

# **뇌공학, 신경공학 연구를 위한 기초 신경해부학**

KAIST

바이오및뇌공학과  
뇌인지공학프로그램

정 용

yong@kaist.ac.kr

# 강의 개요

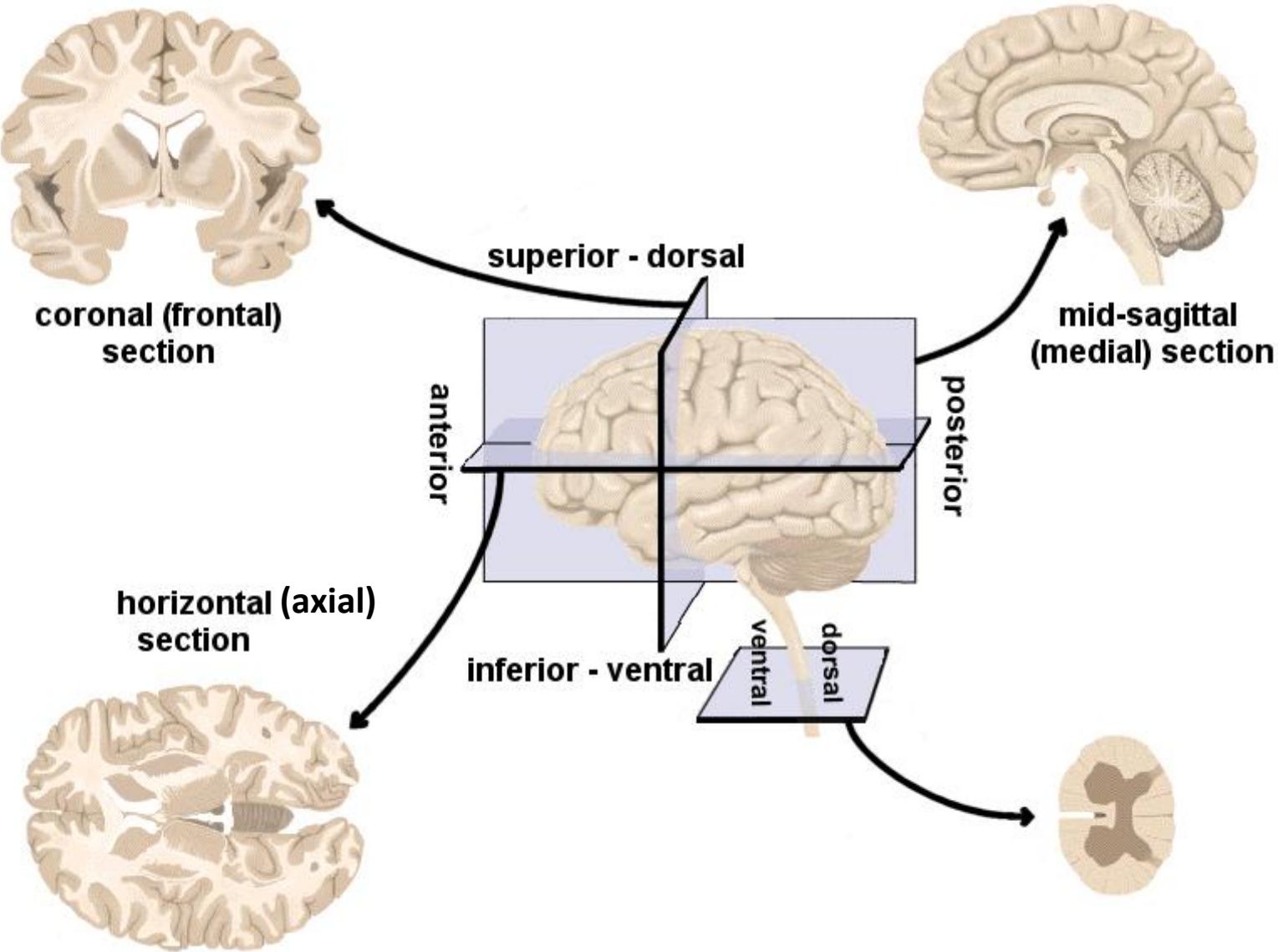
- General Overview
- Anatomy of cerebral cortex
- Anatomy of subcortical structures
- Anatomy of white matter tracts
- MRI Neuroanatomy

# Name the mountain.

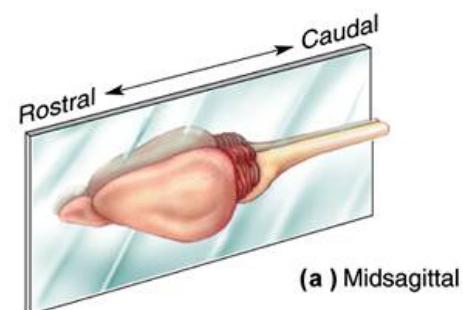
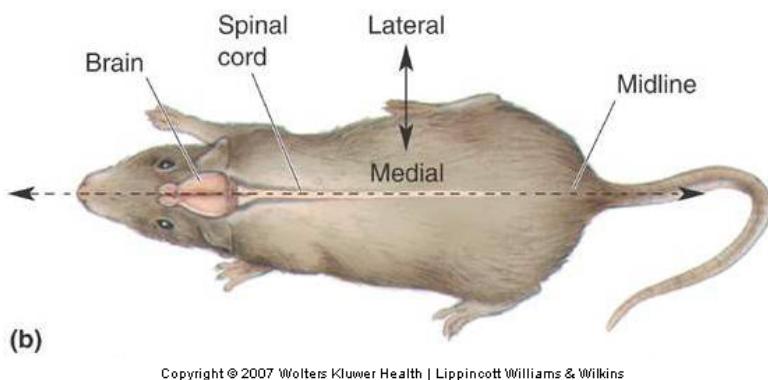
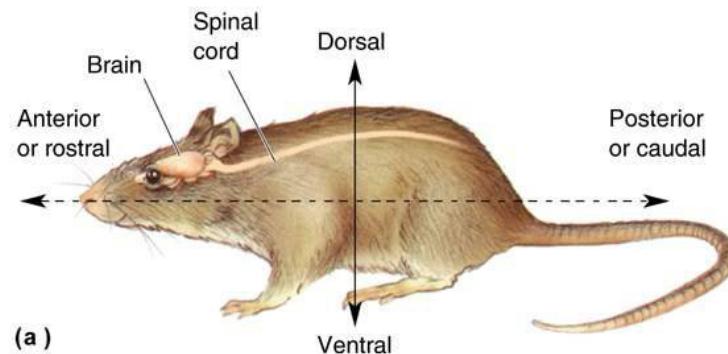


# **General Overview**

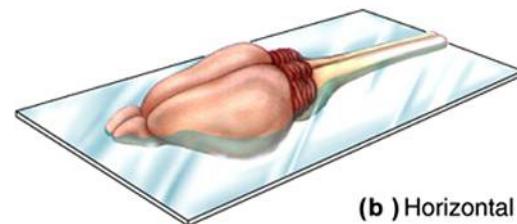
# Anatomical References



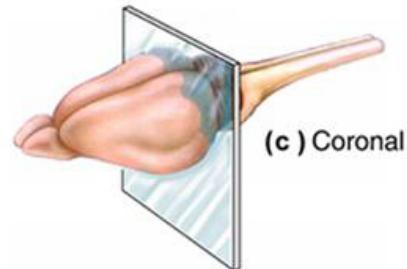
# Anatomical References



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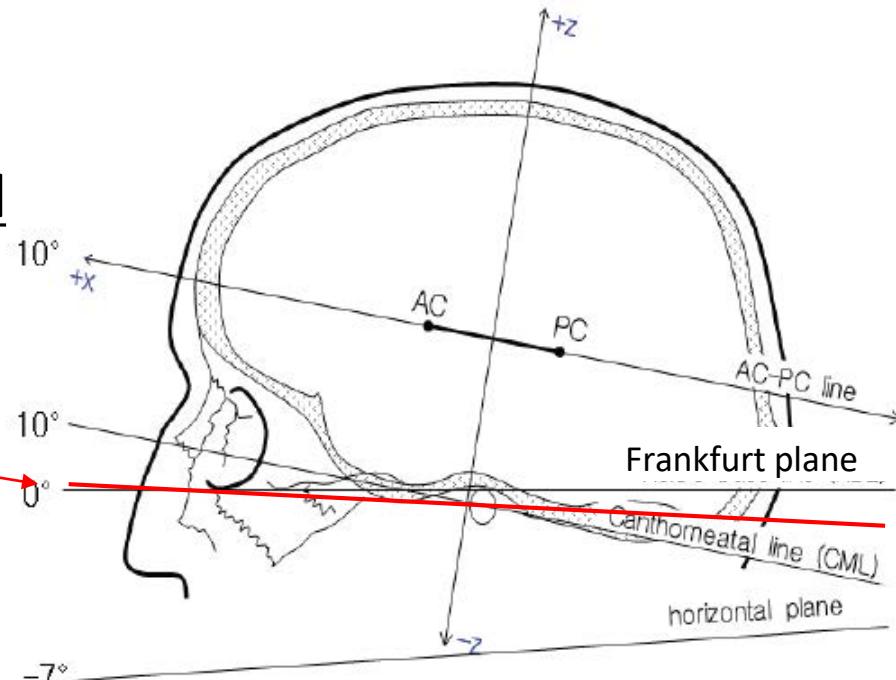
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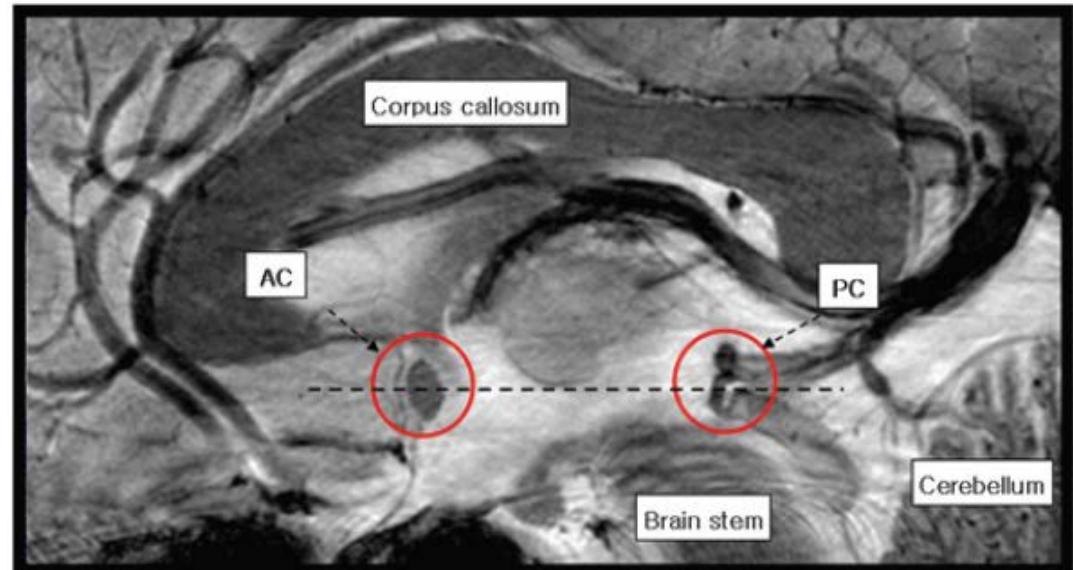
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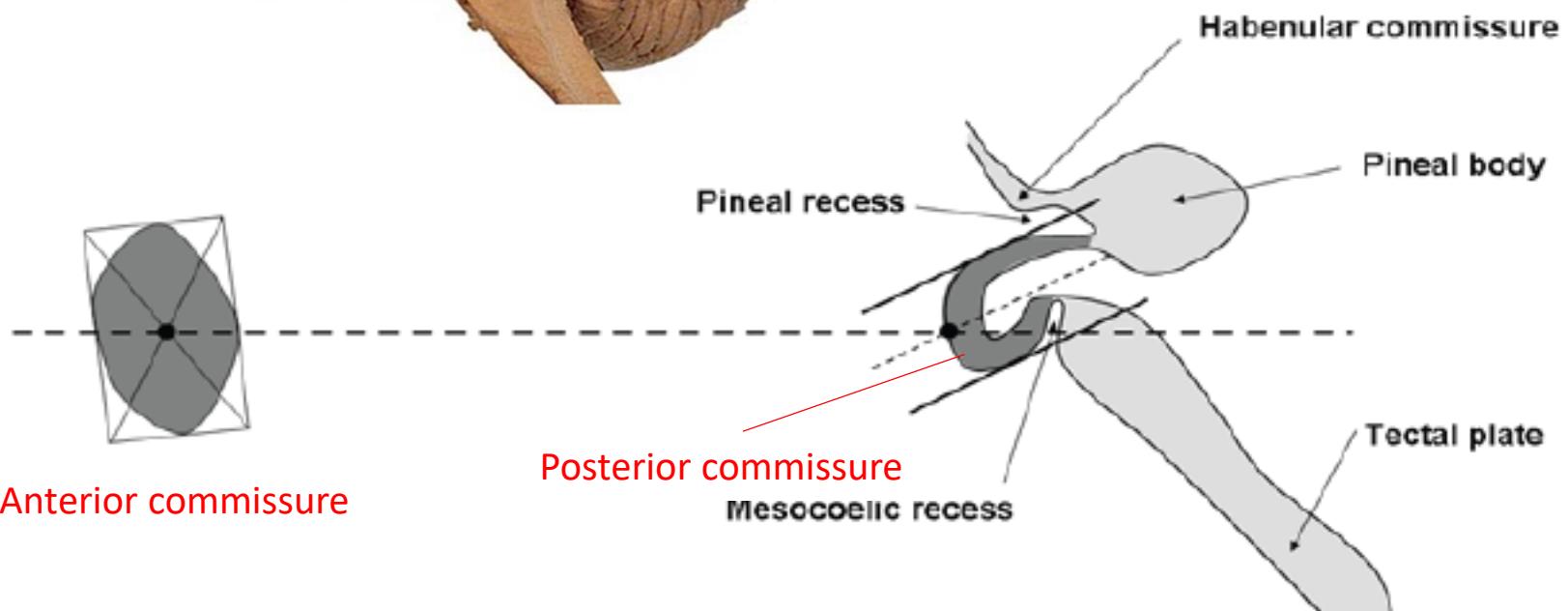
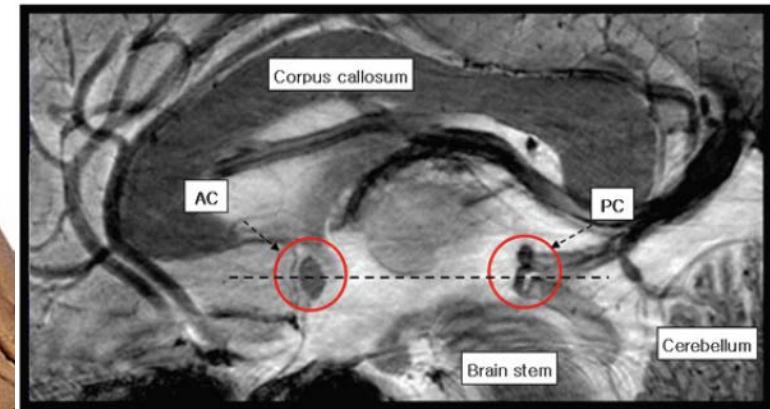
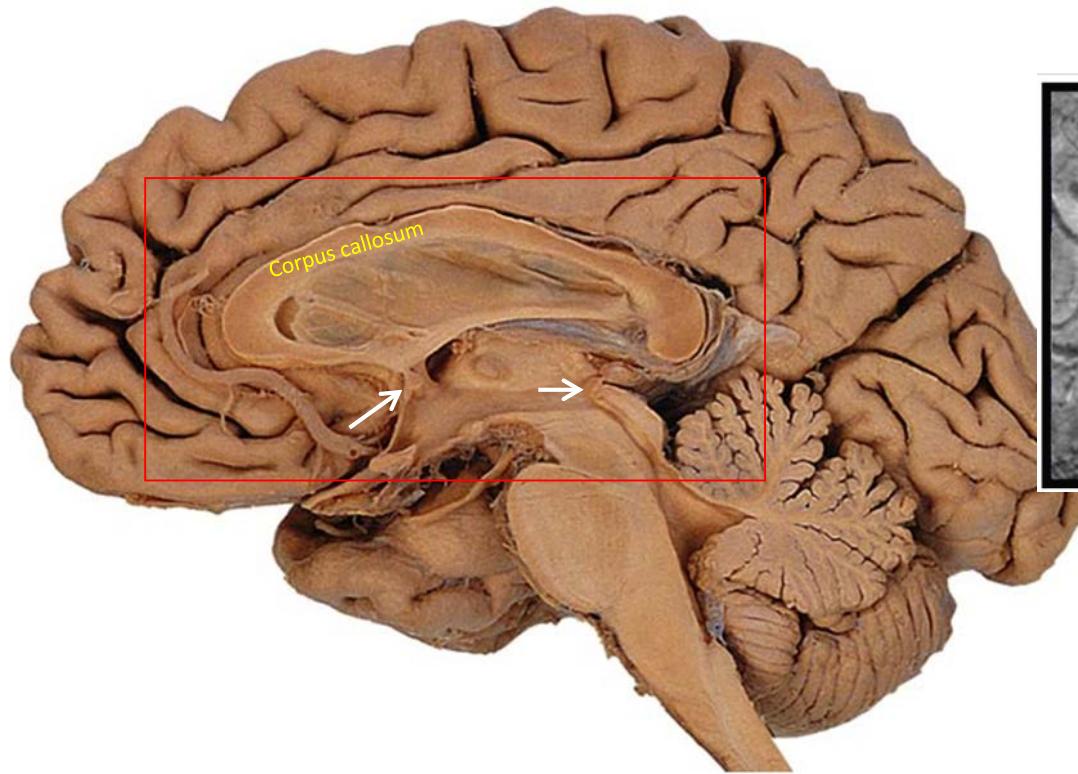
## Definition of horizontal plane of skull and brain

- **Reid's line**
  - ✓ inferior margin of orbit
  - ✓ Center of external acoustic meatus
  - ✓ Conventional X-ray, CT, MRI
  - ✓ Cf) Frankfort plane – upper margin of ext. acoustic meatus



- **AC-PC line**
  - ✓ Anterior commissure
  - ✓ Posterior commissure
  - ✓ Cadaver brain
  - ✓ MRI

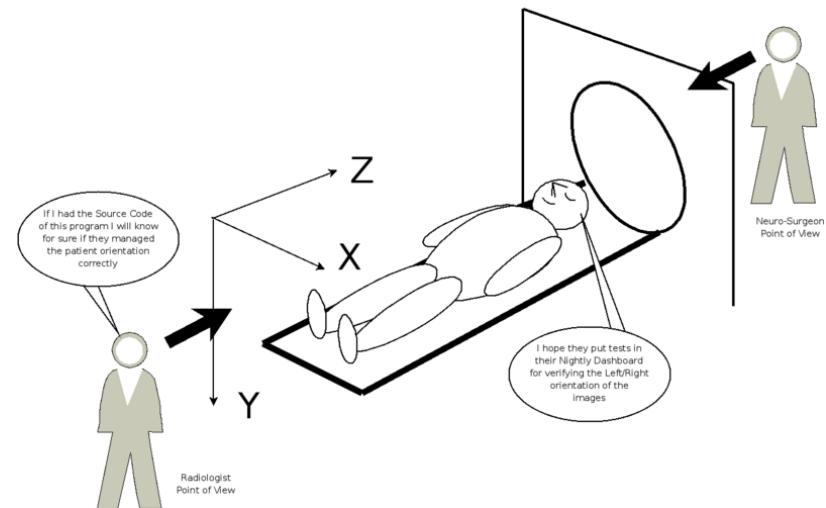
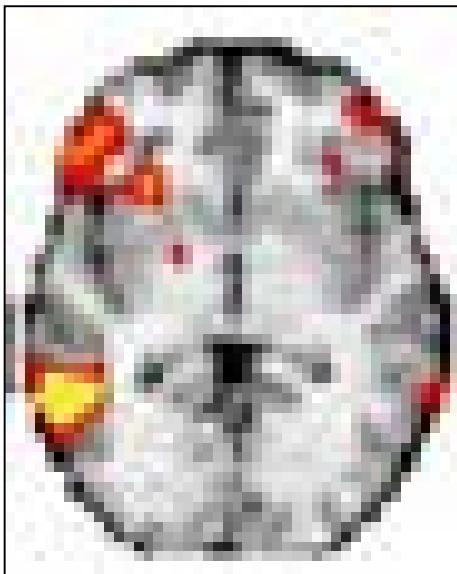
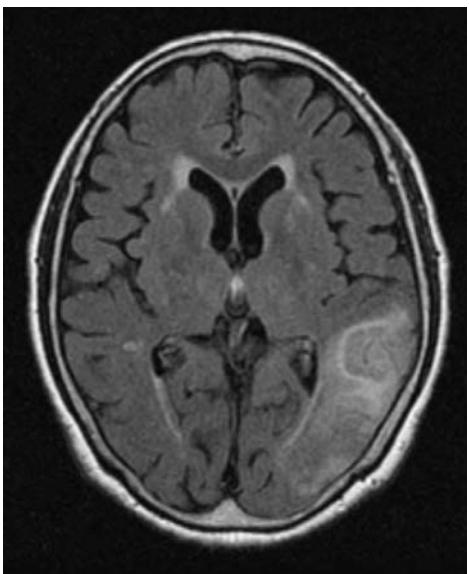




**"The reference coordinate (coronal=0, sagittal=0, horizontal=0)"**

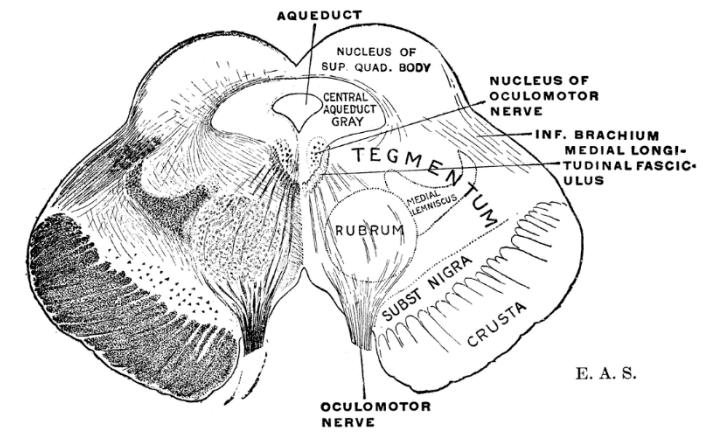
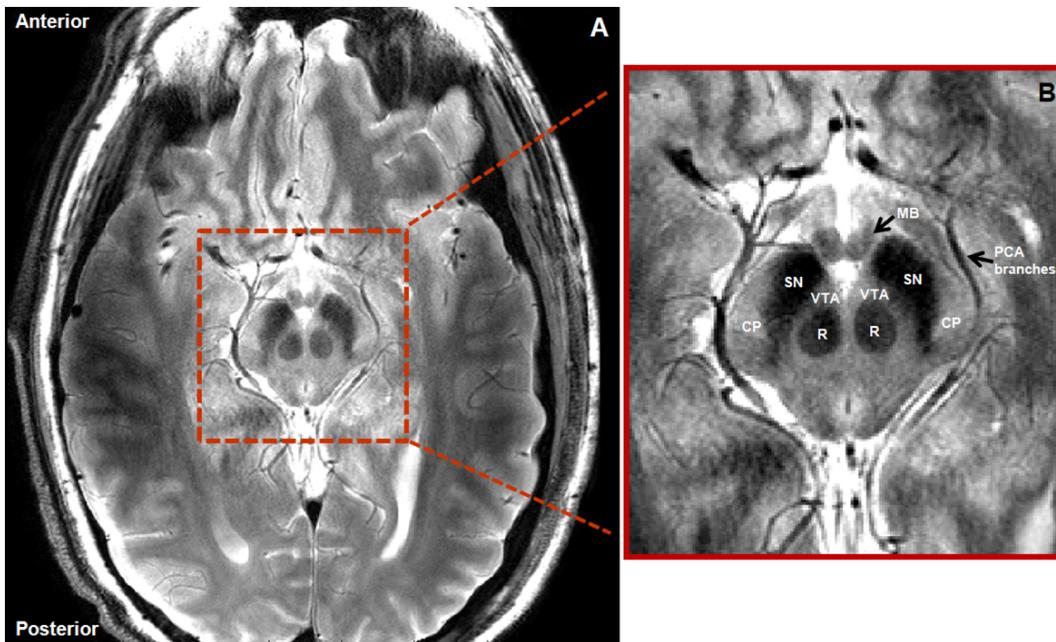
# Image Flipping

- Radiological convention: right is left side
- Neurological convention: right is right side



# Image Flipping

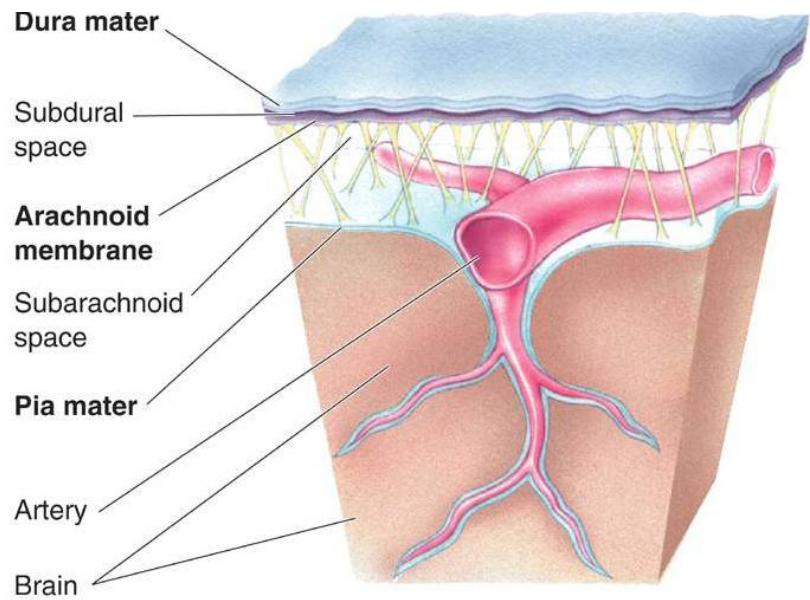
- Neuroanatomy Textbook: Upper is posterior
- Radiology Textbook, MRI: Upper is anterior



# Gross Organization

- Meninges

- Three membranes that surround the brain
  - Dura mater
  - Arachnoid membrane
  - Pia mater

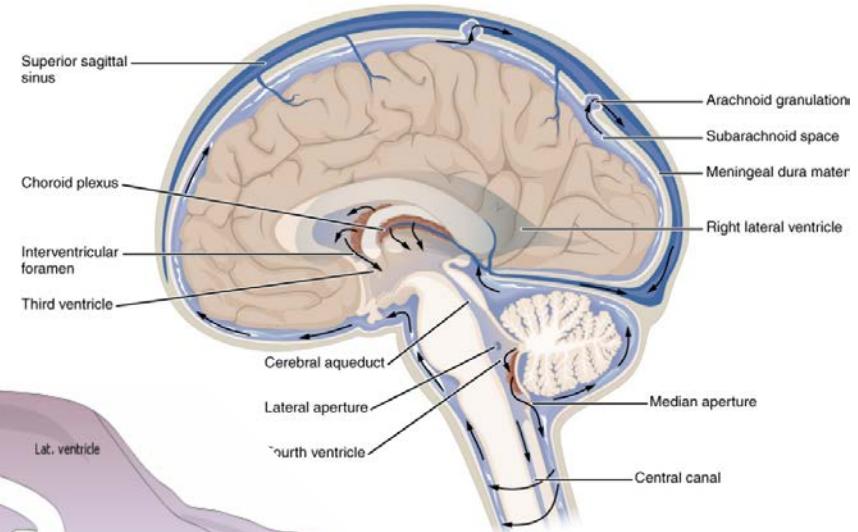
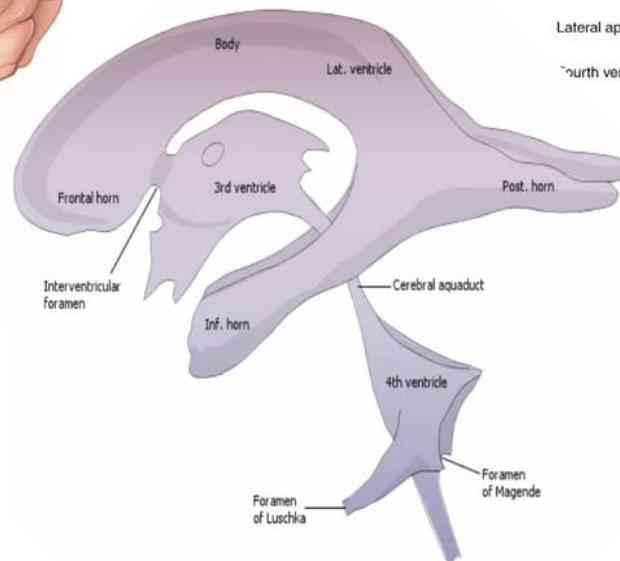
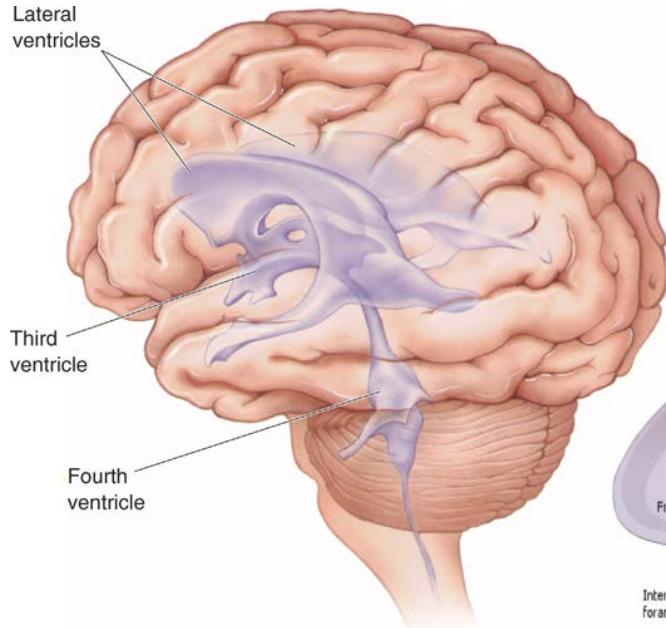


(b)

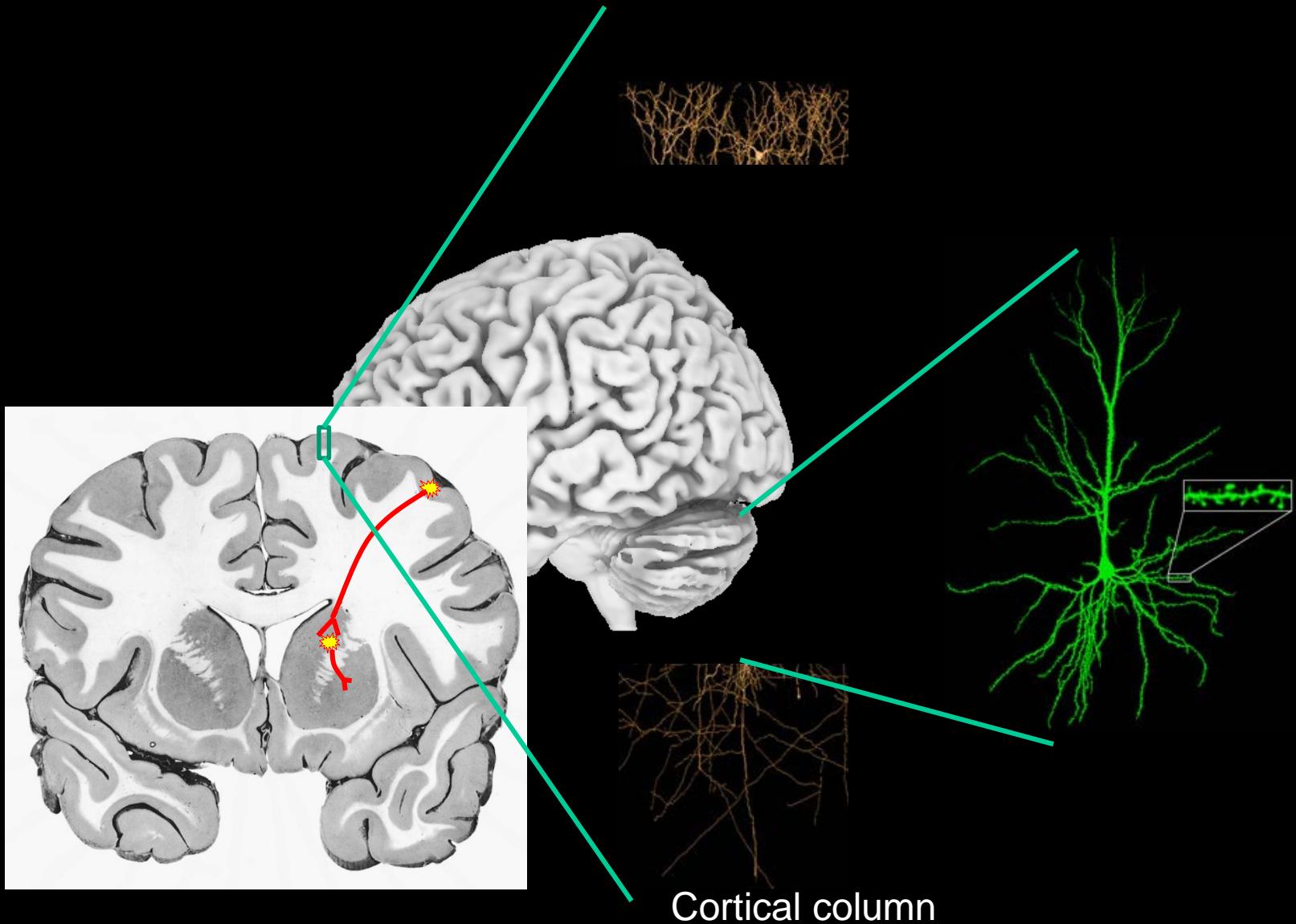
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# Ventricle System

