

Hindbrain, Midbrain, Forebrain

Lecture 3

Phrenology

An Early View of Functional Specialization

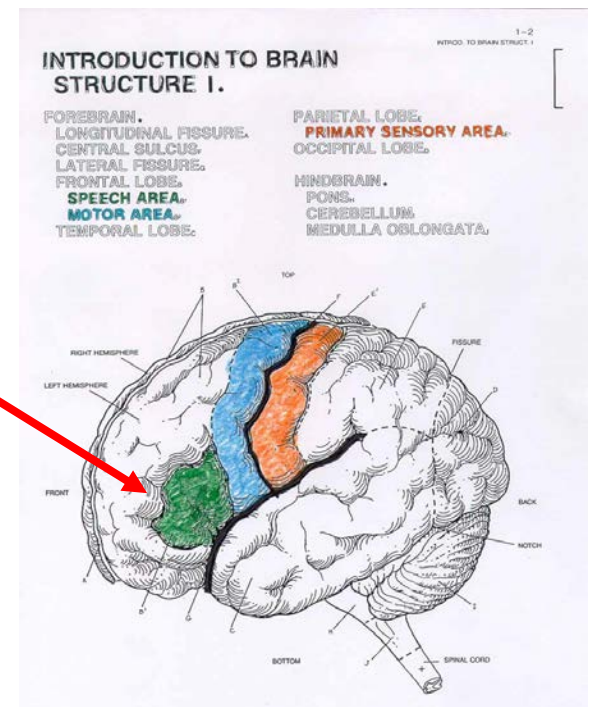
- In Vienna
 - F.J. Gall (1788-1828)
 - J.K. Spurzheim (1776-1832)
- In Scotland
 - G. Combe (1788-1858)
- In the United States
 - O.S. Fowler (1809-1887)
 - L.N. Fowler (1811-1896)
 - N. Sizer (1812-1897)



Fig. 2.50. Phrenological head, by L. N. Fowler, mid-19th century, porcelain, 11 in. high. Courtesy Mrs. Eric T. Carlson.

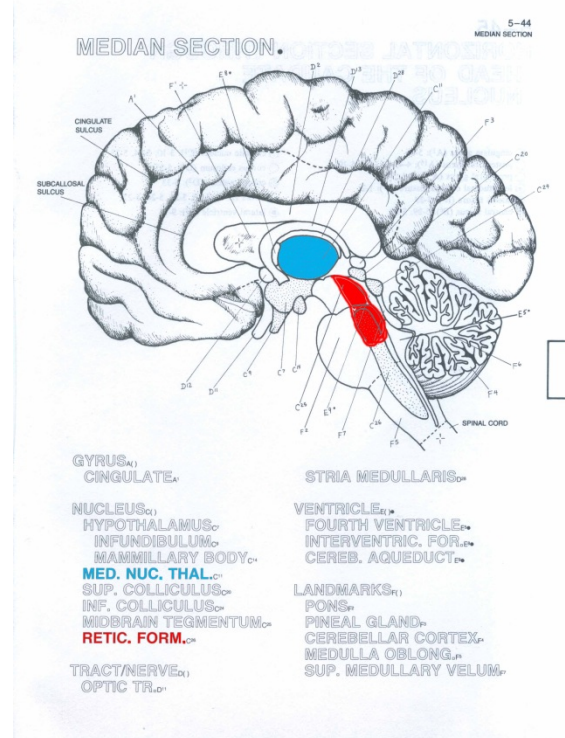
Brain Lesions

- Brain Insult, Injury, or Disease
 - Broca's Area
 - Patient H.M.
- Nonhuman Animals
 - Surgery
 - Electrical Current
- Temporary Lesions
 - Cooling
 - Spreading Depression



Electrical and Magnetic Stimulation

- Electrical Stimulation
 - Reticular Formation
 - Lesions (Nauta)
 - Stimulation (Moruzzi & Magoun)



- Transcranial Magnetic Stimulation
 - Striate Cortex of Occipital Lobe

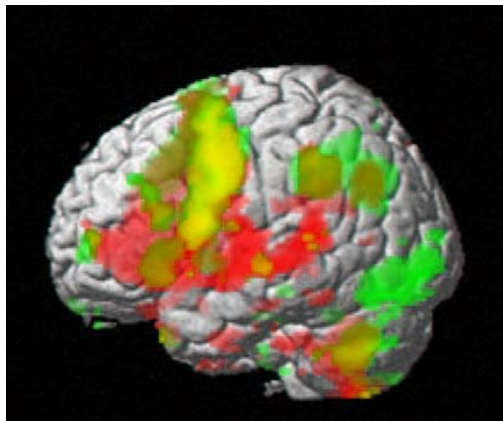
Psychophysiology

- Autonomic Nervous System
 - Electrocardiogram (EKG)
 - Plethysmograph
 - Electrodermal Response (EDR)
 - Skin Conductance/Resistance
 - Electromyogram (EMG)
- Central Nervous system
 - Electroencephalogram (EEG)
 - Event-Related Potentials (ERP)



Brain Imaging

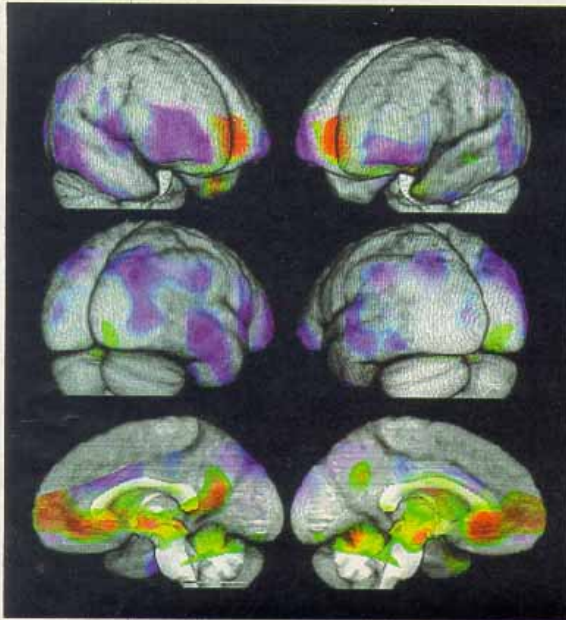
- X-Ray Computed Tomography (CT, CAT)
- Magnetic Resonance Imaging (MRI)
 - Radio Waves
- Positron Emission Tomography (PET)
 - Glucose
- Functional MRI (fMRI)



