala
Involved in fear and the discrimination of objects necessary for survival

Reticular formation
Diffuse collection of neurons involved in arousal and stereotyped patterns, such as walking

Pons
Governs sleep and rousal

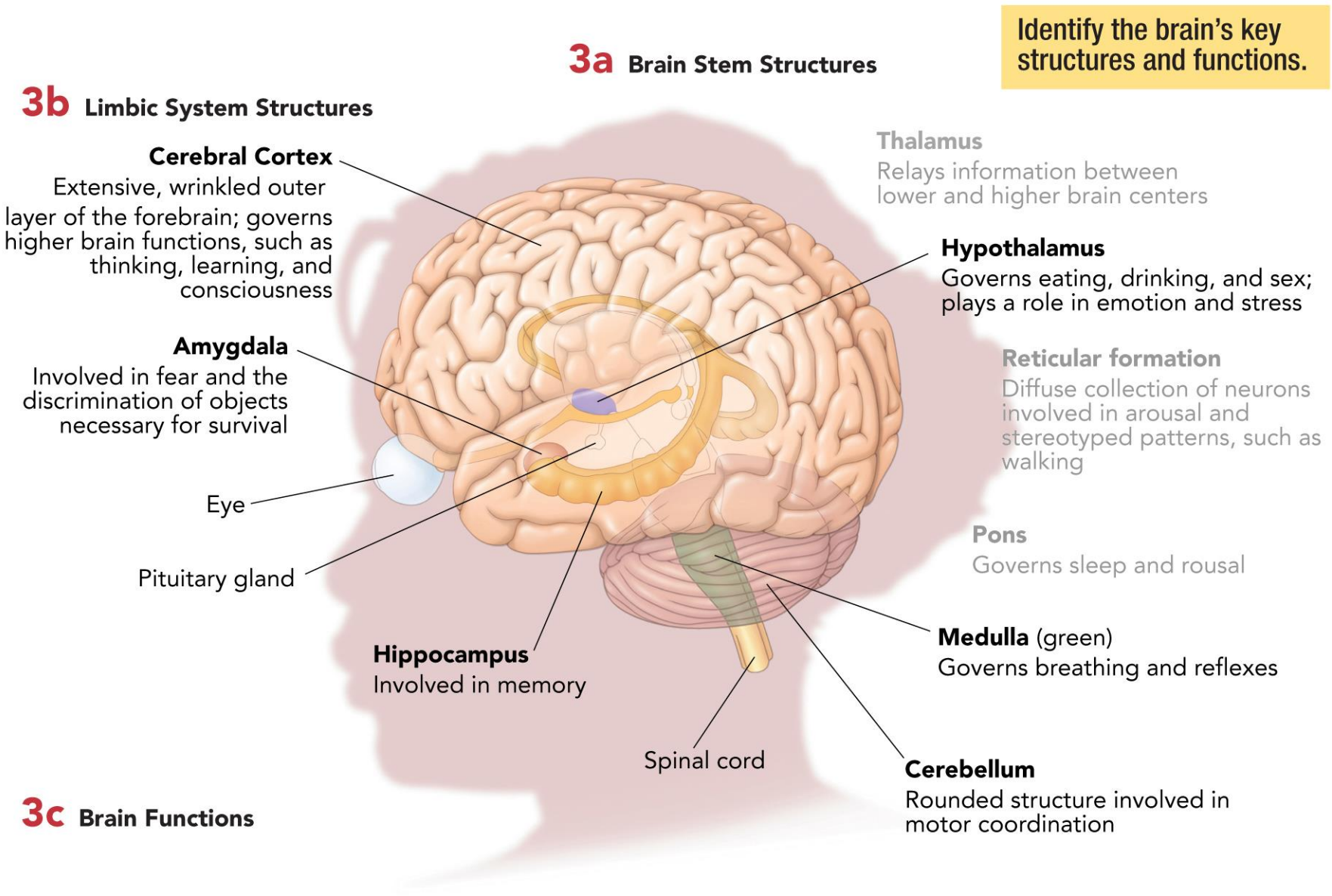
Hippocampus
Involved in memory

Medulla (green)
Governs breathing and reflexes

Spinal cord

Cerebellum
Rounded structure involved in motor coordination

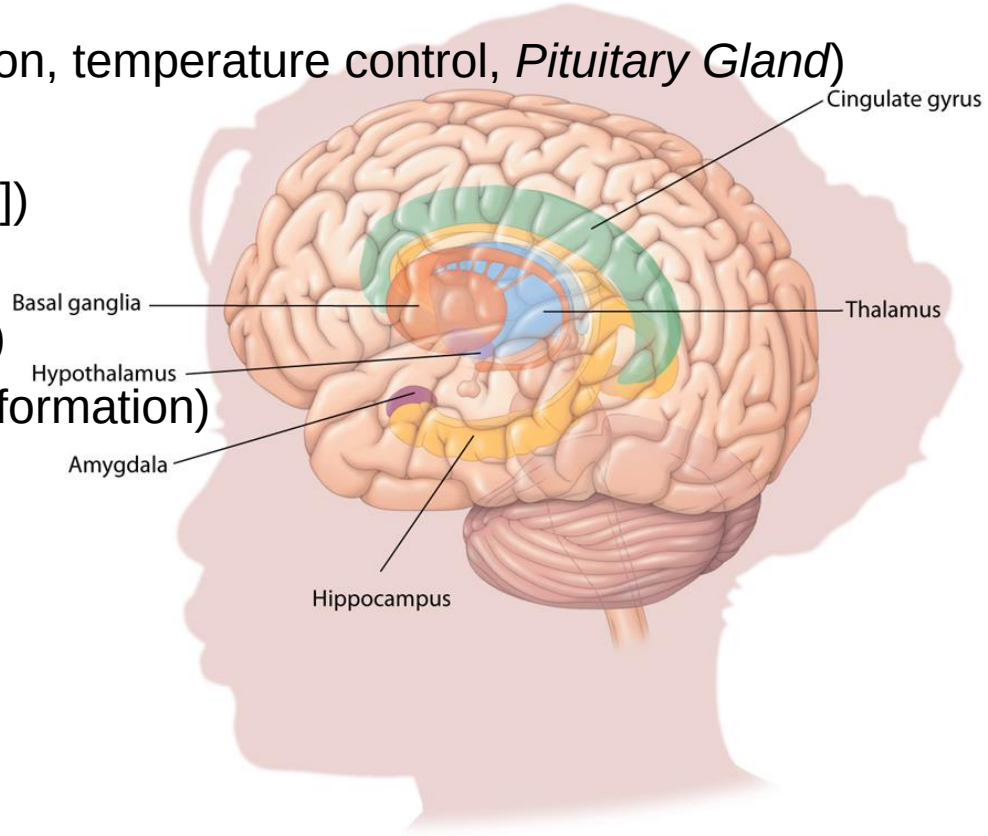
Identify the brain's key structures and functions.