- Features of the Human CNS
  - Human ventricular system



# Grey matter (include cerebral cortex) & White matter



# External Morphology

- Two hemisphere, Corpus callosum
- Cerebellum
- Diencephalon
- Brainstem (midbrain, pons, medulla oblongata)
- Spinal cord

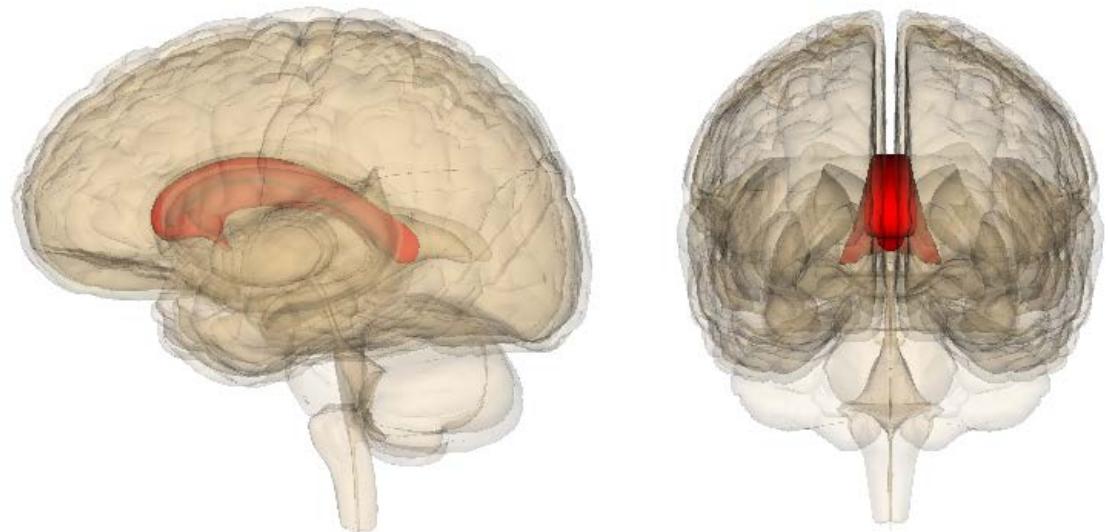


Figure AB-26: Build A Brain, Step 1

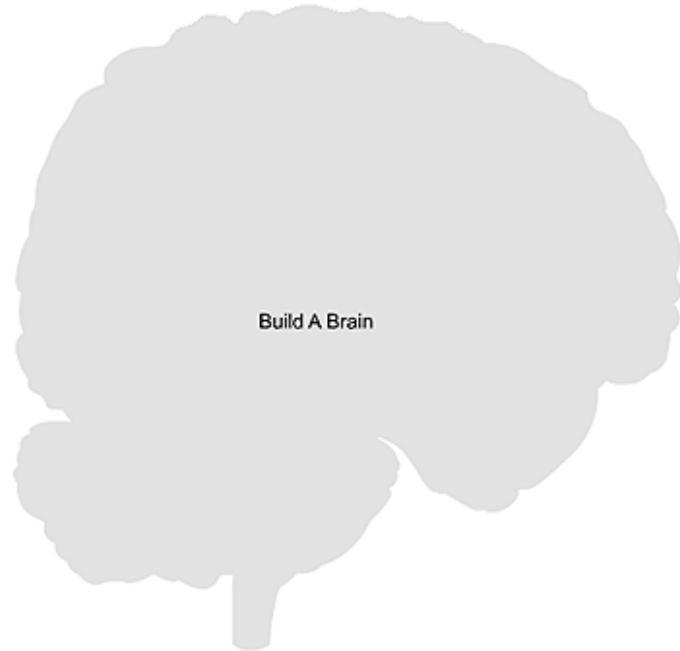


Figure AB-27: Build A Brain, Step 2

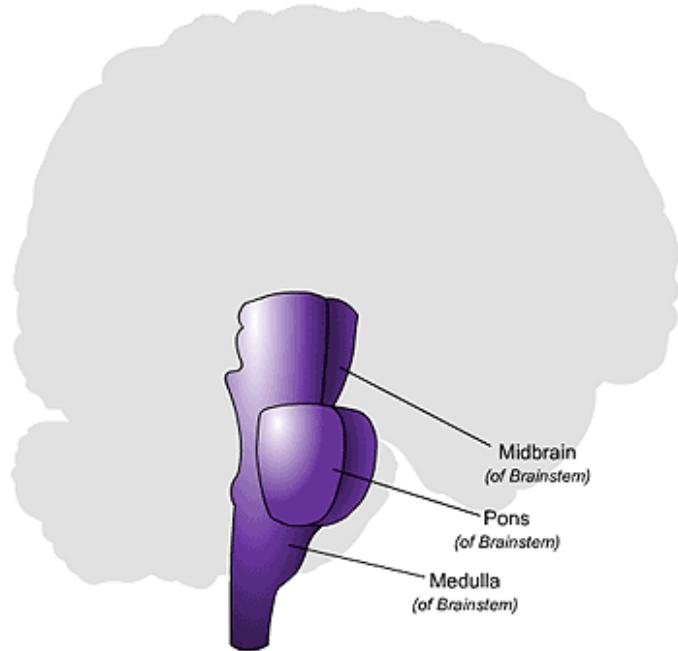


Figure AB-28: Build A Brain, Step 3

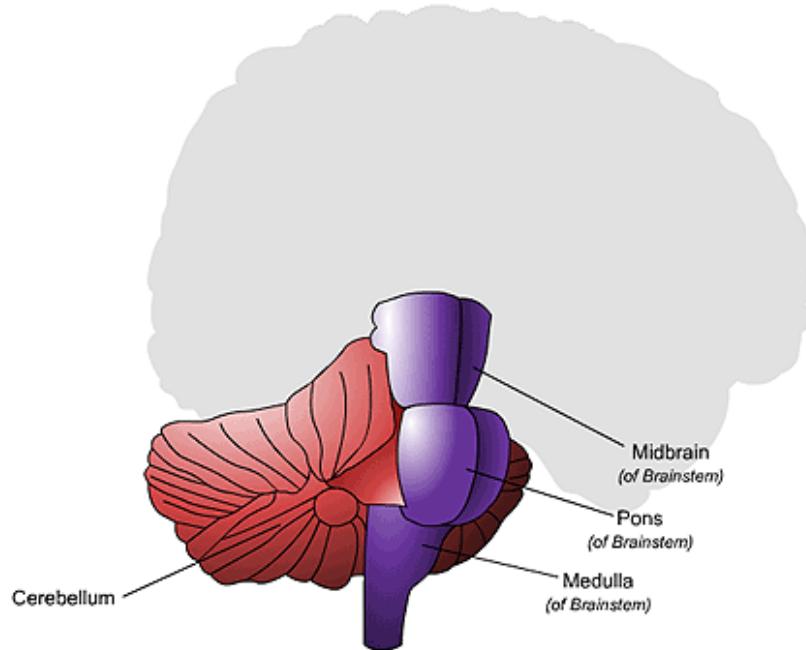


Figure AB-29: Build A Brain, Step 4

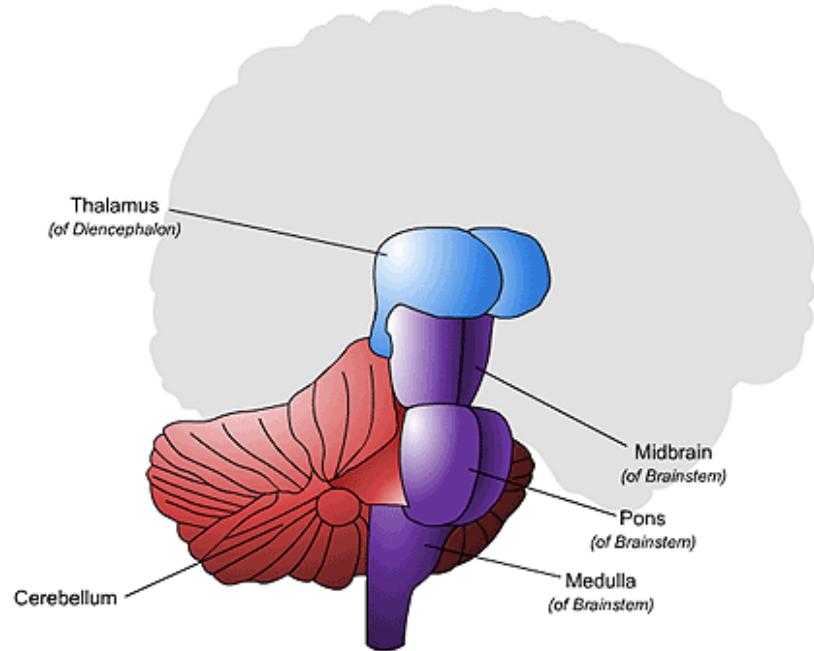


Figure AB-30: Build A Brain, Step 5

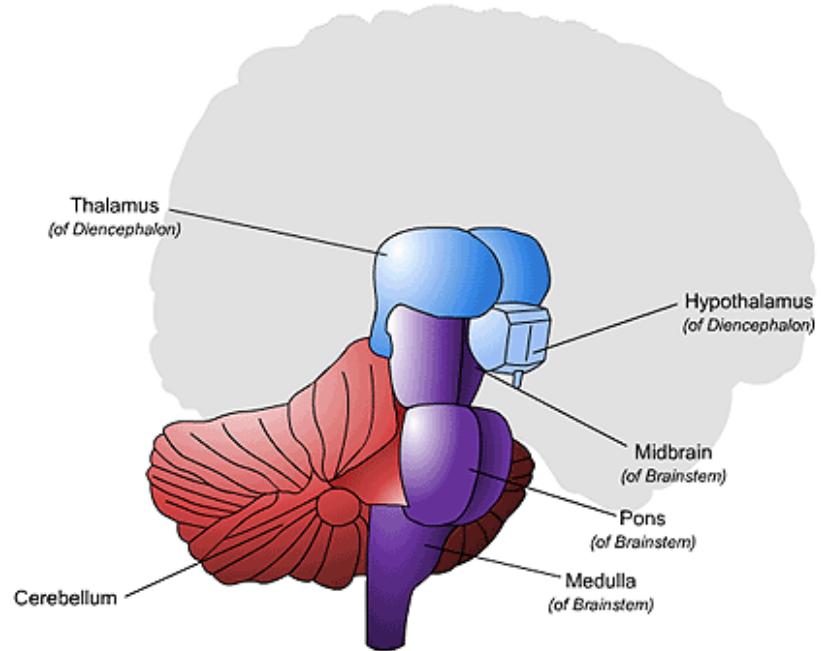


Figure AB-31: Build A Brain, Step 6

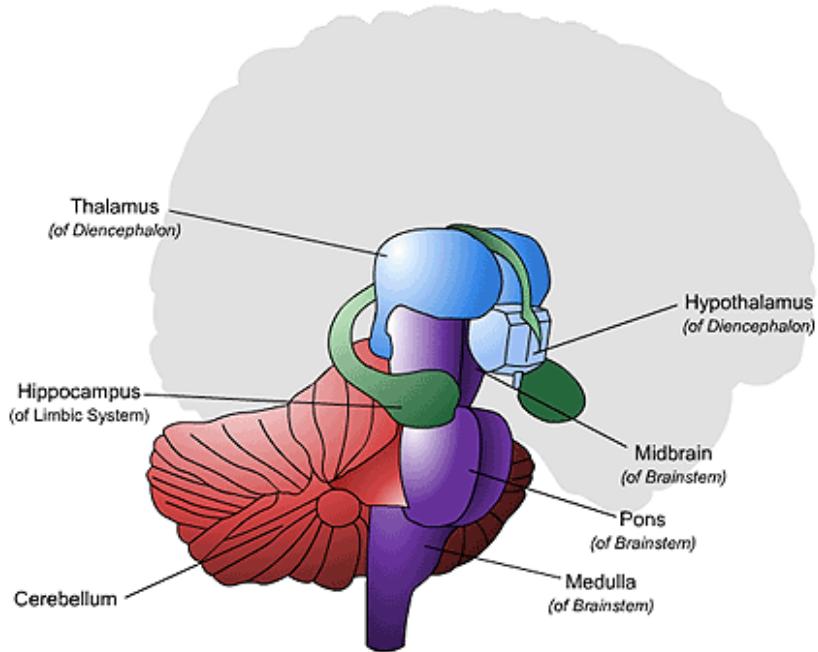


Figure AB-32: Build A Brain, Step 7

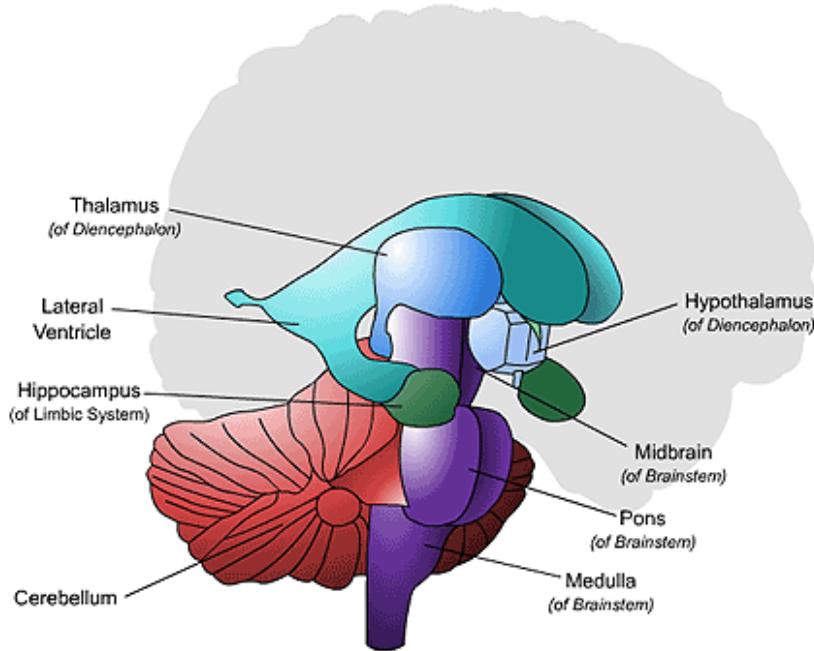


Figure AB-33: Build A Brain, Step 8

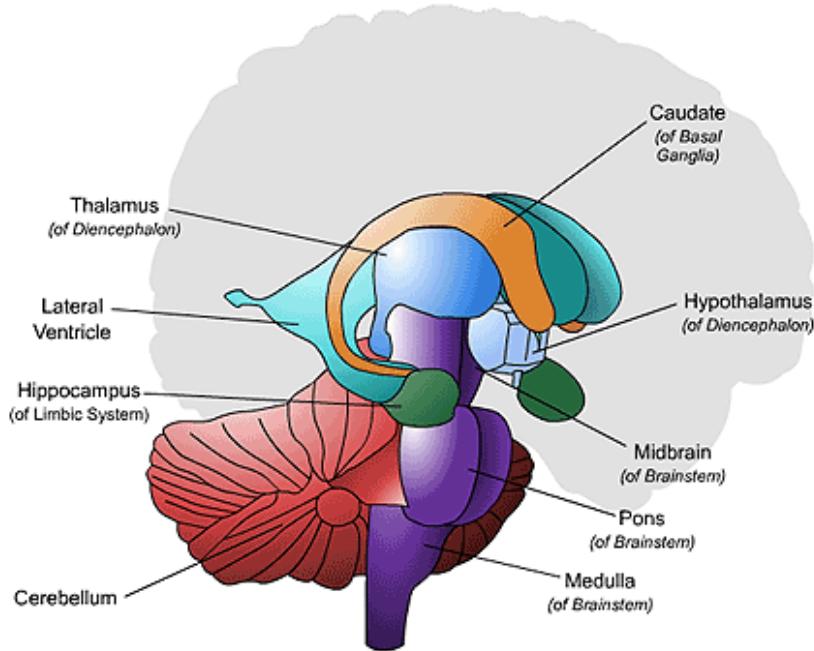


Figure AB-34: Build A Brain, Step 9

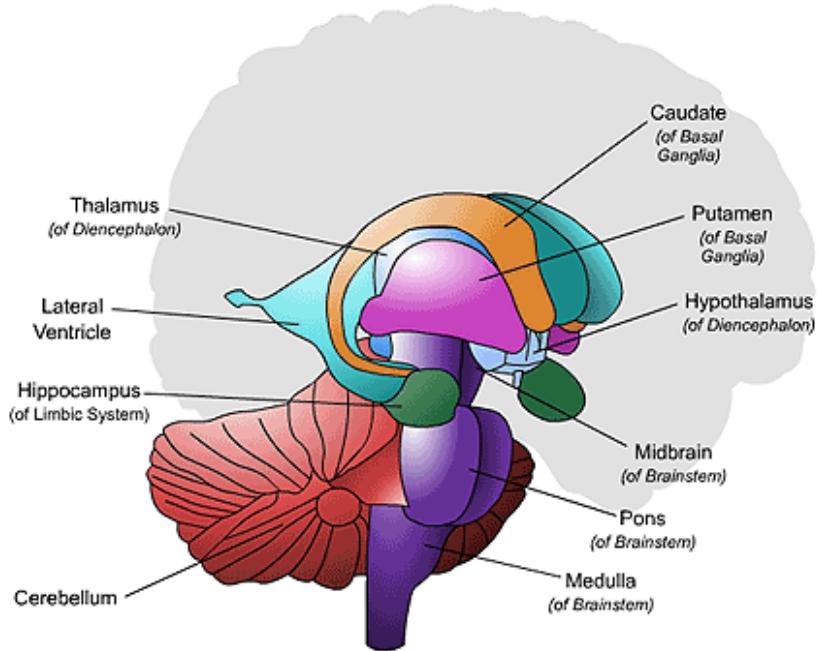


Figure AB-34: Build A Brain, Step 9

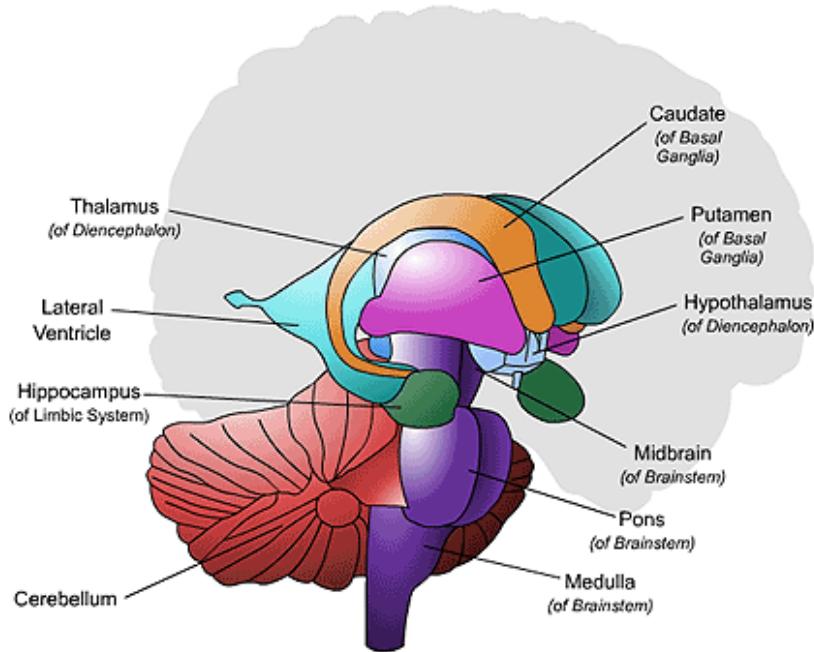


Figure AB-35: Build A Brain, Step 10

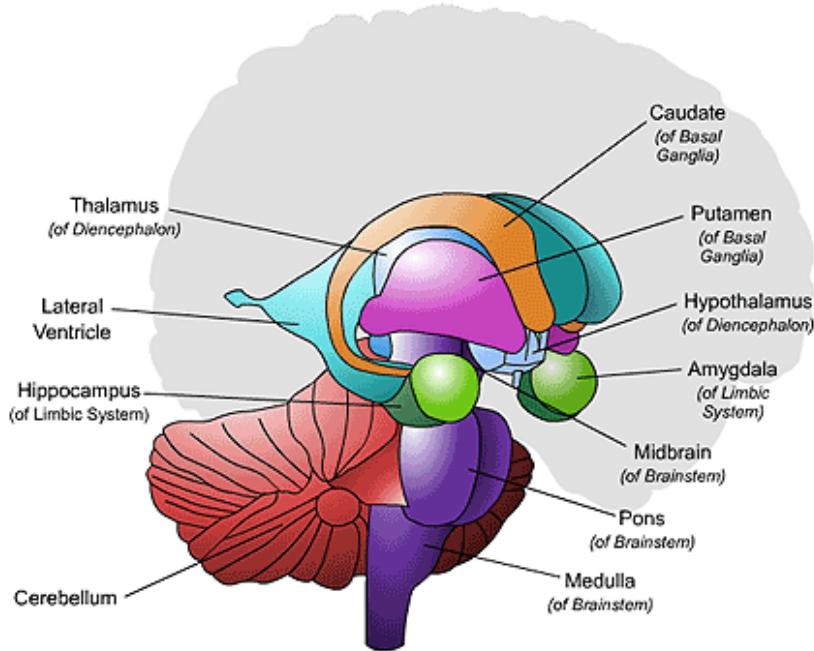


Figure AB-36: Build A Brain, Step 11

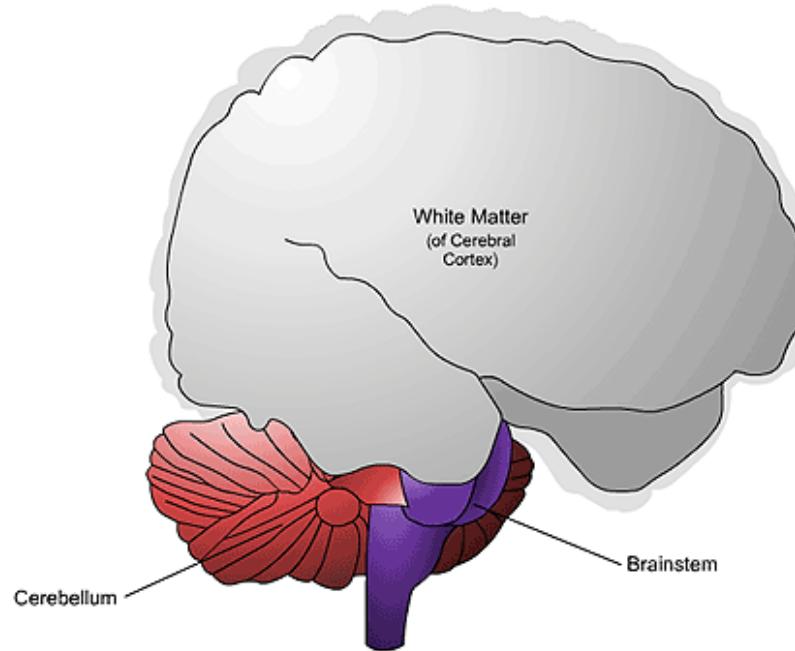
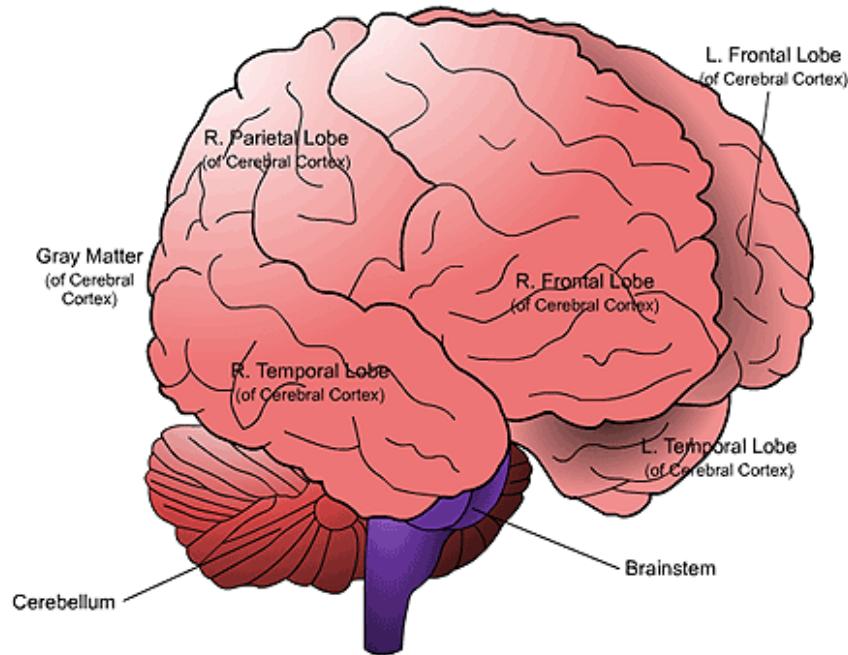


Figure AB-37: Build A Brain, Step 12

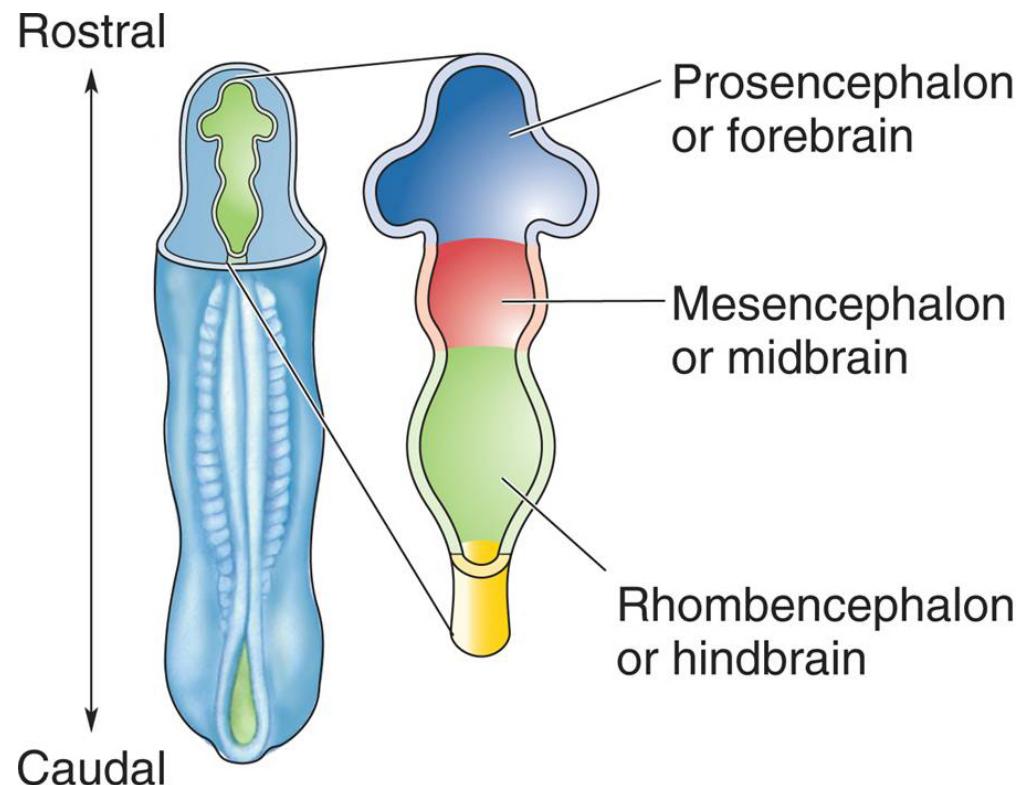


# Understanding CNS Structure Through Development

| Primary Vesicle                | Secondary vesicle | Derivatives           |
|--------------------------------|-------------------|-----------------------|
| Prosencephalon<br>(forebrain)  | Telencephalon     | Cerebral cortex       |
|                                |                   | Cerebral white matter |
|                                |                   | Basal Ganglia         |
|                                | Diencephalon      | Thalamus              |
|                                |                   | Hypothalamus          |
|                                |                   | Subthalamus           |
|                                |                   | Epithalamus           |
| Mesencephalon<br>(midbrain)    | Mesencephalon     | Midbrain              |
| Rhombencephalon<br>(hindbrain) | Metencephalon     | Cerebellum            |
|                                |                   | Pons                  |
|                                | Myelencephalon    | Medulla oblongata     |

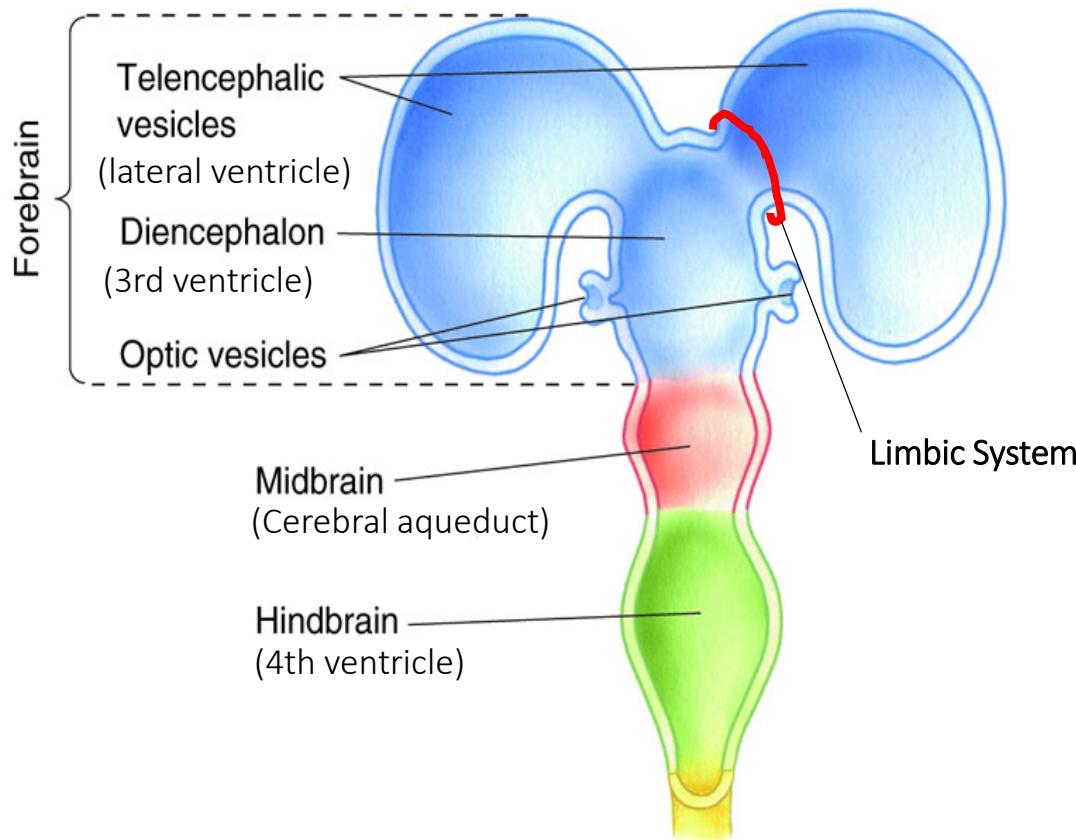
# Understanding CNS Structure Through Development