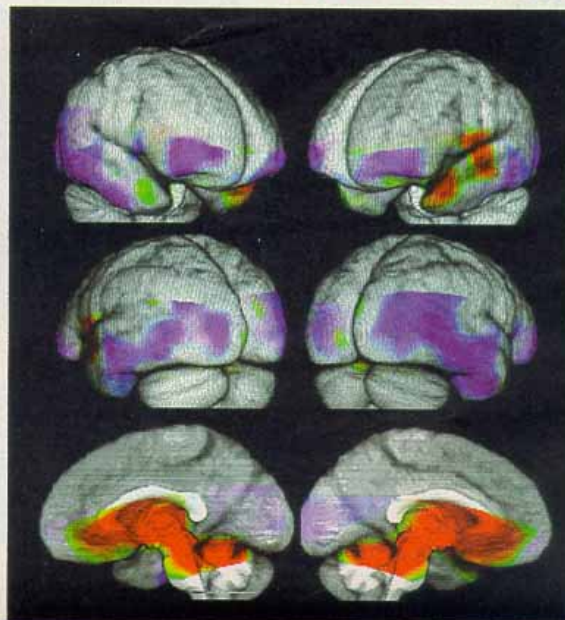
Henry Wheeler Brain Imaging Center, UC Berkeley

WHAT THEY WERE THINKING

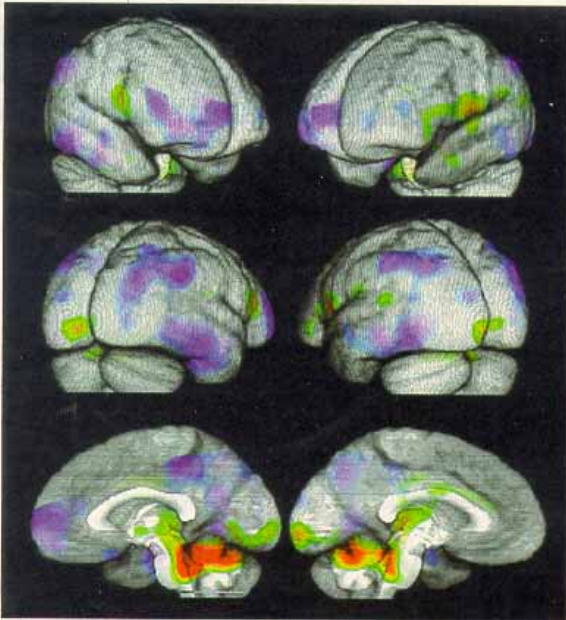
Pleasant Thoughts



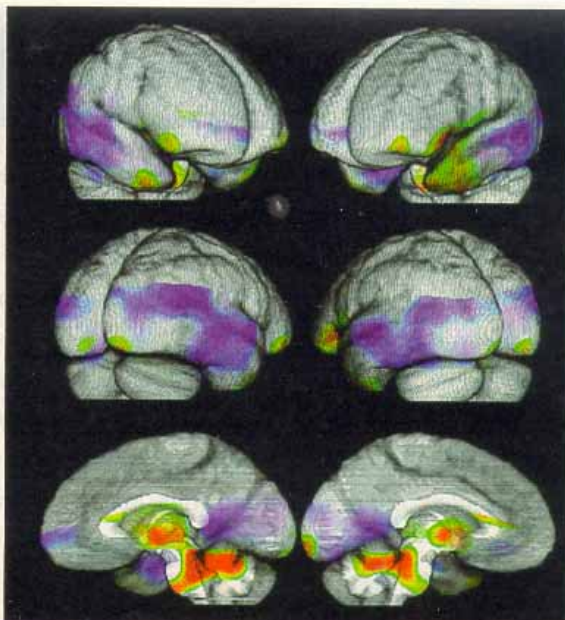
Depressing Thoughts



Anxious Thoughts



Irritating Thoughts

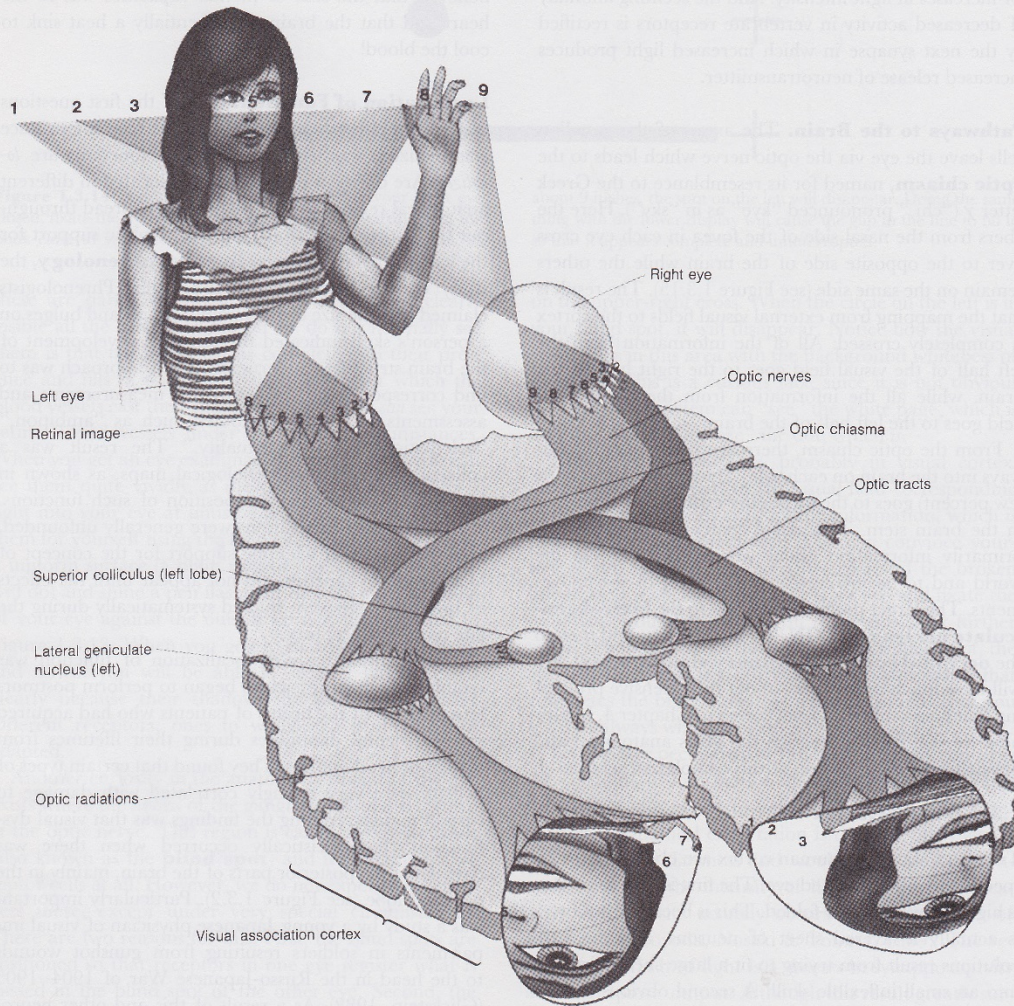




Identifying Natural Objects From Patterns of fMRI Activity



Kay, Naselaris, Prenger, & Gallant (2008)



