

Bi 150

Anatomy and Organization of the Nervous System

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Basic Anatomy of the Nervous System
(Vision: phototransduction)
Vision: Retina to Cortex
Vision: higher-level
Audition
Somatosensation
Motor System
(Circadian Rhythms)
(Olfaction)
Learning & Memory II
Learning and Memory III
(Alzheimer's & Parkinson's)
Autism
Emotion and social behavior
Monoamines and mood
(Schizophrenia)

Reading: Chapters 1, 17
occasional quizzes

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Overview and interesting facts
Terms
Gross structure
Spatial orientation
Major pathways
Parts of Cortex
Methods

The Human Brain in Perspective

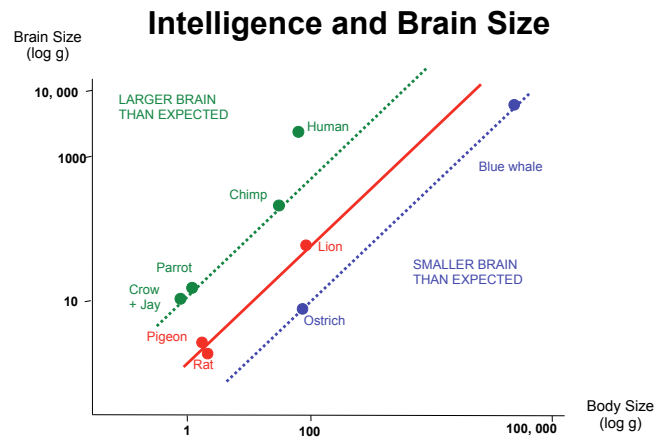
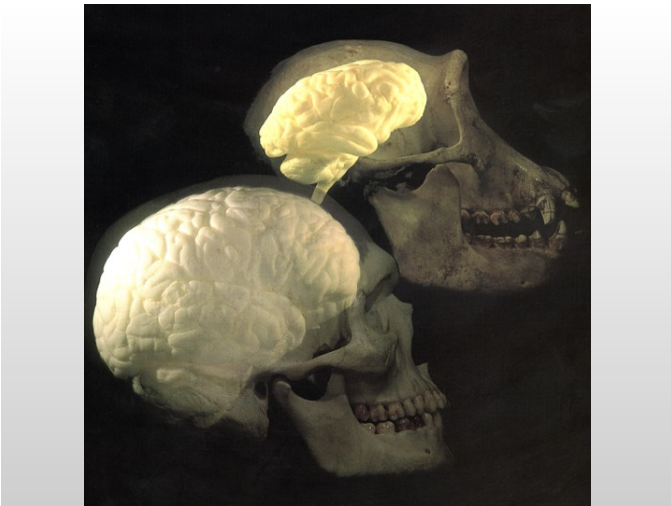
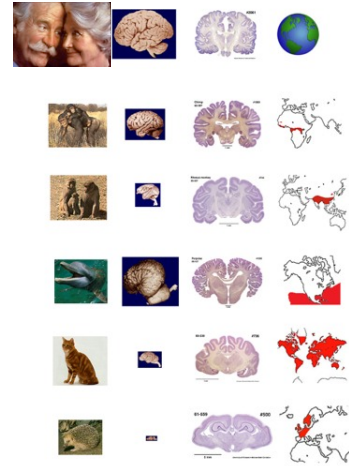
~20,000 protein-coding genes in the genome
>100,000 distinct neuronal phenotypes
ca. 10^{11} neurons
ca. 10^{14} connections
astronomical number of ensembles
unbounded number of mental states?

20,000-30,000 neurons per mm³
4 km axons per mm³
2-4 mm cortical thickness
ca. 10^9 synapses under mm²

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Information is encoded in the wiring of the brain.
 This depends in large part on experience.