- Three Primary Brain Vesicles



# Understanding CNS Structure Through Development

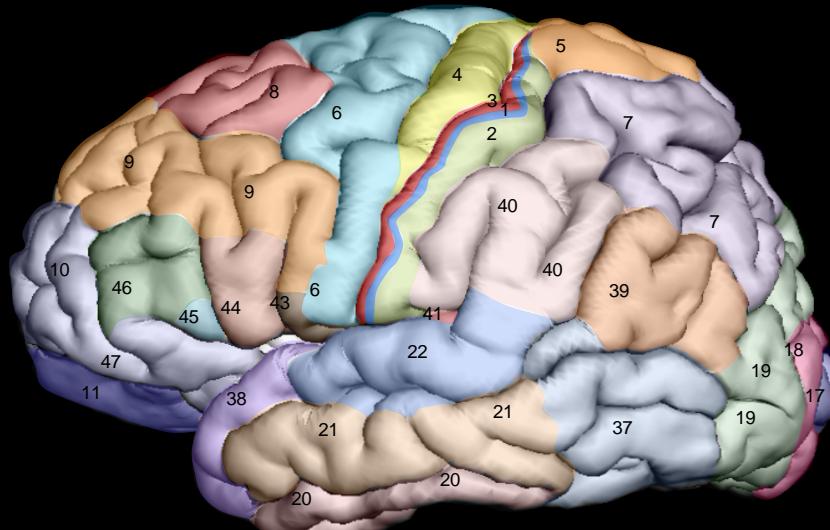
- Five secondary vesicles



# Anatomy of Cerebral Cortex



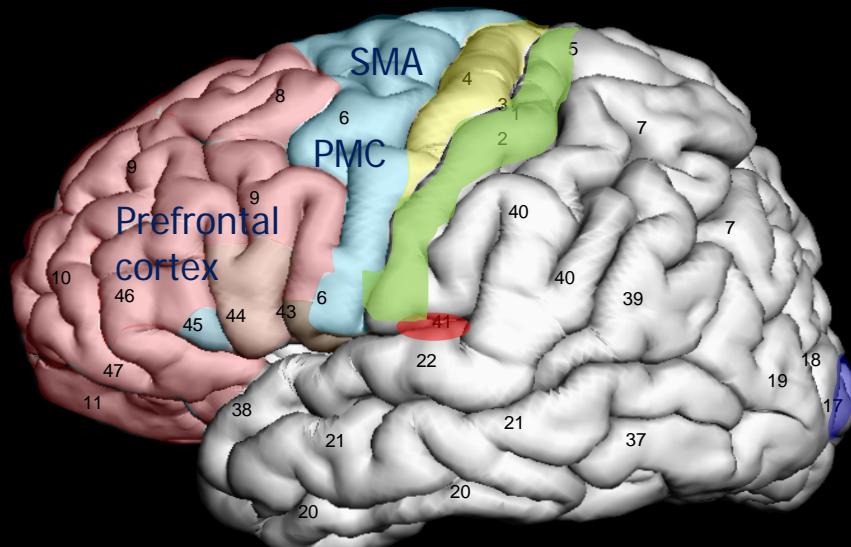
# Cortical area



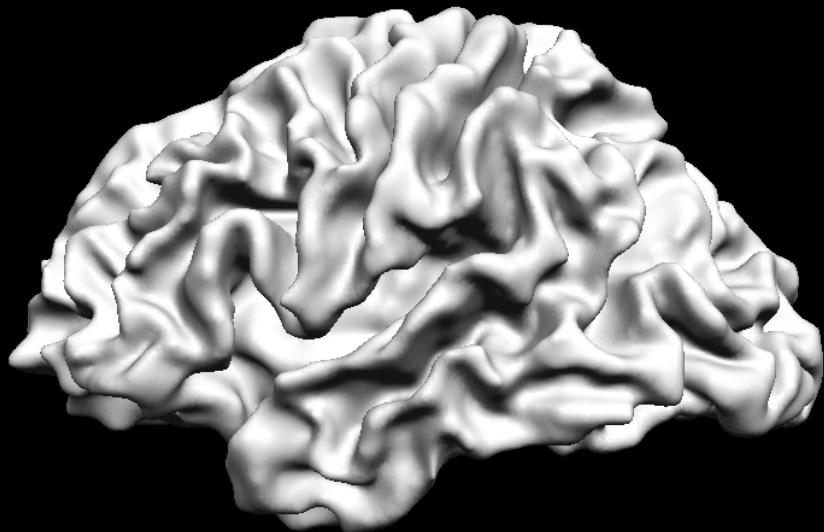
Anatomically defined

## Functionally defined

- Motor and Sensory cortex
- Association cortex



# Sulcus & Gyrus

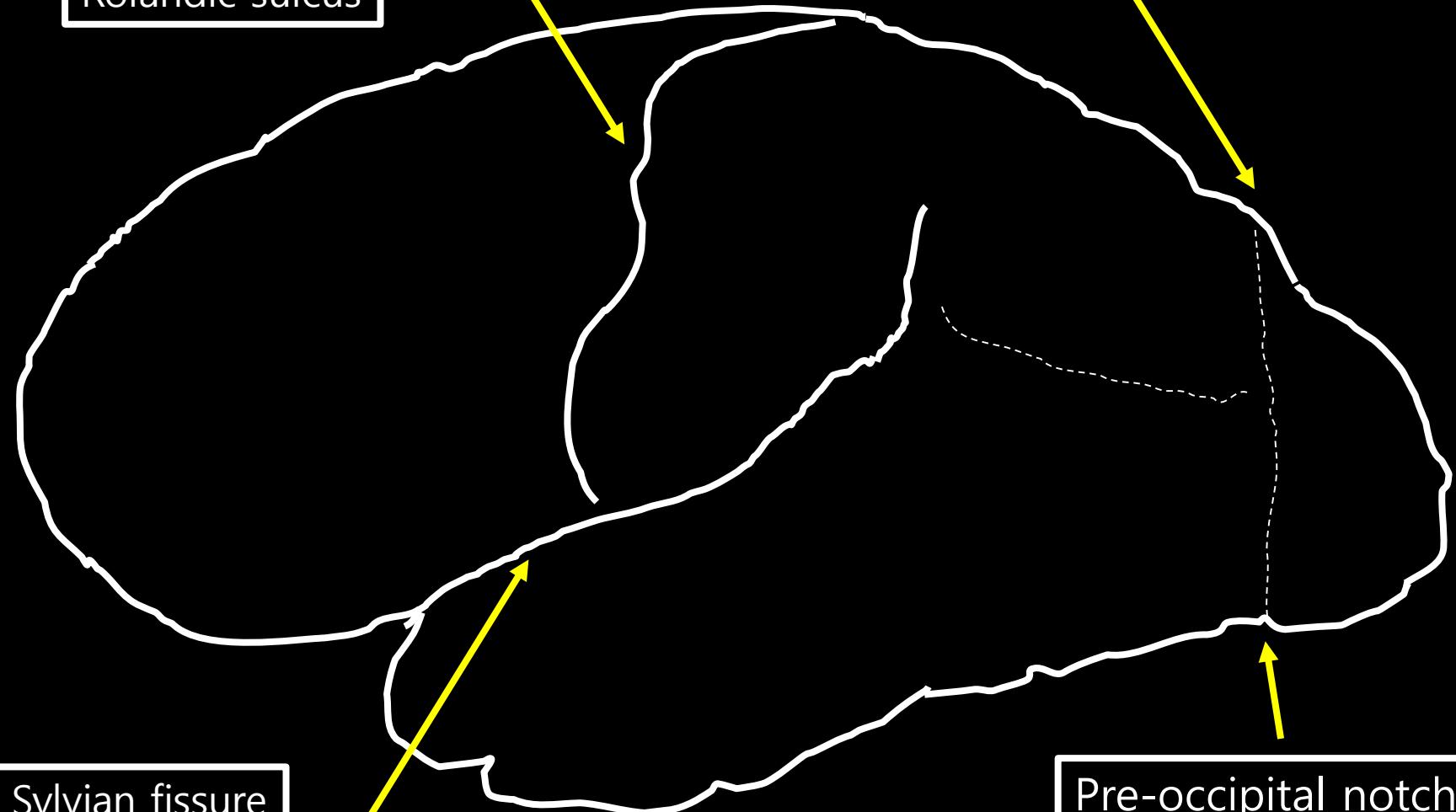


Inflation

중심고랑 (central sulcus)

Rolandic sulcus

Parieto-occipital sulcus

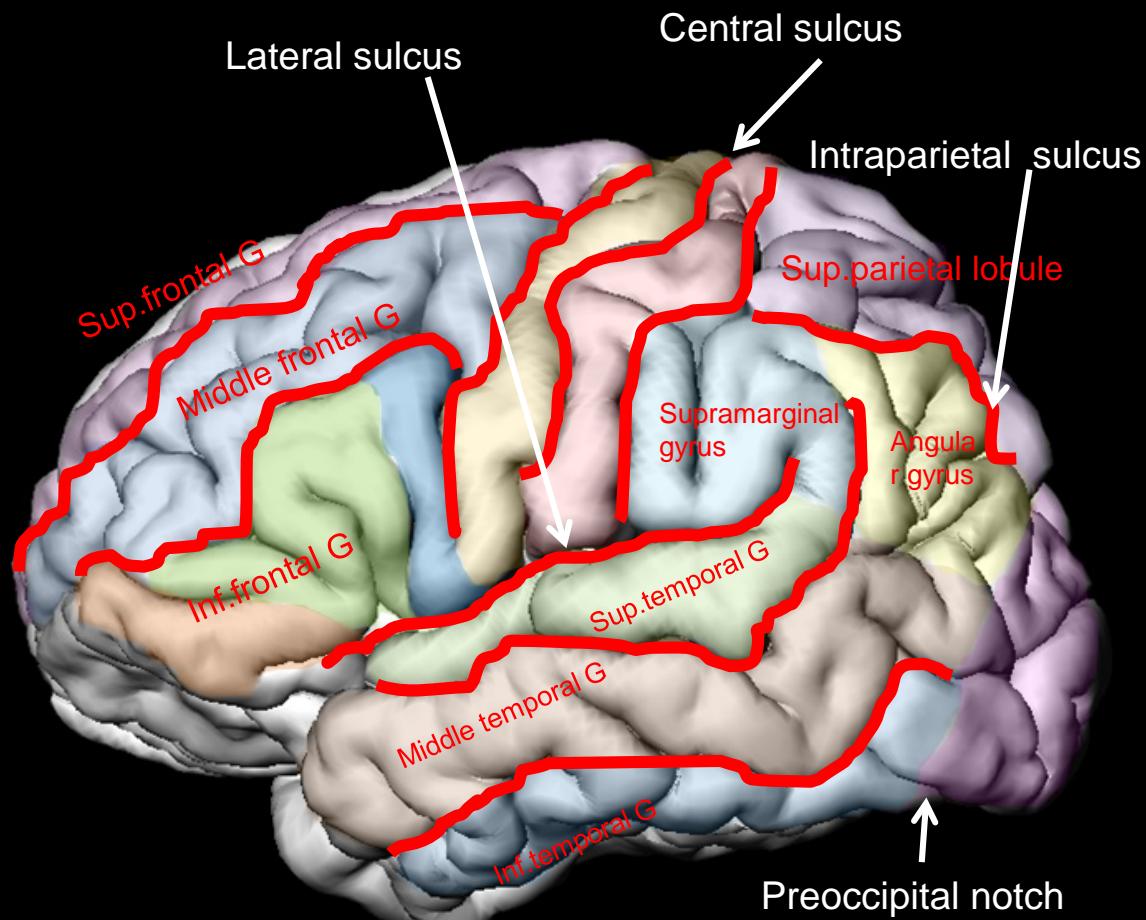


Sylvian fissure

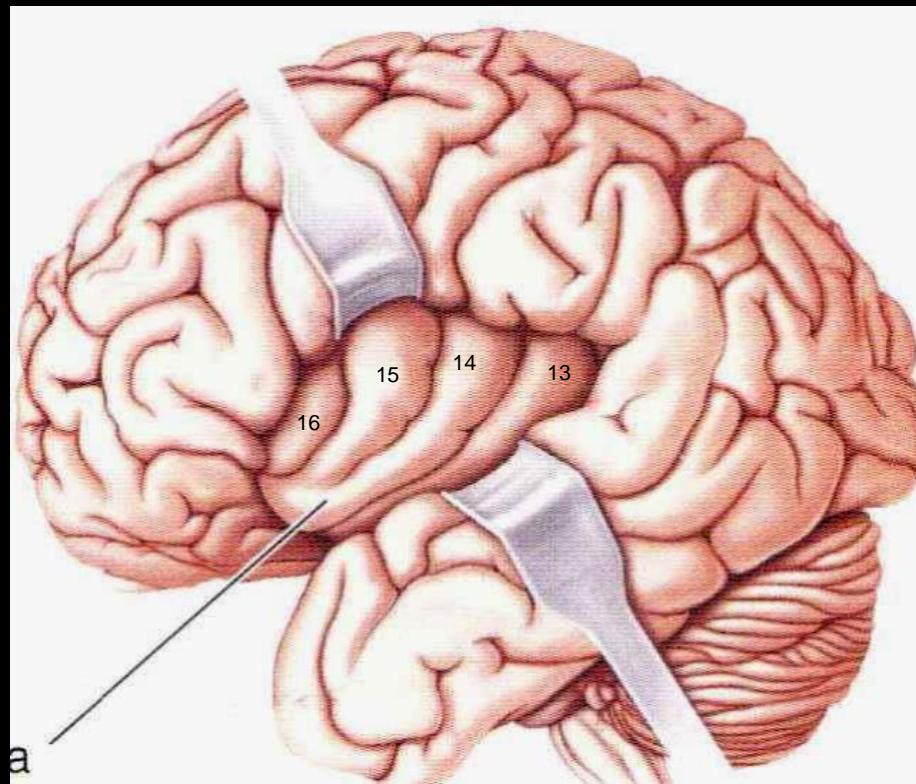
가쪽고랑 (lateral sulcus)

