Cortical Organization

Functionally, cortex is classically divided into 3 general types:

1. **Primary cortex**: _______________________________________
   ___________________________________________________________.
   - receptive field: _________________________________________.

2. **Secondary cortex**: located immediately adjacent to primary cortical areas, they show extensive connections with primary cortical areas.
   - secondary cortex normally involved in extracting ______________
     ___________ derived from simple sensations.
   - ex., in humans, there exists between 20 - 40 secondary visual areas; some of these areas are specialized to extract complex forms, whereas others are specialized to detect motion, etc.

3. **Tertiary cortex**: cortex receiving __________________________
   ___________________________________________________________.
   - these cortical areas are believed to provide integration of several sensory, emotional, and memory characteristics, and be responsible for many of the unique qualities of the human brain.
   - most tertiary cortical areas located in ______________________
     ________________________________.
Cellular Structure of Neocortex

Neocortex is composed of 2 main neuronal cell types:

1. **Pyramidal cells (AKA principal cells)** - cell body shaped in form of __________ with base normally facing deep cortical layers, and apex oriented toward superficial cortical layers.
   - apical dendrite is large dendrite given off at the ______ of the cell.
   - basal dendrites are dendrites given off around the _____ of the cell.
   - single long axon (comparatively small diameter) normally exit cell from _____ of cell.
   - range in size from ______ µm, with some very large cells (up to 100 µm), in primary motor cortex, called ___________.
   - pyramidal neurons probably use __________ as NT, and thus have _________ effects on target neurons.

2. **Stellate cells (AKA granule cells)**: star shape cells, normally much smaller than principal cells, giving them the appearance of ________________.
   - There exist two main types of stellate cells:
     A. Spiny stellate cells - excitatory interneurons, spread excitation across layers within a column. Probably utilizes __________ as NT.
     B. Aspiny stellate cells - inhibitory interneurons, thought to inhibit adjacent columns (lateral inhibition). Uses ________ as NT.
   
N.B. aspiny (smooth) cells are given several different names.
Neocortex is arranged in a specific layer organization:
- arranged in 6 layers, the thickness of which varies between
different cortical areas (ex.: sensory cortex thick in ______, primary
motor cortex thicker in layer __).
Layer 1 - closest to ______________, this ______________ is nearly
devoid of cell bodies, and made mostly of axons and dendrites.
Layer 2 - contains small _________________________________.
Layer 3 - contains mostly ________________ increasing in size from
external to internal borders.
Layer 4 - contains both _________________________________.
Layer 5 - contains largest _________________.
Layer 6 - contains small and multiform pyramidal cells.

Figure 14-2. Cortical histology, as revealed by two staining
methods. (A) Golgi method: 1 = molecular layer; 2 = external
granular layer; 3 = external pyramidal layer; 4 = internal
granular layer; 5 = internal pyramidal layer; 6 = multiform
layer. (B) Weigert method for myelin: 1 = outer line of Baill-
larger; 2 = inner line of Baillarger.
General connectional arrangements of the different cortical layers

A. Major efferent connections:

1. Cells from layer II (D), whether pyramidal or aspiny, only have __________ regional connections (________________).
2. Small to medium pyramidal cells from layer III (C) have callosal (____________) projections to parallel regions in the _________________, and corticocortical connections.
3. Stellate cells (spiny and aspiny) of layer IV make contact with cells in ____________________________.
4. Medium to large pyramidal cells from layer V (B) provide the bulk of the __________________________ to spinal cord, brainstem, basal ganglia (striatum), thalamus, and red nucleus.
5. Pyramidal cells of layer VI (A) provide bulk of projections to ______ (corticofugal efferents), and some callosal projections.
B. Major afferent connections:

1. Layer I provides synaptic interactions between axons from virtually every cortical and extra-cortical sources upon ____________________________________.

2. Layers II and III are the recipients of most callosal (contralateral hemisphere) and association (corticocortical) inputs.

3. Layer IV receives most sensory afferents from ____________.

4. Besides the sensory, association, and callosal afferents providing inputs to neocortex, there are several non-specific afferents which give inputs to ____________.

- these inputs have important overall ____________________ on cortical activity. Examples include serotonergic, dopaminergic, and noradrenergic input from brainstem and cholinergic inputs from basal forebrain.

Figure 14-4. Some intracortical connections. Impulses arriving from other cortical areas directly excite the apical dendrites of pyramidal cells. Afferents from specific thalamic nuclei excite the stellate cells (stippled) in layer 4, which in turn excite pyramidal cells (white) in the same column. Also in layer 4, collateral branches of pyramidal cells excite basket cells (black), which inhibit pyramidal cells in adjacent columns (gray). (Used with permission from Martin JH: The collective electrical behavior of cortical neurons: the electroencephalogram and the mechanisms of epilepsy. In Kandel ER, Schwartz JH, Jessell TM (eds): Principles of Neural Science, 3rd ed, p 781. New York: Elsevier, 1991.)
The neocortex, besides being organized in layers, is also organized in __________.
- neurons in each layer are interconnected with ones directly ________
  ____________ by stellate cells and function as a columnar unit.