Limbic system (motivation, emotion)

Note: the Limbic “system” may not function as a coordinated system

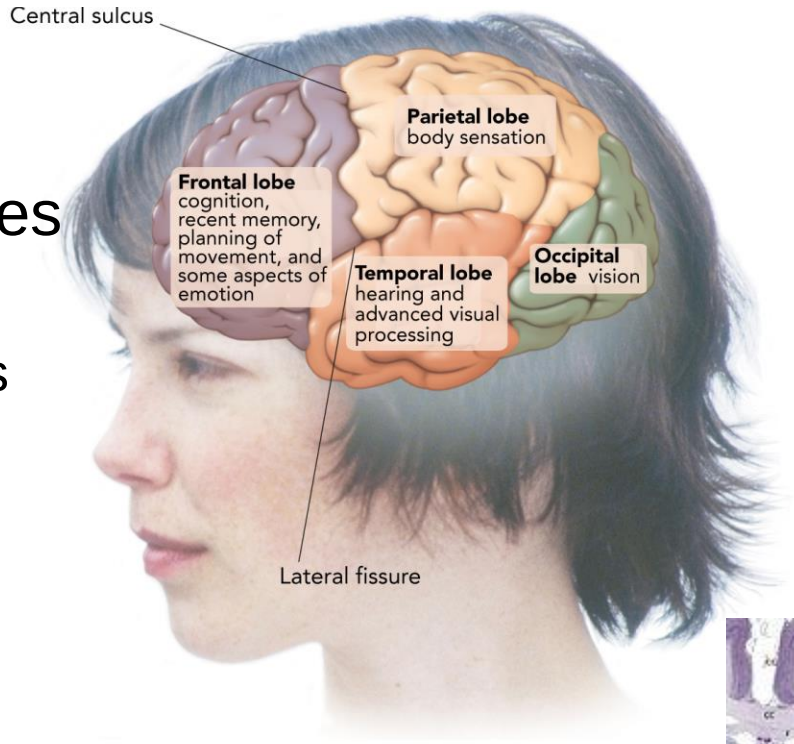
- Hypothalamus (hunger, thirst, motivation, temperature control, *Pituitary Gland*)
- Hippocampus (learning & memory)
- Amygdala (emotion [fear & aggression])
- Cingulate gyrus (attention, control)
- Basal ganglia (voluntary motor control)
- Thalamus (Relay center for sensory information)

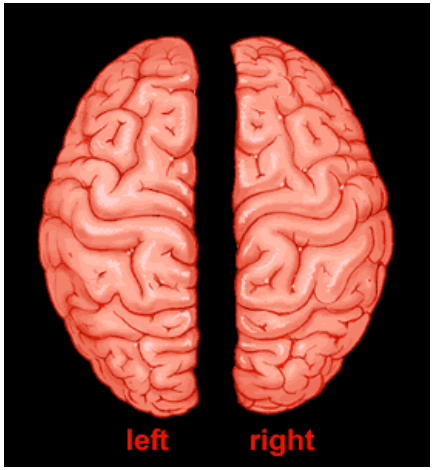


Cerebrum ("new brain") and the Cerebral Cortex

Cerebrum

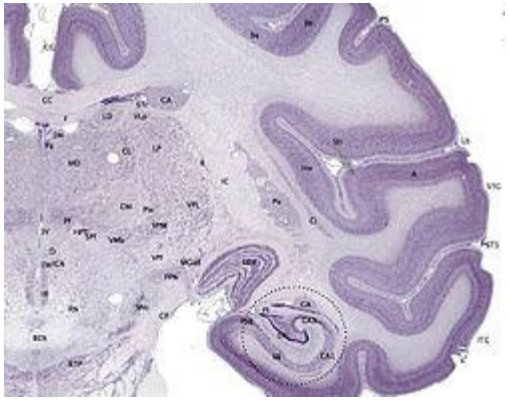
- Two hemispheres
  - Frontal lobes
  - Temporal lobes
  - Parietal lobes
  - Occipital lobes

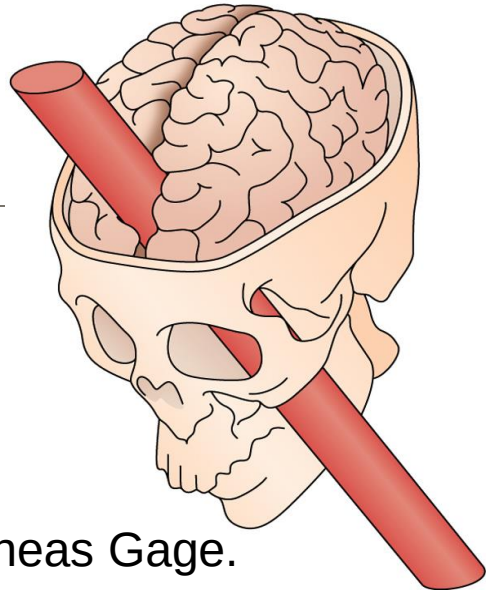




Cerebral cortex

- Outer layer of the cerebrum





Frontal Lobe Damage: The case of Phineas Gage

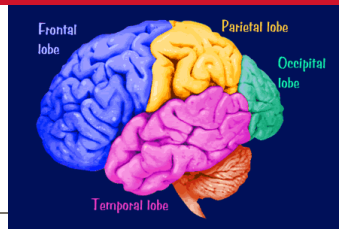
In 1848 a tamping iron was blown through the frontal lobe of Phineas Gage.