Human brains are unusually large.
 -adult human brains are unusually large
 -newborn human brains are unusually small
 -humans are very altricial (the opposite of precocious)

Noteworthy inventions:

- myelin: vertebrates
- neocortex: mammals
- corpus callosum: placental mammals
- large prefrontal cortex: primates
- mirror neurons: primates
- Von Economo neurons: apes



1. Foramen magnum level
2. Brachial plexus
3. 1st thoracic nerve
4. 1st lumbar spinal ganglion
5. 1st sacral nerve
6. Filum terminale

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CNS

Central Nervous System

PNS

Peripheral Nervous System

Afferent (vs. Efferent)

Input (output) to (from) a certain structure

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ANS

Autonomic Nervous System

= Central + Peripheral Components

Efferents to smooth muscle, organs

Afferents from cranial nerves (Vagus) and spinal

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White matter

Made up of Myelinated Axons (which are white)

Gray Matter

Made up of cell bodies of neurons

Myelin

Fatty substance derived from oligodendrocytes or Schwann cells that surrounds axons

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Ganglion (ganglia)

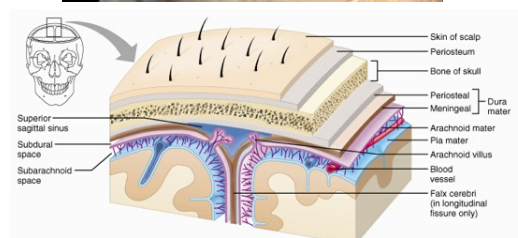
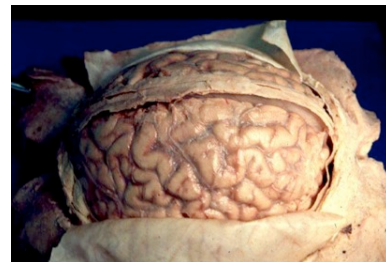
Group of cell bodies found in the PNS

Nucleus (nuclei)

Group of cell bodies found in the CNS (not the same as a cell nucleus)

Nerve

Bundle of axons found in the PNS (vs. **Tract**).

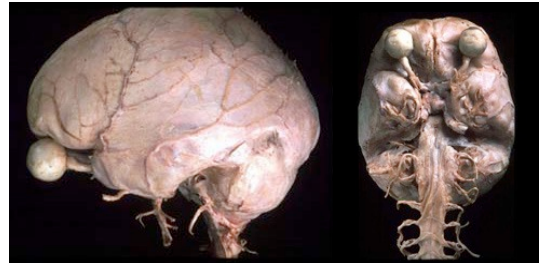


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Meninges and Ventricles

Dura Mater



- Surrounds brain, closely adherent to skull (no epidural space)
- Two fused layers (periosteal and meningeal) which split to form venous sinuses.
- Thick and leather-like, contains pain receptors (none in arachnoid, pia, or brain)

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Arachnoid

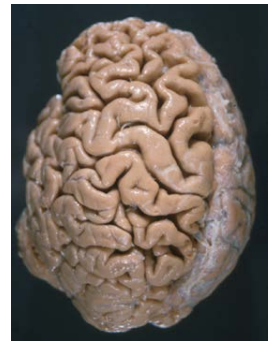
- Closely associated with brain and dura (no subdural space).
- Subarachnoid space where CSF and Blood Vessels live
- Does not follow surface of brain into sulci
- Forms arachnoid granulations on the dorsal surface



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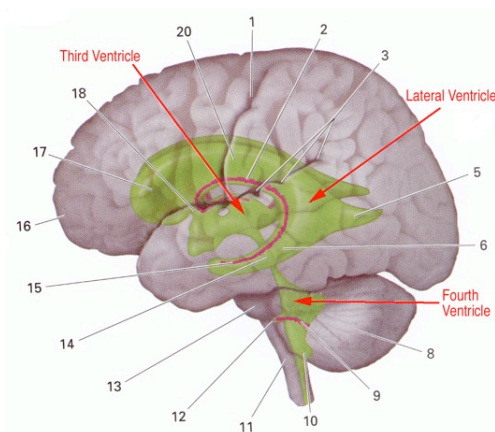
Pia Mater

- Closely adherent to surface of the brain
- Cannot be separated without destroying cortical surface
- Follows vessels as they pierce the cortex