Pre-occipital notch

# 주요 이랑 및 고랑(외측면)

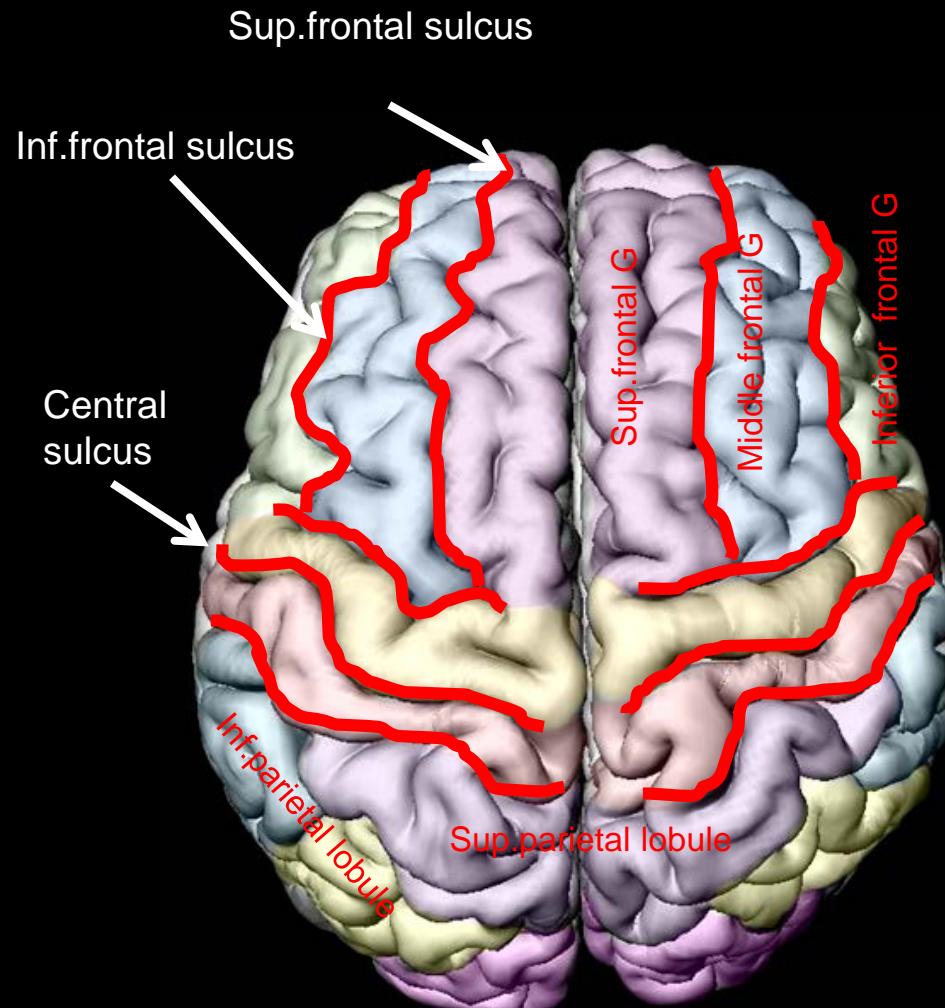


# insula

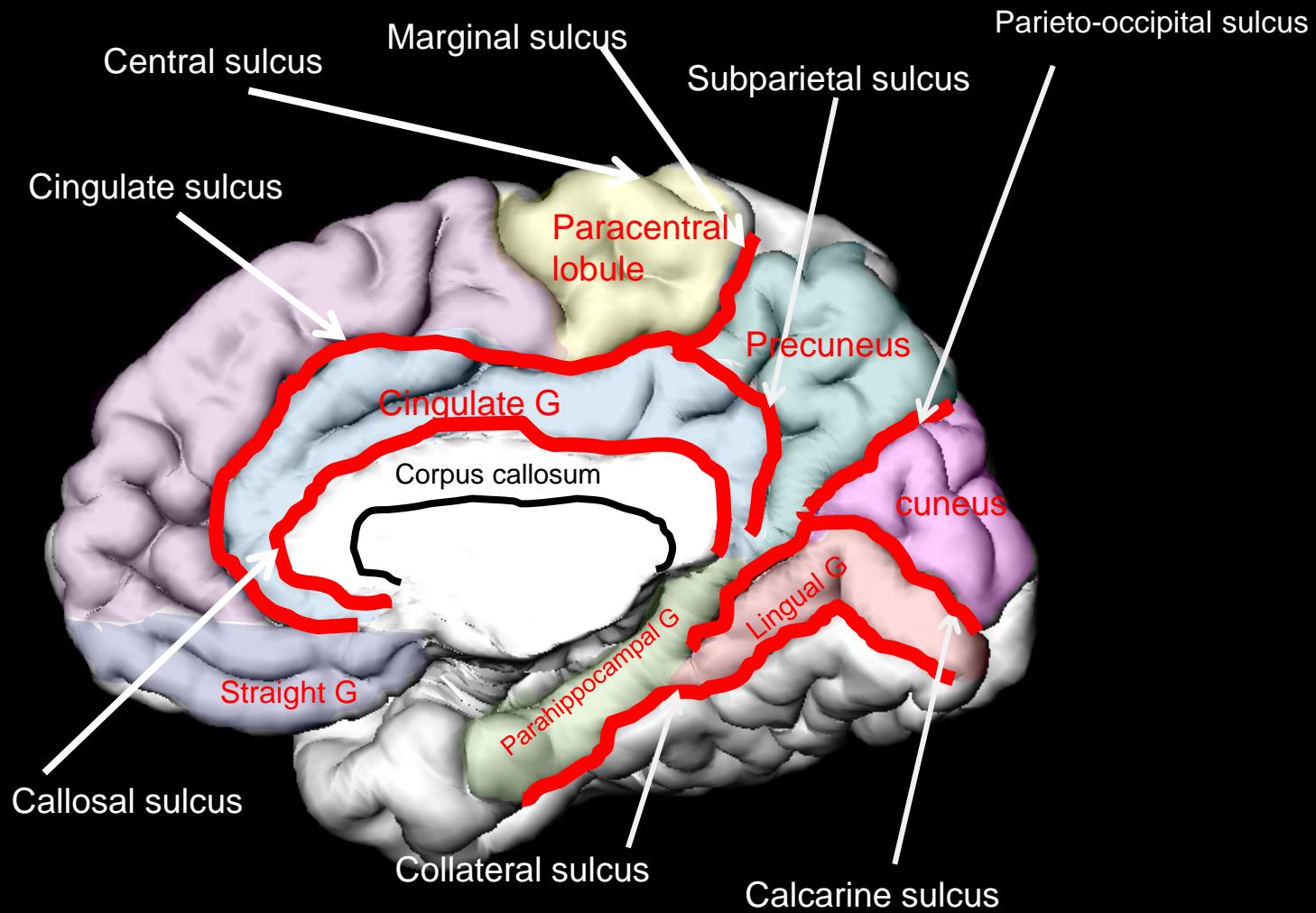


- Brodmann areas 13 to 16
- Left insula > right insula

# 주요 이탕 및 고탕



# 주요 이랑 및 고랑(내측면)



Straight gyrus

Olfactory sulcus

Orbital gyrus

Orbital sulcus

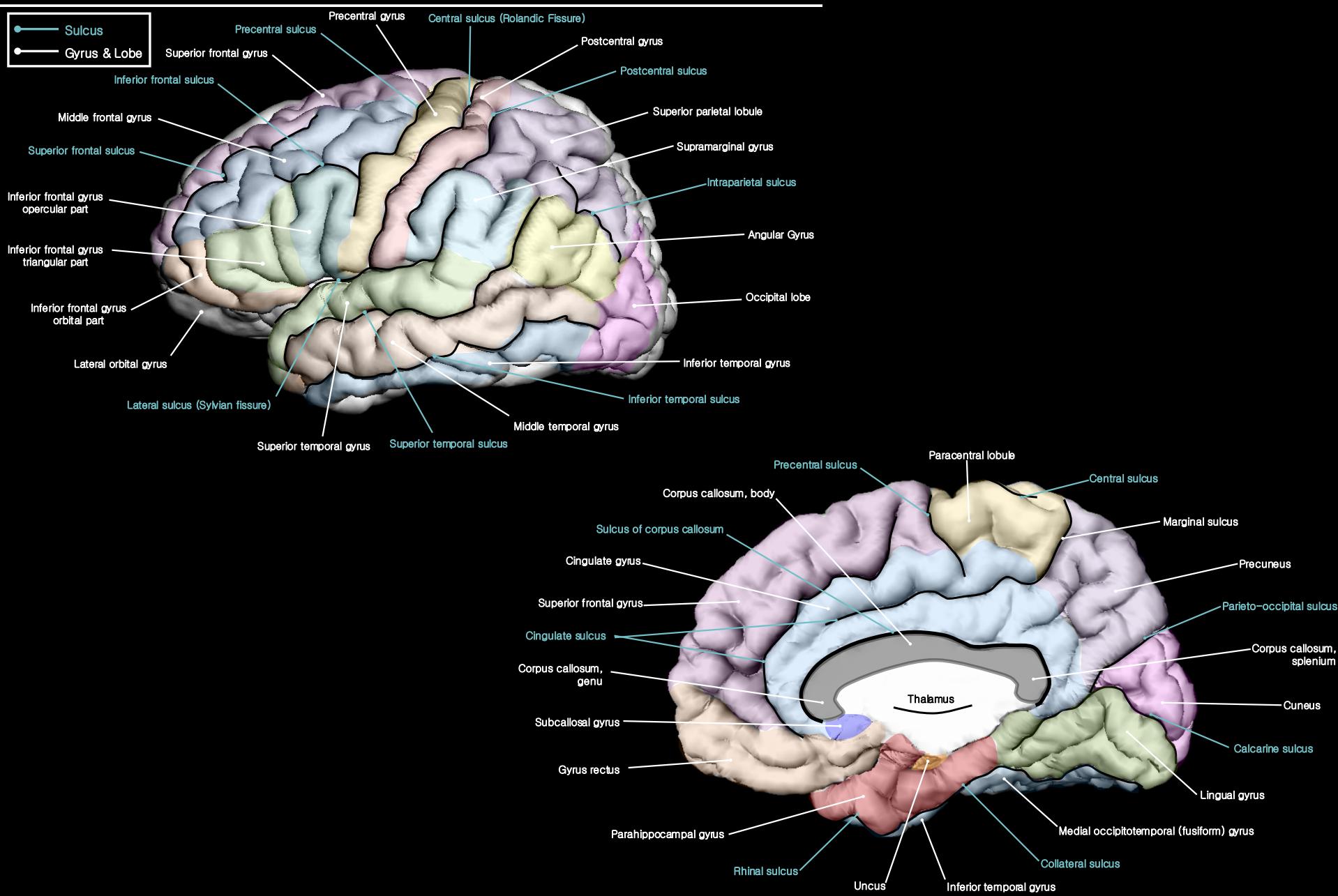
Rhinal sulcus

Collateral sulcus

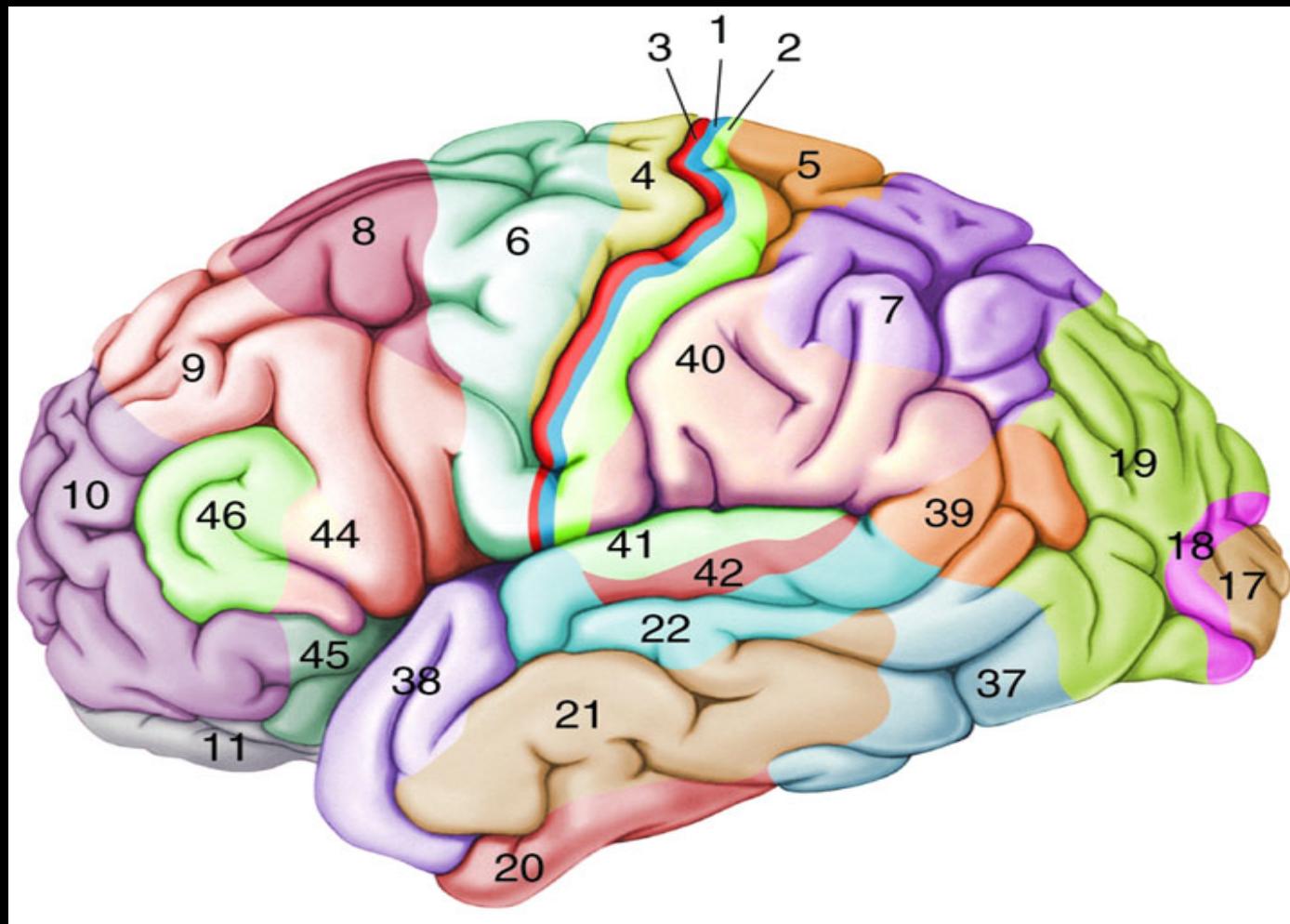
Parahippocampal gyrus

Fusiform, Occipitotemporal  
gyrus

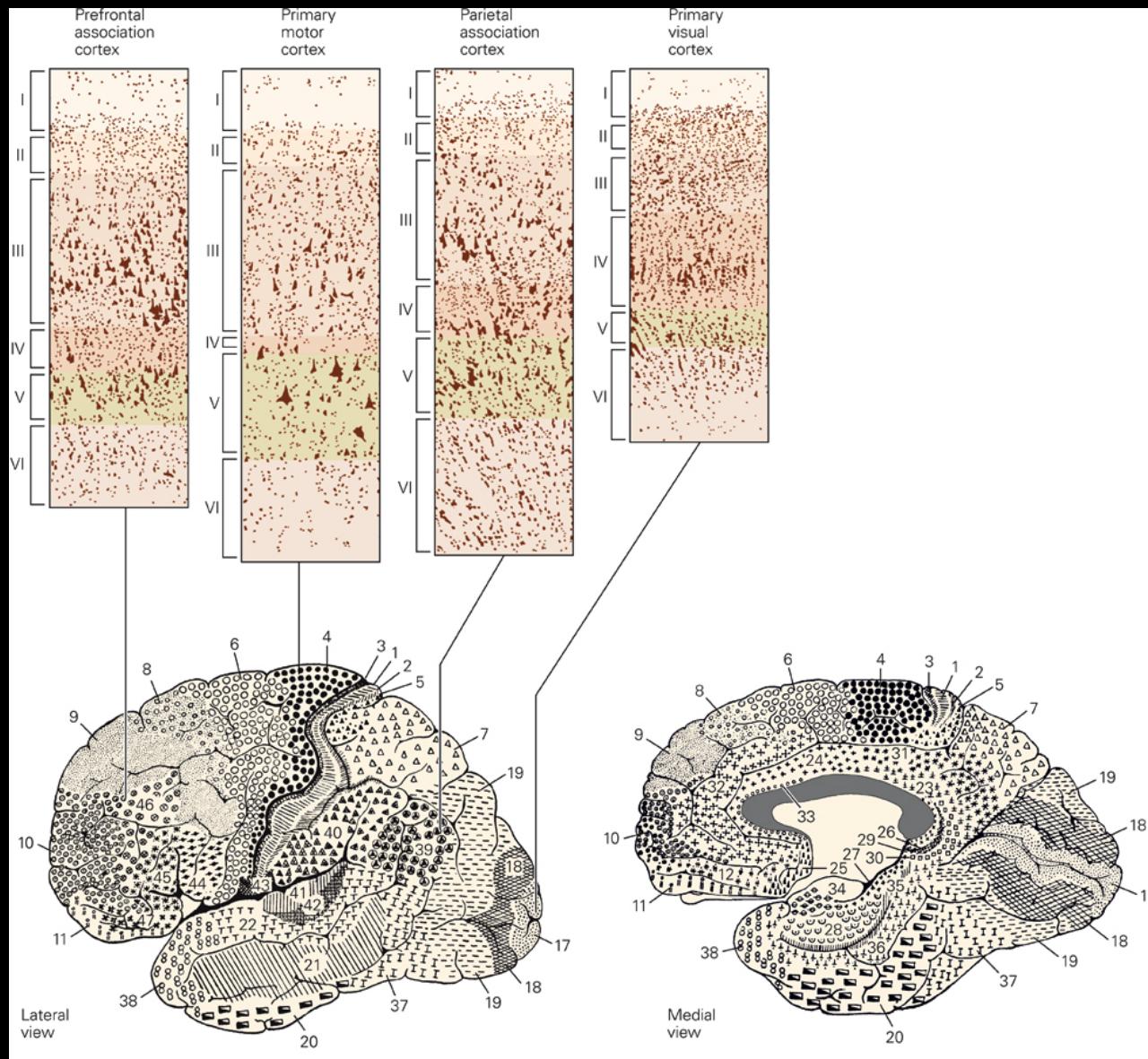
Occipitotemporal  
sulcus



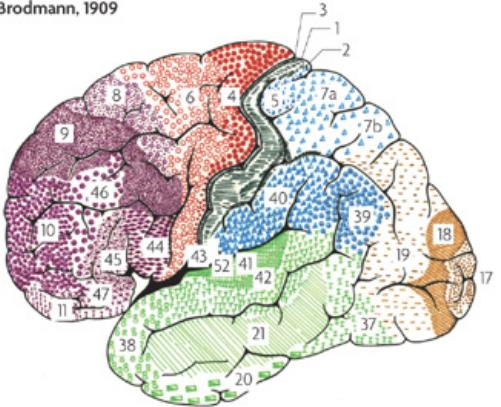
# Brodmann Area



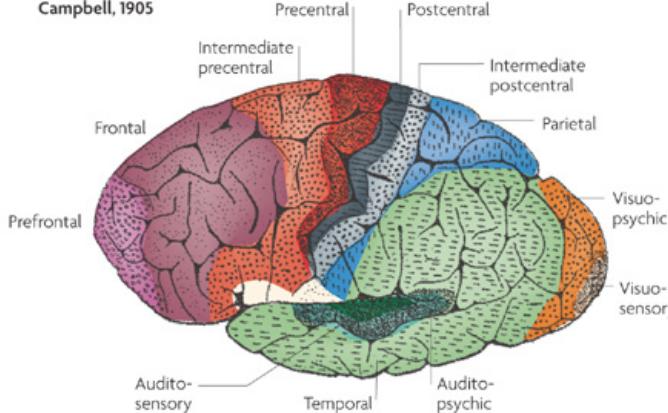
# Cytoarchitectonics



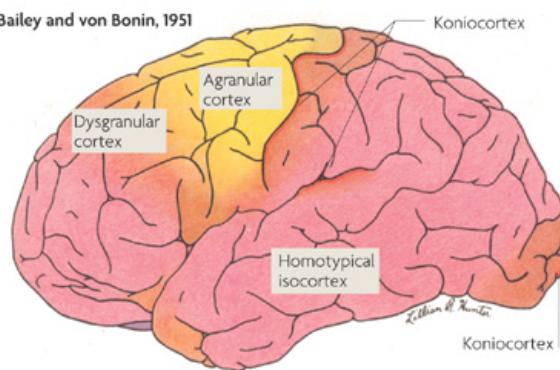
Brodmann, 1909



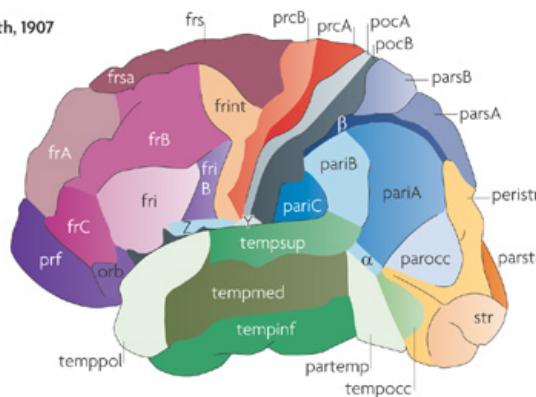
Campbell, 1905



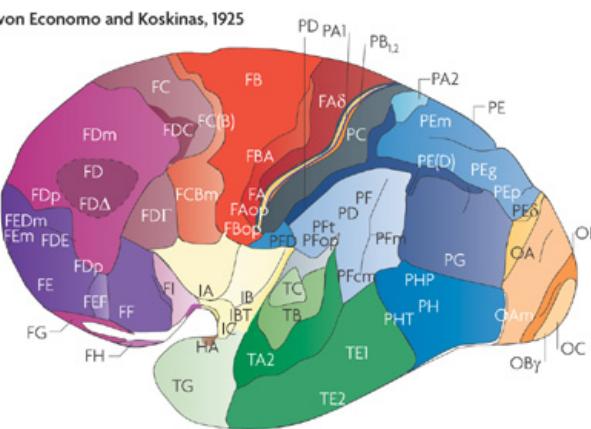
Bailey and von Bonin, 1951



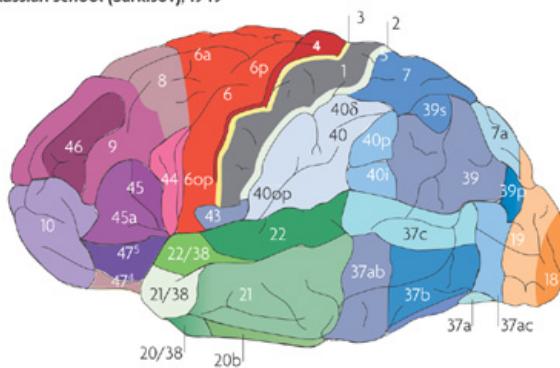
Smith, 1907

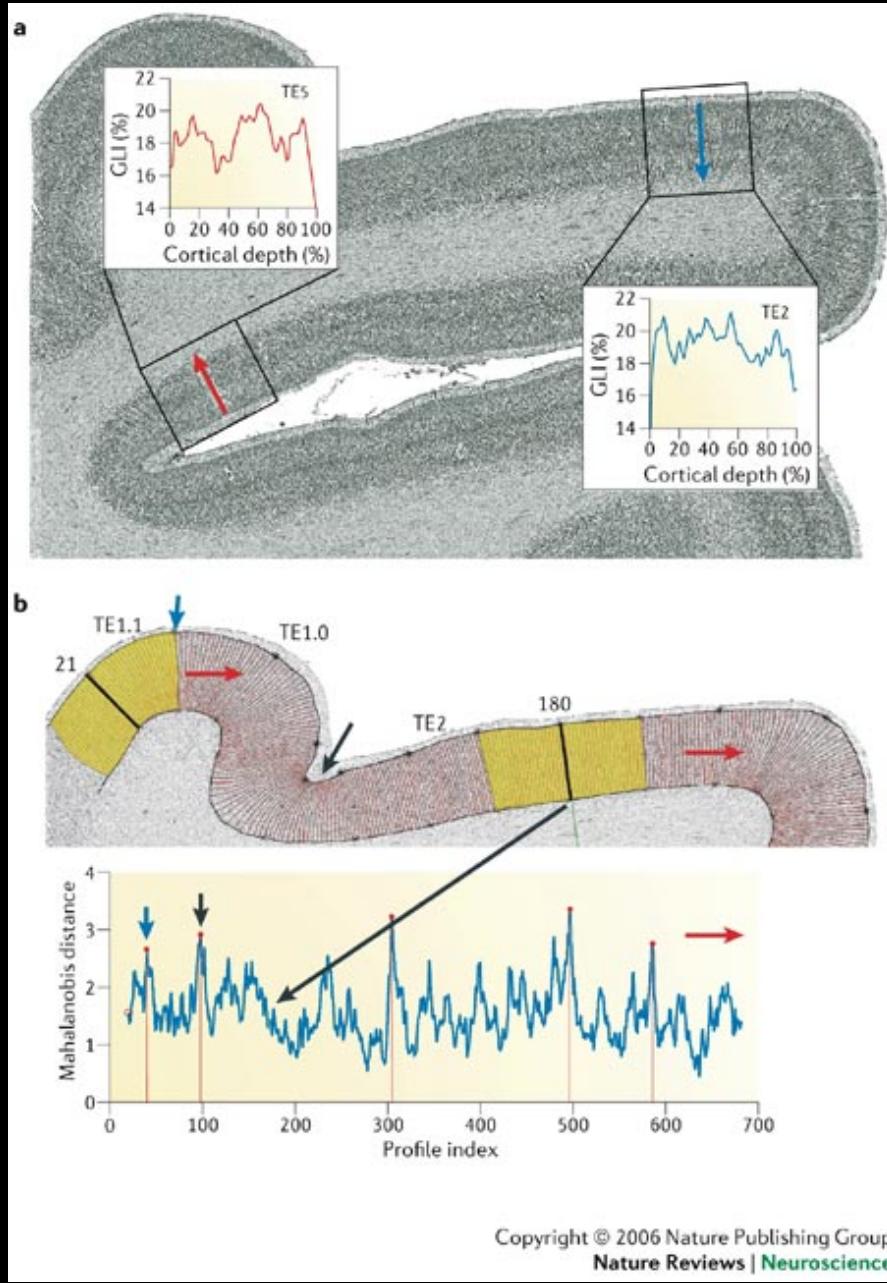


von Economo and Koskinas, 1925



Russian school (Sarkisov), 1949

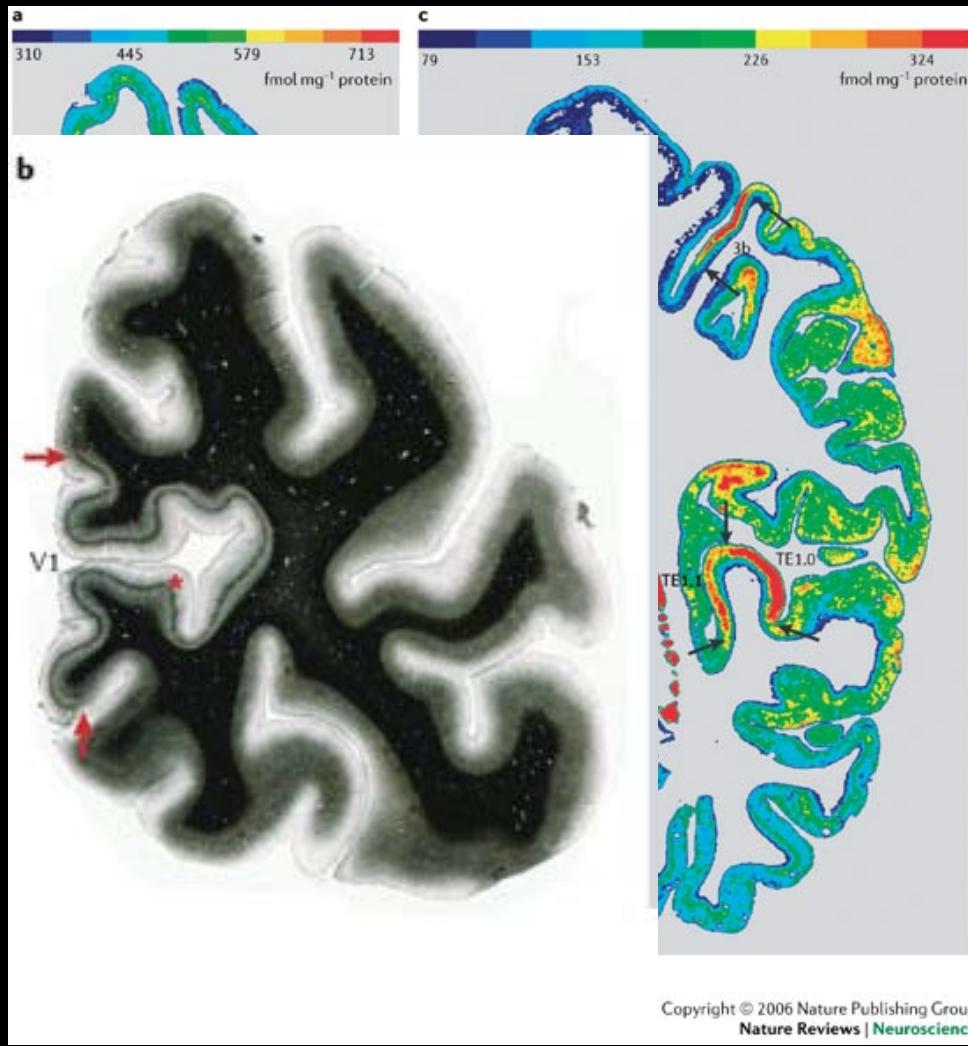




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Toga et al. *Nature Reviews Neuroscience* 7, 952–966 (December 2006) | doi:10.1038/nrn2012

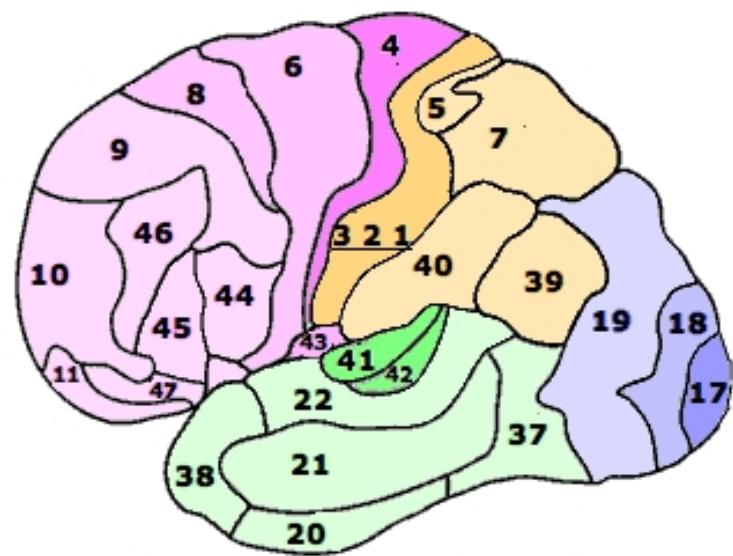
# Receptor mapping



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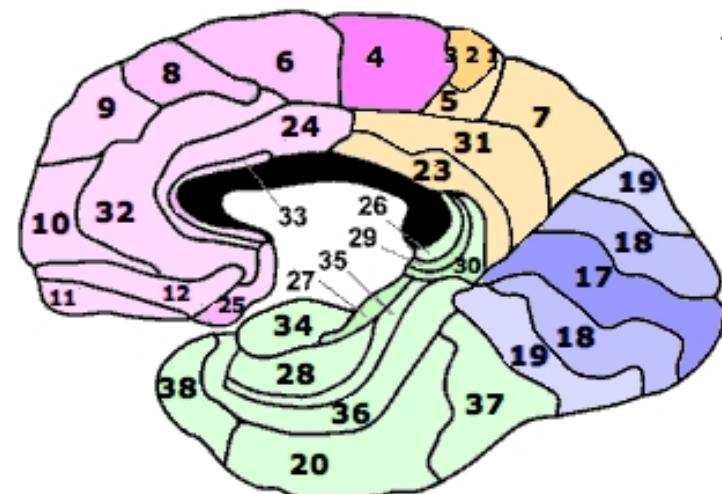
nature  
REVIEWS NEUROSCIENCE

# Functional Relationship



Frontal Lobe  
Primary Motor Area  
Supplemental Motor Areas

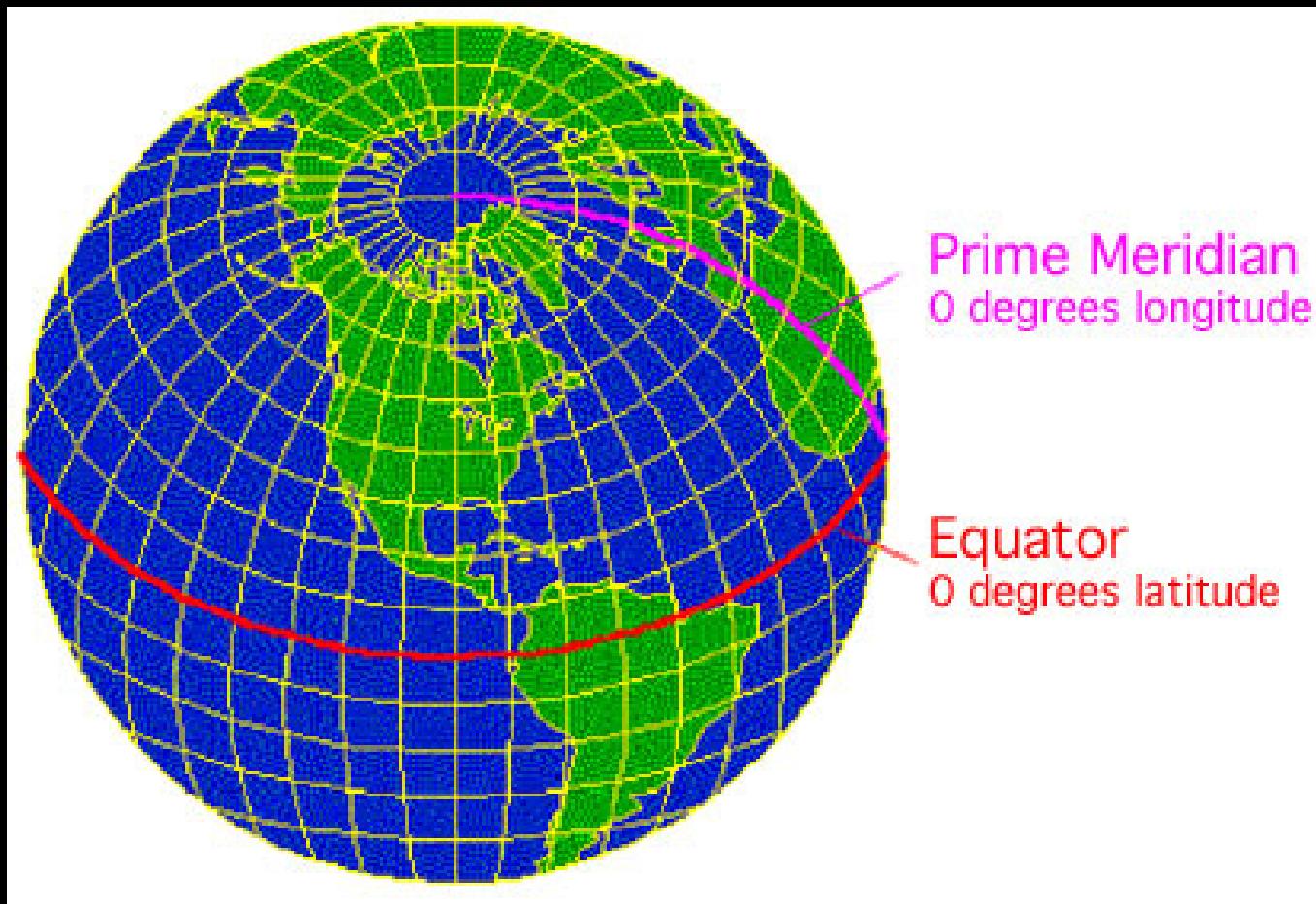
Parietal Lobe  
Primary Somatosensory Area



Occipital Lobe  
Primary Visual Area

Temporal Cortex  
Primary Auditory Areas

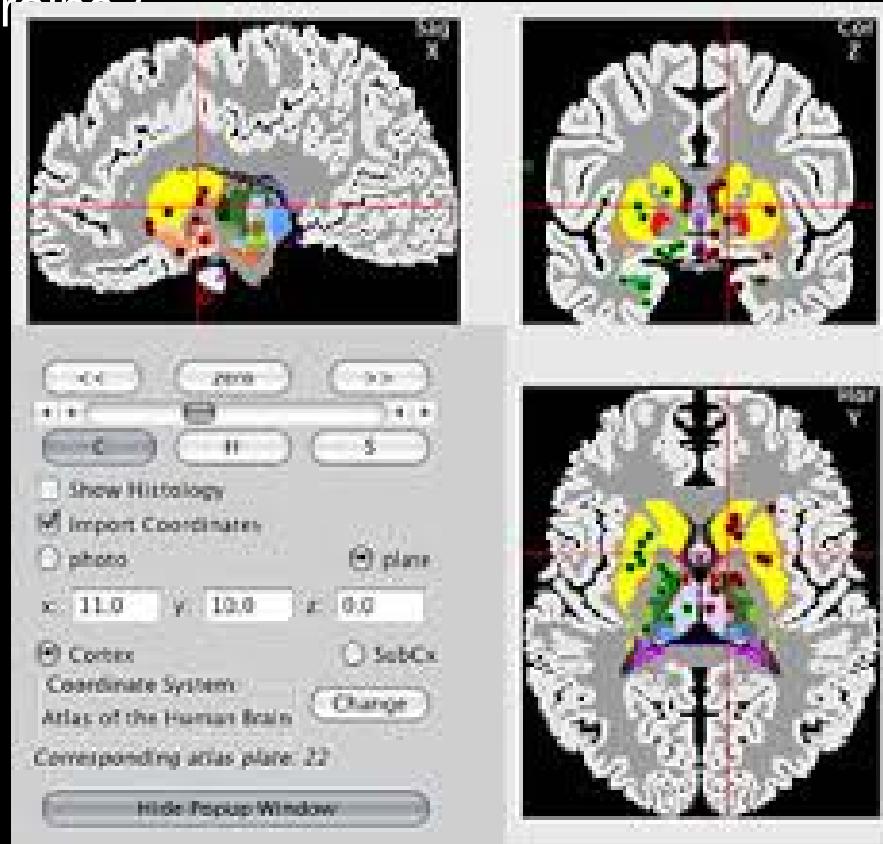
# Brain Mapping



# Talairach Coordinate System

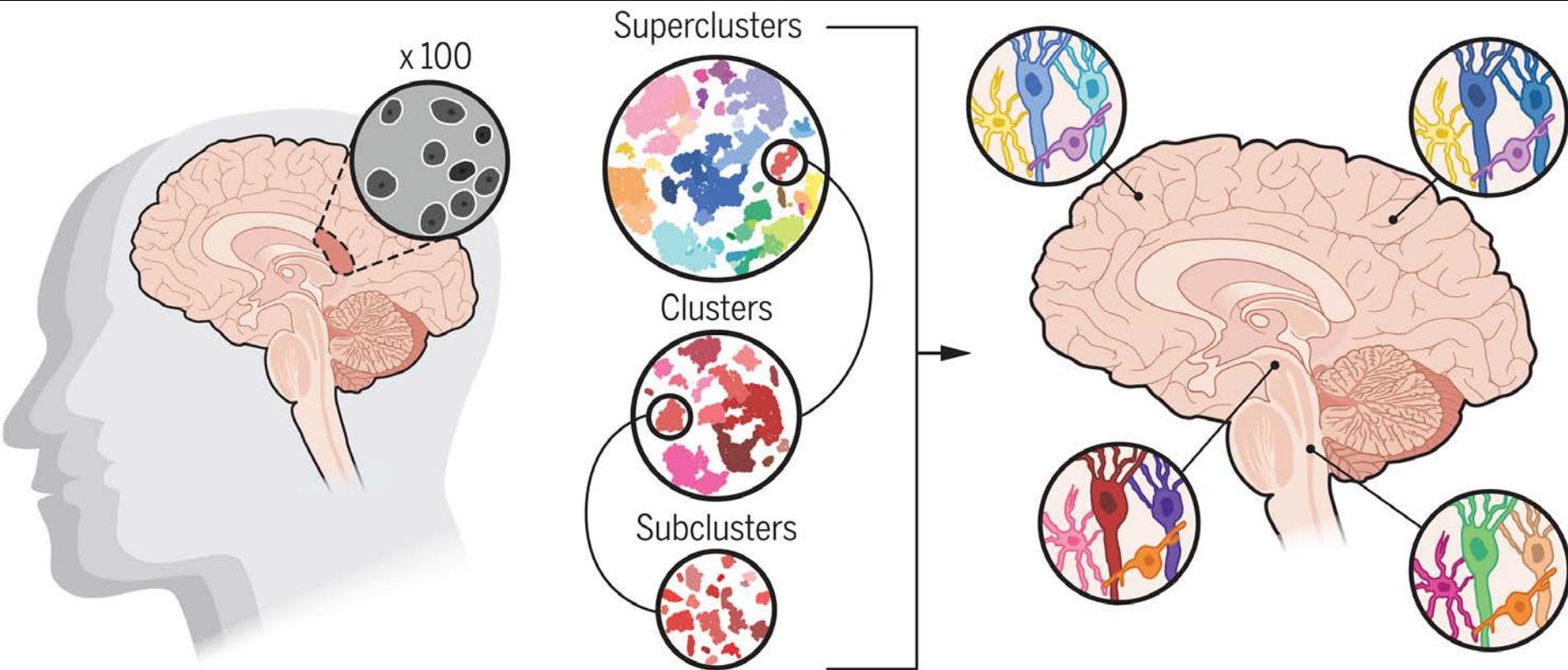
Individual brains are different shapes and sizes...

How can we compare or average brains?



Source: Brain Voyager course slides

# Cell diversity mapping



# Transcriptome mapping

## ARTICLE

doi:10.1038/nature11405

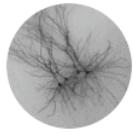
### An anatomically comprehensive atlas of the adult human brain transcriptome

Michael J. Hawrylycz<sup>1\*</sup>, Ed S. Lein<sup>1\*</sup>, Angela L. Guillozet-Bongaarts<sup>1</sup>, Elaine H. Shen<sup>1</sup>, Lydia Ng<sup>1</sup>, Jeremy A. Miller<sup>1</sup>, Louie N. van de Lagemaat<sup>2</sup>, Kimberly A. Smith<sup>1</sup>, Amanda Ebbert<sup>1</sup>, Zackery L. Riley<sup>1</sup>, Chris Abajian<sup>1</sup>, Christian F. Beckmann<sup>3</sup>, Amy Bernard<sup>1</sup>, Darren Bertagnoli<sup>1</sup>, Andrew F. Boe<sup>1</sup>, Preston M. Cartagena<sup>4</sup>, M. Mallar Chakravarty<sup>1,5</sup>, Mike Chapin<sup>1</sup>, Jimmy Chong<sup>1</sup>, Rachel A. Dalley<sup>1</sup>, Barry David Daly<sup>6</sup>, Chinh Dang<sup>1</sup>, Suvro Datta<sup>1</sup>, Nick Dee<sup>1</sup>, Tim A. Dolbeare<sup>1</sup>, Vance Faber<sup>1</sup>, David Feng<sup>1</sup>, David R. Fowler<sup>7</sup>, Jeff Goldy<sup>1</sup>, Benjamin W. Gregor<sup>1</sup>, Zeb Haradon<sup>1</sup>, David R. Haynor<sup>8</sup>, John G. Hohmann<sup>1</sup>, Steve Horvath<sup>9</sup>, Robert E. Howard<sup>1</sup>, Andreas Jeromin<sup>10</sup>, Jayson M. Jochim<sup>1</sup>, Marty Kinnunen<sup>1</sup>, Christopher Lau<sup>1</sup>, Evan T. Lazarz<sup>1</sup>, Changkyu Lee<sup>1</sup>, Tracy A. Lemon<sup>1</sup>, Ling Li<sup>11</sup>, Yang Li<sup>1</sup>, John A. Morris<sup>1</sup>, Caroline C. Overly<sup>1</sup>, Patrick D. Parker<sup>1</sup>, Sheana E. Parry<sup>1</sup>, Melissa Reding<sup>1</sup>, Joshua J. Royall<sup>1</sup>, Jay Schulkin<sup>12</sup>, Pedro Adolfo Sequeira<sup>13</sup>, Clifford R. Slaughterbeck<sup>1</sup>, Simon C. Smith<sup>14</sup>, Andy J. Sodt<sup>1</sup>, Susan M. Sunkin<sup>1</sup>, Beryl E. Swanson<sup>1</sup>, Marquis P. Vawter<sup>13</sup>, Derric Williams<sup>1</sup>, Paul Wohnoutka<sup>1</sup>, H. Ronald Zielke<sup>15</sup>, Daniel H. Geschwind<sup>16</sup>, Patrick R. Hof<sup>17</sup>, Stephen M. Smith<sup>18</sup>, Christof Koch<sup>1,19</sup>, Seth G. N. Grant<sup>2</sup> & Allan R. Jones<sup>1</sup>

Neuroanatomically precise, genome-wide maps of transcript distributions are critical resources to complement genomic sequence data and to correlate functional and genetic brain architecture. Here we describe the generation and analysis of a transcriptional atlas of the adult human brain, comprising extensive histological analysis and comprehensive microarray profiling of ~900 neuroanatomically precise subdivisions in two individuals. Transcriptional regulation varies enormously by anatomical location, with different regions and their constituent cell types displaying robust molecular signatures that are highly conserved between individuals. Analysis of differential gene expression and gene co-expression relationships demonstrates that brain-wide variation strongly reflects the distributions of major cell classes such as neurons, oligodendrocytes, astrocytes and microglia. Local neighbourhood relationships between fine anatomical subdivisions are associated with discrete neuronal subtypes and genes involved with synaptic transmission. The neocortex displays a relatively homogeneous transcriptional pattern, but with distinct features associated selectively with primary sensorimotor cortices and with enriched frontal lobe expression. Notably, the spatial topography of the neocortex is strongly reflected in its molecular topography—the closer two cortical regions, the more similar their transcriptomes. This freely accessible online data resource forms a high-resolution transcriptional baseline for neurogenetic studies of normal and abnormal human brain function.

Accelerating progress  
toward understanding  
the brain.

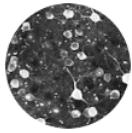
## Allen Brain Atlases and Data



### CELL TYPES DATABASE

A database of biological features derived from single cells, from both human and mouse.

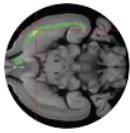
[View Data →](#)



### BRAIN OBSERVATORY

A new approach to open data, featuring a survey of *in vivo* recordings from the mouse visual cortex.

[View Data →](#)



### MOUSE BRAIN CONNECTIVITY ATLAS

A brain-wide map of neural projections, including cell class-specific data.

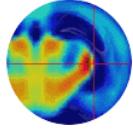
[View Atlas →](#)



### REFERENCE ATLASES

High resolution anatomical reference atlases and histology for mouse and human.

[View Atlases →](#)



### MOUSE BRAIN ATLAS

A unique multimodal atlas of the adult mouse brain, featuring anatomic and genomic data.

[View Atlas →](#)



### DEVELOPING MOUSE BRAIN ATLAS

A detailed atlas of gene expression across 7 stages of development.

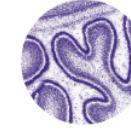
[View Atlas →](#)



### MOUSE SPINAL CORD ATLAS

A detailed atlas of gene expression across the adult and juvenile mouse spinal cord.

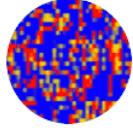
[View Atlas →](#)



### ADULT AND DEVELOPING NHP ATLAS

The NIH Blueprint Non-Human Primate Atlas characterizes the developing rhesus macaque brain.

[View Atlas →](#)



### HUMAN BRAIN ATLAS

A unique multimodal atlas of the adult human brain, featuring anatomic and genomic data.

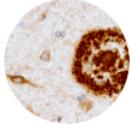
[View Atlas →](#)



### DEVELOPING HUMAN BRAIN

The BrainSpan project is a detailed atlas of gene expression across human development.

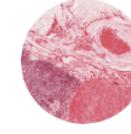
[View Data →](#)



### AGING, DEMENTIA AND TBI

A dataset for exploring the neuropathology and genomic features of disease and aging.

[View Data →](#)



### IVY GLIOBLASTOMA ATLAS PROJECT

IvyGAP is a dataset for exploring the anatomic and genomic basis of glioblastoma.