He survived with no paralysis or sensory deficits except for the loss of vision in his left eye, which was directly damaged by the rod. His manual dexterity was intact, and there was no noticeable difficulty in his speech, language, or capacity for rational thought.

What was impaired was his personality; Gage was no longer able to behave appropriately as a social being, and instead made choices that were consistently disadvantageous to him.

The implications became embroiled in medical debates of the time regarding the organization of the brain.

At the time, the idea of an area responsible for personality was beyond the pale for the vast majority of physicians and scientists.



Frontal Lobe Damage: The case of “Elliot”

1980s: neurologist Antonio Damasio began studying a patient with damage to a similar pre-frontal region (a benign tumor that had been surgically removed).

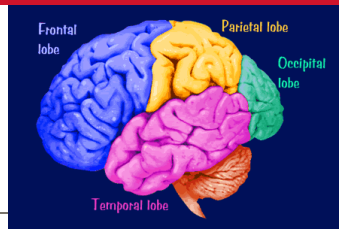
Elliott underwent significant personality changes that prompted Damasio to describe him as a "modern Phineas Gage."

His knowledge base survived and he could perform many separate functions just as well as he had before, Elliott could not be counted on to perform an appropriate action when it was expected. For example, if required to read and classify documents for a given client, Elliot could understand and categorize each of the separate documents, but he was likely to suddenly switch from sorting to spending the entire day reading individual papers in detail.

Very little impact on tested-IQ (convergent, not divergent thinking)

Elliot's relatives and Elliot himself recognized that he was "emotionally flat" compared to before his illness.

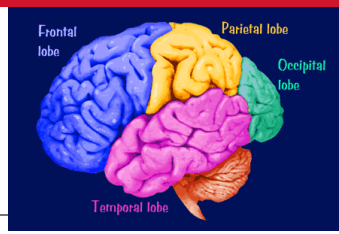
Objects and events that evoke emotional responses in most individuals failed to evoke an emotional response in Elliot.



Frontal Lobe: Conclusions

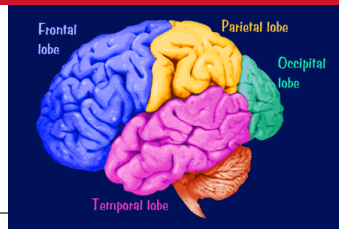
The frontal lobes are considered our emotional control center and home to our personality. There is no other part of the brain where lesions can cause such a wide variety of symptoms (Kolb & Wishaw, 1990).

Due to their location within the head and their size, the frontal lobes are extremely vulnerable to injury.



The frontal lobes are involved in:

- Motor function
- Problem solving
- Memory
- Judgment
- Impulse control (frontal lobe contribution to OCD)
- Social behavior (risk taking)
- Sexual behavior
- Kolb & Milner (1981) found that individual with frontal damage displayed fewer spontaneous facial movements, spoke fewer words (left frontal lesions) or excessively (right frontal lesions).
- One of the most common characteristics of frontal lobe damage is difficulty in interpreting feedback from the environment, manifest in impaired associated learning (i.e., using external cues to help guide behavior) (Drewe, 1975)
- Perseverating on a response (Milner, 1964)
- Noncompliance with rules (Miller, 1985)



Right hemisphere dominant functions: spatial, emotion, math (geometry)

Left hemisphere dominant functions: language, sequences, math (algebra)

Frontal lobe (front): inhibition, control, attention, personality

Temporal lobe (sides): sounds/smells (smell direct sense), time, balance, emotional control, categorize, abstract thought [broca's: semantics w/out syntax; wernicke's syntax w/out semantics (see pg 79).

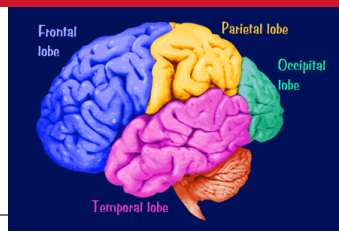
Parietal lobe (top): pain, touch, spatial relations, (homunculus), language

Occipital Lobe (back): vision

Corpus callosum: connects R/L hemisphere; if separated, shows "split brain" function (function without name, …)

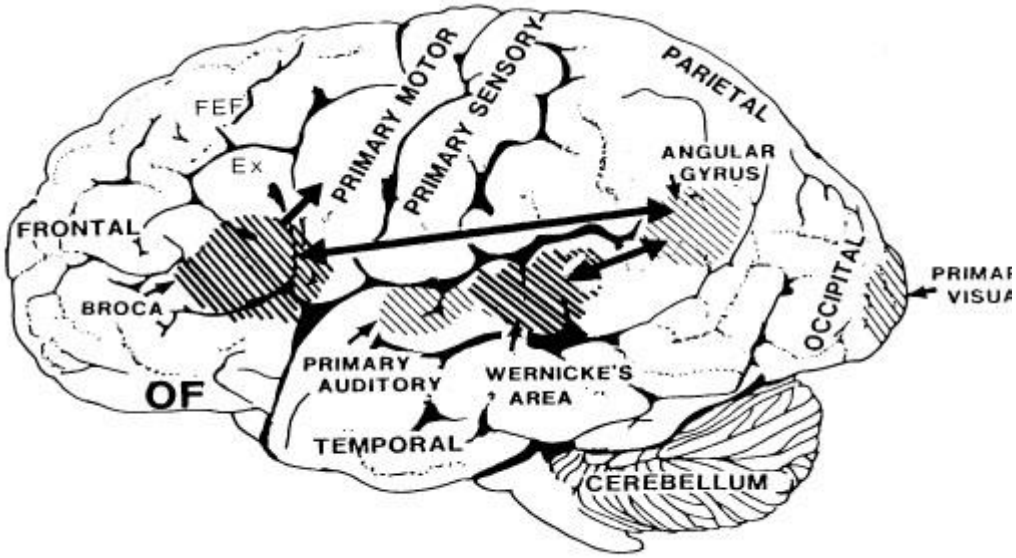
Somatosensory Cortex: (front of parietal lobe) receives sensory input from touch receptors

