Association cortex (Ch 25)

Cerebral Cortex
Brain’s most complex area with billions of neurons and trillions of synapses: the tissue responsible for mental activities
Consciousness
Perceives sensations
Commands skilled movements
Emotional awareness
Memory, thinking, language ability
Motivation
All “higher” mental functions

Types of Cerebral Cortex
Neocortex
  Newest in evolution
  About 90% of total
  6 layers, most complex
Paleocortex
  Associated with olfactory system, the parahippocampal gyrus, uncus
  fewer than 6 layers (3 layers)
Archicortex
  Hippocampal formation; limbic system
  fewer than 6 layers (3-4 layers), most primitive
Mesocortex
  Cingulate gyrus
  Transitional between archicortex and neocortex

Information through:
Functional Brain Imaging (fMRI, PET, etc)
Brain “damaged” persons
Cognitive tests, etc
Studying of other species

The Brain - Some repetition
Histology of the Cerebral Cortex

2 main cell types are pyramidal and granule cells.
Pyramidal cells have large apical dendrites and basal dendrites.
Axon projects downward into subcortical white matter.
Pyramidal cell is the primary output neuron.
Granule (stellate) cells are interneurons.
Short dendrites extending in all directions.
Short axon projecting to adjacent pyramidal cells.
Granule cells are especially numerous in sensory and association cortex.

Cortical Columns (minicolumn – macro/hypercolumn)

Functional units are cortical columns.
Columns are vertically oriented groups of thousands of neurons in synaptic contact.
Main input layer is layer IV which receives thalamic input.
Thalamus is the main source of input to the cortex.
Functional Histology - summary

Layers V and VI = output
V to Basal ganglia, brainstem and spinal cord
VI to thalamus
Layers I, II, III = associative, projecting to cortical areas
Layer IV = layer receiving inputs from thalamus and other cortical areas
**The Brain: Lobes**

- **Occipital Lobes**
- **Temporal Lobes**
- **Parietal Lobes**
- **Frontal Lobes**
  (sometimes also **Limbic Lobes**
  **Insular Lobes**)

**Neuroanatomy - Parietal Lobes**

**Functions:**
- Sensory integration, visual attention, perceptual awareness, attention

**Lesions can cause:**
- Neglect, inattention, dyscalculia, anomia, agraphia (writing problems), alexia (reading problems), apraxia (orient to sound)

**Parietal Neglect Syndrome**

- Failure to recognize side of body contralateral to injury
- May not bathe contralateral side of body or shave contralateral side of face
- Deny own limbs
- Objects in contralateral visual field ignored

**Locations of the Underlying Lesions in Patients Diagnosed With Contralateral Neglect Syndrome**

(A)

(B)
The Right Parietal Cortex of Normal Subjects is Highly Active During Tasks Requiring Attention

(A) Attending to the left visual field
(B) Attending to the right visual field

Note: "better" to damage left part

Neuroanatomy - Temporal Lobes

Functions:
- Memory, auditory processing, object recognition and identifying, naming

Lesions can cause:
- Amnesia, Wernicke’s aphasia (more if left side affected), agnosias, prosopagnosia (if right side damaged - faces not recognized), category specific deficits.

Neuroanatomy - Frontal Lobes

Can be divided into:
- Motor: Control of movement
  - weakness / paralysis
- Premotor: Integration of motor skills / learned action
  - uncoordinated movements / impaired motor skills / speech
- Prefrontal: Complex cognitive functions
  - difficulties with planning / decision making / inhibition / memory / attention / perseveration / personality changes / aphasia etc etc.

Neuroanatomy - Occipital Lobes

Functions:
- Sensory integration, visuoperception, vision

Lesions can cause:
- Heminopia, Blindsight, Visual Agnosia, Colour Agnosia

Psychosurgery

Typical experimental approaches – role of different lobe neurons:

Recording From Single Neurons in the Brain of an Awake, Behaving Rhesus Monkey
Selective Activation of Neurons in the Parietal Cortex During Fixation of a Significant Visual Target

Selective Activation of Face Cells in the Inferior Temporal Cortex of a Rhesus Monkey

Selective Activation of Face Cells in the Inferior Temporal Cortex of a Rhesus Monkey

Finding “Planning” neurons

“Attention” neuron

“Recognition” neuron

“Recognition” neuron

Activation of Neurons Near the Principal Sulcus of the Frontal Lobe During Delayed Response Task
Activation of Neurons Near the Principal Sulcus of the Frontal Lobe During Delayed Response Task

“Planning” neurons

Neuron does not continue to fire during delay period; animal makes incorrect response

Cellular evidence supports the importance of continuous activity

Very Complex Functions - Example

Phenomenology and pathophysiology of autoscopic phenomena

Phenomena observed:
- experiences felt “realistic”
- vestibular sensations, floating
- “egocentric” perspective lost


Neuropsychological Testing – Wisconsin Card Sorting Task

Sort by color  Sort by shape  Sort by number

Neuropsychological Testing – Stroop Interference Test

Testing:
- Attention
- Automaticity
- Learning
- Response Selection
- Word Reading
- Color cognition

rabbit
Anatomy of the mind – more complete view

Cognition (perception and memory)
- Neocortex and hippocampus

Affect (feeling and expression)
- Amygdala-hippocampus and cingulate

Conation (thinking and action)
- Prefrontal cortex and basal ganglia

The hardware of cognition: The neocortex association regions.

The hardware of emotions: The limbic system.

The hardware of “executive” functions:
- The corticostriatal structures.

Disorders of Perception and memory: ADHD, Schizophrenia, Alzheimer’s
Emotional encoding
Cingulate
Emotional experience
Amygdala
Disorders of emotion regulation
Hippocampus
Arousal
Thalamus
Sensory inputs

Endocrine
Autonomic

Anxiety, Depression, PTSD

Study questions for The Association Cortices

1. Describe the basic organizational features of association cortices, shared by association cortices and sensory and motor cortices.
2. What features distinguish association cortices from sensory and motor cortices? Consider thalamic input and corticocortical connections.
3. How did Brodmann decide where to put the boundaries between Brodmann’s areas?
4. What are the main function(s) of each of the following? What techniques and approaches have been used to reveal these functions?
   - parietal association cortex
   - temporal association cortex
   - frontal association cortex
5. What does the study of agnosias contribute to cognitive neuroscience?
6. What does contralateral neglect syndrome suggest about the neuroanatomy of attention? Why does contralateral neglect result from damage to the right, but not left, parietal lobe cortex?
7. Where and what are “recognition neurons”? “planning neurons”? “attention neurons”?
8. What cortical region is particularly critical for the delayed response task?
9. Is brain size a good measure of intelligence?
10. Other terms to know:
    - cognition
    - apraxia
    - cytoarchitectonic
    - prosopagnosia

Neurochemical systems involved

Norepinephrine
- Flight/Fight/Fright

Dopamine
- Pleasure seeking/executive
- Appetitive functions

Serotonin
- Memory, arousal
- Inhibitory

Acetylcholine
- Excitatory

GABA

Glutamate

Box D Brain Size and Intelligence

Frontal executive system
Motor system, Basal ganglia, cerebellum
Disorders of executive functions
psychosis, OCD.