

5. Brain Areas

Outline

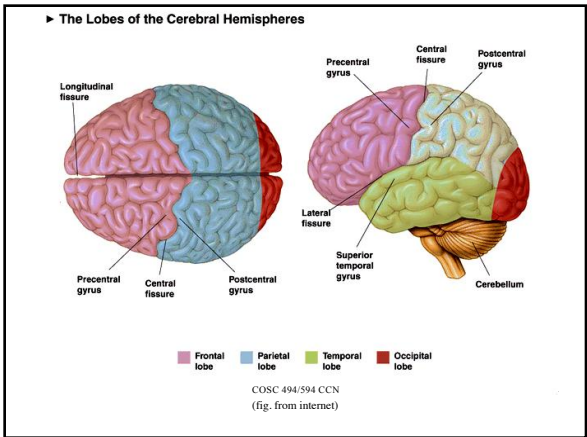
- A. Functional Anatomy of the Brain
- B. Perception and Attention
- C. Motor Control
- D. Learning and Memory
- E. Language
- F. Executive Function

2/7/17 COSC 494/594 CCN 2

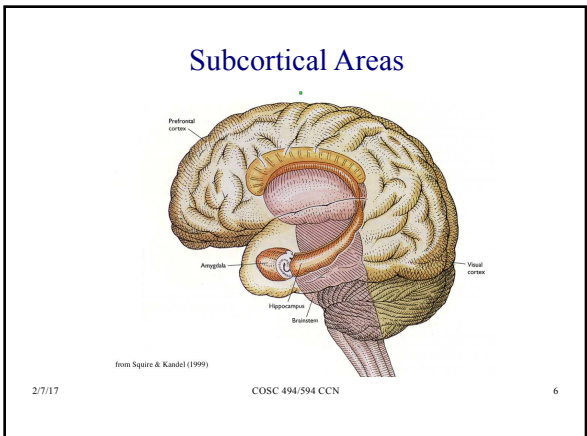
A. Functional Anatomy of the Brain