Example of columnar organization in primary visual cortex:
- L (left) and R (right) indicate ocular dominance columns or slabs.
- orientation columns are narrower and run orthogonally to ocular
  dominance columns.
Parietal Lobe Functions

Visual information processing associated with 2 projection systems (AKA visual “streams”):
- **Dorsal stream** to posterior parietal lobe: ________________________________

- **Ventral stream** to middle and inferior gyri of temporal lobe: ________________________________

Anatomically, the parietal lobe is subdivided into 3 major “zones”:
1) **Anterior parietal cortex**: includes the primary somatosensory cortex;
   and Posterior parietal cortex subdivided into:
2) **Superior parietal lobule**, and
3) **Inferior parietal lobule** (divided into the supramarginal and angular gyri).
Overall functional specialty of these 3 parietal areas

1) Anterior parietal: _________________________________________________________________.

2) Posterior superior parietal: ________________________________________________________.
   - general “spatial” functions (visuo-motor functions).

3) Posterior inferior parietal: ________________________________________________________
   ____________________________________________________________
   ____________________________________________________________________

Details of the Theory on the general role of parietal tertiary cortex (both superior and inferior parietal lobules).

I. Construction of a spatial representation of the world
   1. _________________: sense of where things are in relation to each other and in relation to the self or viewer (egocentric map).
   2. _________________: guidance of movements to points in space based on egocentric map.
   - these functions are mostly localized to the superior parietal lobe.

II. Recognizing and producing abstract stimuli (symbols)
   1) Sensory component: _________________ (a square from a circle).
   2) Motor component: knowing _________________ and objects (this includes covertly manipulating the symbols, as in mentally rotating objects or in mental arithmetic).
   - these functions are mostly localized to the inferior parietal lobe.
Laterality of Parietal Lobe Function

I. Left hemisphere specialties (______________________):

1) processing of symbolic and analytic information (math and language).
   - supramarginal and angular gyri appear most important (inferior parietal lobule).
   - association of angular gyrus with language processing;

2) accurate positioning of body parts during movement and the association of skilled movements with concepts;
   ________________________________.

II. Right hemisphere specialties (______________________):

1) construction of a spatial representation of the world;
   ________________________________.

2) ability to construct things (in real world or in “mind’s eye”).
   - both functions especially associated with superior parietal lobule.
Disorders associated with Parietal Lobe Damage

I. Anterior parietal lobe damage:
   1) Somatosensory thresholds: _____________________________
   2) Two-point threshold: _________________________________
   3) Perception of passive movement: ______________________

- all these deficits are observed ____________ to the site of the
  lesion (ex., left postcentral gyrus lesion leads to deficits on right
  side of the body).

II. Posterior parietal lobe damage: (sensory dysfunctions)
   General sensory failure to recognize objects by touch or one’s
   sense of own body or movement are called __________.

   There are two general classes of agnosias:
   1) _____________: inability to recognize objects by touch.

   2) _____________: loss of knowledge or sense of one’s own body
      and bodily condition. These agnosias give rise to neglect.

   There exists several subtypes of agnosias within the two major
   categories:
      a) Tactile agnosia (astereognosis): can have difficulty
         recognizing objects ______________________________
         (example of woman who can point to a touched area of left
         hand with right hand without conscious awareness of it).
b) Anosognosia: ______________________________.

c) Autopagnosia: ______________________________.
   (most often encountered in patients unable to show or point to fingers of either hand).

d) Contralateral neglect: ______________________________
   ___________________________ (ex., will shave or apply make-up to one side of face).
   - this includes visual field.
III. Posterior parietal lobe damage: (motor dysfunctions)

Disorders of movement in which there is a loss of skilled movement not due to muscle weakness are called _________. There are two major categories of apraxia, each subserved by ____________________________:

1) Left hemisphere posterior parietal damage can produce:
   a) ________________: unable to form a goal to be performed motorly.
   b) ________________: unable to copy movement or to make gestures (ex., waving hello).

Example of ideomotor apraxia:

Patient unable to copy models, but does better from memory when prompted to do so.
2) **Right hemisphere** posterior parietal damage often produces:
   a) _____________________: inability to assemble, build, or draw. Will produce very distorted drawings.

3) _____________________: Inability to mentally manipulate objects (mental rotations, arithmetic).
   - NB. Can be produced by lesions on either side of the brain.

Such deficits could be caused by right or left posterior parietal lobe damage depending on whether image can be produced mentally (left hemisphere dominance) and then can be manipulated (right hemisphere dominant).
Classically described symptom patterns (syndromes) following parietal lobe damage

A) Gerstmann’s syndrome (damage to left parietal lobe, especially in angular gyrus region):

1) finger agnosia (unable to name or point to fingers of either hand);
2) right-left confusion (chance assignment to right or left);
3) agraphia (inability to write); and
4) acalculia (inability to perform mathematical operations).

P.S. Remember individual differences

How to account for individual differences? Concept of preferred mode of cognitive processing.
- example of using either a verbal cognitive mode or a spatial nonverbal cognitive mode.

B) Balint’s syndrome (damage to both hemispheres more likely associated with superior parietal lobule):

- no simple aphasia, apraxia, or agnosia, but:
  1) defective gaze (unable to fixate on specific visual stimuli);
  2) simultagnosia (can attend to only one stimulus at a time); &
  3) optic ataxia (deficit in reaching under visual guidance).

Again, individual difference in outcome in what appears to be similar areas of the parietal lobe.