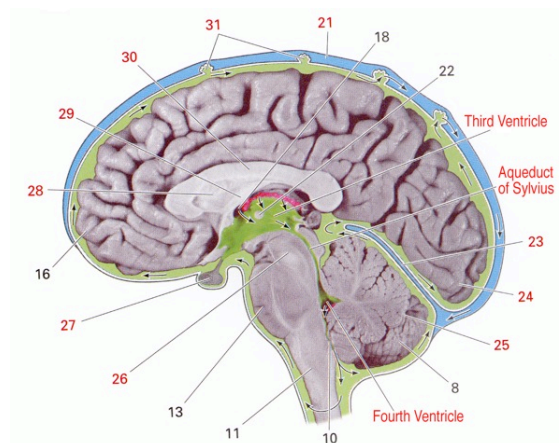
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Ventricles

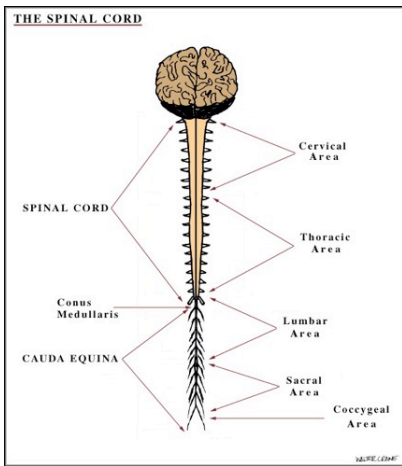


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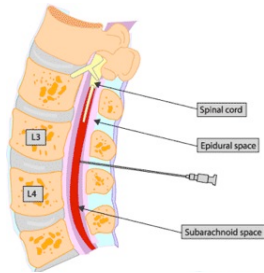
Flow of Cerebrospinal Fluid



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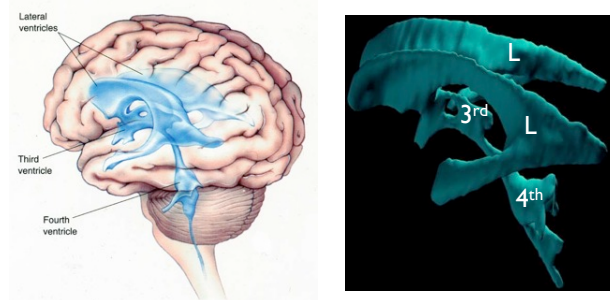


lumbar puncture aka "spinal tap"



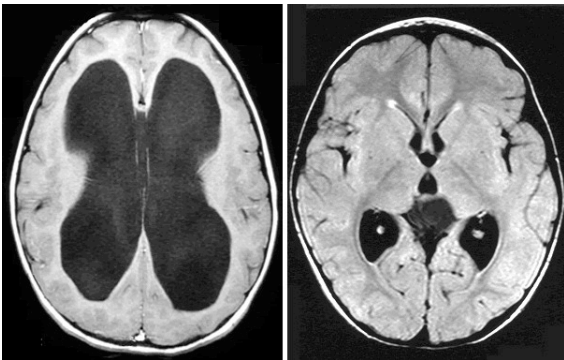
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Cerebral Ventricles



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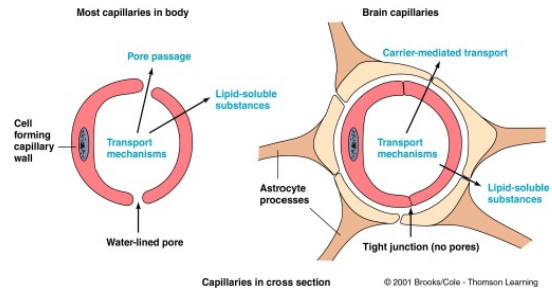
Hydrocephalus



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There is a blood-brain barrier

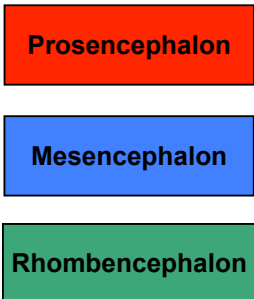
- prevents large molecules from passing through
- tight junctions in blood vessels
- separation of CFS from blood