Topographical Organization of Visual System

Accuracy of Identification

Kay et al. (2008)

- Chance = $1/120 = 0.8\%$

- 13 Repeated Trials

- Subject 1: 92%

- 1000 Images: 82%

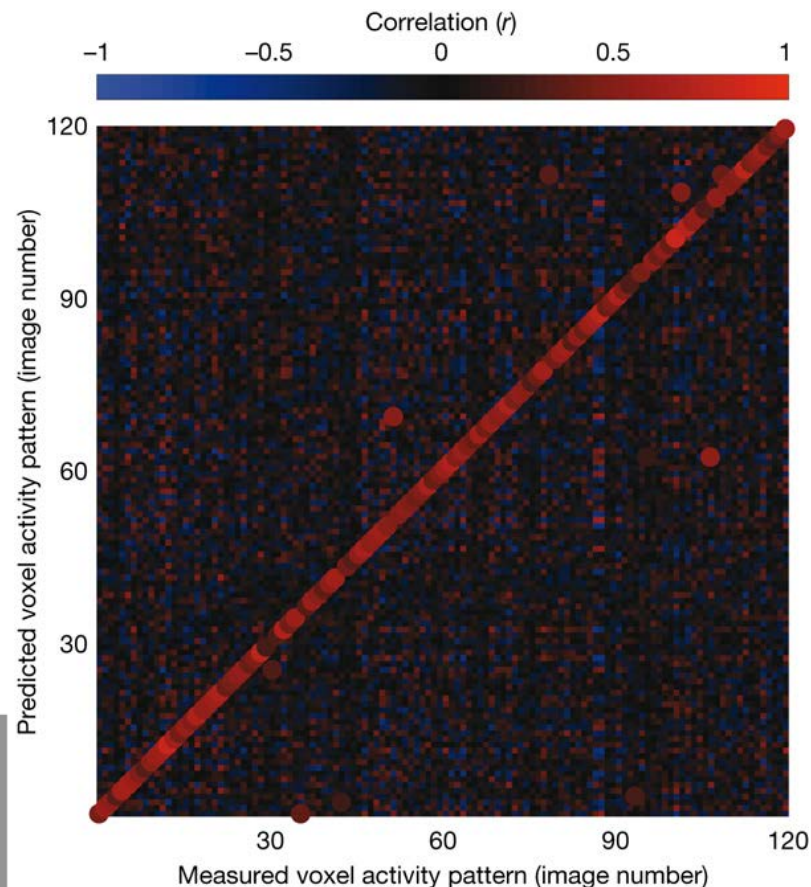
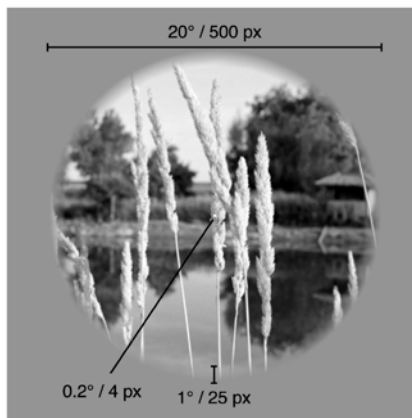
- Chance = 0.1%

- Subject 2: 72%

- Single-Trial Performance

- Subject 1: 51%

- Subject 2: 32%



Reconstructing Natural Images

Naselaris, Prenger, Kay, Oliver, & Gallant (2009)



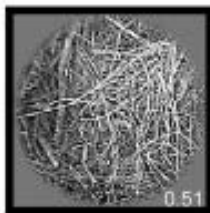
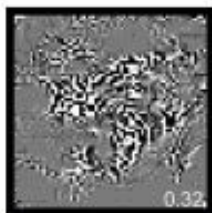
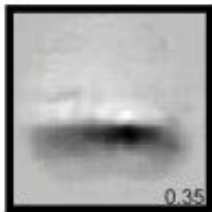
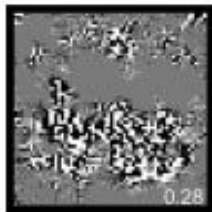
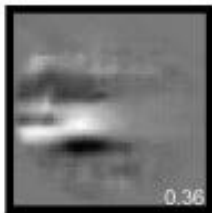
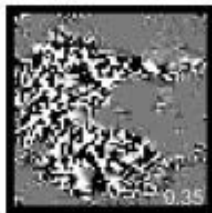
Target image

Reconstructions with structural encoding model

Flat prior

Sparse Gabor prior

Natural image prior

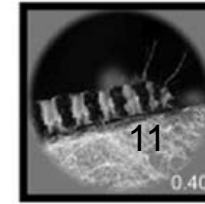
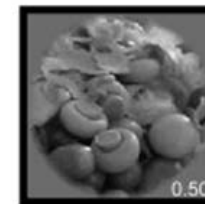
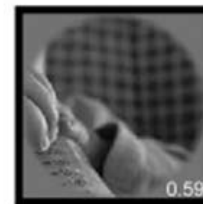
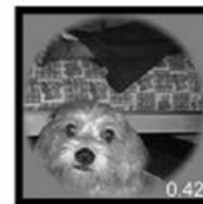


Target image

Reconstructions with natural image prior

Structural model only

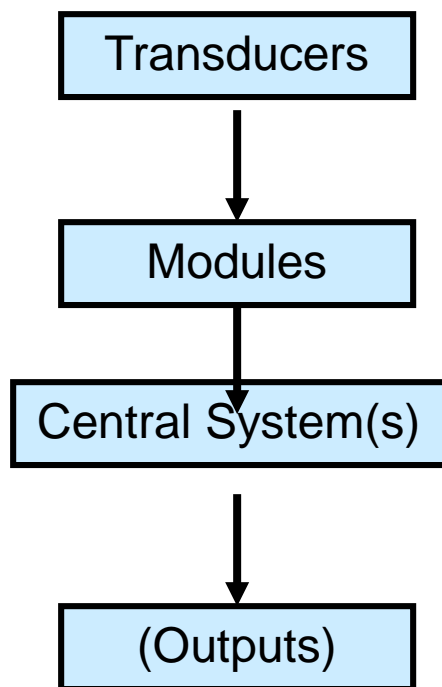
Structural and semantic models (hybrid method)





The Doctrine of Modularity

Fodor (1983)