[View Atlas →](#)

# **Anatomy of Subcortical Structures**

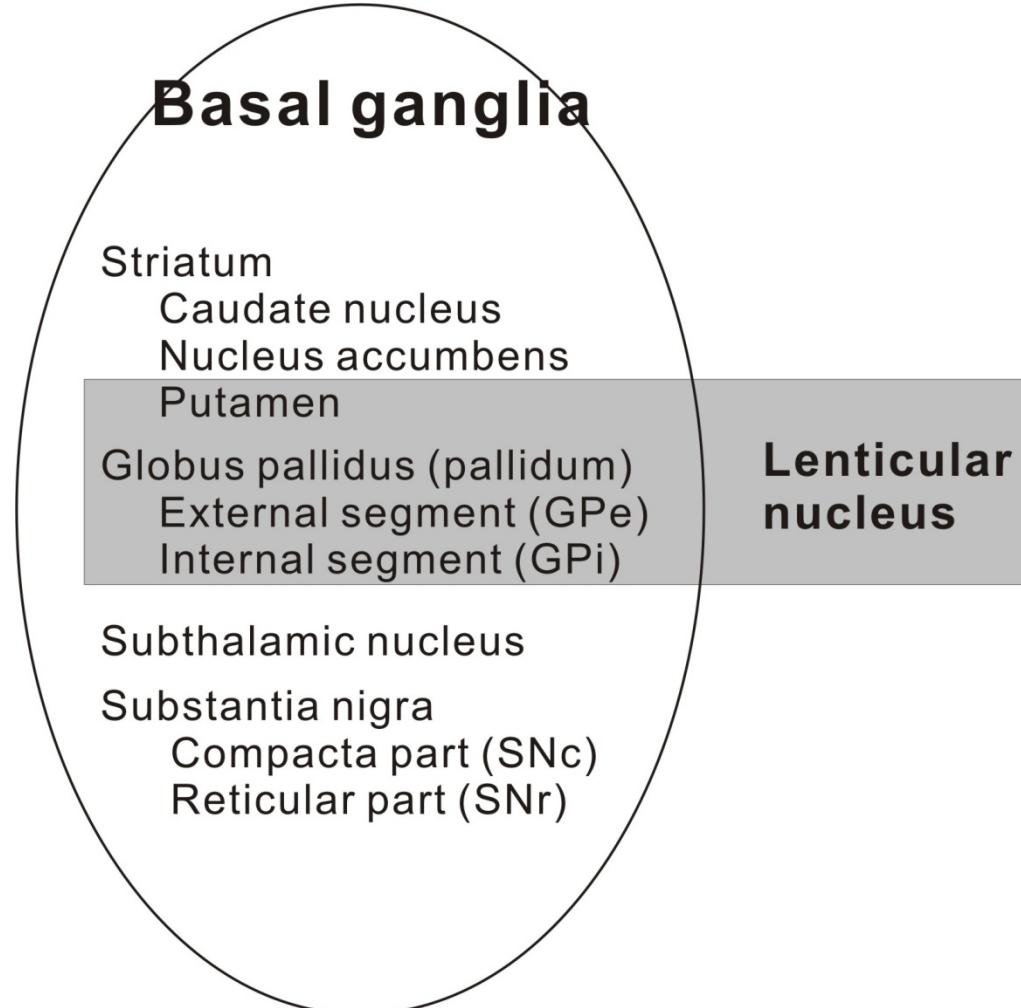
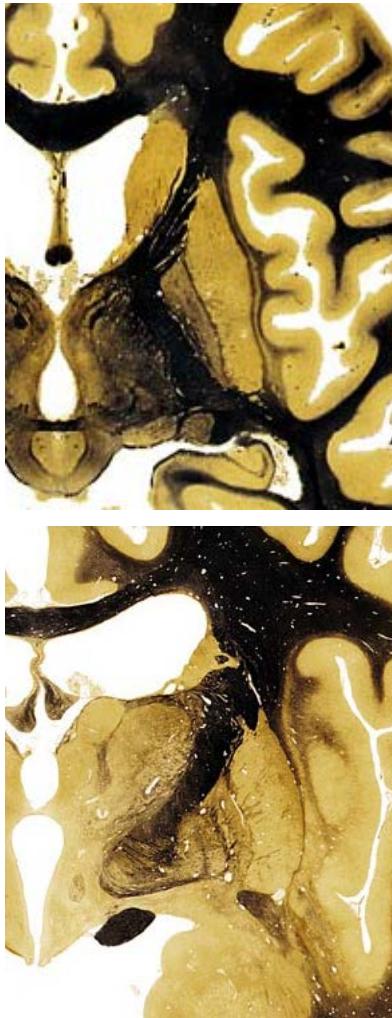
  

## **(Basal Ganglia & Thalamus)**

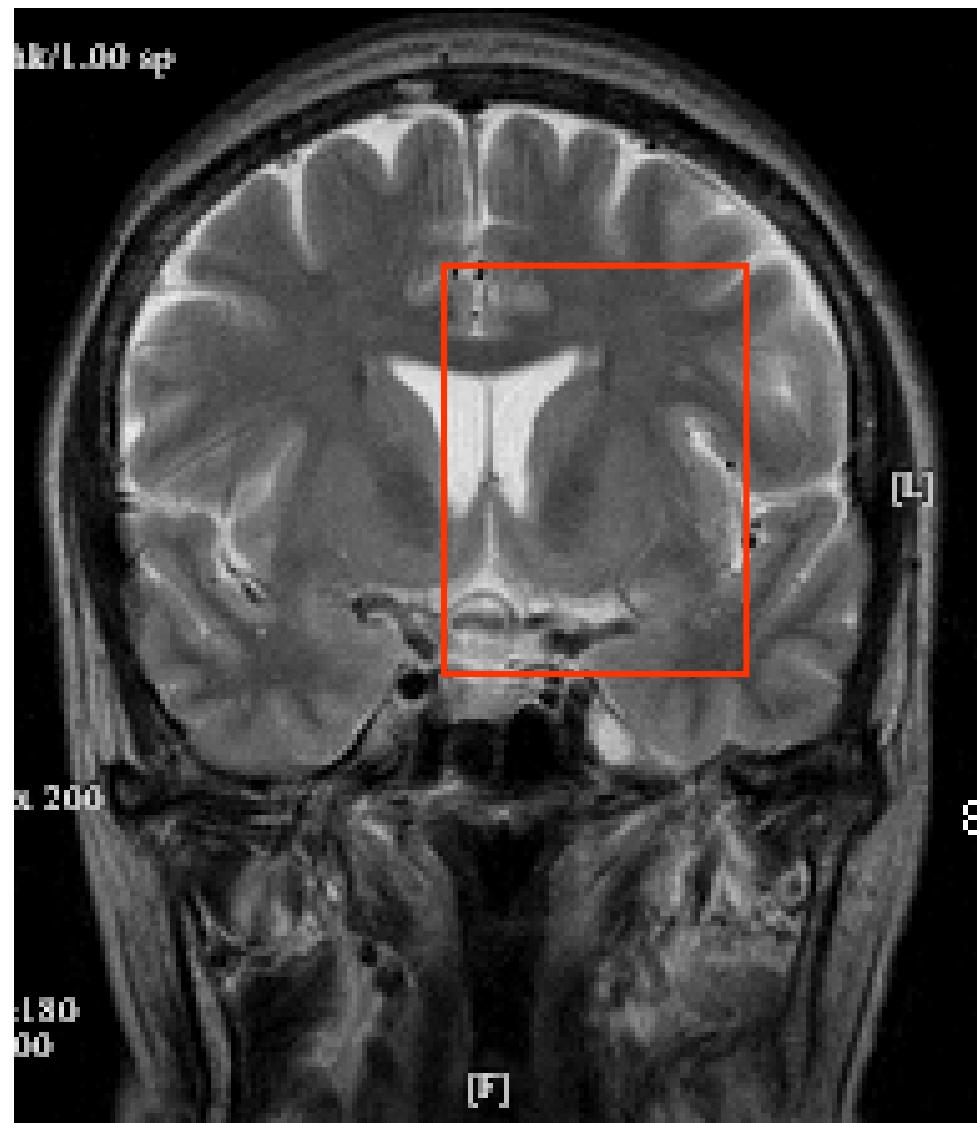
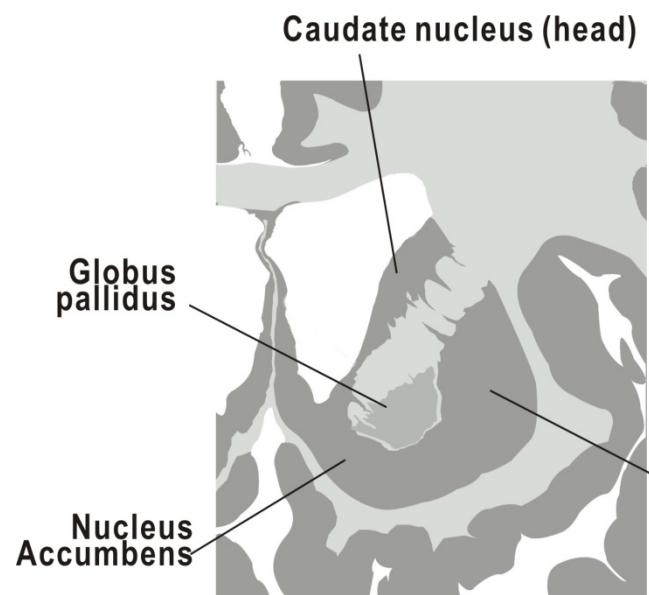
# Understanding Anatomy of Basal Ganglia

- Anatomical structures and their names
  - Nuclei of the basal ganglia
- Biochemical anatomy
  - Neurotransmitter systems
- Physiological anatomy
  - Connections
  - Functional anatomy

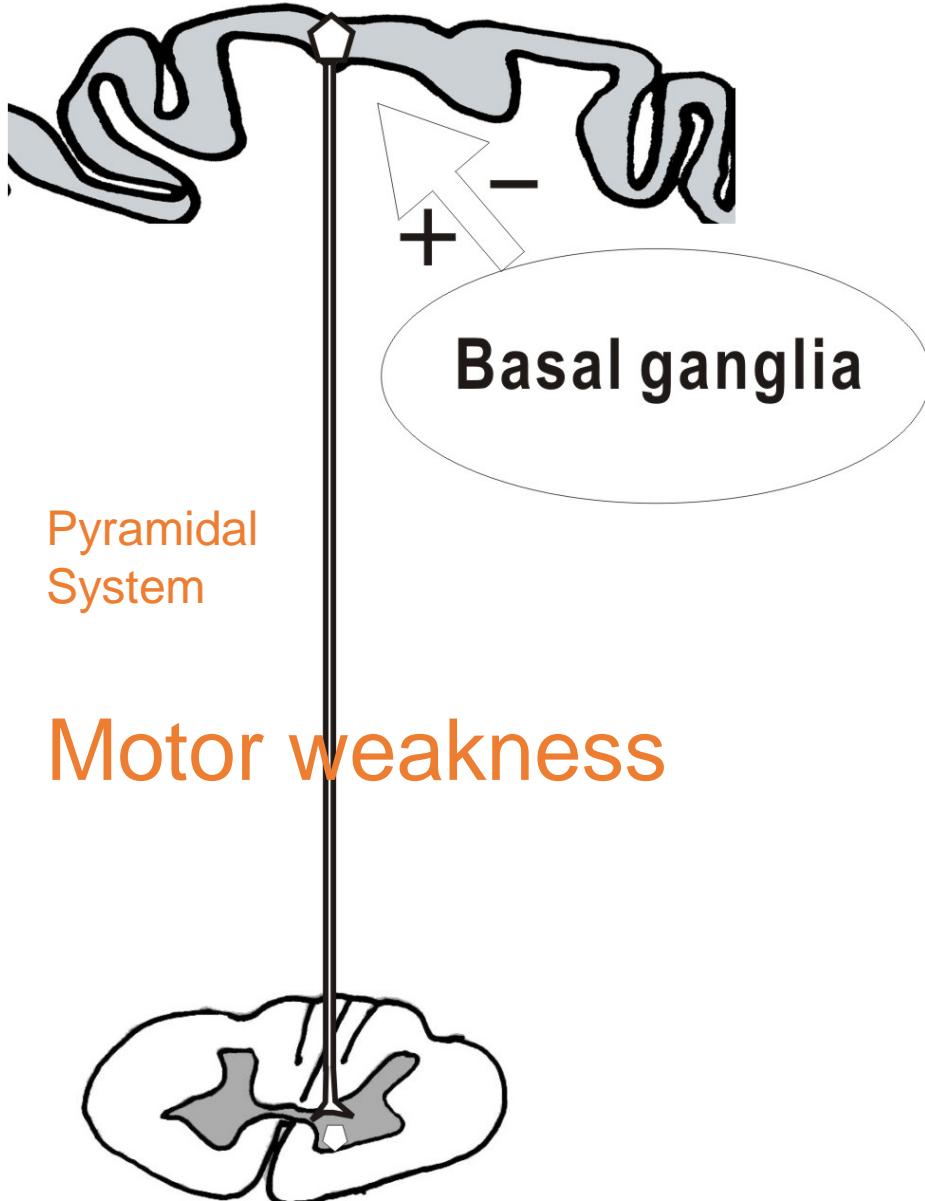
# Nuclei of Basal Ganglia



Courtesy of Yun-Jung Kim, Yonsei Univ.



Courtesy of Yun-Jung Kim, Yonsei Univ.

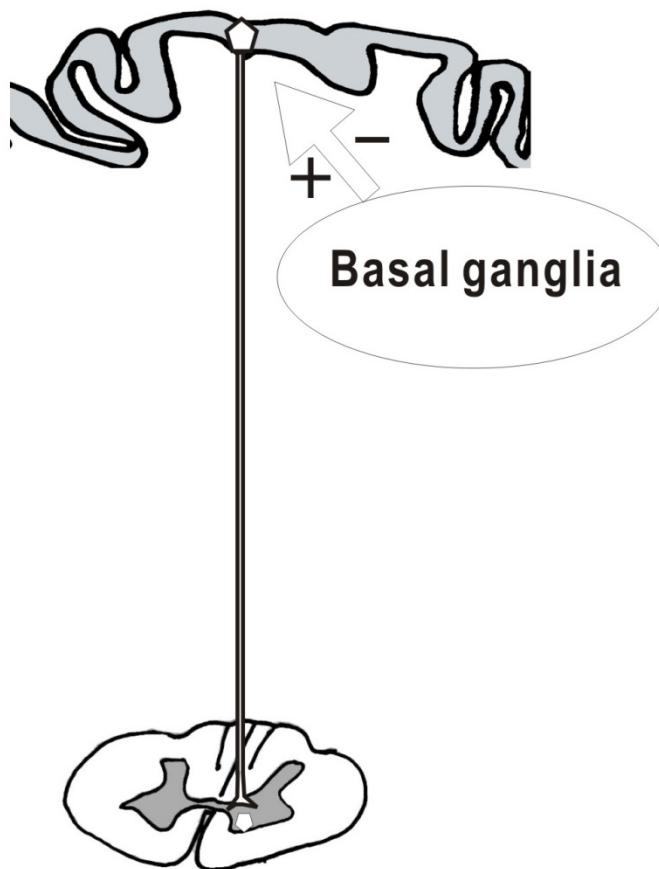


Extrapyramidal  
System

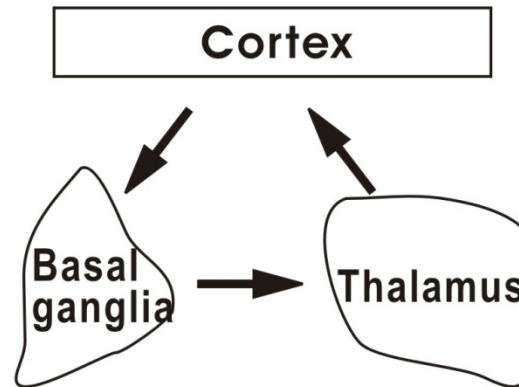
**Muscle tone change**  
**Hypo/hyperkinesia**

# Basal ganglia modulates cortical activity through CORTEX-BASAL GANGLIA-THALAMUS LOOP

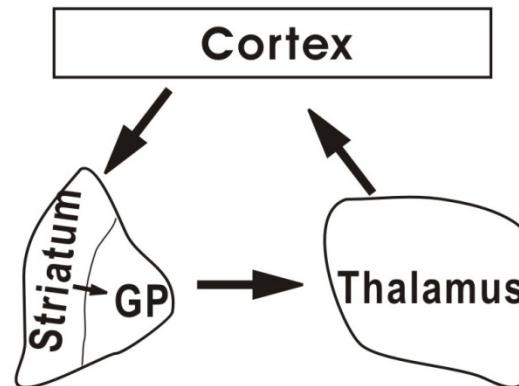
A



B



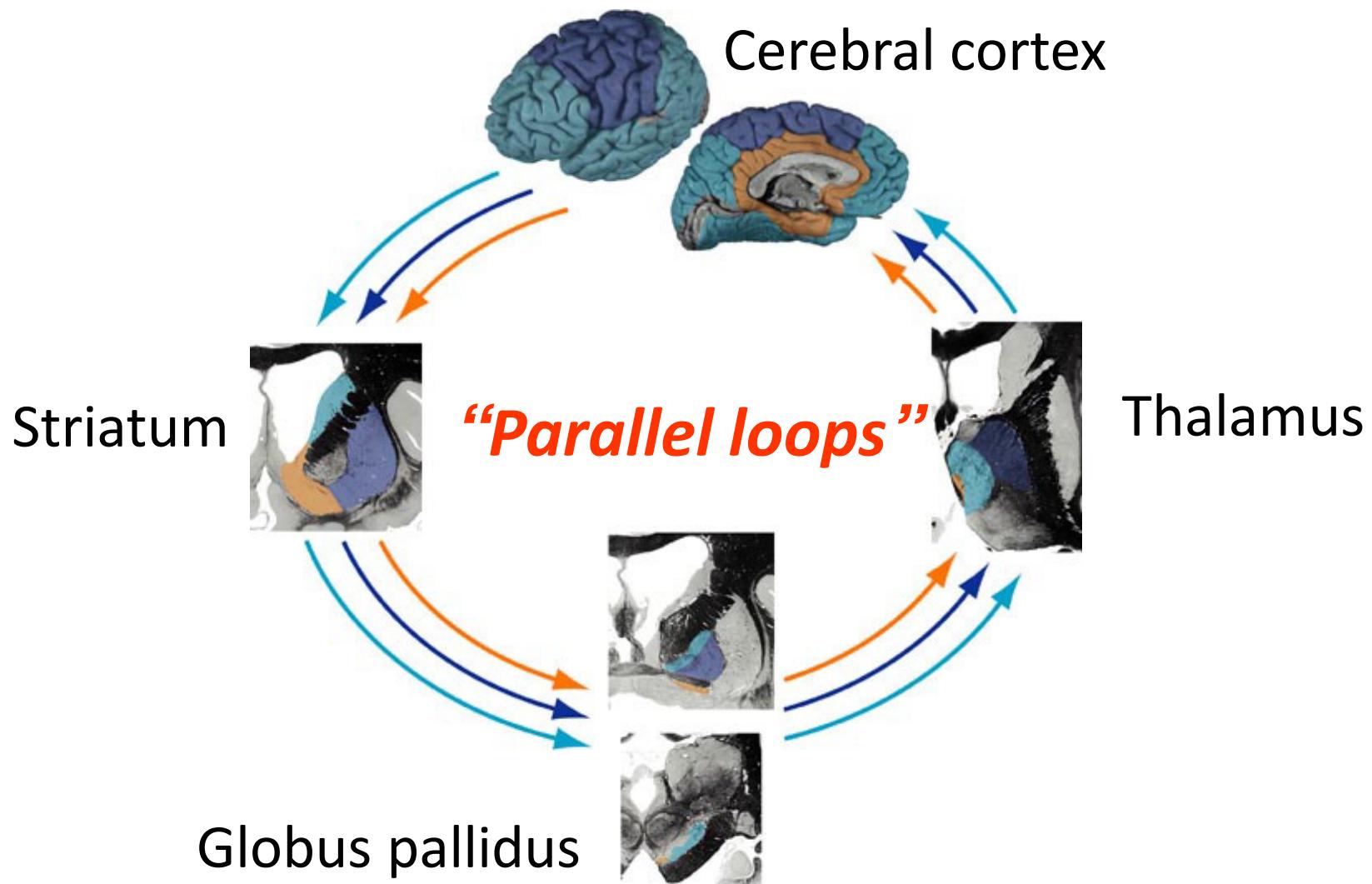
C



*"cortico-striato-pallido-thalamo-cortical loop"*

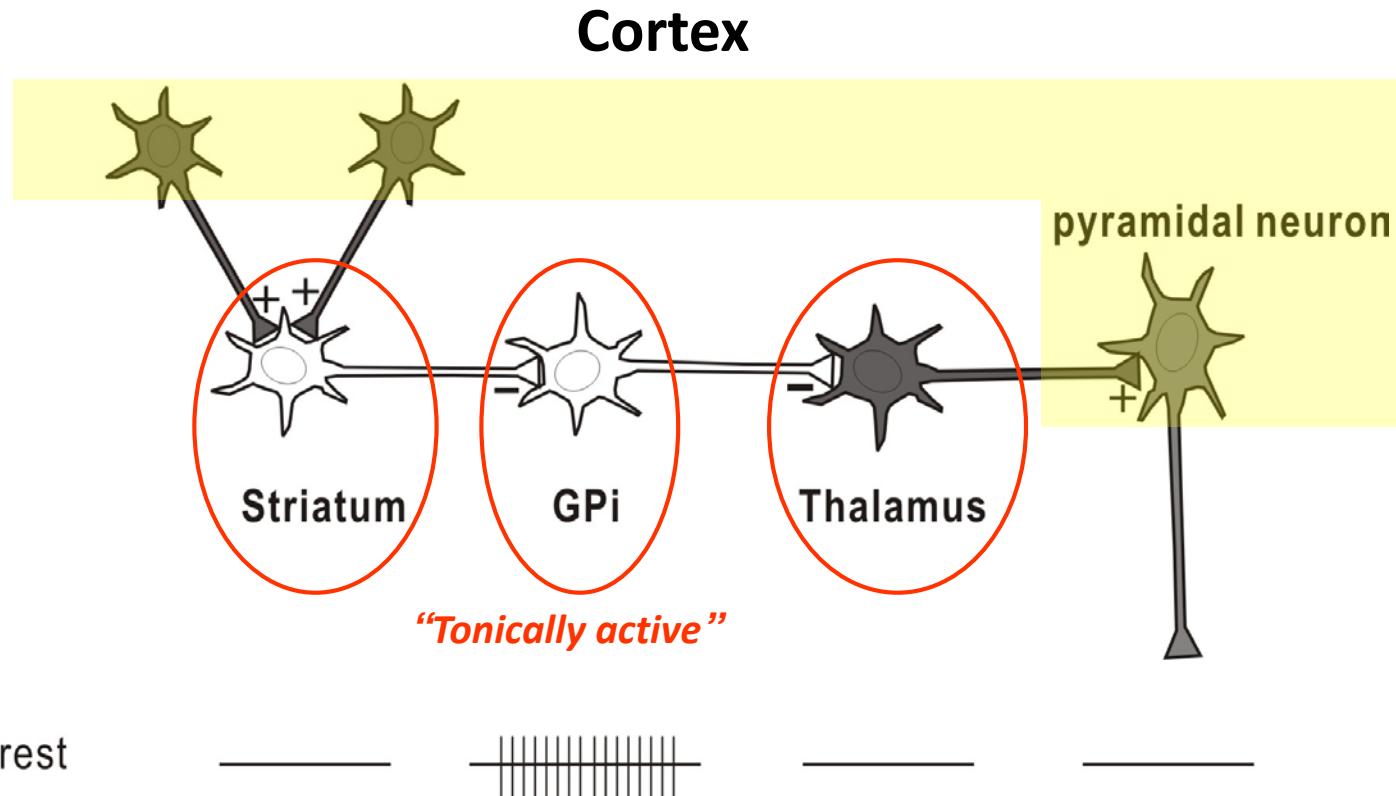
Courtesy of Yun-Jung Kim, Yonsei Univ.

# Cortico-Striato-Pallido-Thalamo-Cortical Loop



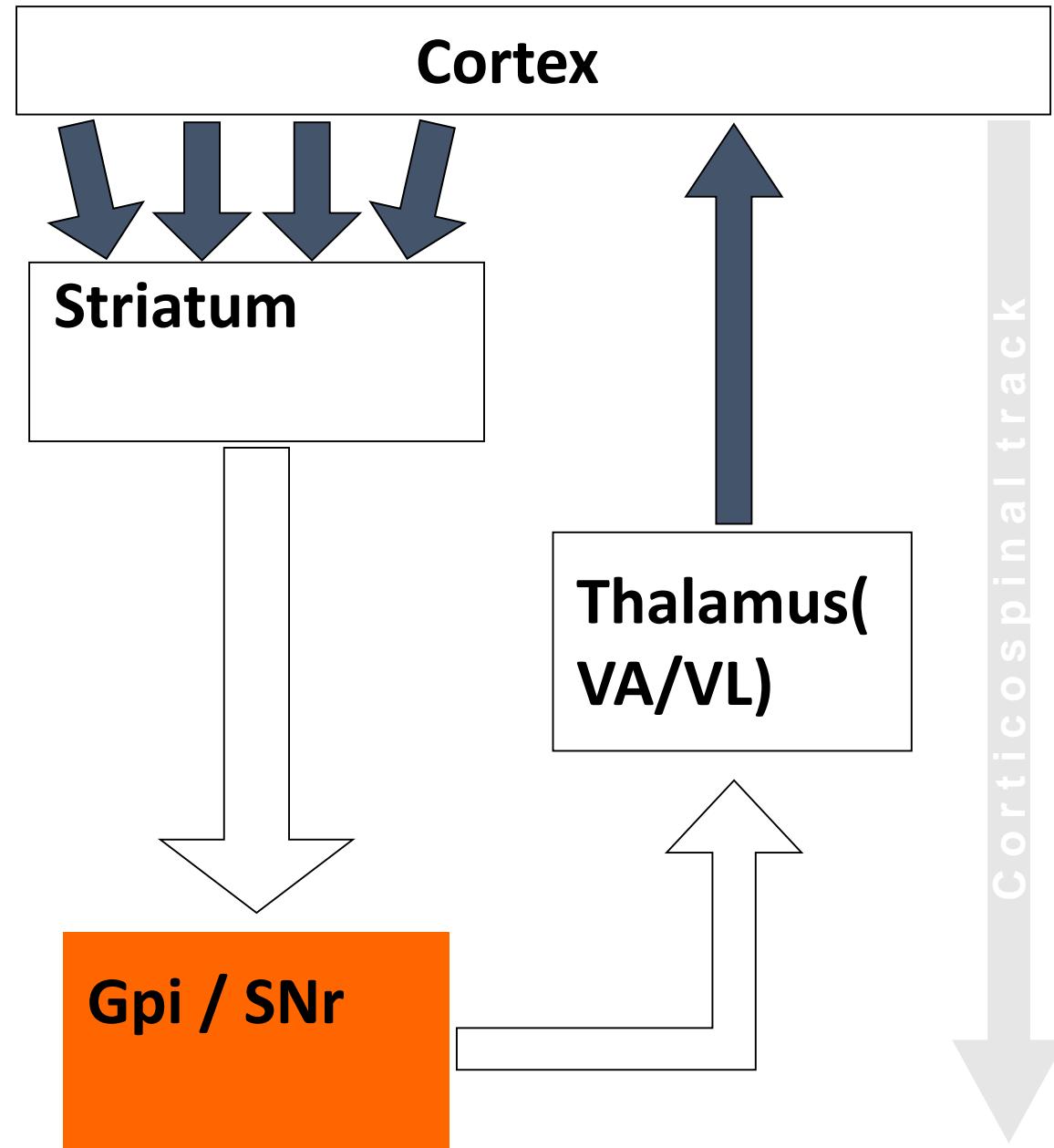
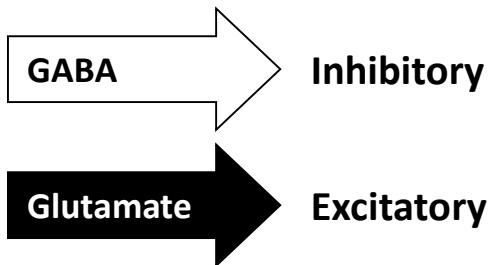
Courtesy of Yun-Jung Kim, Yonsei Univ.

# Cortico-Striato-Pallido-Thalamo-Cortical Loop for Motor control : “*a brake or switch*”



# CSPTC loop

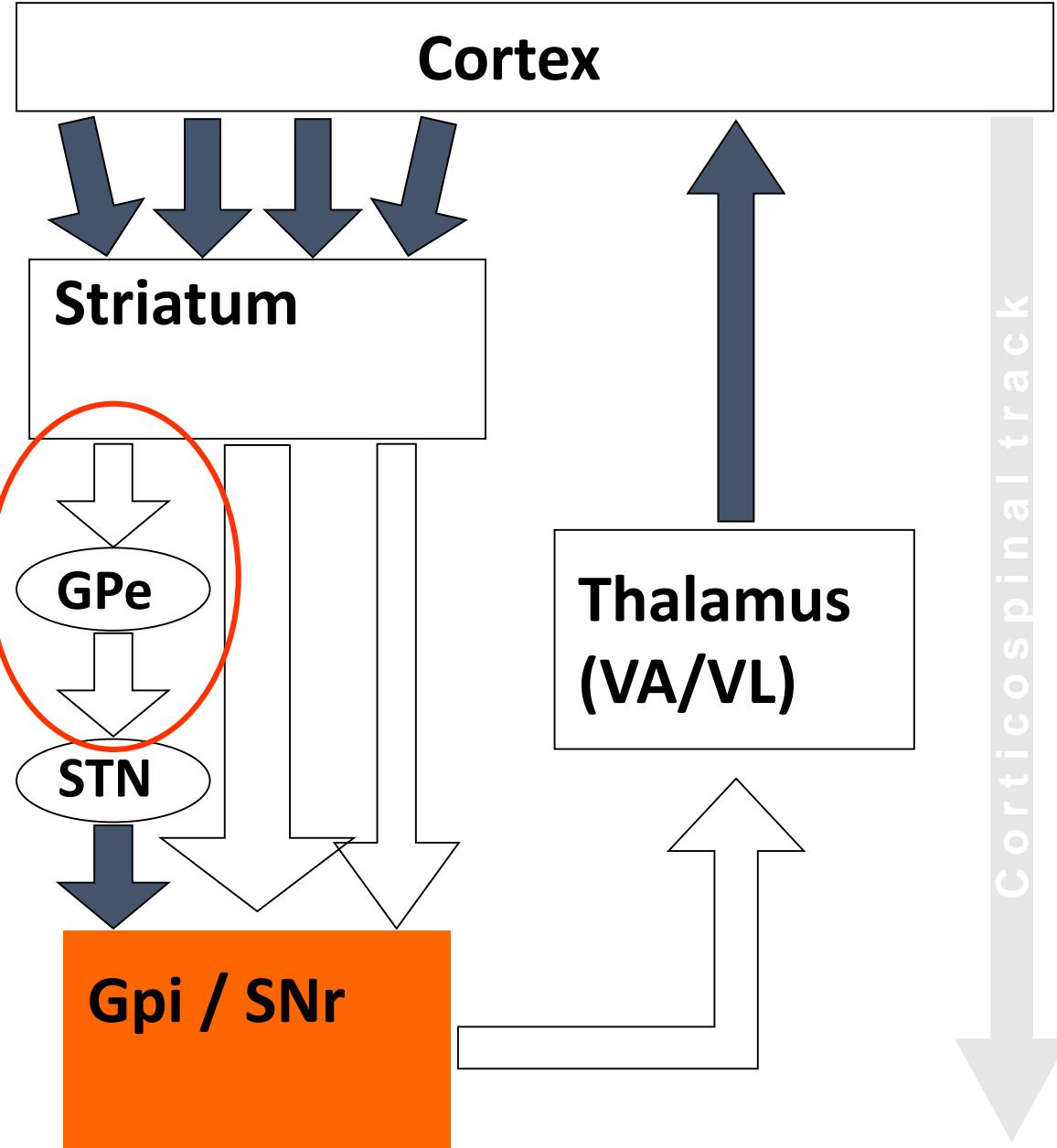
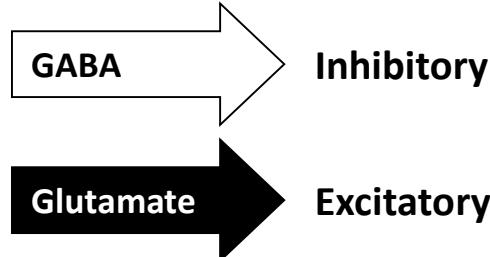
for  
**Motor  
Control**



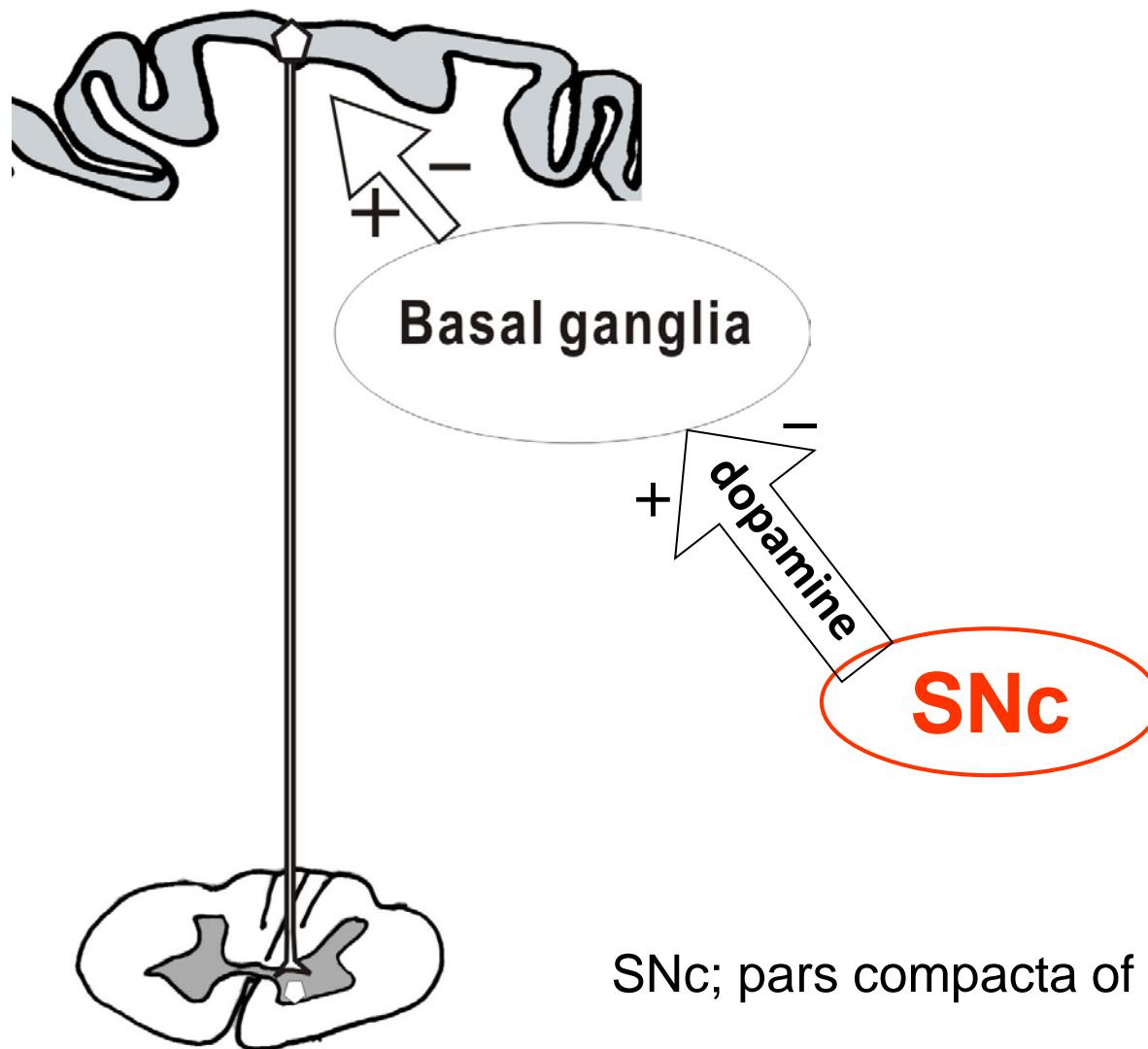
Courtesy of Yun-Jung Kim, Yonsei Univ.