© 2001 Brooks/Cole - Thomson Learning

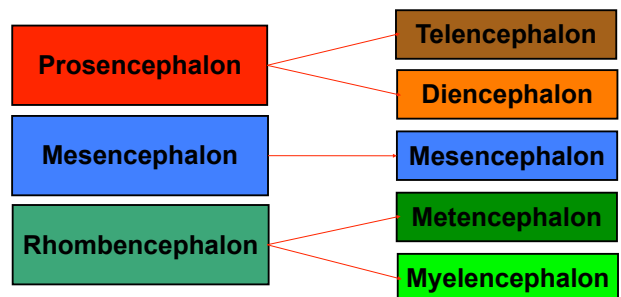
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The brain begins with three developmental divisions.



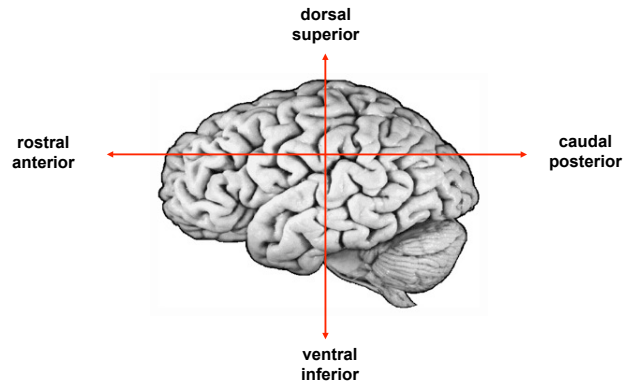
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These develop into five vesicle divisions.



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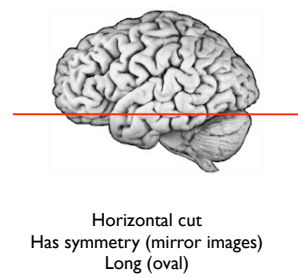
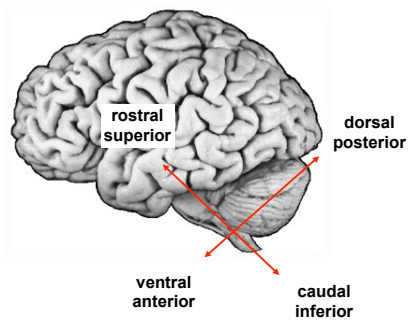
Orientation



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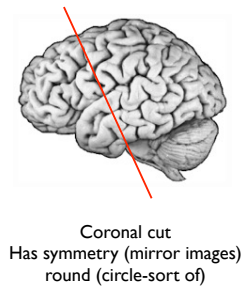
the brain takes a turn at the cephalic flexure



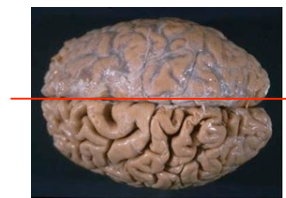
Horizontal cut
Has symmetry (mirror images)
Long (oval)

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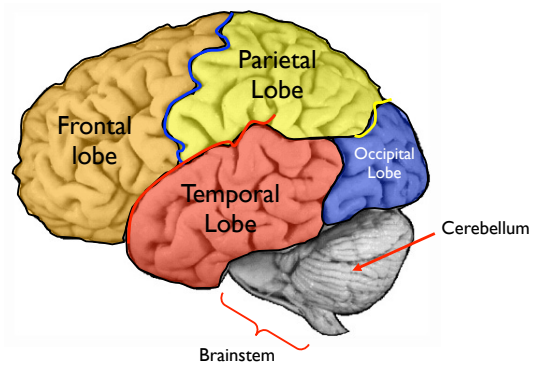
Coronal cut
Has symmetry (mirror images)
round (circle-sort of)