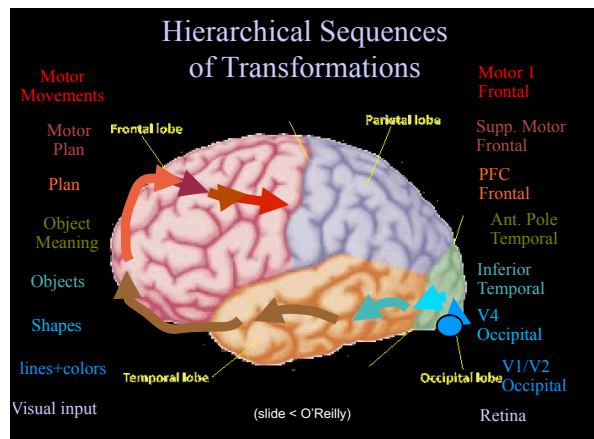
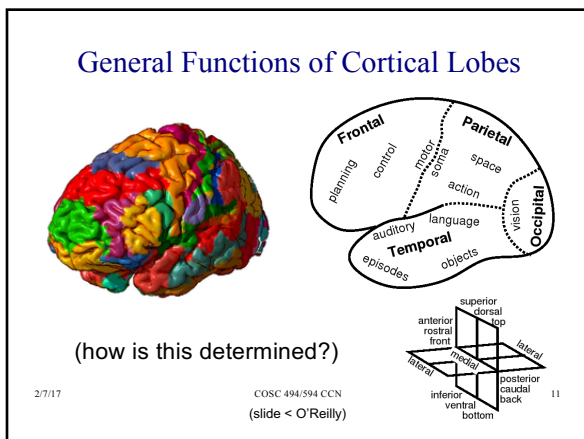
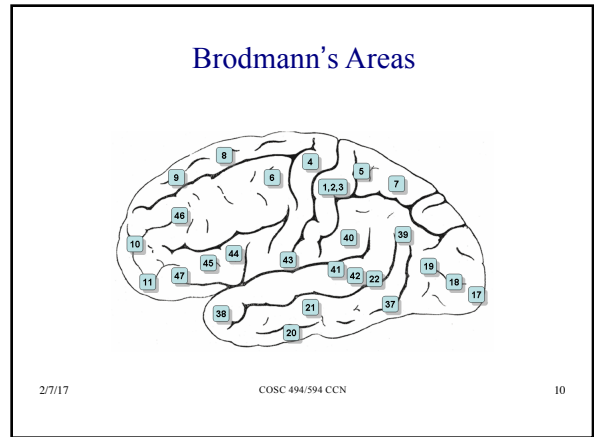
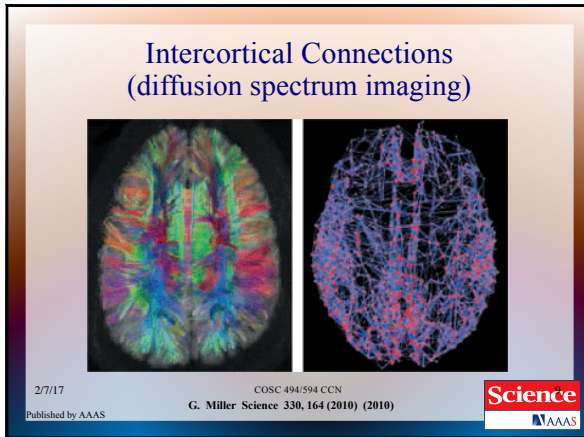
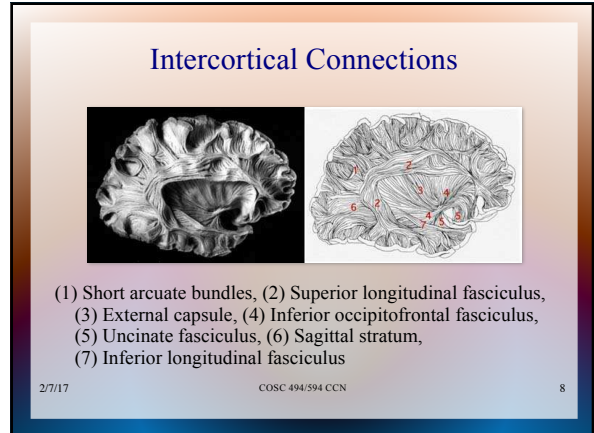
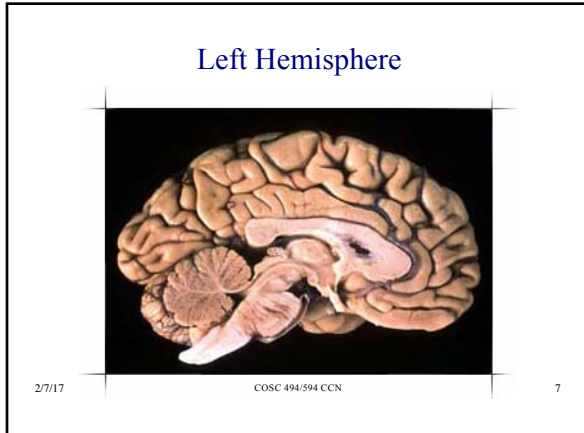
Comparing and Contrasting Major Brain Areas