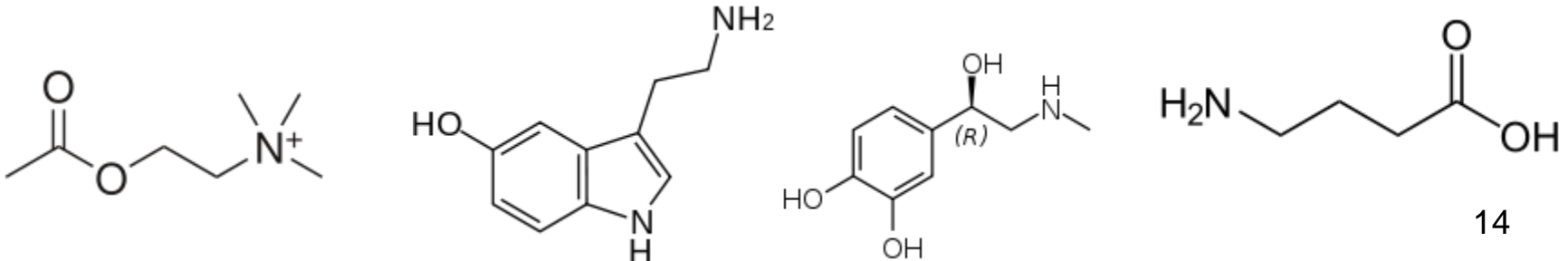
- Domain-Specific
- Informational Encapsulation
- Hardwiring
- Innate Specification
- Automaticity
- Characteristic Development
- Characteristic Breakdown
- **Fixed Neural Architecture**

Functional Specialization Outside the Brain

- Afferent and Efferent Neurons, Nerves
- Interneurons, Ganglia, Nuclei
- Autonomic Nervous System
 - Sympathetic and Parasympathetic Branches
- Somatic Nervous System
 - Afferent and Efferent Cranial Nerves
 - Afferent and Efferent Tracts in Spinal Nerves
 - Afferent and Efferent Tracts in Spinal Cord

Excitatory and Inhibitory Neurotransmitters

- Amines
 - Acetylcholine (ACh)
- Monoamines
 - Catecholamines
 - Epinephrine (Adrenaline)
 - Norepinephrine (NA)
 - Dopamine (DA)
 - Serotonin (5-HT)
- Amino Acids
 - Glutamate
 - GABA
- Peptides
 - Substance P
 - Beta-Endorphin
 - Corticotropin (ACTH)
 - Oxytocin

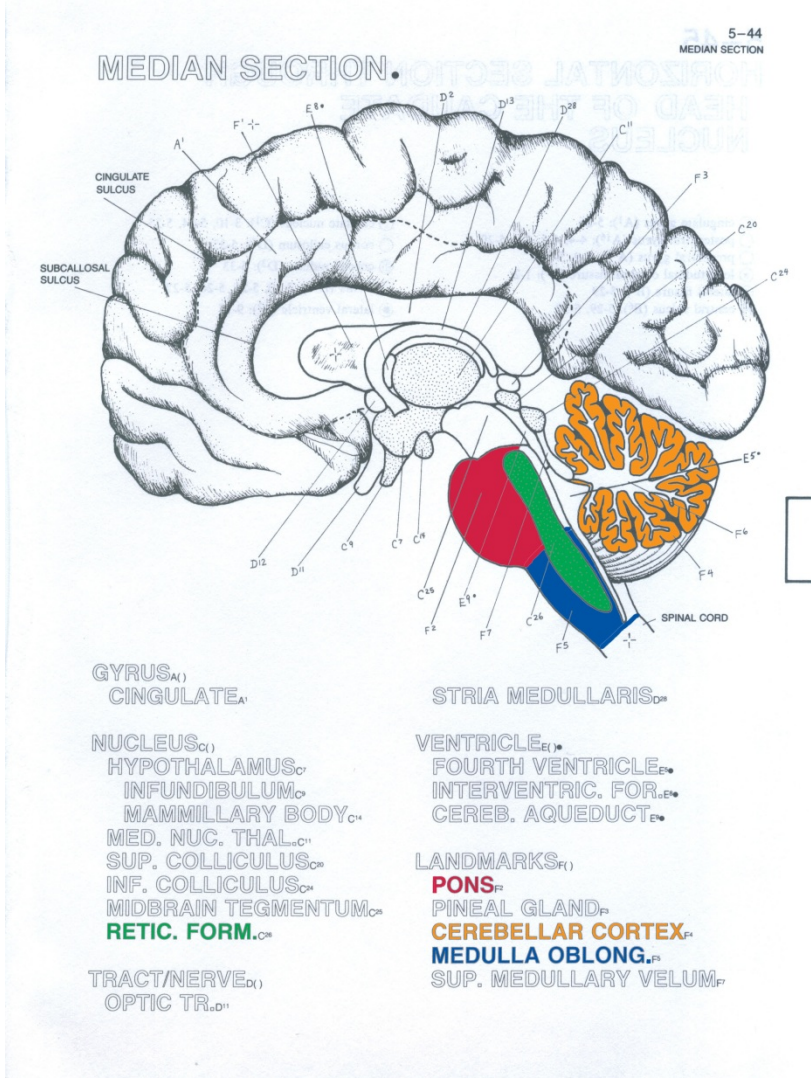


Neurotransmitters and Brain Disease

- Myasthenia Gravis (Ach)
- Parkinson's disease (Dopamine, L-DOPA)
- Chorea (Dopamine; Haloperidol)
- Huntington's Disease
- Gilles de la Tourette's Syndrome
- Schizophrenia
 - Dopamine Hypothesis, Chlorpromazine
- Affective Disorder
 - Serotonin Hypothesis, SSRIs

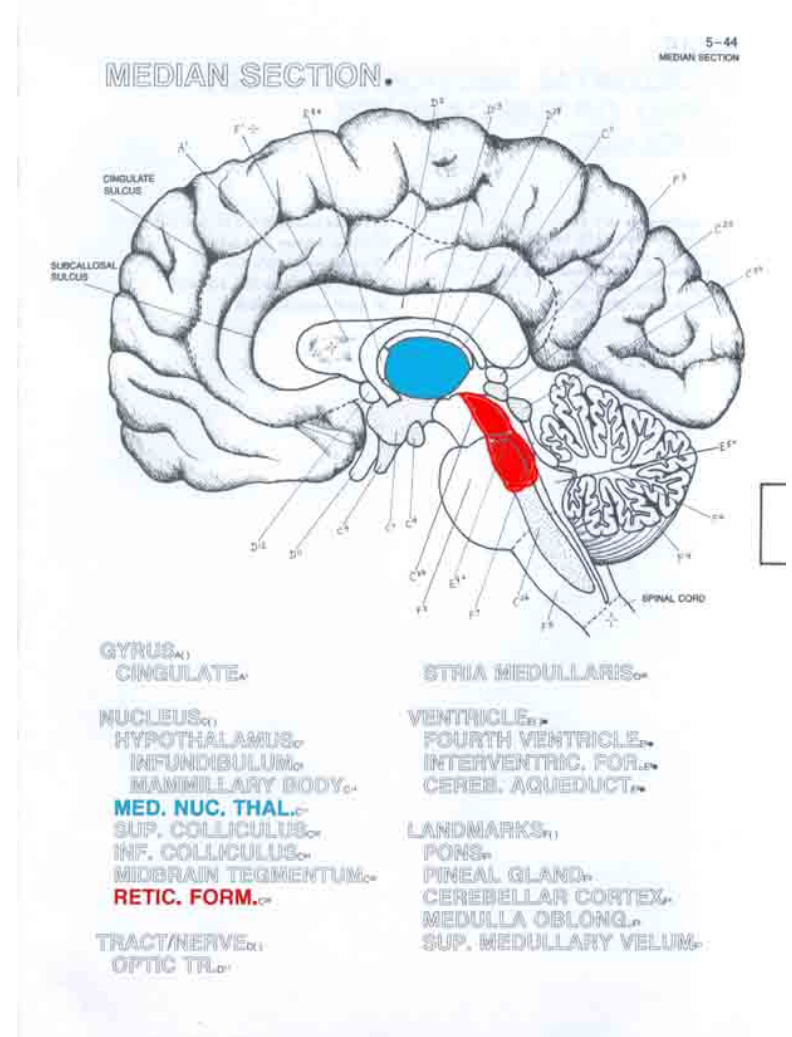
Functional Specialization in the Brainstem