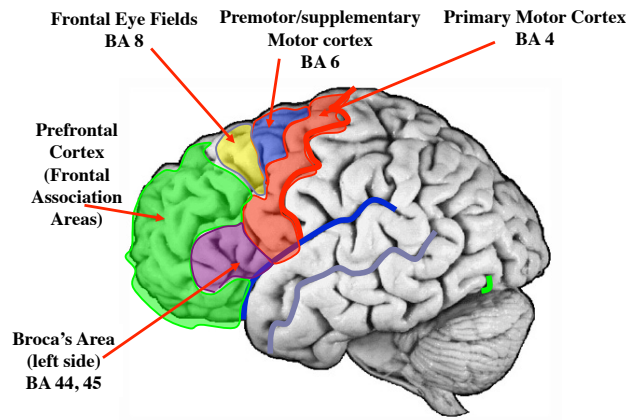
Sagittal cut
Does not have symmetry

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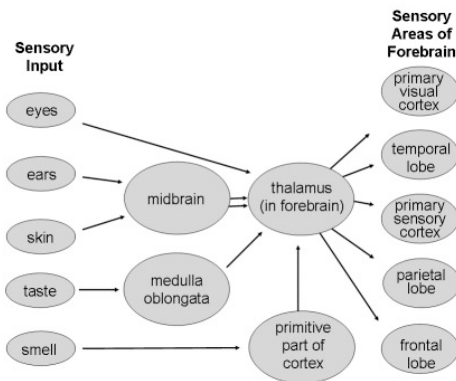
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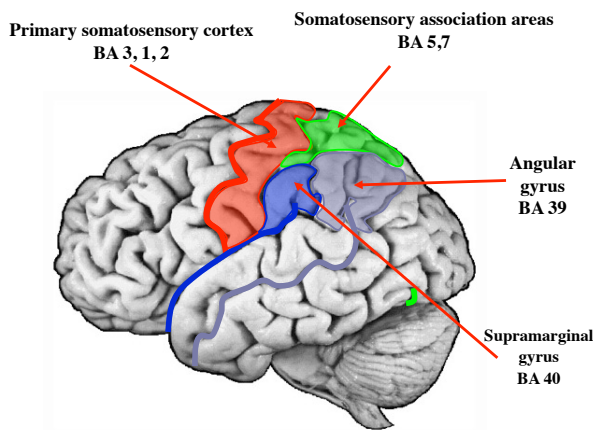
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All sensory input goes through the thalamus
 -exception: olfaction

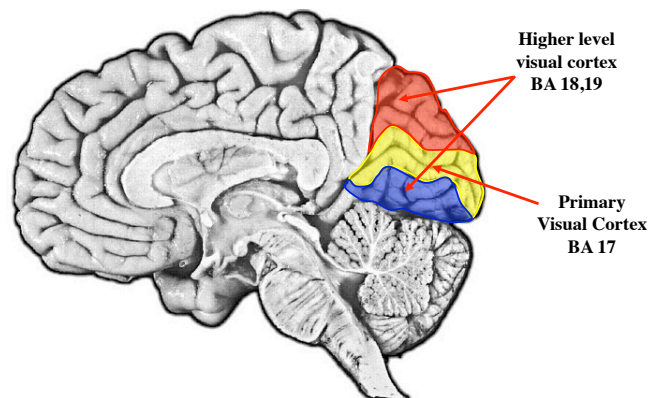
All cortex receives thalamic inputs
 -possible exception: frontopolar cortex

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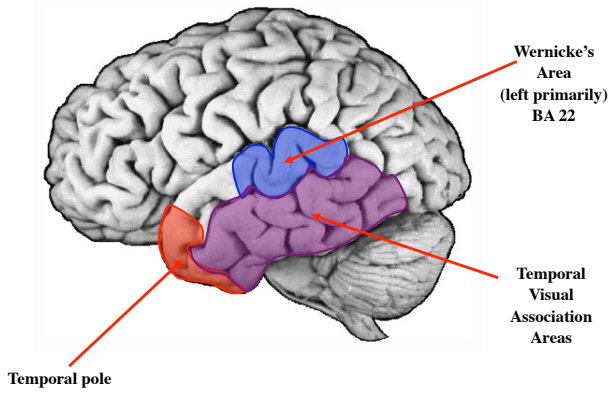
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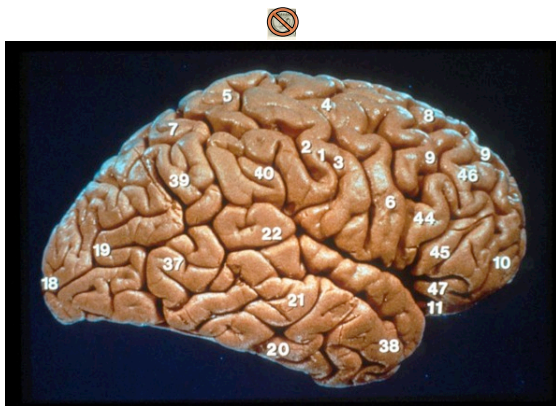