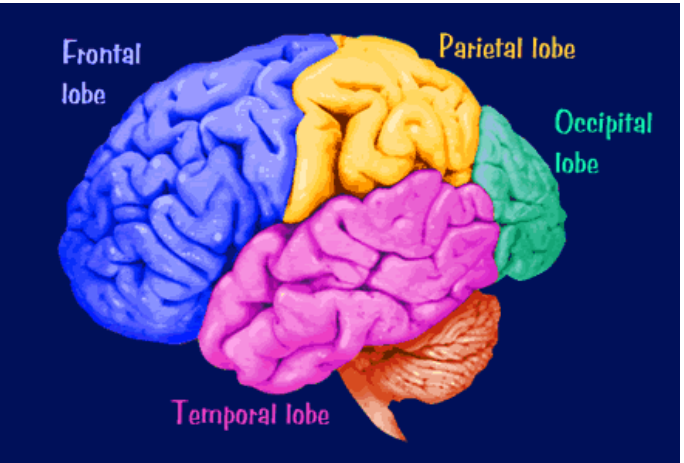
Motor Cortex: motor movement (back of frontal cortex)

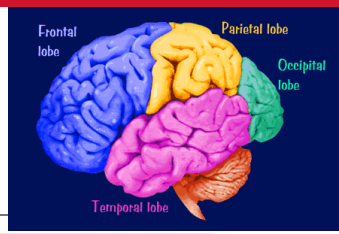


Hemispheres of the Cerebrum

- Language
  - Left hemisphere
  - Aphasia
    - Broca's area
    - Wernicke's area