- Hindbrain
 - Medulla Oblongata (Myelencephalon)
 - Pons (Metencephalon)
- Midbrain (Mesencephalon)
 - Reticular Formation
- Cerebellum



Coma

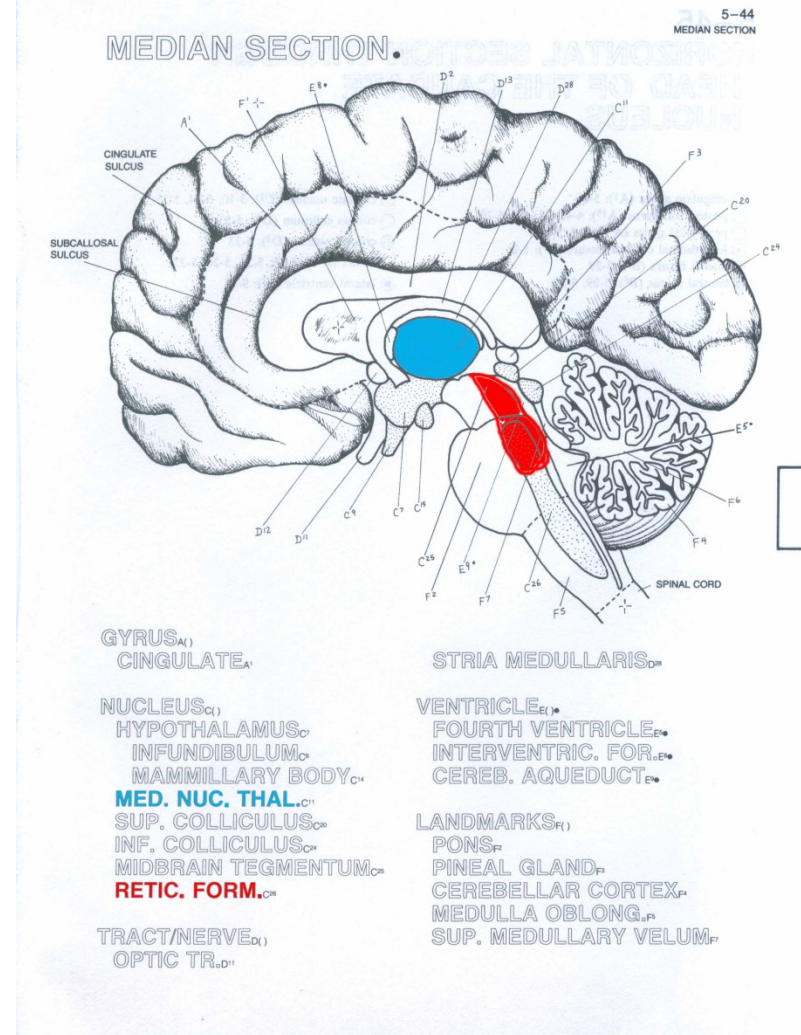
- Loss of Consciousness
 - Eyes Closed
 - Unresponsive to Stimulation
 - No Sleep-Wake Cycle
 - Spared Vegetative Function
- Posterior Brain Stem
 - Reticular Formation
 - Periaqueductal Gray
 - Parabrachial Nucleus
 - Diencephalon (Bilateral)
 - Thalamus, Hypothalamus



Persistent Vegetative State

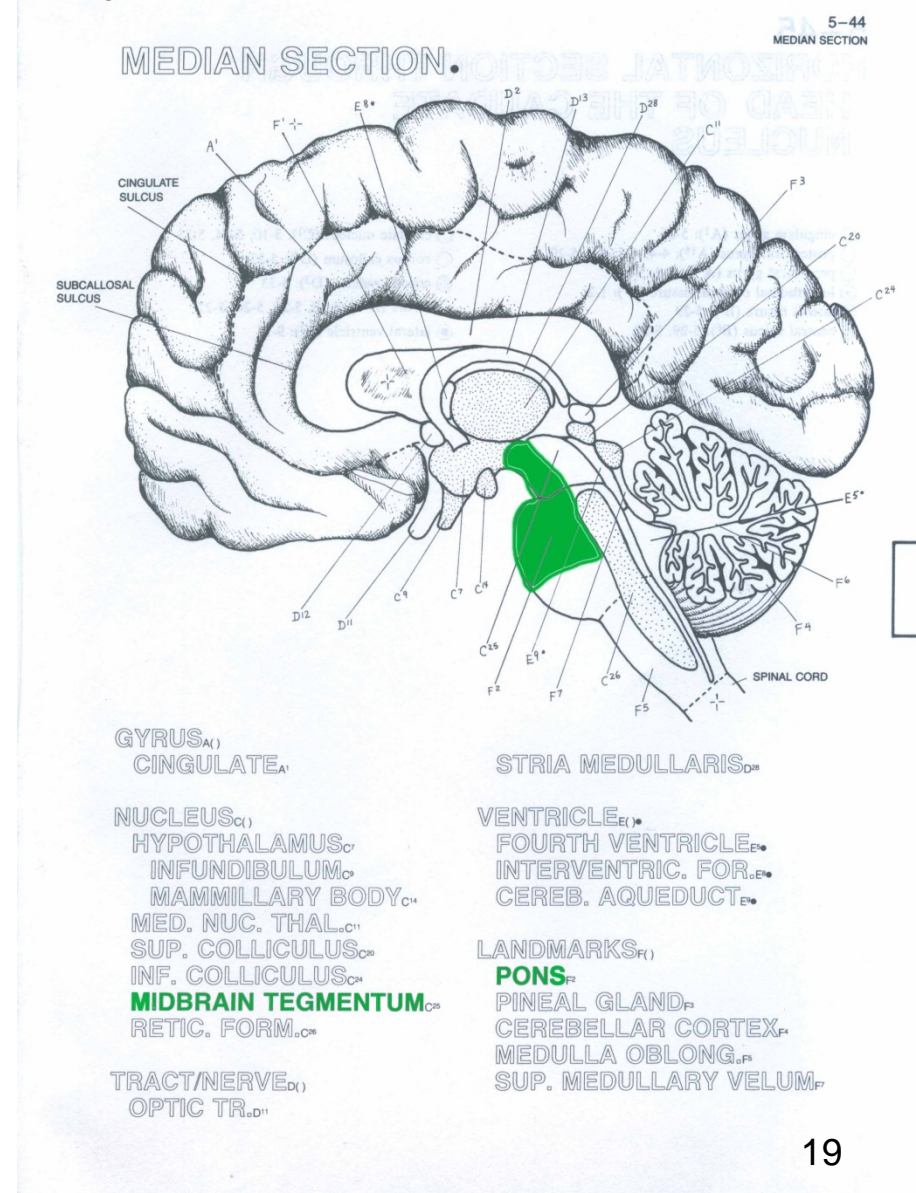
Jennett & Plum (1972)