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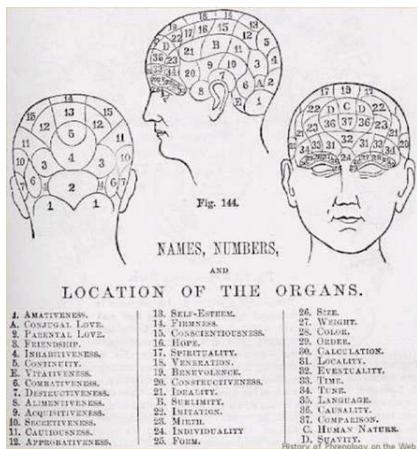


Neocortex is organized into maps

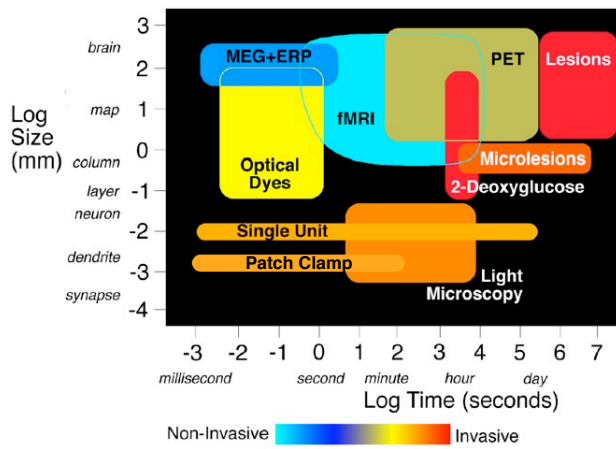
- primary sensory cortices are topographic
- higher-order cortices are next to primary cortices
- there are information processing streams through cortex



Phrenology



1. The instinct of reproduction (located in the cerebellum).
2. The love of one's offspring.
3. Affection and friendship.
4. The instinct of self-defense and courage; the tendency to get into fights.
5. The carnivorous instinct; the tendency to murder.
6. Guile; acuteness; cleverness.
7. The feeling of property; the instinct of stocking up on food (in animals); covetousness; the tendency to steal.
8. Pride; arrogance; haughtiness; love of authority; loftiness.
9. Vanity; ambition; love of glory (a quality "beneficent for the individual and for society").
10. Circumspection; forethought.
11. The memory of things; the memory of facts; educability; perfectibility.
12. The sense of places; of space proportions.
13. The memory of people; the sense of people.
14. The memory of words.
15. The sense of language; of speech.
16. The sense of colours.
17. The sense of sounds; the gift of music.
18. The sense of connectedness between numbers.
19. The sense of mechanics, of construction; the talent for architecture.
20. Comparative sagacity.
21. The sense of metaphysics.
22. The sense of satire; the sense of witicism.
23. The poetical talent.
24. Kindness; benevolence; gentleness; compassion; sensitivity; moral sense.
25. The faculty to imitate; the mimic.
26. The organ of religion.
27. The firmness of purpose; constancy; perseverance; obscurity.



Features of different methods:

- resolution in space and time
- field of view
- relationship to neuronal activity (direct vs. indirect)
- feasibility
- correlation vs. causation
- statistical power (SNR, etc)

Summary of basic principles

1. inputs/outputs are contralaterally organized
2. functional specialization in anatomical regions
3. hemispheric asymmetry in function
4. there are functional and anatomical pathways
5. there is massive feedback
6. terms: parallel, serial, digital, analog, convergence, divergence, hierarchy