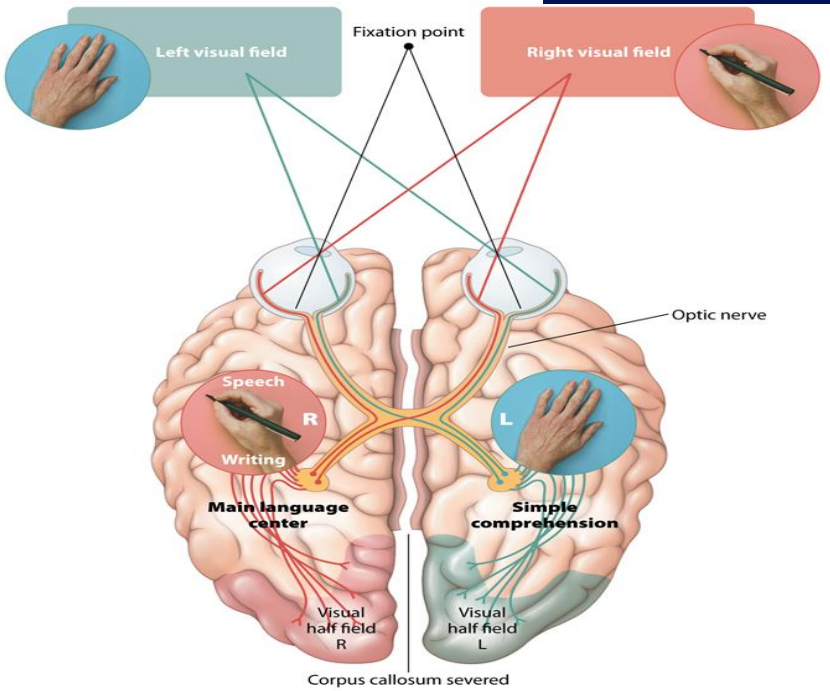


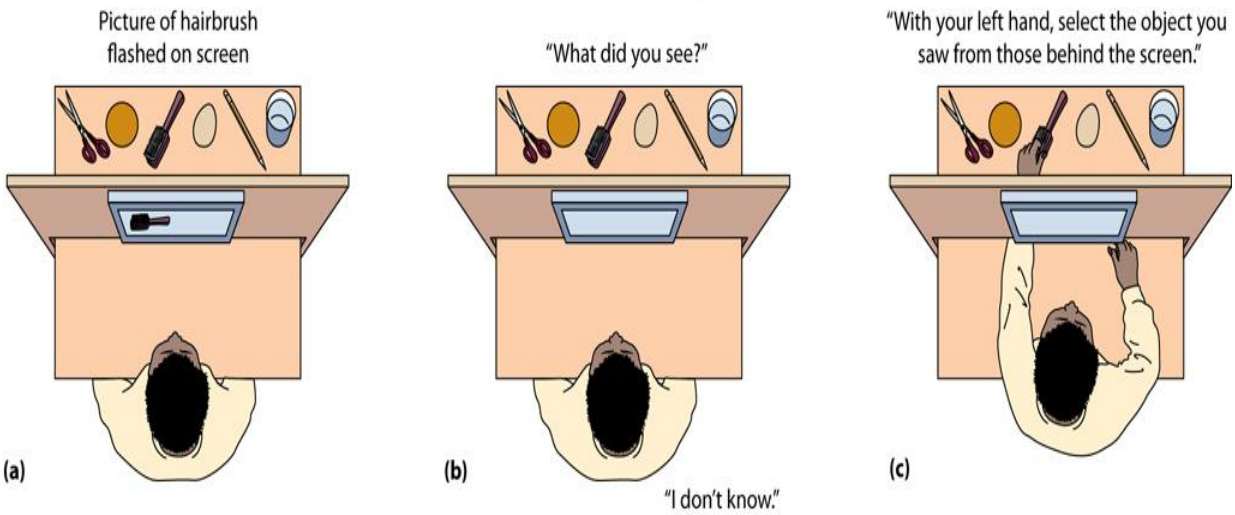


Communication Between the Hemispheres

The two hemispheres do not really operate independently

- Corpus callosum
- Split-brain research
  - PRP interference





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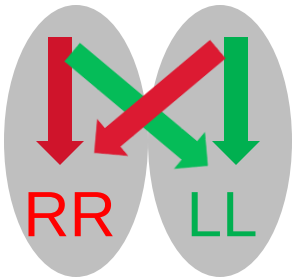
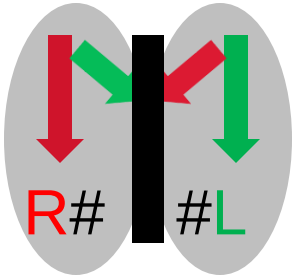
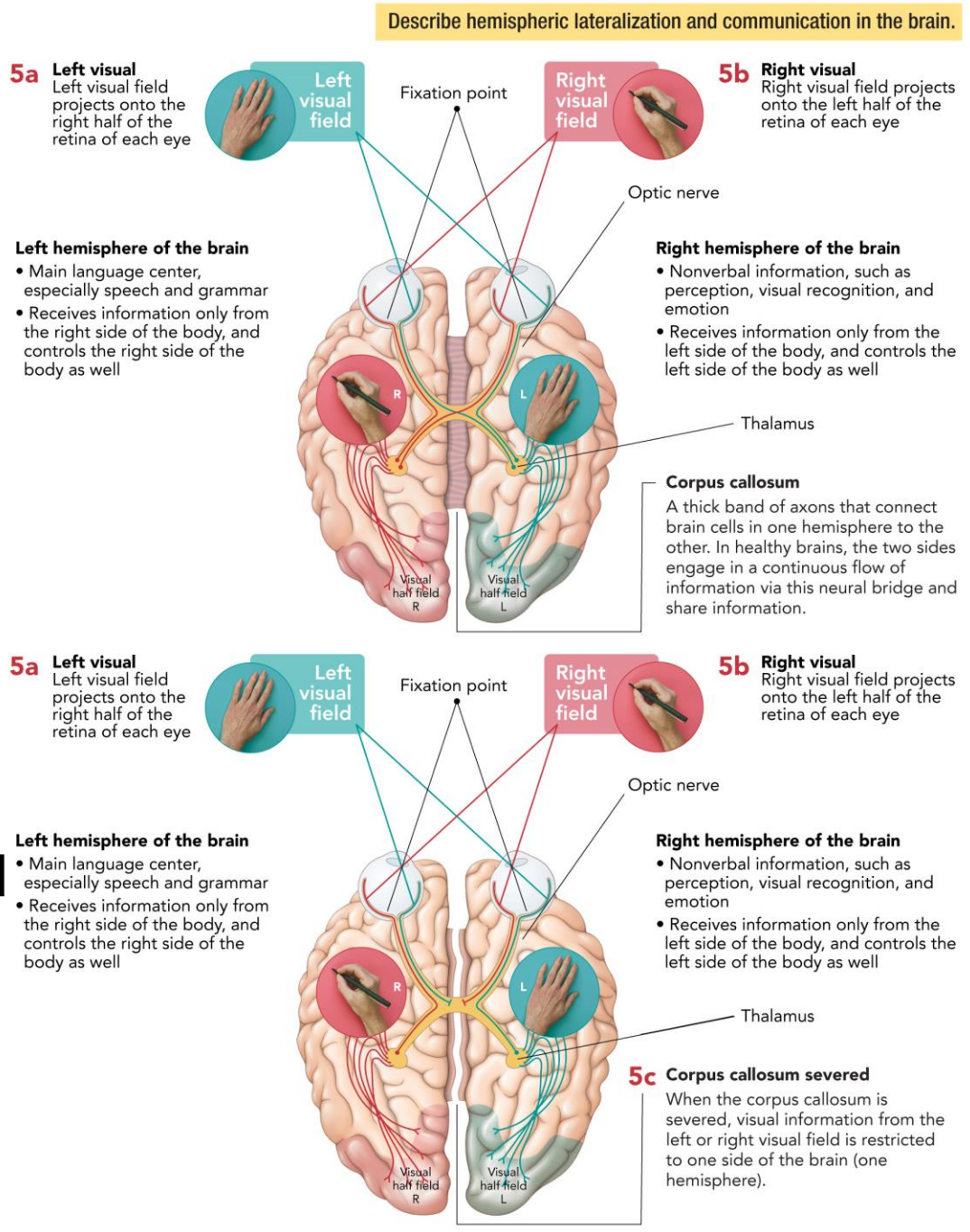
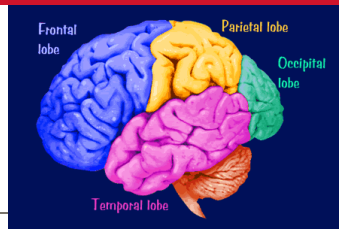
Corpus Callosum Intact