- Follows Coma
 - Within 1 month
- Wakefulness Without Consciousness
 - Eyes Open
 - Apparently Vigilant
 - Some reflex functions
 - Normal Sleep Cycle
 - Unresponsive to Stimulation
 - Spared Vegetative Function
- “Minimally Conscious State”

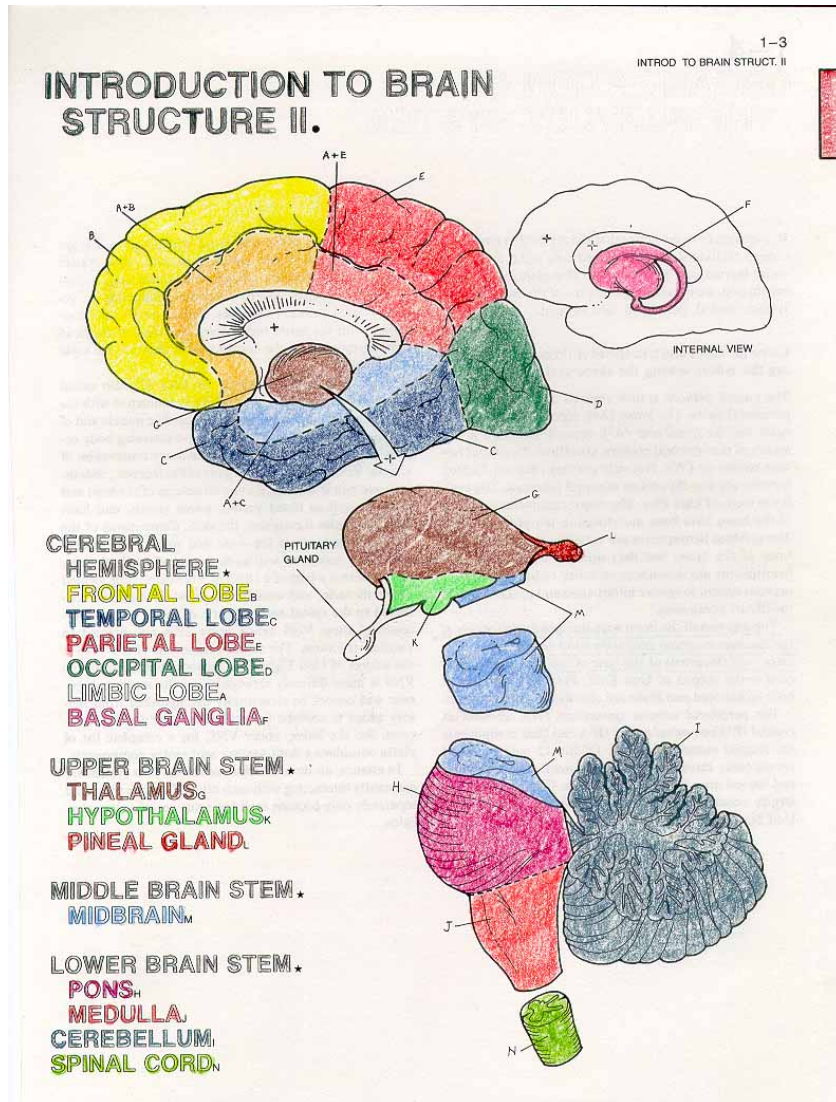


“Locked-In” Syndrome

- Follows Coma
- Largely Immobile
- Limited Responsiveness
 - Vertical Eye Movements
 - Blinking
- Anterior Brain Stem
 - Pons
 - Excludes Reticular Formation
 - Above Trigeminal Nerve (V)
 - Oculomotor Nerve (III)
 - Trochlear Nerve (IV)



Subcortical Structures of the Forebrain



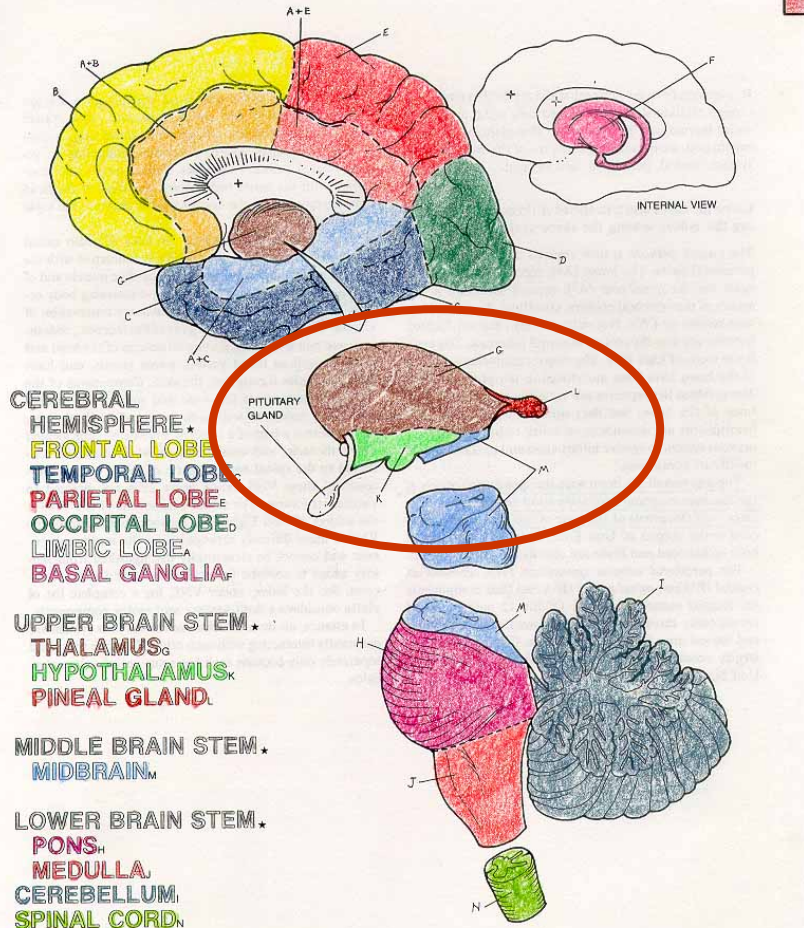
- Limbic System (Lobe)
 - Cingulate Gyrus
 - Parahippocampal Gyrus
 - Hippocampal Formation
 - Amygdala
 - Hippocampus
 - Fornix
 - Mammillary Bodies
- Basal Ganglia
 - Globus Pallidus
 - Caudate Nucleus
 - Putamen
- Diencephalon
 - Thalamus
 - Hypothalamus

Hypothalamus and Eating Behavior

Teitelbaum & Epstein (1962); Teitelbaum (1976)

INTRODUCTION TO BRAIN STRUCTURE II.