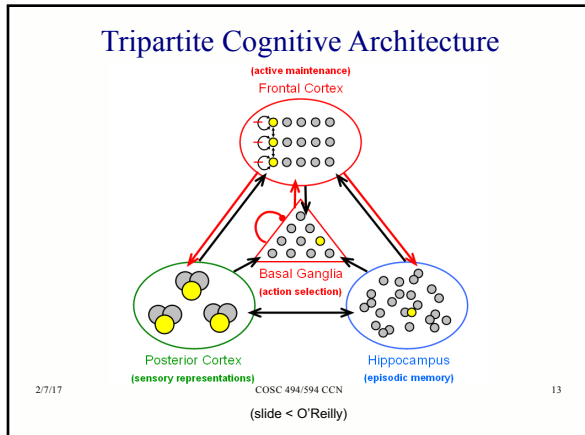
2/7/17 COSC 494/594 CCN 3



- ### Other (Subcortical) Areas
- Hippocampus: rapid learning
 - Thalamus: sensory input, attention
 - Amygdala: emotion, fear/desire
 - Basal Ganglia: motor control, gating of PFC
 - Cerebellum: coordinating movements
 - Reward prediction system: dopamine release
- 2/7/17 COSC 494/594 CCN (slide < O'Reilly) 5







- ### Large Scale Distributed Organizations
- Knowledge is distributed across multiple brain areas
 - Multiple areas participate in representing a given thing (e.g., apple)
 - Each area represents multiple things
 - Same idea as distributed representation among units for individual items, but in this case across multiple areas/modalities, etc.
- 2/7/17 COSC 494/594 CCN (slide based on Frank) 14

Learning Across the Brain

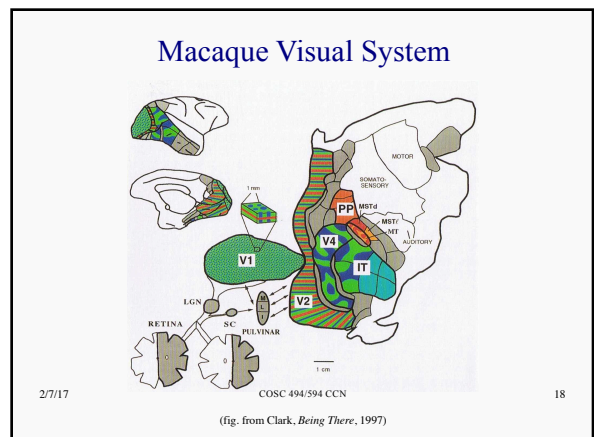
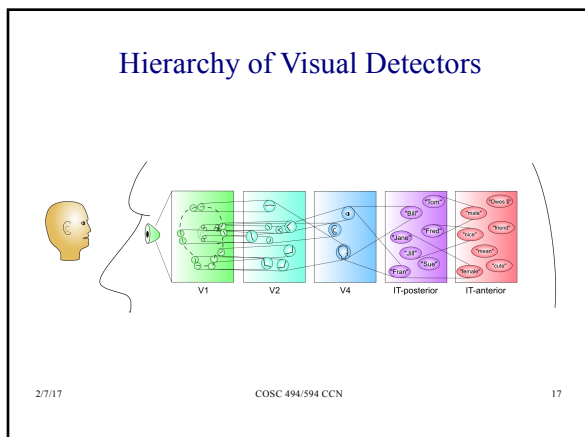
Area	Learning Signal			Dynamics		
	Reward	Error	Self Org	Separator	Integrator	Attractor
Basal Ganglia	+++	---	---	++	-	---
Cerebellum	---	+++	---	+++	---	---
Hippocampus	+	+	+++	+++	---	+++
Neocortex	++	+++	++	---	+++	+++

2/7/17 COSC 494/594 CCN 15

B. Perception and Attention

What versus Where

2/7/17 COSC 494/594 CCN 16



Hierarchy of Macaque Visual Areas

2/7/17 COSC 494/594 CCN 19 (fig. from Van Essen & al. 1992)

“What” vs. “Where” Pathways

- “What” ignores differences in location, illumination, size, rotation
- “Where” emphasizes location, size, and ignores object identity

2/7/17 COSC 494/594 CCN 20

Multiple Interacting Pathways

Maintaining Abstract Information (plans, sensory info, etc) Movement Spatial Processing Touch