# Normal Motor Control

“STN (subthalamic nu) is disinhibited”

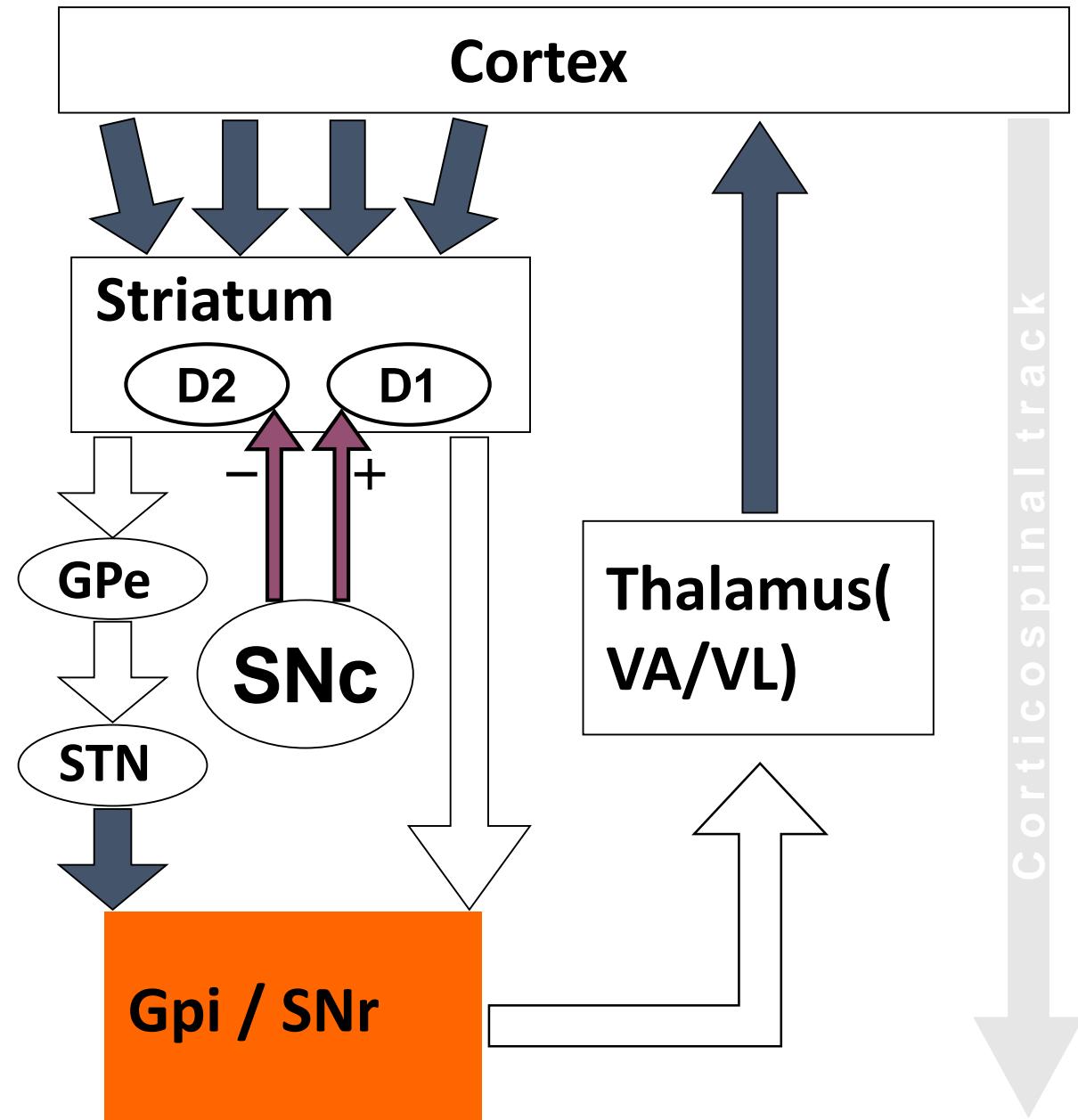


# Substantia nigra modulates basal ganglia



SNC; pars compacta of substantia nigra

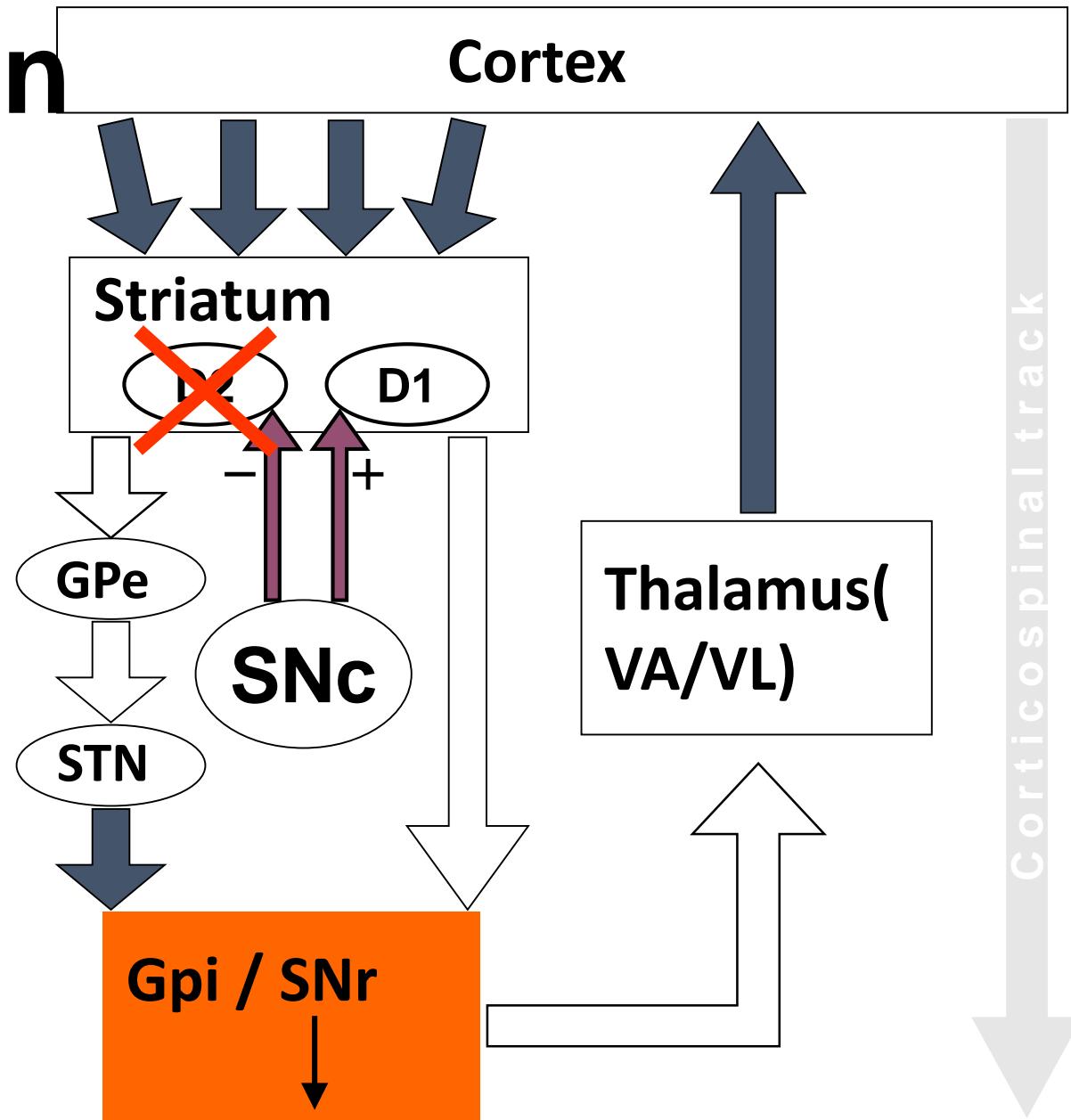
# Normal Motor Control



Courtesy of Yun-Jung Kim, Yonsei Univ.

# Huntington Disease

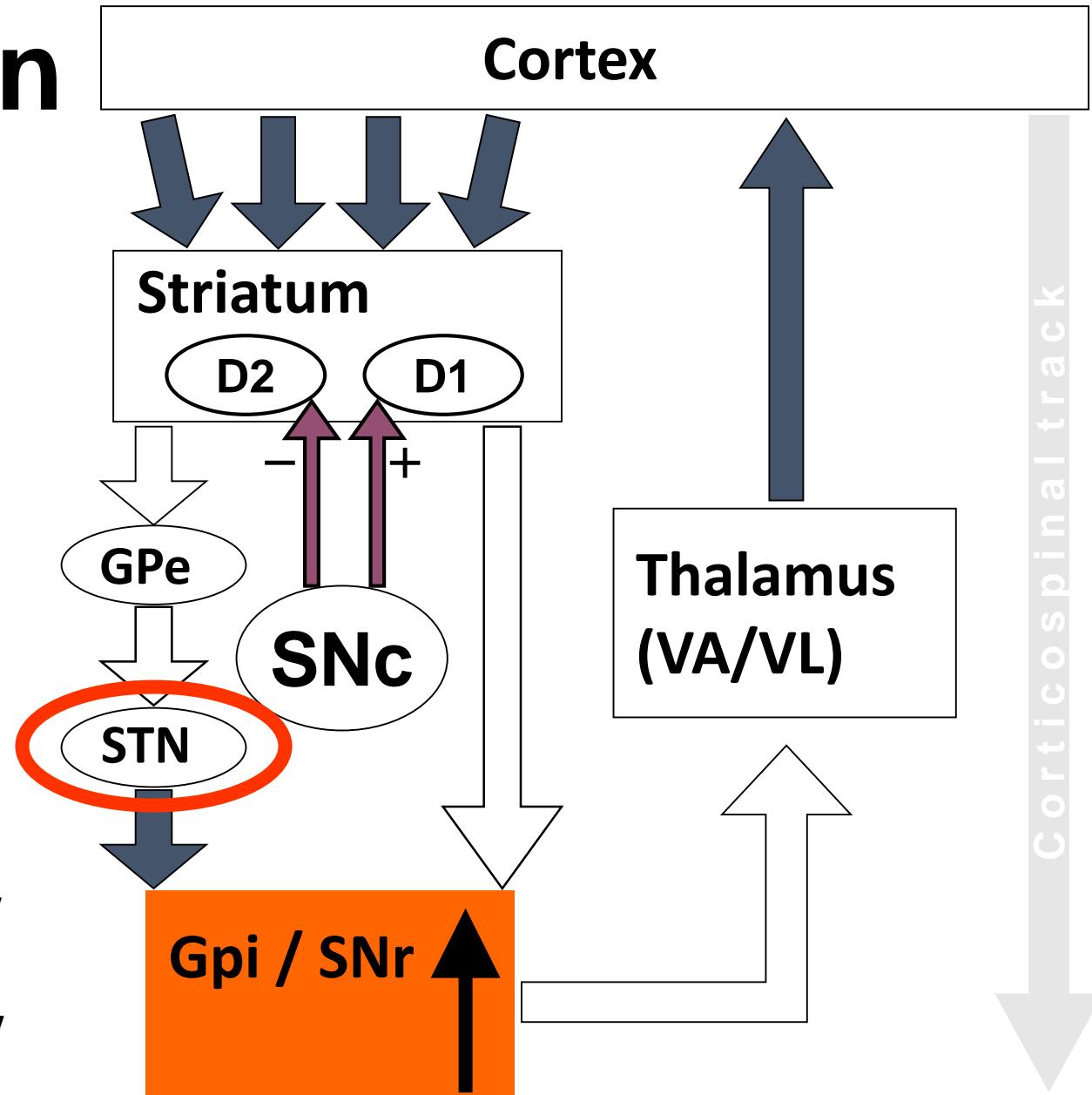
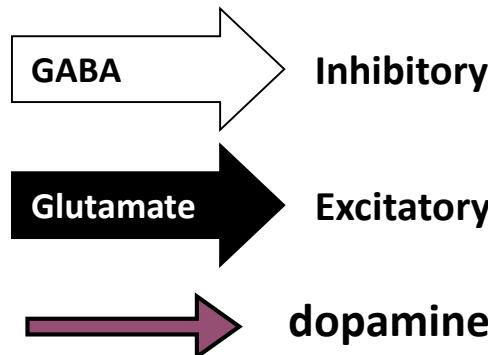
Hyperkinetic movement Disorder



Courtesy of Yun-Jung Kim, Yonsei Univ.

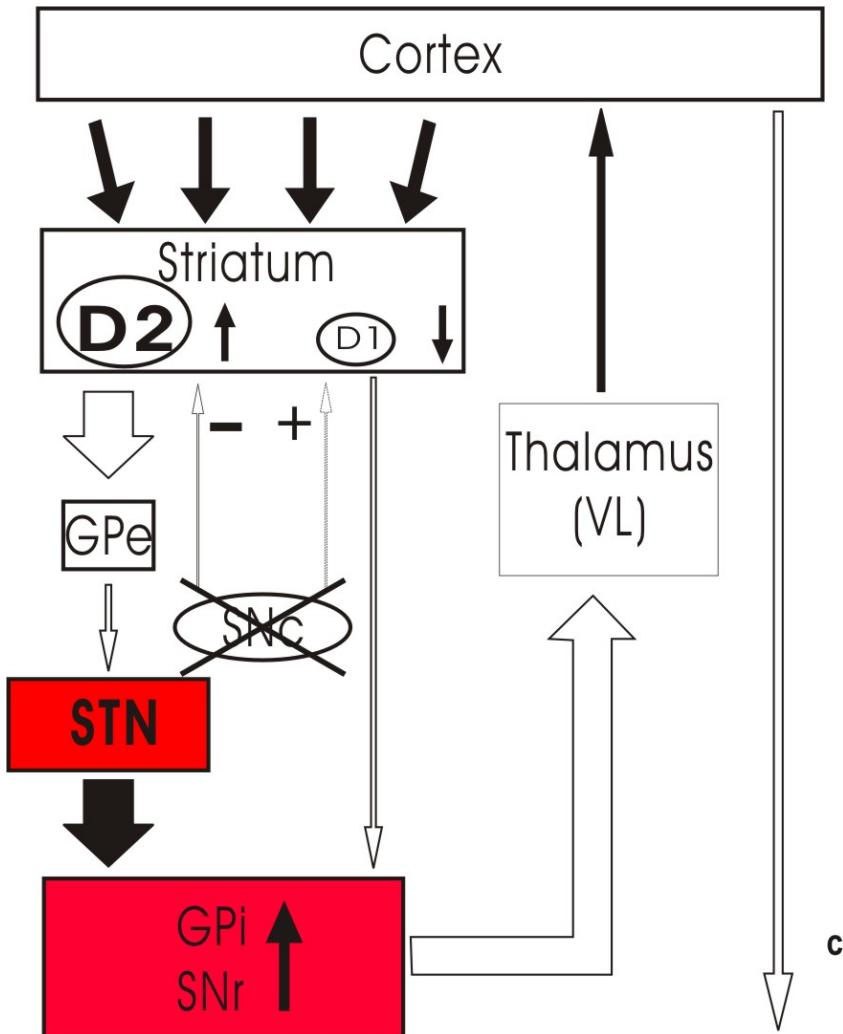
# Parkinson Disease

Hypokinetic movement disorder

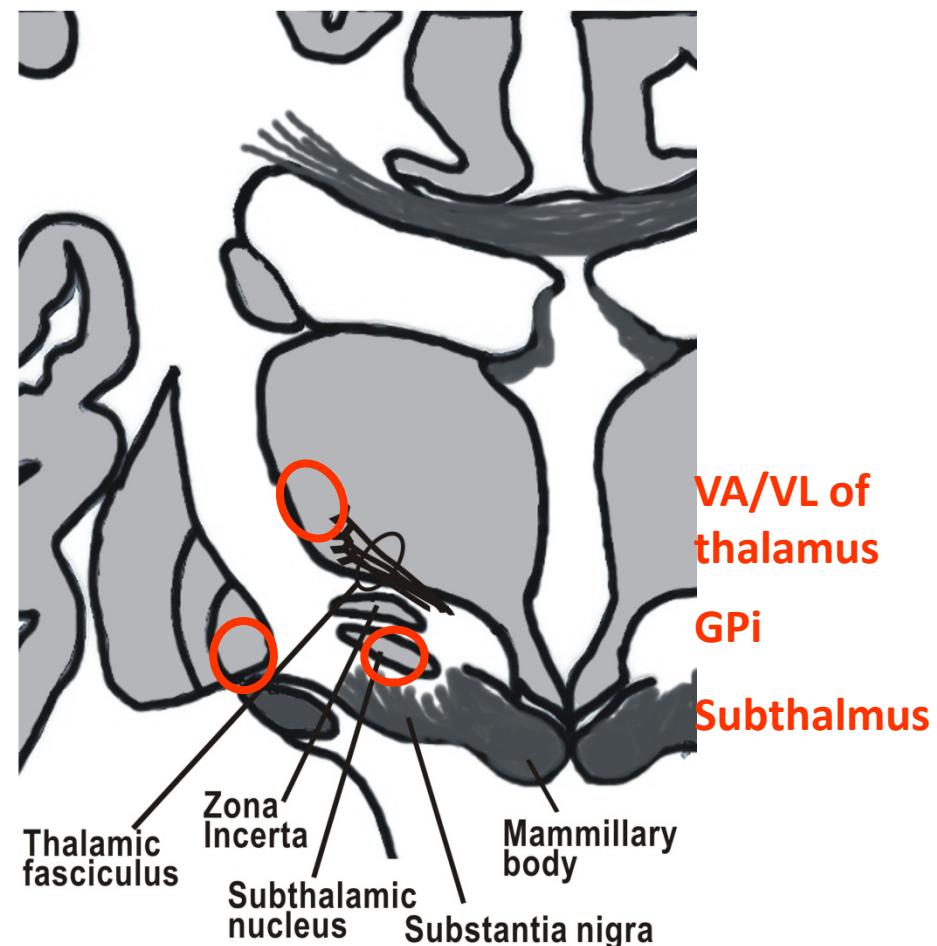


Courtesy of Yun-Jung Kim, Yonsei Univ.

# Targets of Functional Stereotaxic Surgery for Parkinson's disease



B

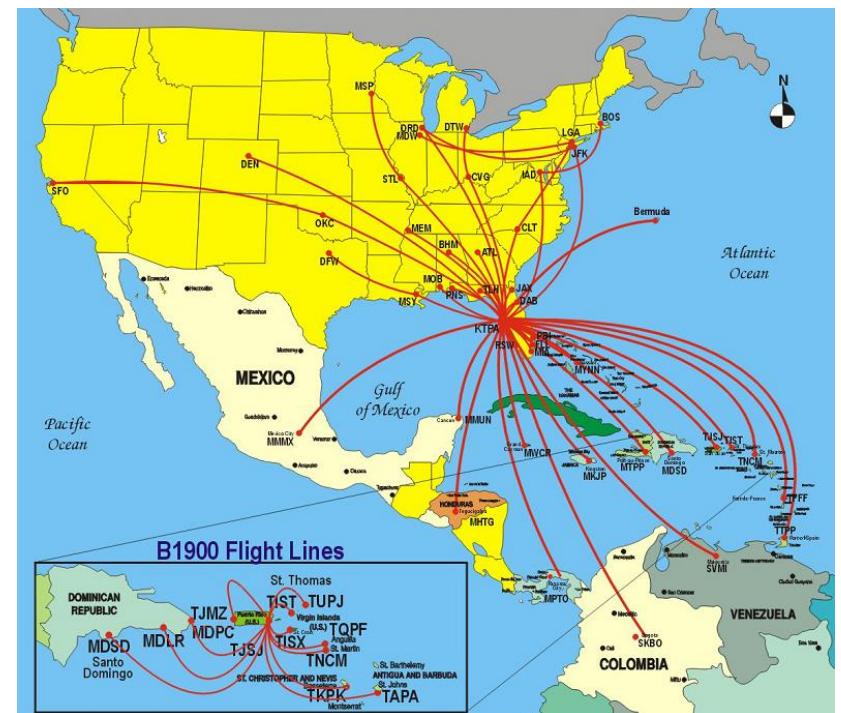
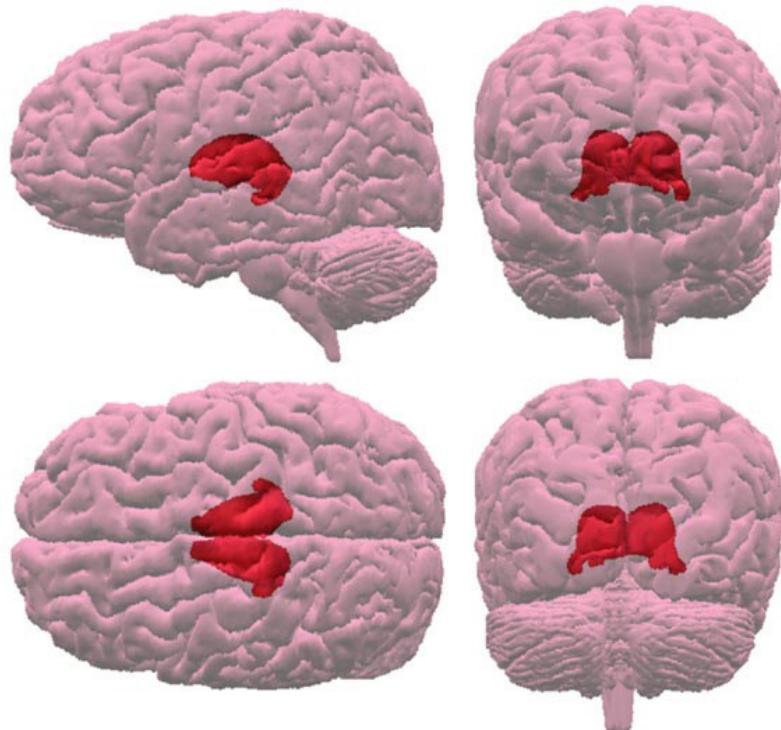


c

Courtesy of Yun-Jung Kim, Yonsei Univ.

# Thalamus

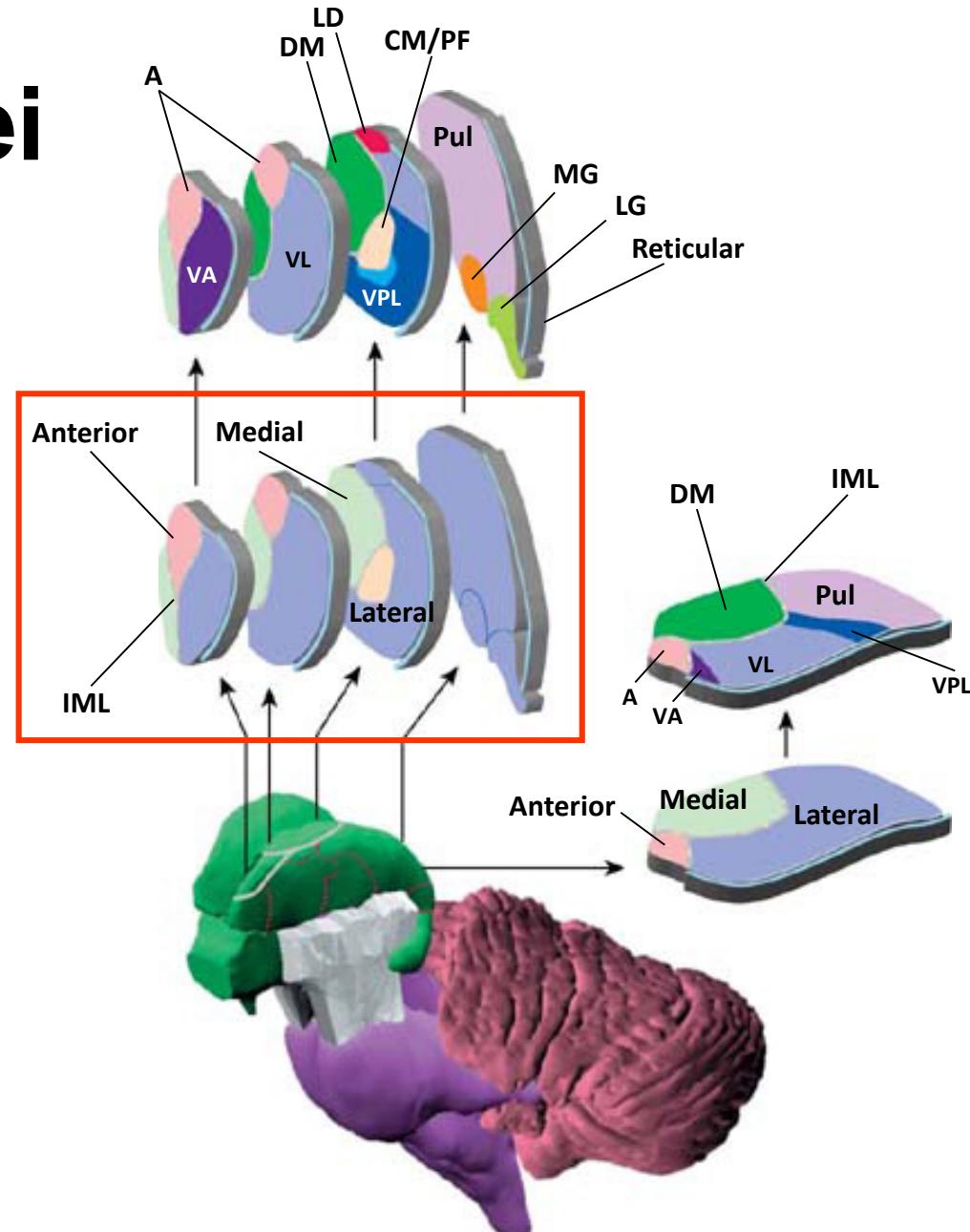
- Centrally located in the brain
- **RELAY of ALL sensory except for olfactory**
- Connected with association cortex
- Consciousness



Courtesy of Yun-Jung Kim, Yonsei Univ.

# Thalamic nuclei

- Anterior division
  - A (Anterior)
- Medial division
  - DM (dorsomedial)
- Lateral division
  - VA (ventral anterior)
  - VL (ventral lateral)
  - VPL (ventral posterolateral nu)
  - VPM (ventral posteromedial nu)
  - LD (lateral dorsal)
  - Pulvinar
  - MG (medial geniculate nu)
  - LG (lateral geniculate nu)
- Intralaminar
  - CM / PF
- Others
  - Reticular



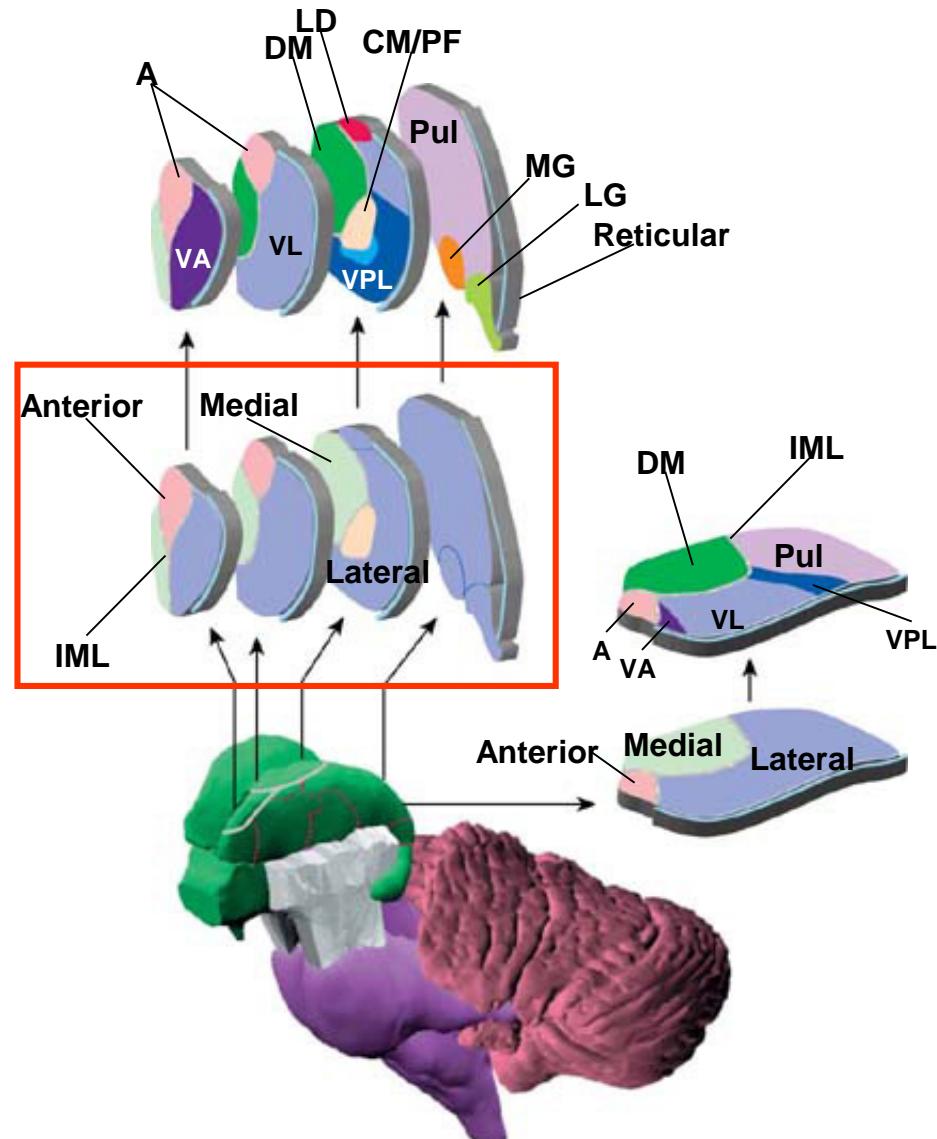
Courtesy of Yun-Jung Kim, Yonsei Univ.

# Thalamic Nuclei & Connections

- Sensory
  - VP (VPL/VPM)
  - LGN
  - MGN

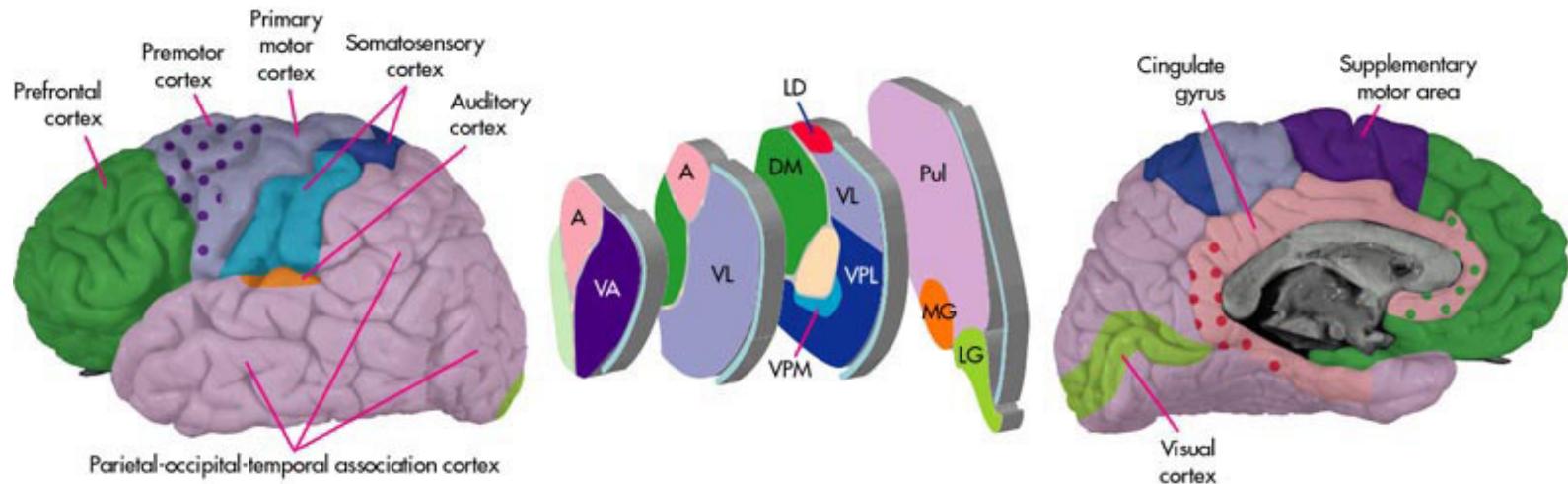
- Motor
  - VA/VL

- Limbic / Association
  - A (AT)
  - MD



Courtesy of Yun-Jung Kim, Yonsei Univ.