1-3
INTROD TO BRAIN STRUCT. II



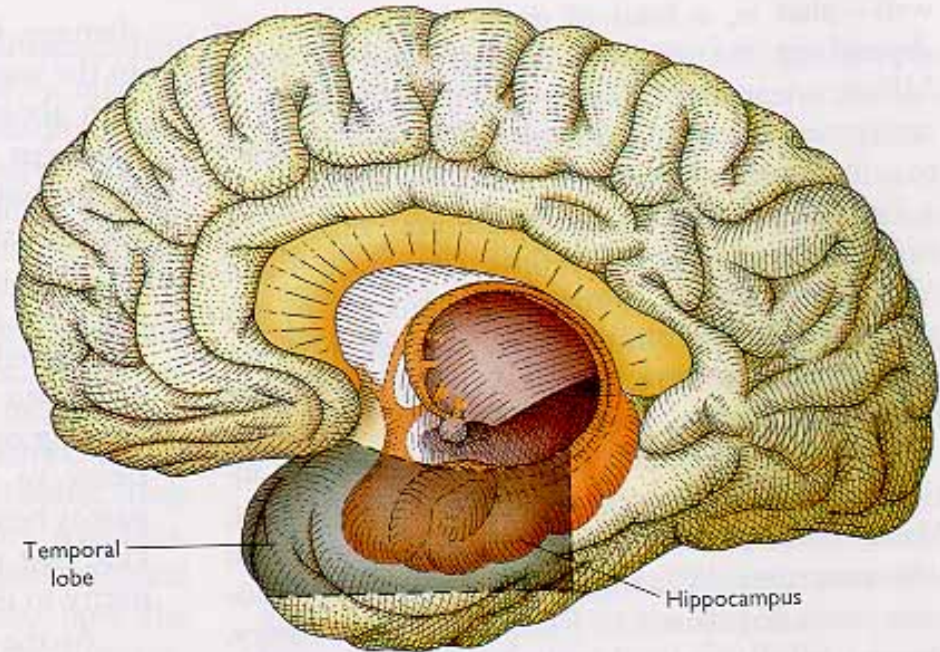
- Ventromedial Lesions
 - Hyperphagia
- Lateral Lesions
 - Aphagia
- Dual-Center Theory
 - VMH Inhibits Eating
 - LH *Disinhibits* Eating



Patient H.M.

Bilateral Resection of Hippocampus

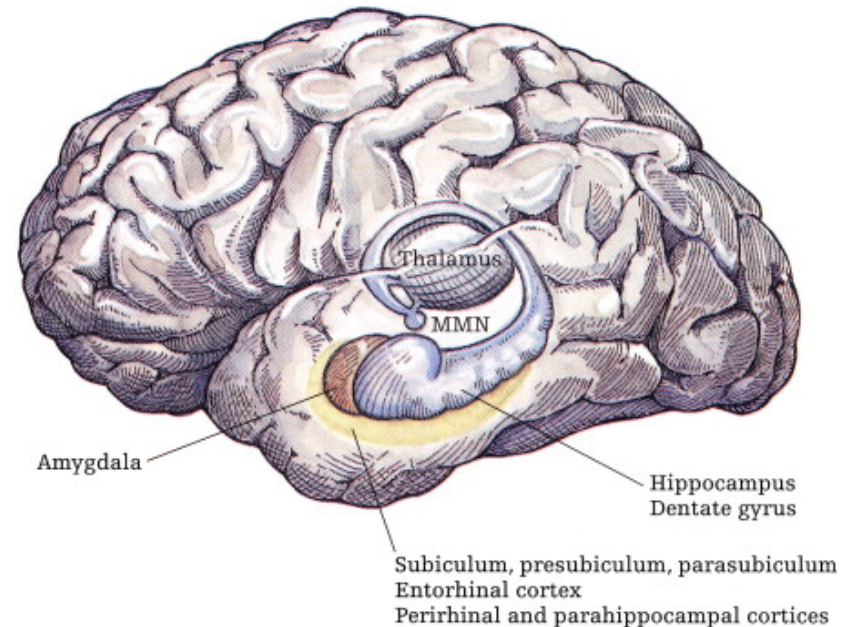
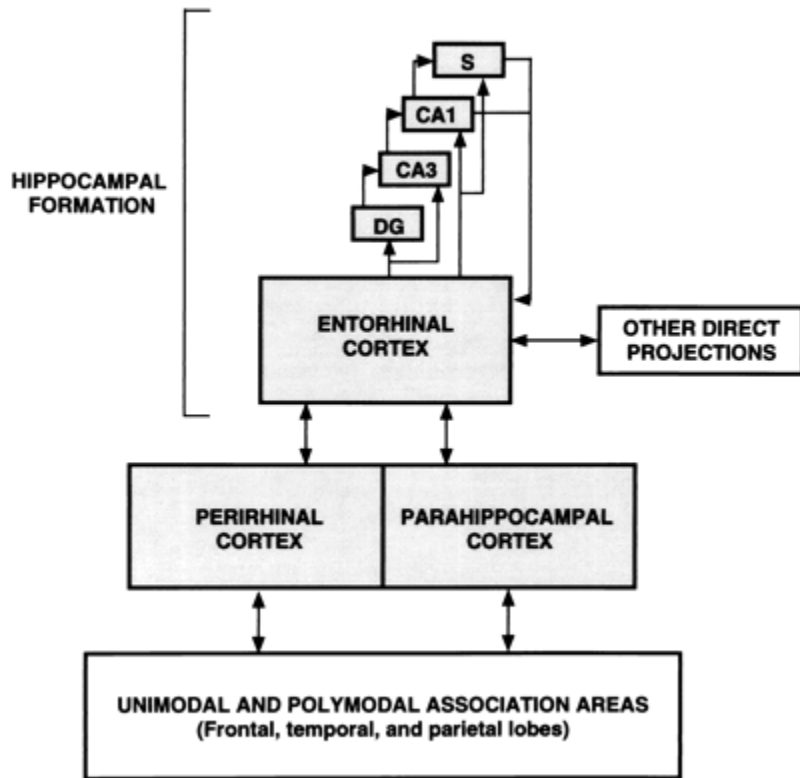
Scoville & Milner (1957); Milner, Corkin, & Teuber (1968)