Corpus Callosum Severed







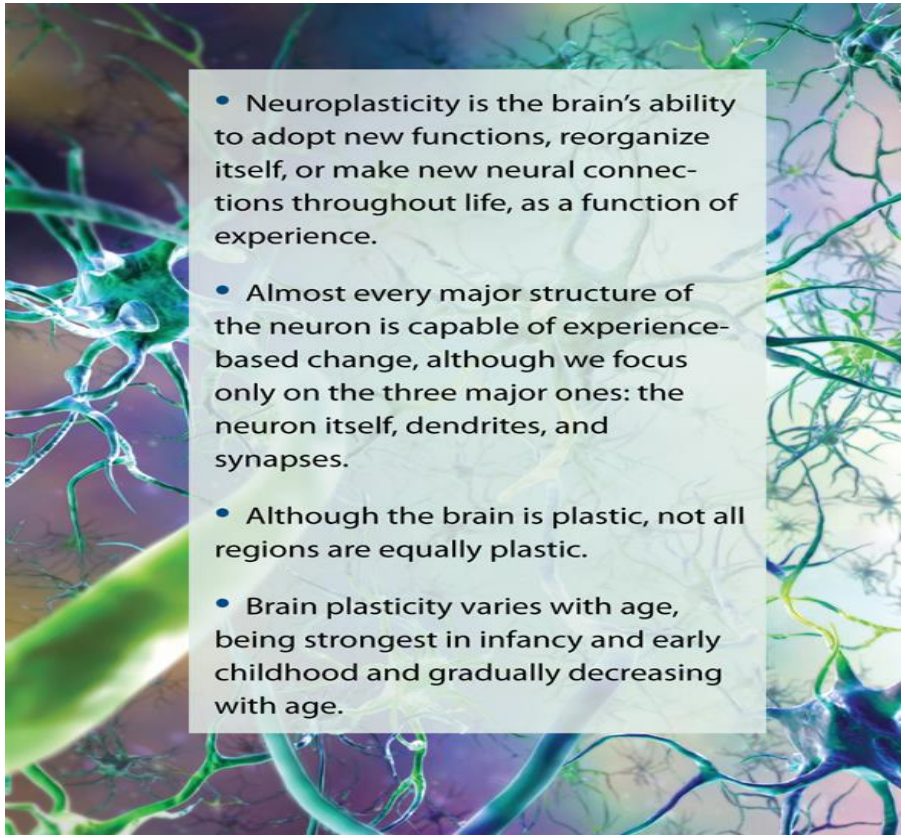
Brain Plasticity and Neurogenesis

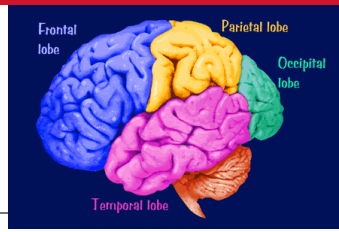
Neuroplasticity: adopt new functions or reorganize

Neurogenesis: development of new neurons

Arborization: development of new dendrites

Synaptogenesis: development of new synaptic connections





Evidence of Neuron Growth

- 1960s
  - cell division in the brains of adult rats was detected
  - Joseph Altman
- 1980s and 1990s
  - Neurogenesis in hippocampus

Learning About Brain Functioning

Electrical Recordings:

- *EEG* (Electroencephalography): measure of electrical activity at scalp to derive electrical activity within brain
- *ERP* (evoked response potential): characteristic 'spikes' and 'dips' in electrical signature derived from EEG data.

Direct Intervention:

- *Phrenology*: bumps on the head (discredited)
- *Direct Stimulation* (e.g., Penfield)
- *Lesion* (e.g., Phineas Gage, "Elliot", motorcyle/war/.., surgery)
  - **Broca's Area:** "production aphasia" (content w/out syntax): damage to predominantly motor area leading to difficulty in the production of speech.
  - **Wernicke's Area:** "receptive aphasia"(syntax w/out content); failure of comprehension.
  - **Plasticity:** recovery from damage; reuse of "available" areas
- *Anesthesia*

Brain Imaging

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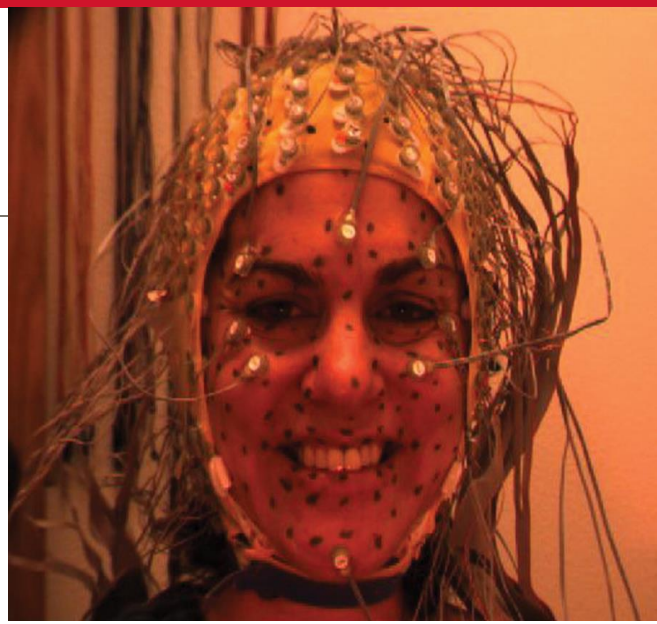
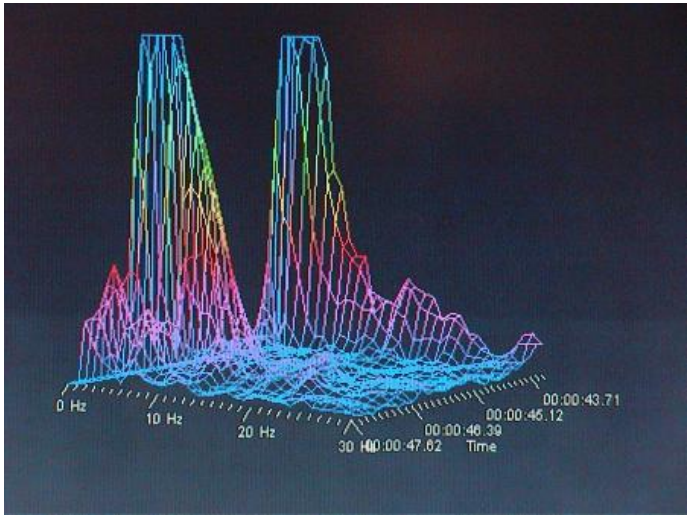
Electroencephalography



EEG

- Records electrical activity
- Shows *when* brain activity occurs but not *where*
- Event-related potential (**ERP**)



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Neural Imaging

Magnetic Resonance Imagine (**MRI**)

- Uses magnetic fields to produce very finely detailed images of the *structure* of the human brain and other soft tissues – Shows *where* but not *when*

Functional Magnetic Resonance Imaging (**fMRI**)