# Thalamic Nuclei & Connections

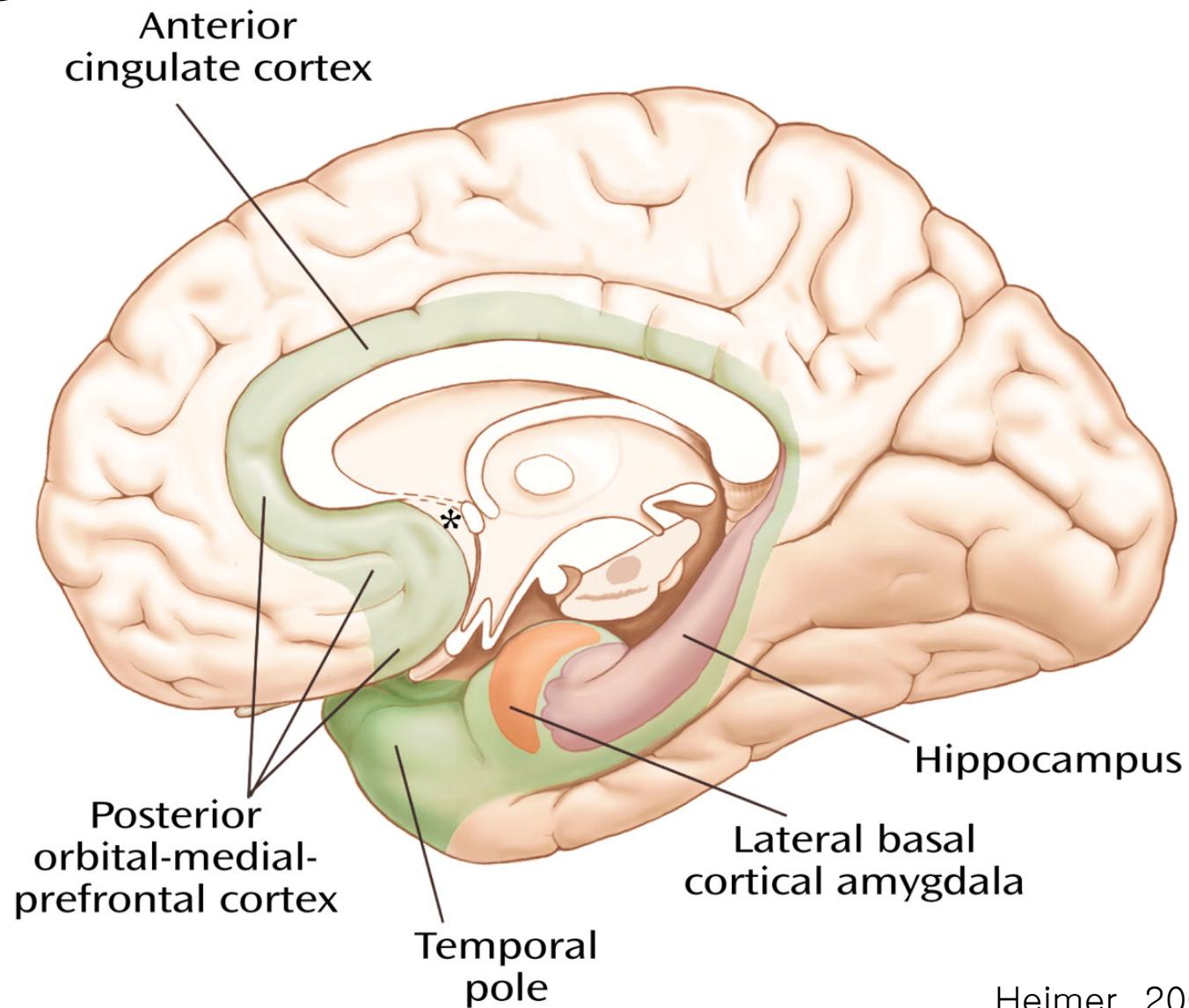


| Thalamic Nuclei   | Specific input                                    | Cortical output                   |
|-------------------|---|-----------------------------------|
| Anterior          | Mammillary body, Hippocampus                      | Cingulate gyrus                   |
| VA / VL           | Basal ganglia, cerebellum                         | Motor area                        |
| VPL / VPM         | Spinothalamic tr & medial lemniscus (body / face) | Somatosensory cortex              |
| MGN               | Brachium of inferior colliculus                   | Auditory cortex                   |
| LGN               | Optic track                                       | Visual cortex                     |
| Dorsomedial (DM)  | Prefrontal cortex, limbic system                  | Prefrontal cortex                 |
| Lateral posterior | Parietal  | Parietal                          |
| Pulvinar          | Parietal, occipital, and temporal lobe            | Parietal, occipital, temporal Ctx |

Courtesy of Yun-Jung Kim, Yonsei Univ.

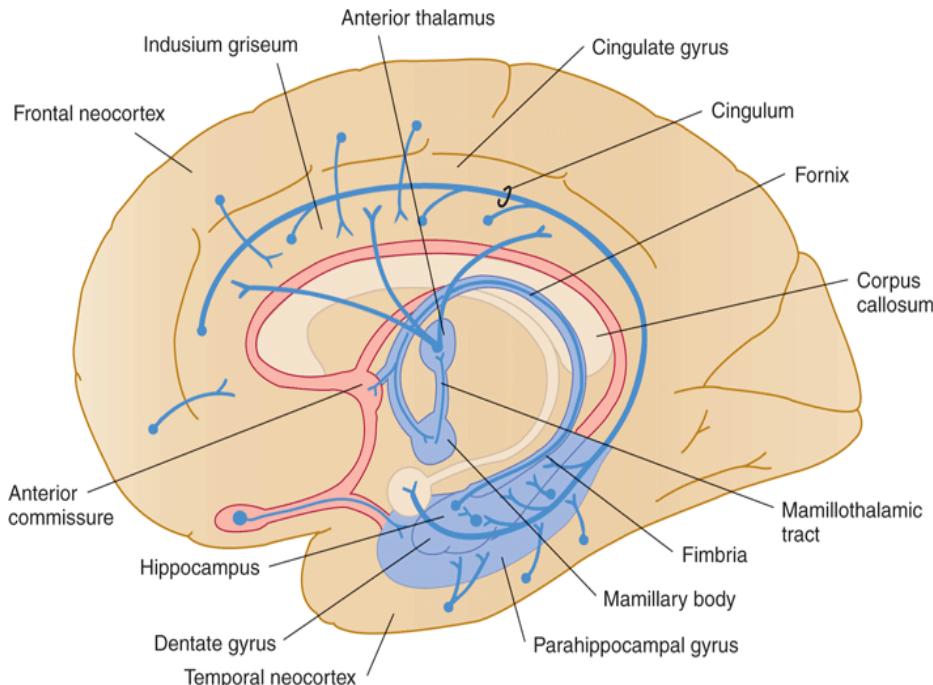
# **Limbic System**

# Le grand lobe limbique of Broca



Heimer, 2003

# Papez Circuit



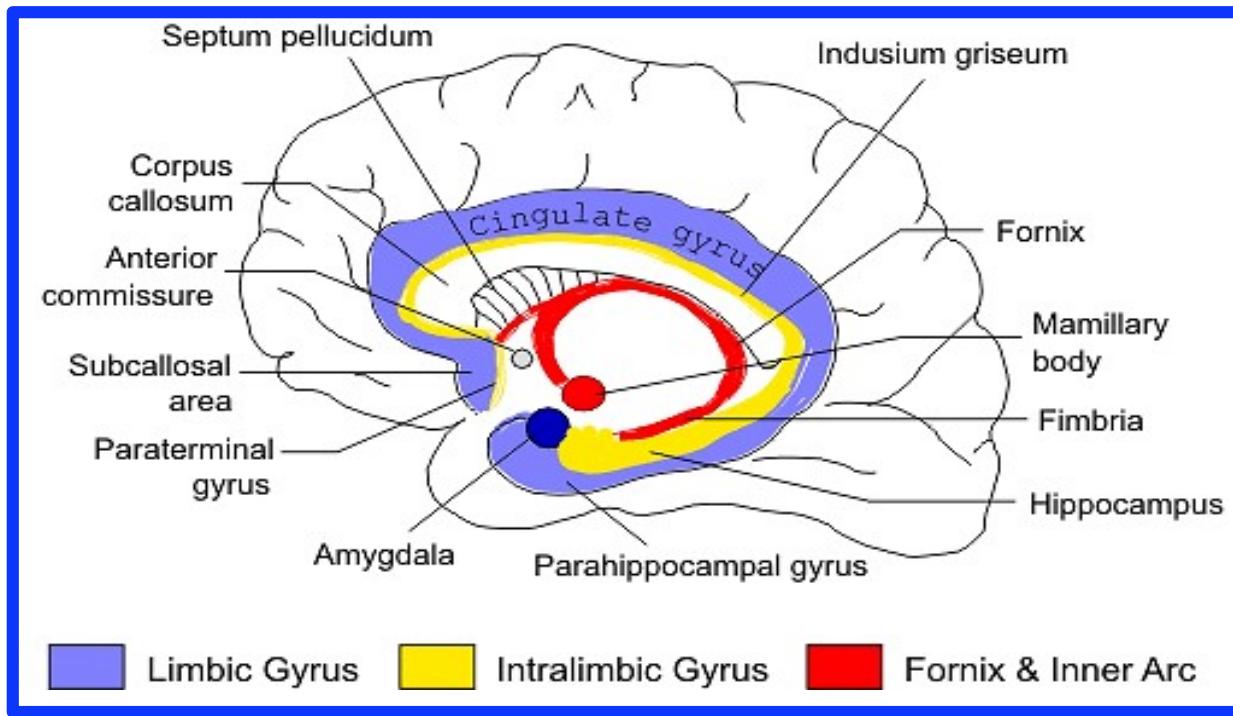
**Hippocampal formation (subiculum)**

- fornix
- mammillary bodies
- mammillothalamic tract
- anterior thalamic nucleus
- genu of internal capsule
- cingulate gyrus
- cingulum
- parahippocampal gyrus

Source: Waxman SG: Clinical Neuroanatomy, 26th Edition:  
<http://www.accessmedicine.com>

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# Limbic System

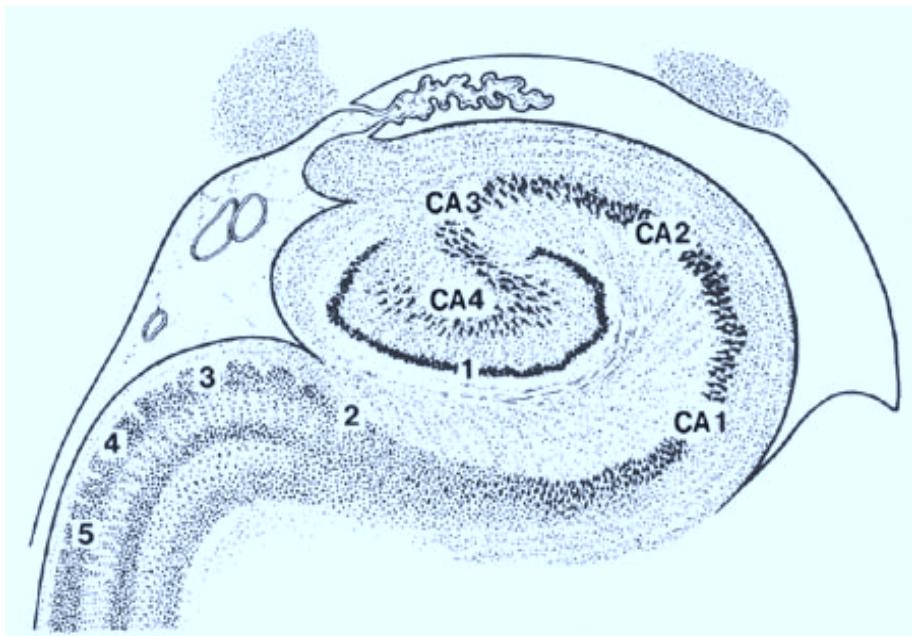


## Limbic gyrus (outer arc of LS) Intralimbic gyrus (middle arc of LS)

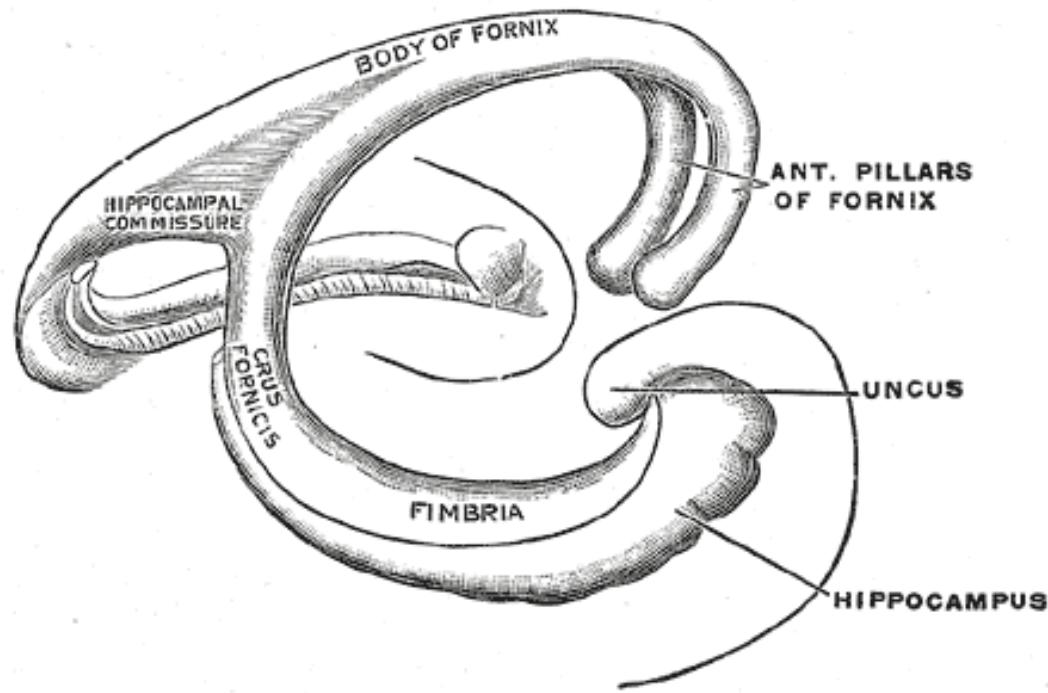
- |   |   |
|---|---|
| <ul style="list-style-type: none"><li>▪ Subcallosal area</li><li>▪ Cingulate gyrus</li><li>▪ Parahippocampal gyrus<ul style="list-style-type: none"><li>- Subiculum</li><li>- Piriform lobe (uncus)</li><li>- Entorhinal area</li></ul></li></ul> | <ul style="list-style-type: none"><li>▪ Prehippocampal rudiment<ul style="list-style-type: none"><li>- Paraterminal gyrus</li><li>- Septal nuclei (region)</li></ul></li><li>▪ Indusium griseum<ul style="list-style-type: none"><li>- Medial &amp; lateral longitudinal striae</li></ul></li><li>▪ Hippocampus</li></ul> |
|---|---|

# Hippocampal Formation

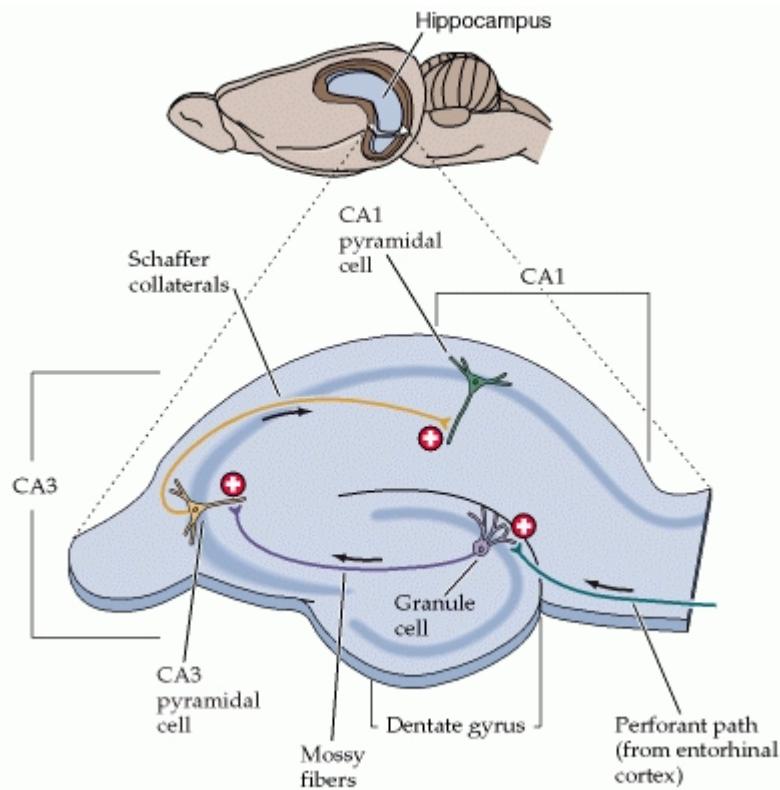
- Hippocampus
  - Cornu Ammonis (hippocampus proper)
- Gyrus dentatus
- Subiculum



# Hippocampus



# Classic Trisynaptic Intrinsic Pathway



1. Entorhinal cortex (**Perforant path**)  
→ dentate gyrus granular cells
  2. Granular cell axon (**Mossy fiber**)  
→ CA3 pyramidal cells
  3. CA3 Pyramidal cell  
(**Schaffer collateral**)  
→ CA1 pyramidal cells
- → subiculum  
→ → entorhinal cortex

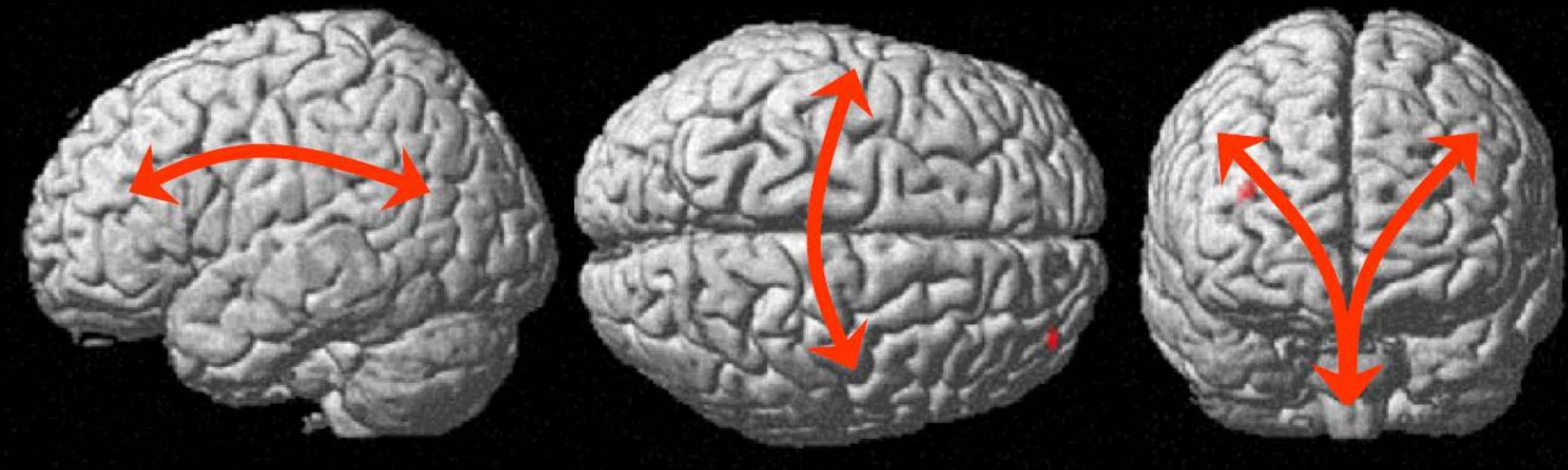
# **Anatomy of White Matter Tracts**

# Anatomical Classification of White Matter Tract

Association

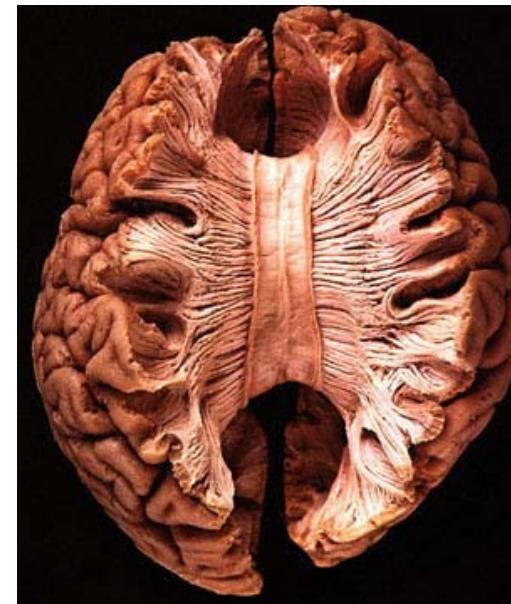
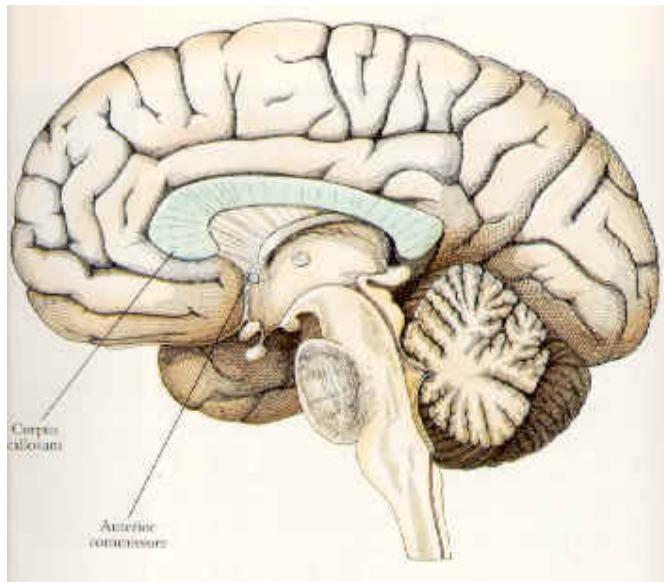
Commissural

Projection

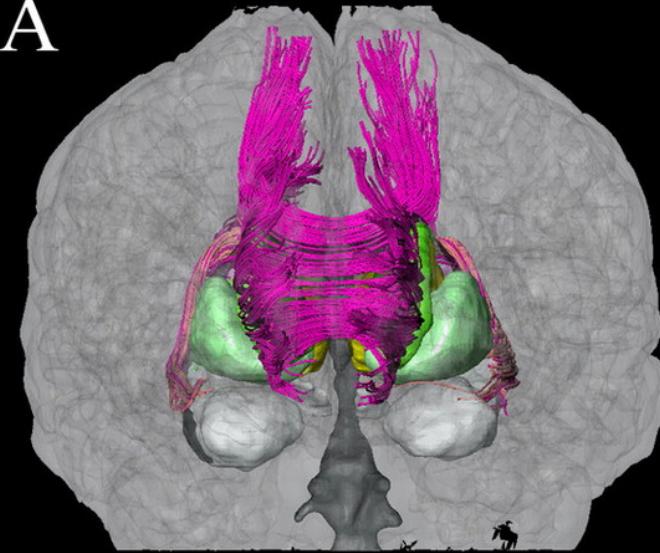


# Commissural Fibers

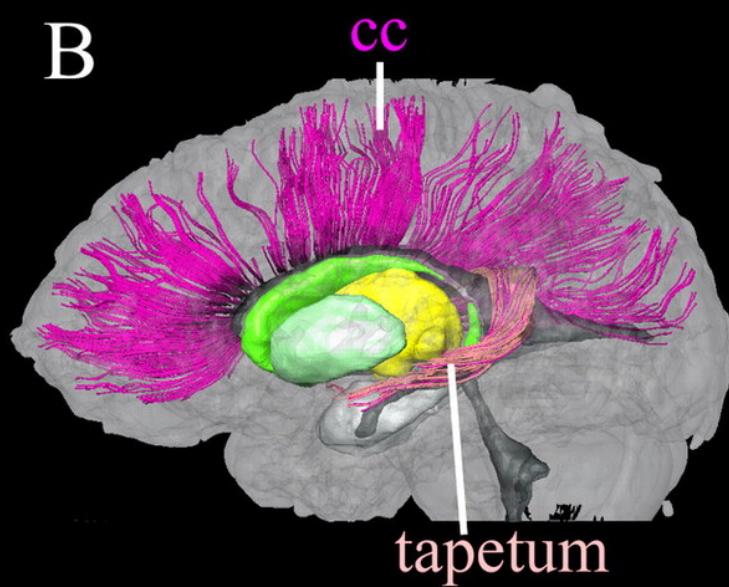
- Corpus callosum
  - Rostrum
  - Genu
  - Trunk
  - Slenium
- Callosal fibers
  - Forceps minor
  - Forceps major
  - Tapetum