Anterograde Amnesia

The Medial Temporal Lobe Memory System

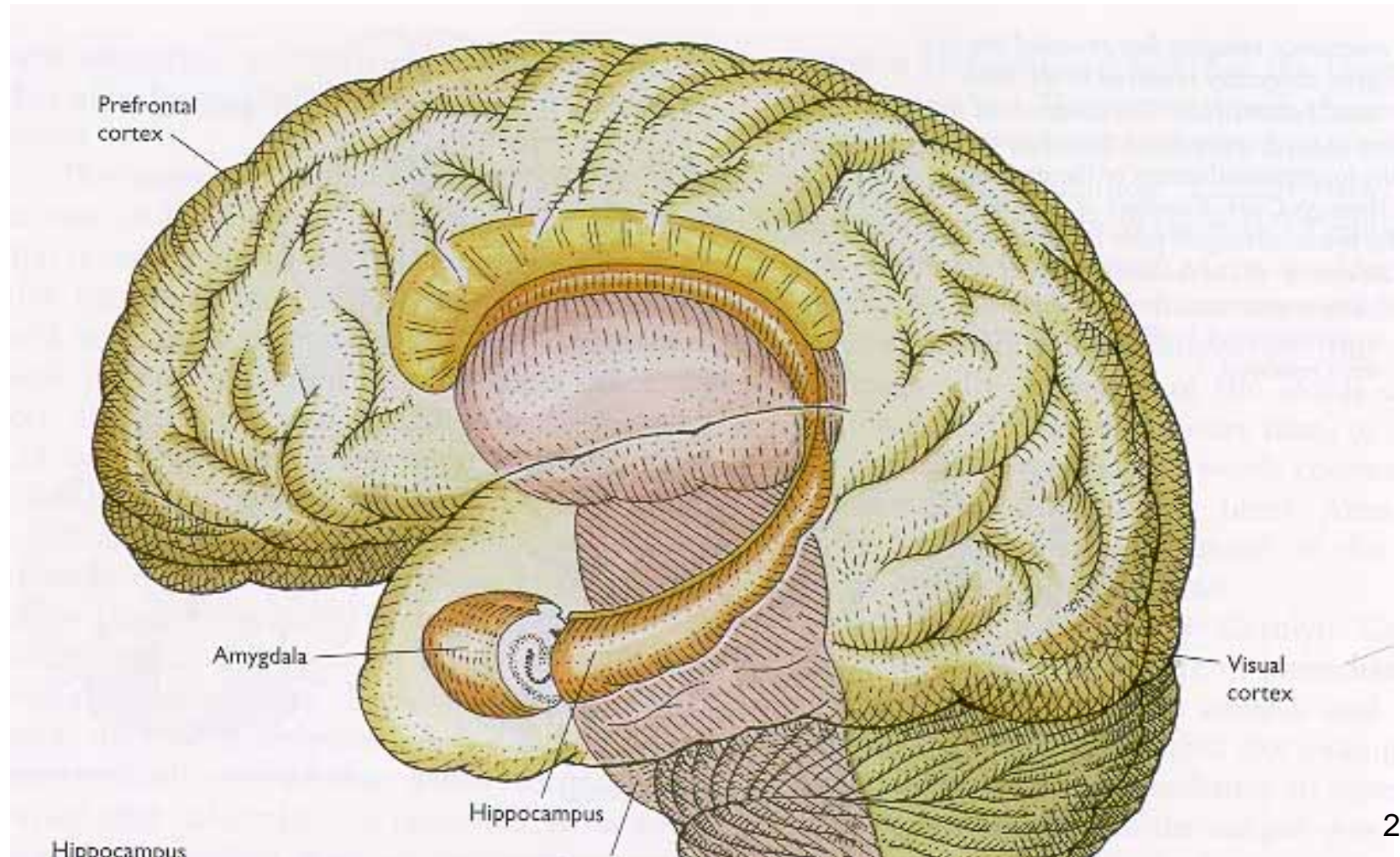
Squire & Zola-Morgan (1991)



Patient S.

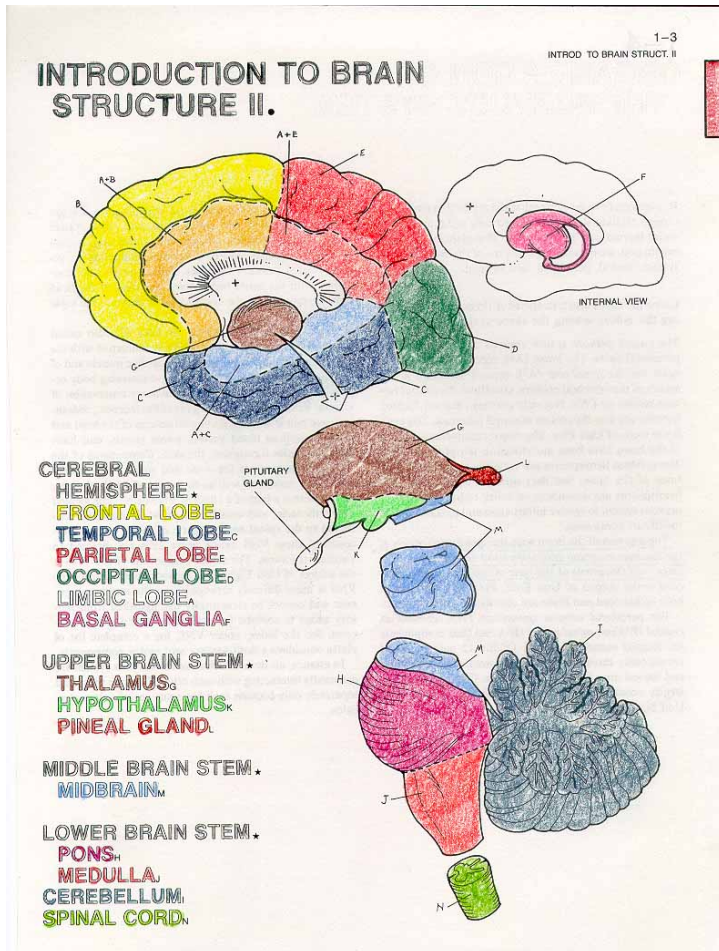
Bilateral Calcification of Amygdala

Adolphs, Tranel, Damasio, & Damasio (1994)



The Triune Brain

MacLean (1970, 1990)



- Neocortex
 - “New Brain”
- Limbic System
 - “Old Mammalian Brain”
 - Amygdala
 - Hypothalamus
 - Hippocampus
- R-Complex
 - “Reptilian Brain”
 - Brain Stem
 - Cerebellum