- Variation on MRI, tells about brain *activity*

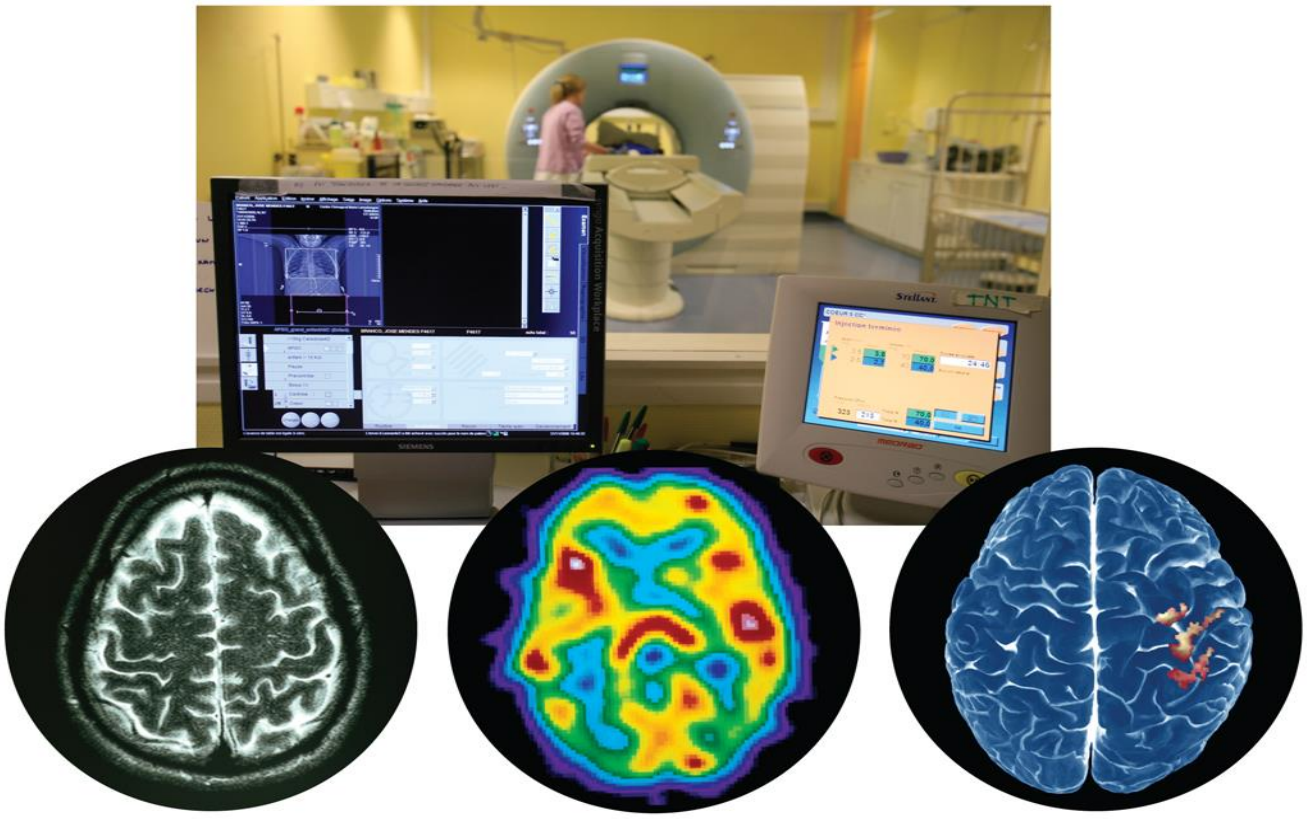
Positron Emission Tomography (**PET**) Scan

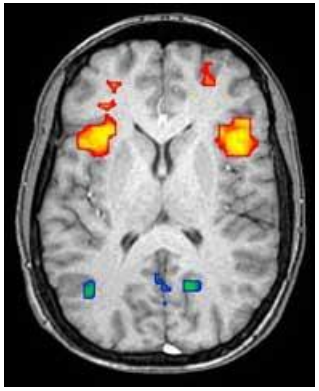
- Measures blood flow to brain areas in the active brain
- Radioactive form of oxygen (glucose) is injected into participant

Computerized Axial Tomography (**CT/CAT**) Scan

- Combines many X-ray images to build representation of structures

Neural Imaging





fMRI

Structure of Neurons

SOMA (cell body)

DENDRITES (receptive branches)

AXON (sending branches; sends impulses to other branches)

AXON TERMINALS (contains neurotransmitters)

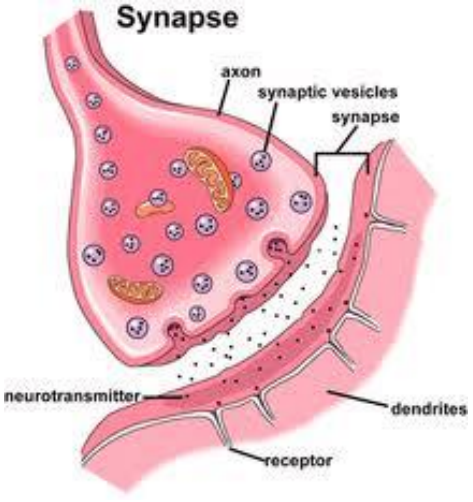
Mylenation: fatty layer around axons; speeds impulses by insulating the axon.

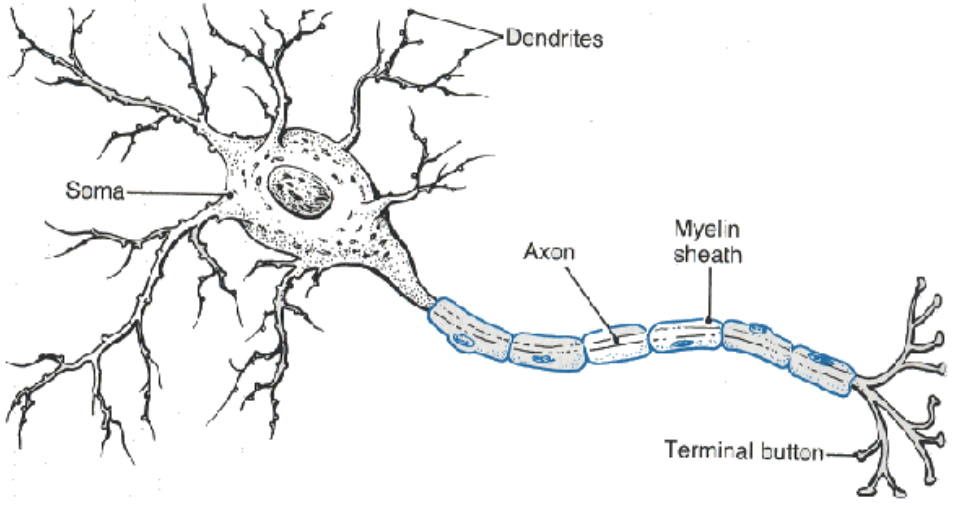
SYNAPSE: Terminal button: an axon ending holding synaptic vesicles with transmitters