Frontal lobe: Visual Object Recognition, Audition, Abstract Semantics

Parietal lobe: Touch

Temporal lobe: Audition, Abstract Semantics

Occipital lobe: Early Vision

(slide < O'Reilly)

2/7/17 COSC 494/594 CCN 22

Principal Regions in “What” Pathway

- V1: Primary Visual Cortex
 - encodes image in terms of oriented edges
- V2: Secondary Visual Cortex
 - encodes in terms of intersections & junctions
- V4
 - more complex features over wider range of locations
- PIT: Posterior Inferotemporal (IT) Cortex
 - location & size invariant object recognition
 - includes FFA (fusiform face area)
- AIT: Anterior IT Cortex
 - abstract/semantic visual information

2/7/17 COSC 494/594 CCN 22

C. Motor Control

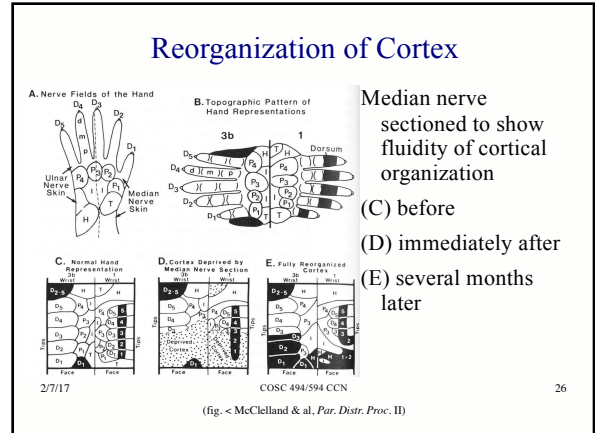
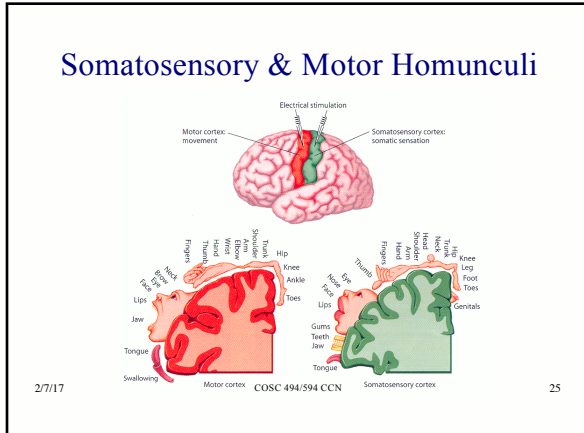
Parietal and Motor Cortex Interacting with Basal Ganglia and Cerebellum

2/7/17 COSC 494/594 CCN 23

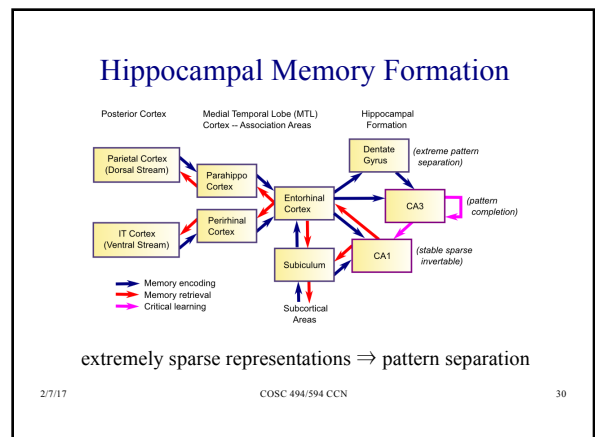
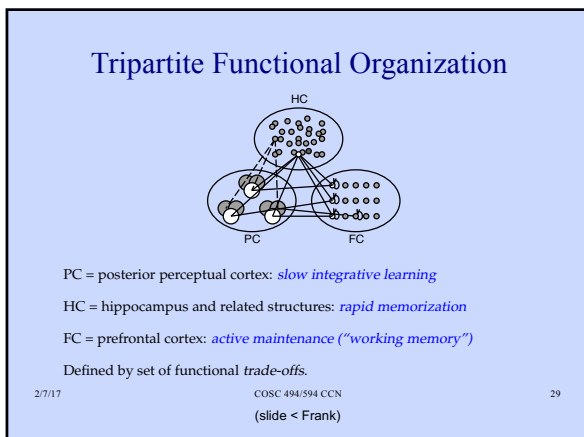
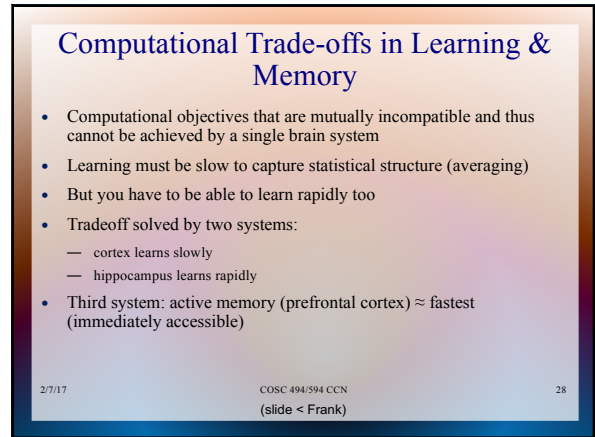
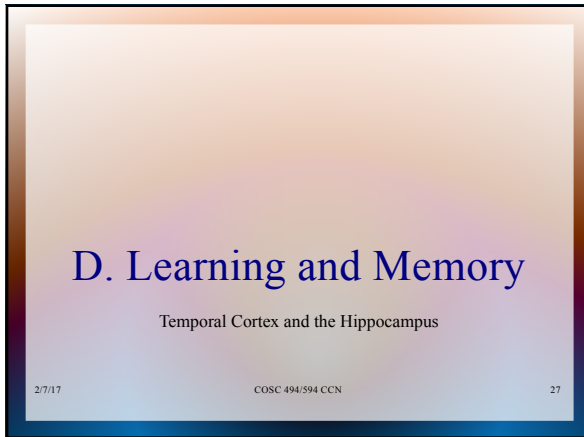
Motor Control

- Motor cortex (frontal to parietal)
 - high-level metrical processing of sensory information,
 - integrating multiple modalities and translating between different reference
 - arrives at a range of possible responses to the current sensory environment
- Basal ganglia
 - action selection: receives sensory inputs and potential responses being “considered” in frontal cortex; triggers disinhibitory signal enabling best action
 - action selection is shaped by reinforcement learning driven by dopamine signal
 - amygdala plays key role in driving these dopamine signals in response to sensory cues associated with reward and punishment
- Cerebellum
 - uses error-driven learning to acquire high-resolution metrical maps between sensory inputs and motor outputs

2/7/17 COSC 494/594 CCN 24



Median nerve sectioned to show fluidity of cortical organization
 (C) before
 (D) immediately after
 (E) several months later



E. Language

2/7/17 COSC 494/594 CCN 31

- ### Language
- Involves many of the foregoing functions
 - perception, memory, executive function, motor control
 - Models (ch. 9) will address:
 - small scale model of reading, incorporating orthographic, phonological, and semantic aspects
 - regular behavior without rules
 - self-organization of semantic representations
 - interaction of syntax and semantics
- 2/7/17 COSC 494/594 CCN 32

F. Executive Function

Prefrontal Cortex and Basal Ganglia

2/7/17 COSC 494/594 CCN 33

- ### Executive Function
- Builds on motor control functions of frontal cortex (FC) and basal ganglia (BG)
 - Areas of FC oriented to
 - “what” vs. “how” processing
 - “hot” emotional vs. “cold” cognitive processing
 - Prefrontal cortex (PFC) control over posterior cortex
 - PFC and BG interact to implement dynamically gated working memory system
- 2/7/17 COSC 494/594 CCN 34