Neurotransmitters: message carrying chemicals stored in sysaptic vissicles

Synaptic cleft (space in the synapse)

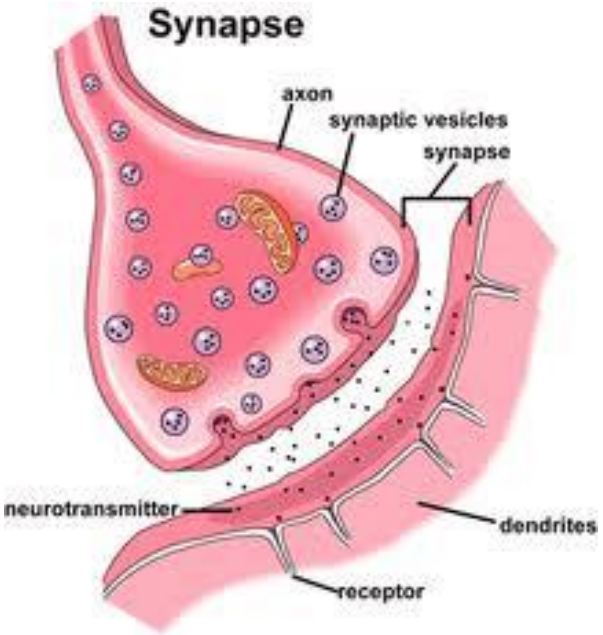
Receptor sites: tailored neruotransmitter docking locations

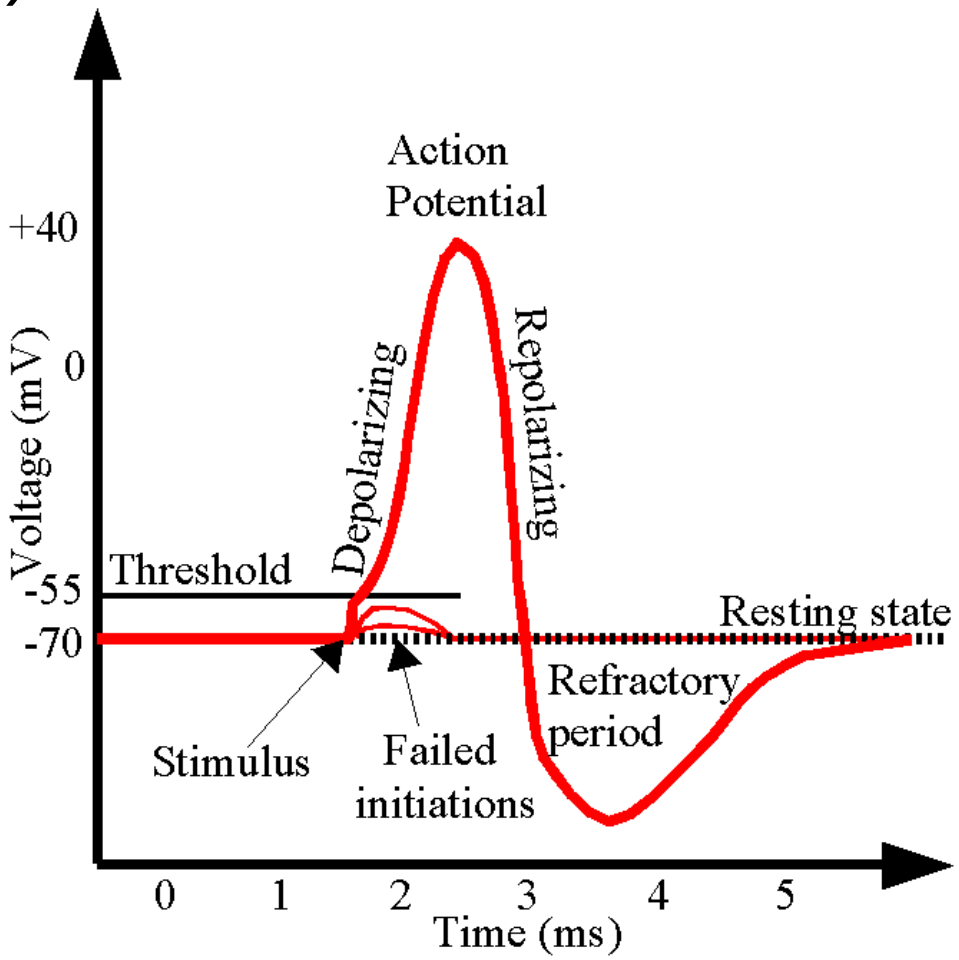




Neural Communication: The Action Potential

- Action potential (impulse)
- Resting potential
- Refractory period





Terminology

- **Epiphenomena:** a secondary or concomitant phenomenon
- **Epiphenomenalism**: consciousness is a secondary byproduct of physical and physiological brain processes, which produce it.
- **Introspection**: looking inward; to report inner sensations and experiences.
- **Verbal Report**: a statement about your thoughts, ideas, and strategies during cognitive processing.

Terminology

- Cognitive science
- Mental representation
- Stages of processing
- Parallel processing
- Serial processing
- Cognitive architecture
- Module / modularity
- Connectionist models
- Metacognition / self-knowledge
- Sentience
- (all of the –isms)
- Neocortex
- Limbic system
- Frontal lobe
- Temporal lobe
- Parietal lobe
- Occipital lobe
- Brainstem
- Cerebellum
- Method of subtraction
- Additive factors
- Dissociation / double-dissociation

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