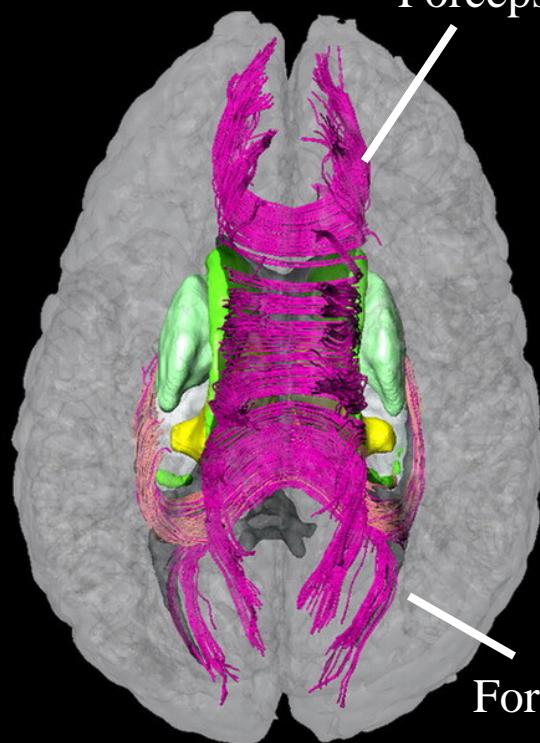
A



B

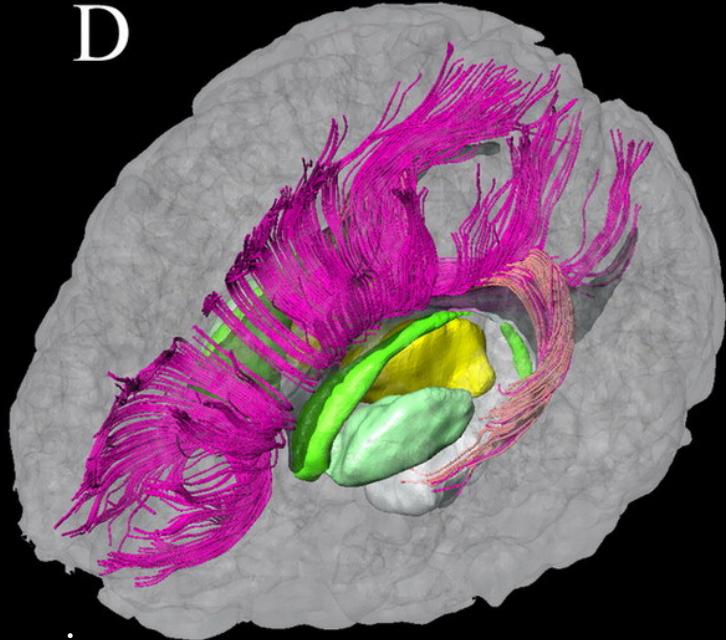


C

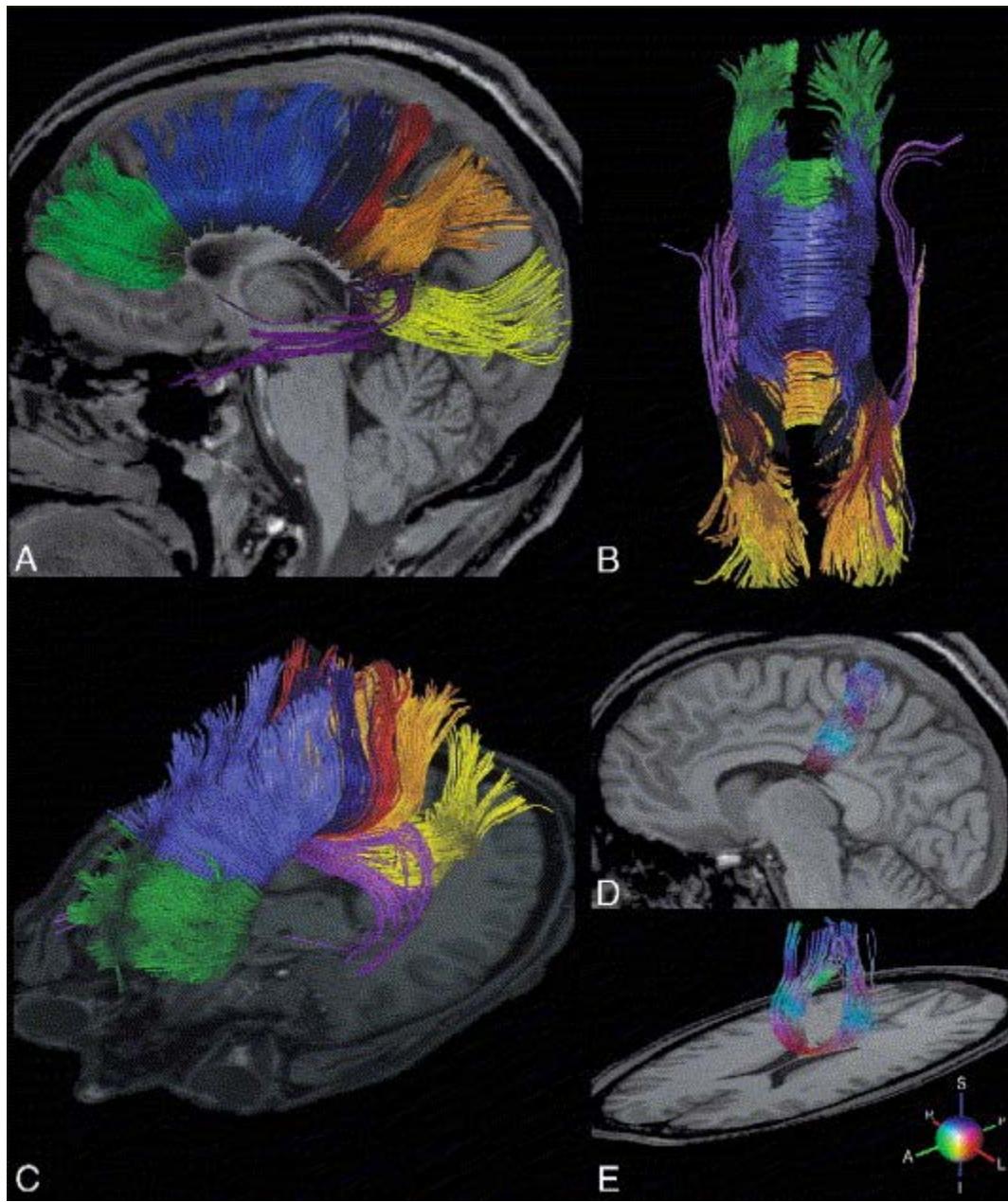


Forceps minor

D



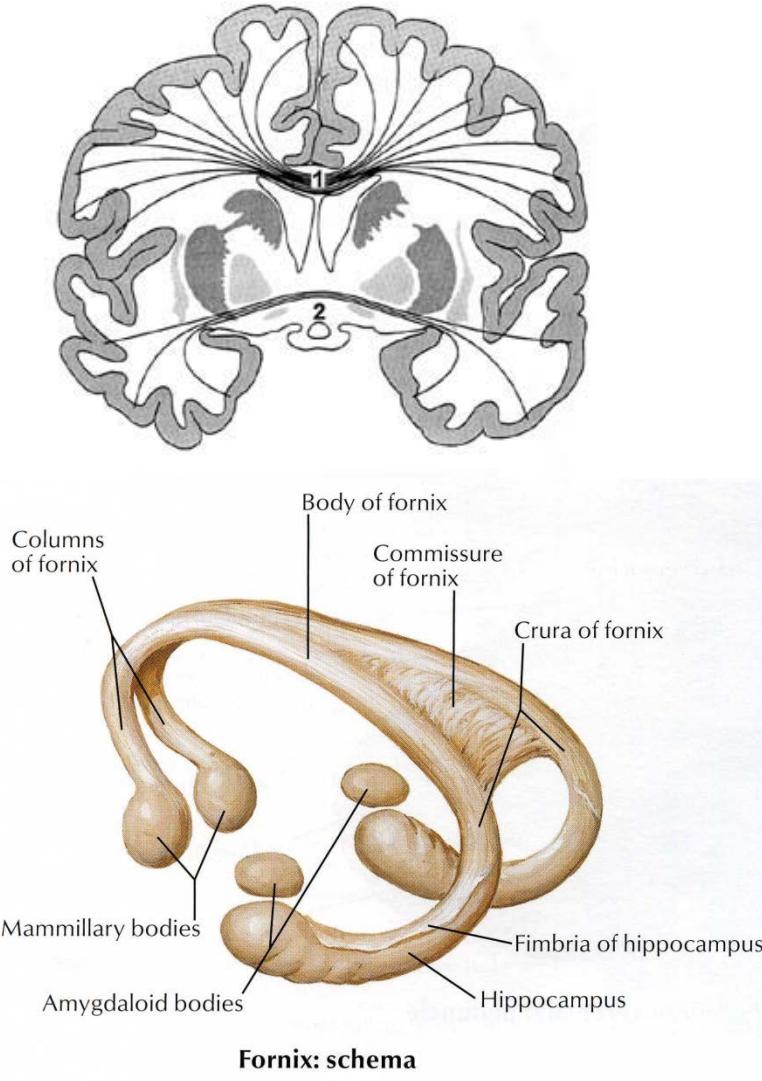
Forceps major



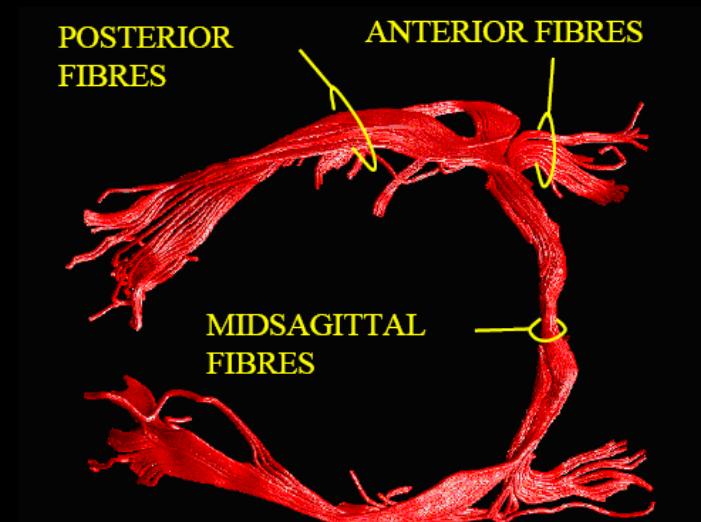
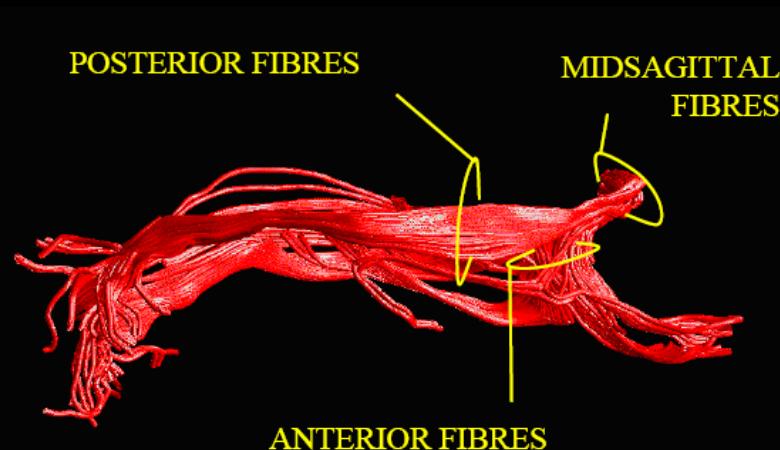
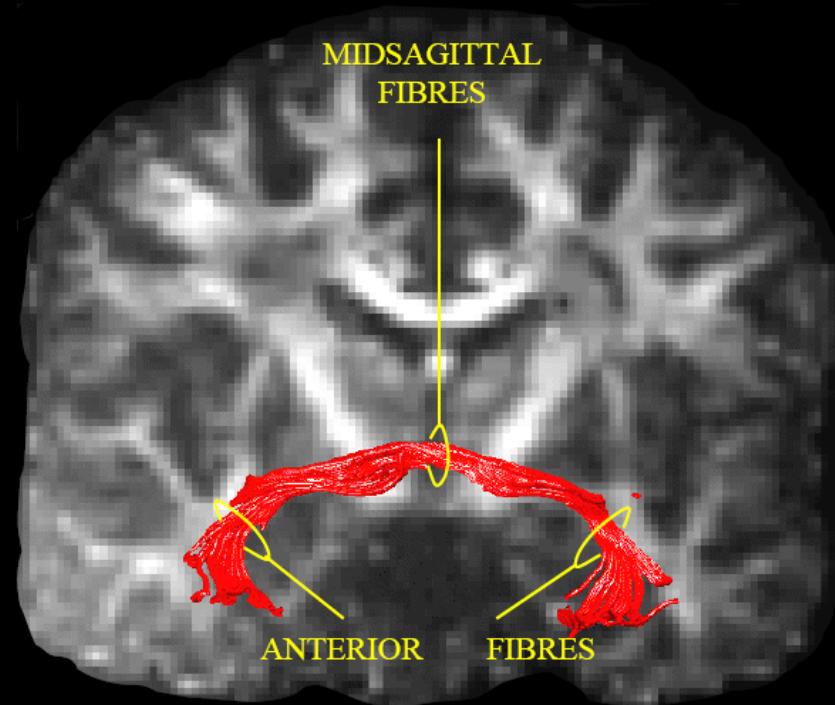
- █ prefrontal
- █ premotor
- █ Primary motor
- █ Primary sensory
- █ parietal
- █ occipital

# Commissural Fibers

- Anterior commissure
  - Anterior: connect olfactory bulb
  - Posterior: connect middle and inferior temporal gyri
- Commissure of fornix
- Other (in diencephalon)
  - posterior commissure
  - massa intermedia (inter-thalamic adhesion)
  - habenular commissure

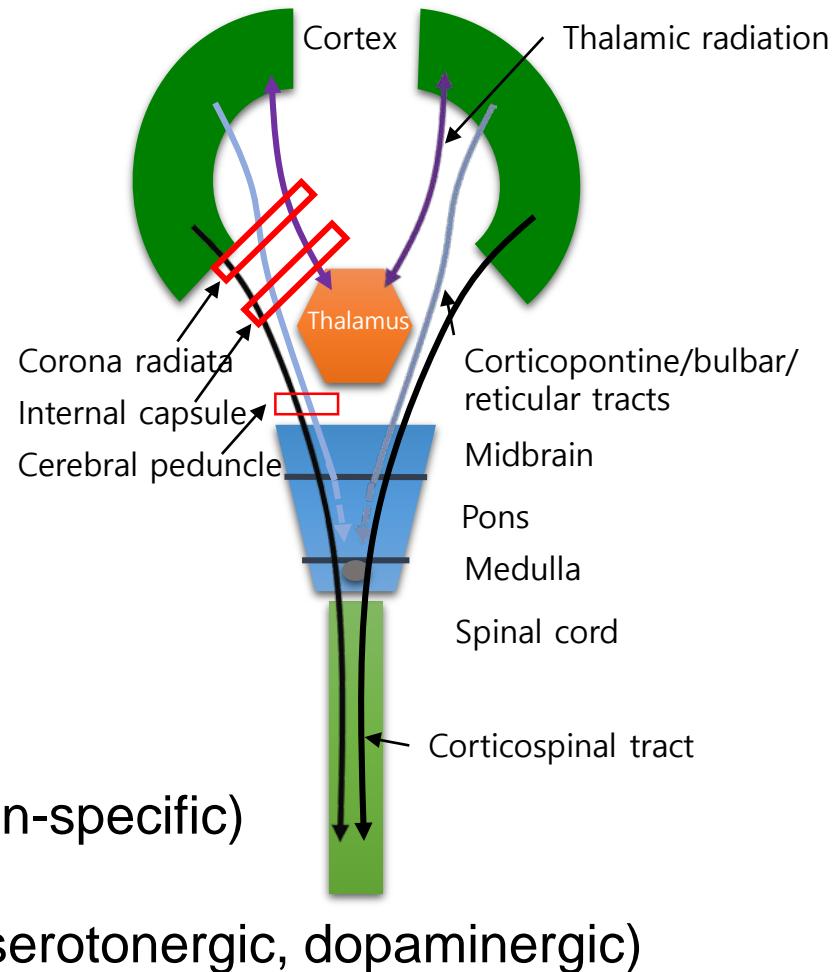


# Anterior Commissure

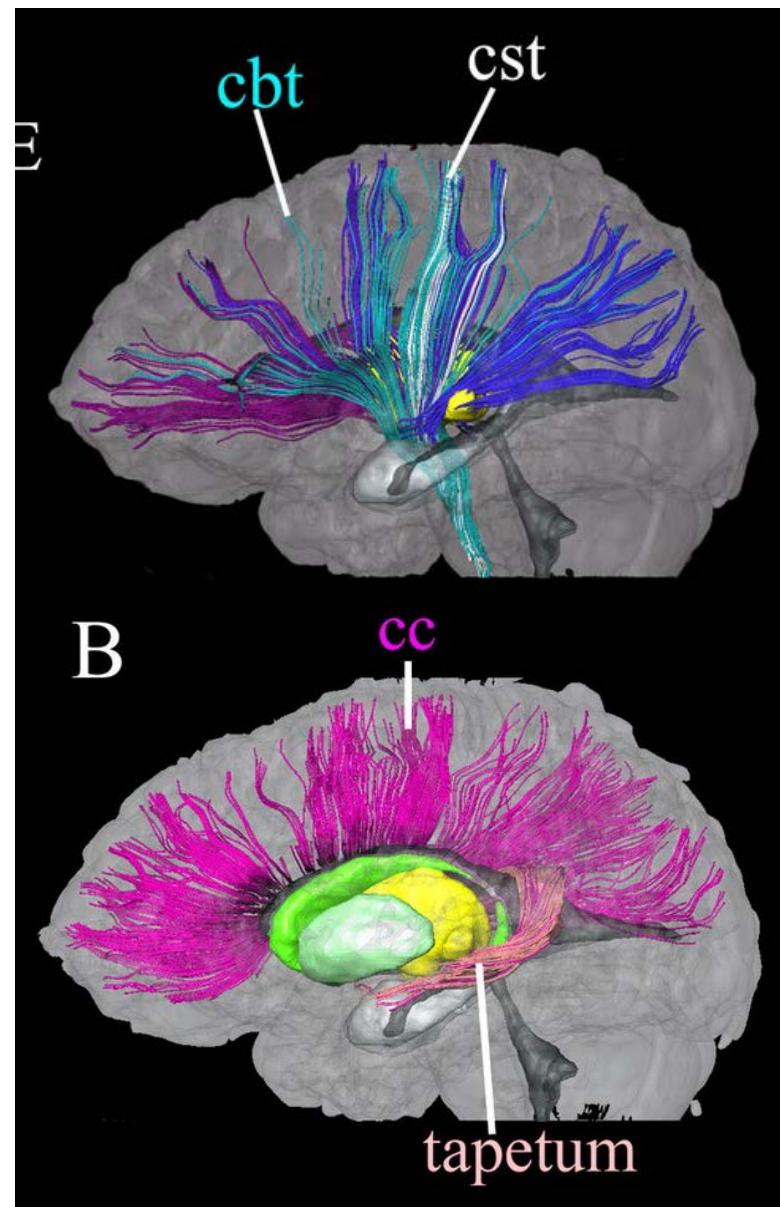


# Projection Fibers

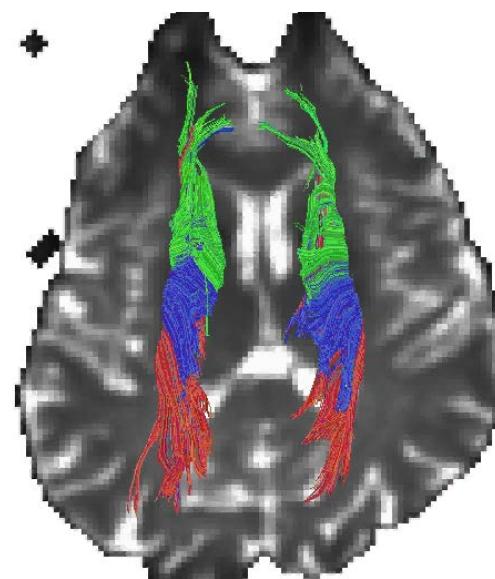
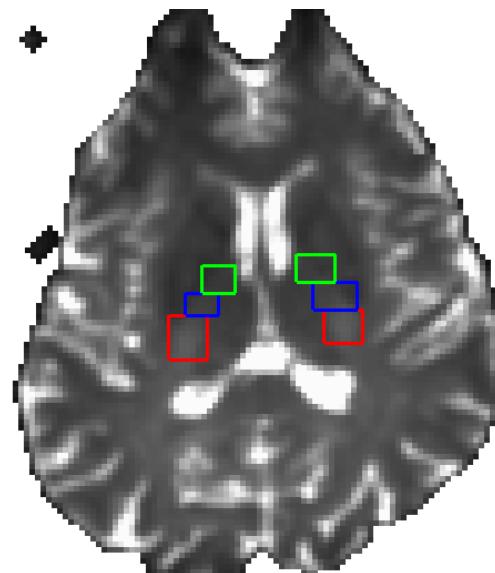
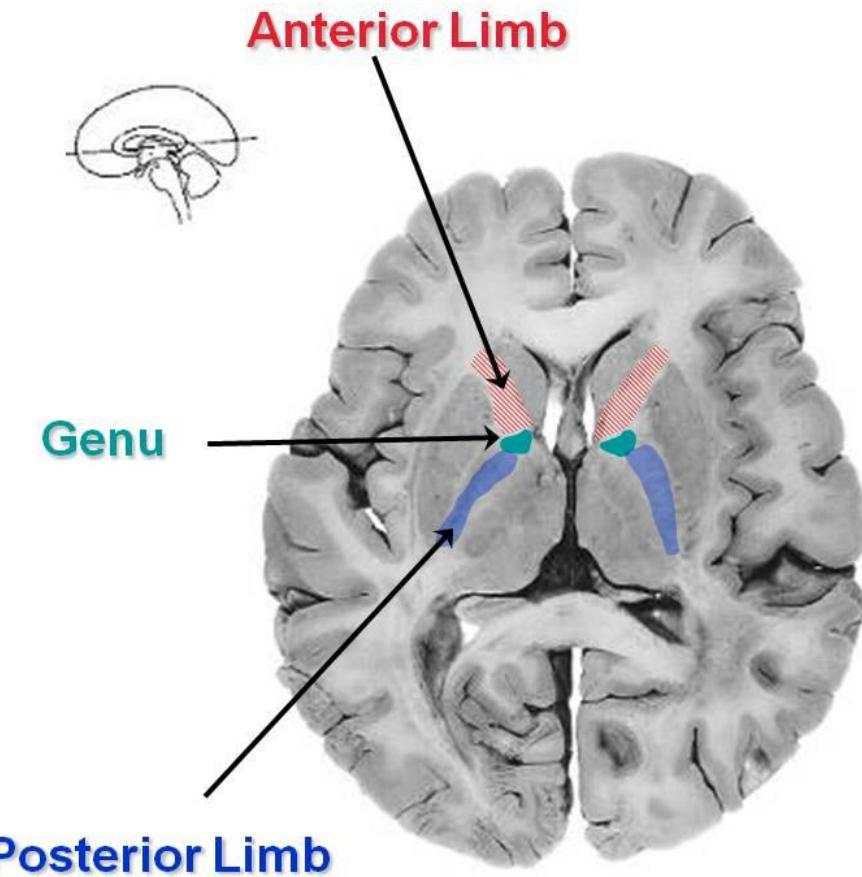
- Corticopetal fiber
  - Corticostriate fiber
  - Corticothalamic fiber
  - Corticorubral fiber
  - Corticotectal fiber
  - Corticopontocerebellar fiber
  - Corticoreticular fiber
  - Corticobulbar tract
  - Corticospinal tract
- Corticofugal fiber
  - Thalamocortical tract (specific, non-specific)
  - Extra-thalamic subcortical fiber  
(cholinergic, norepinephrinergic, serotonergic, dopaminergic)



# Corona Radiata

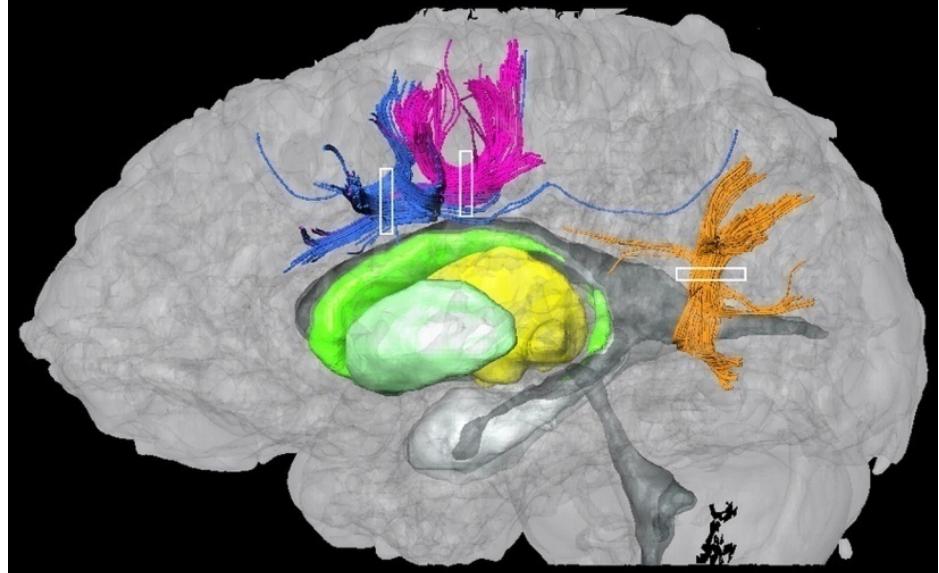
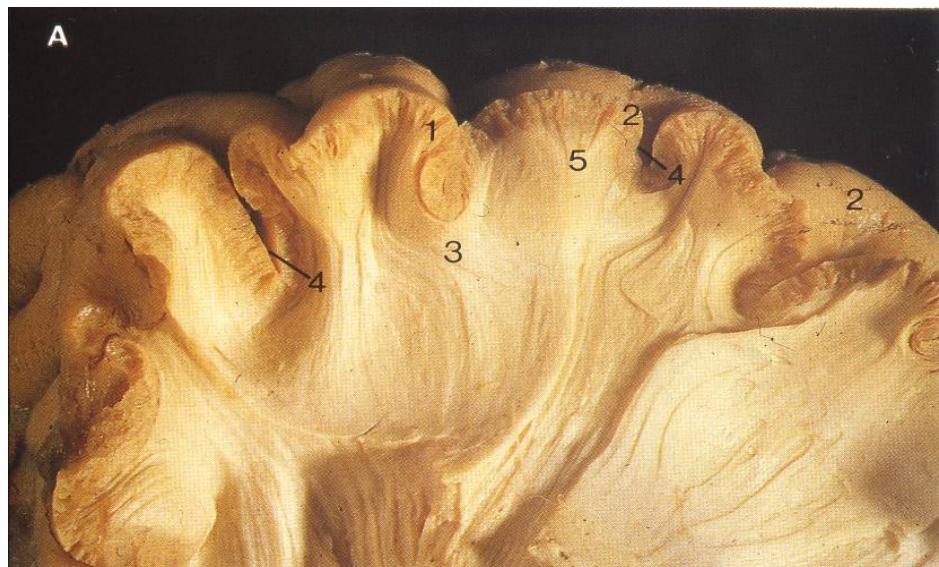


# Internal Capsule



# Association Fibers

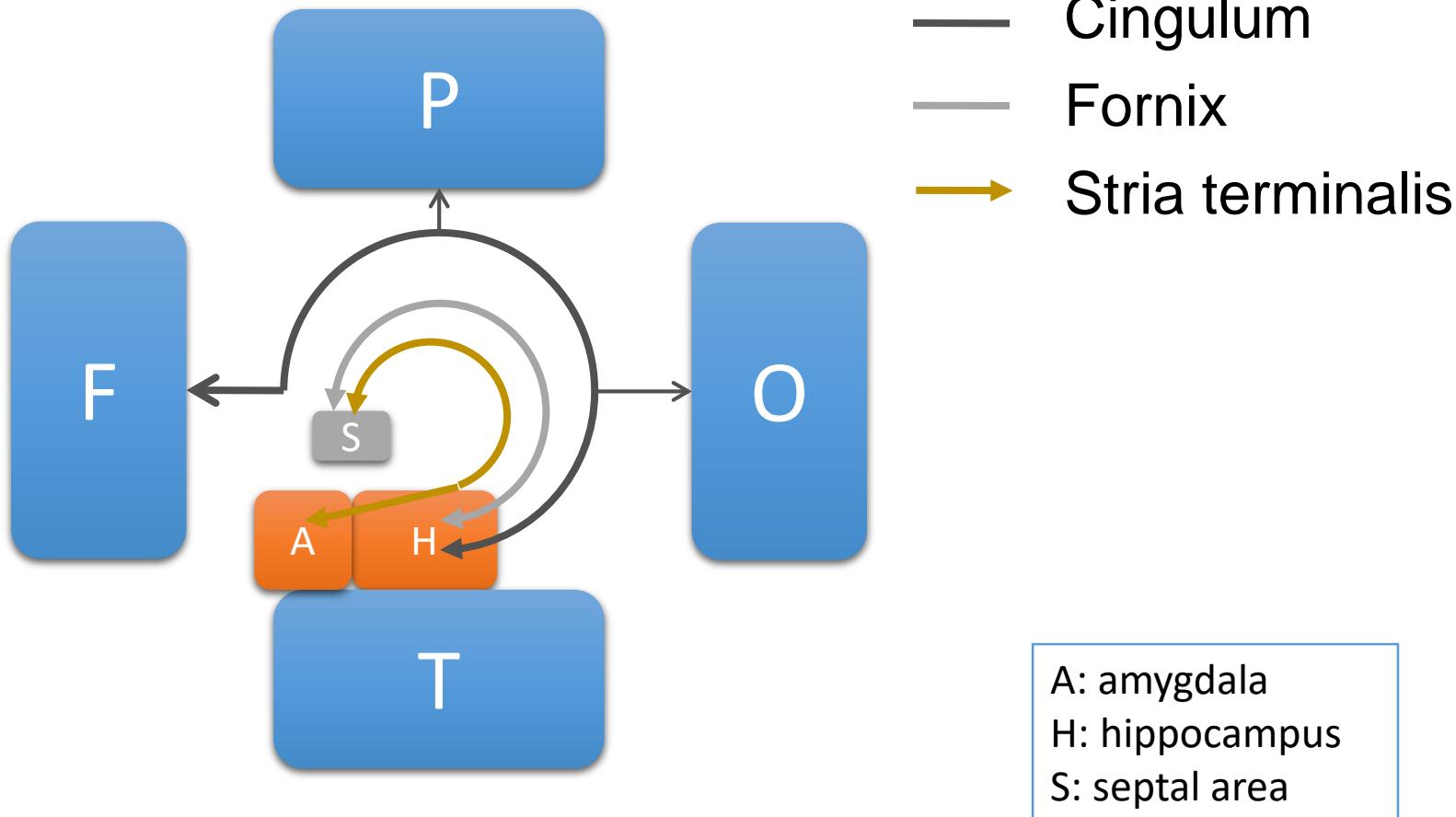
- Short association fibers  
: U-fiber, arcuate fiber
- Long association fibers

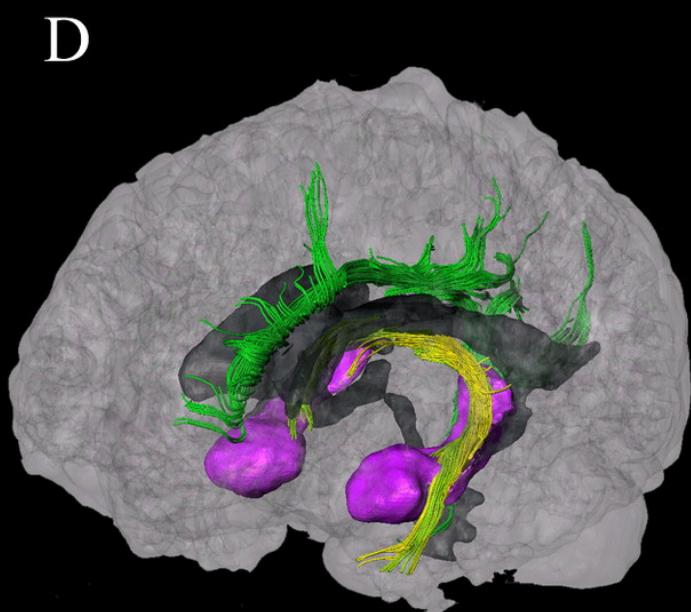
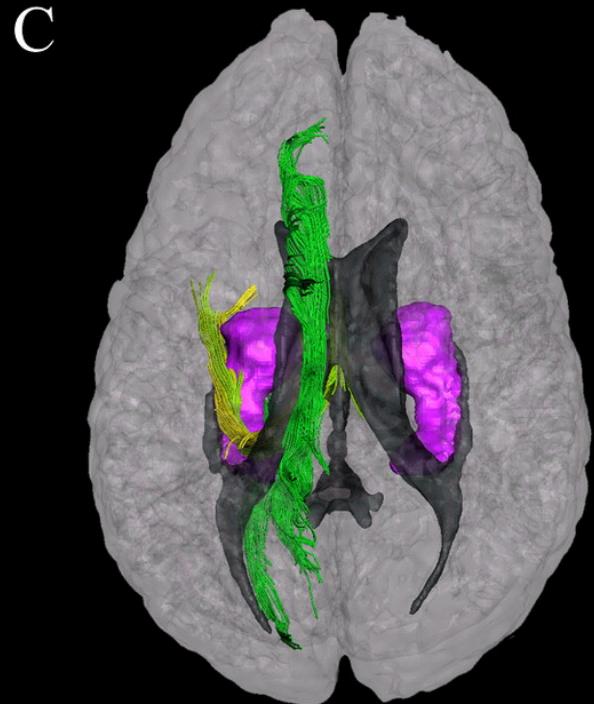
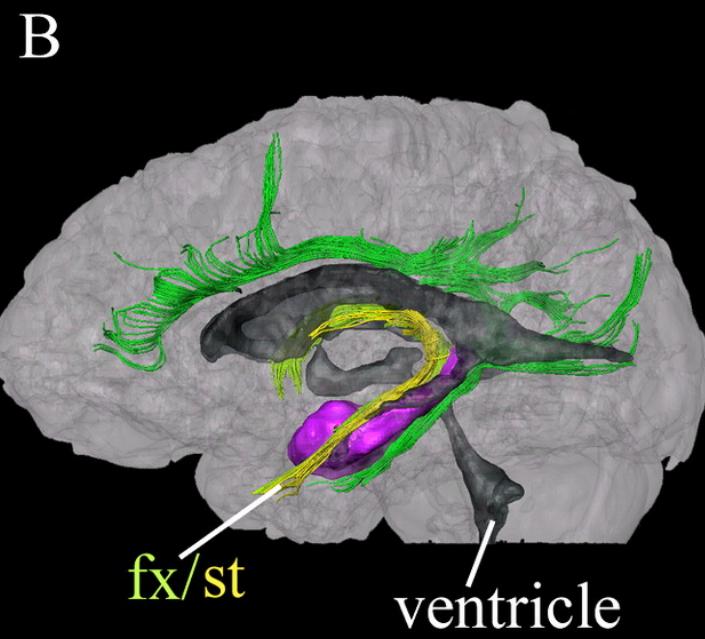
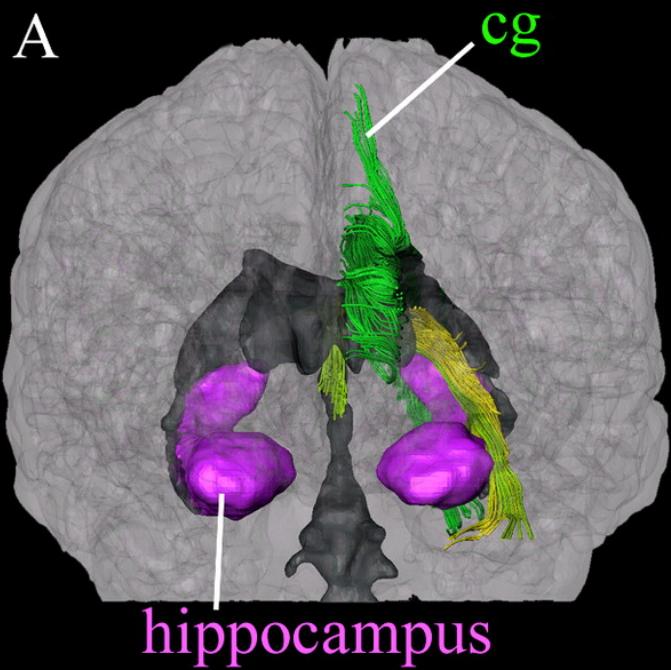


# Association Fibers

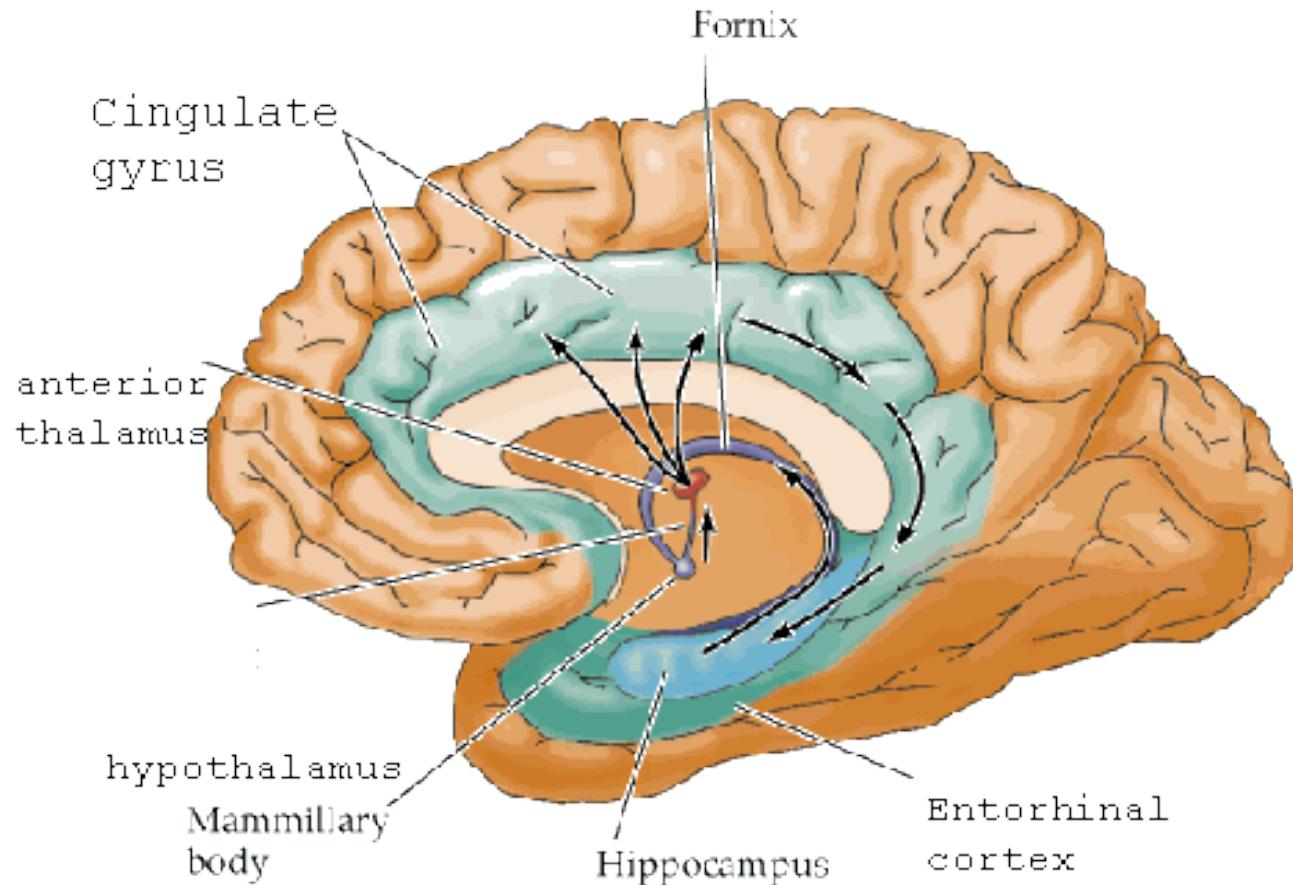
- Long association fibers
  - Superior longitudianal fasciculus (SLF)
  - Middle longitudianal fasciculus (MLF): ?
  - Inferior longitudianal fasciculus (ILF)
  - Superior occipitofrontal fasciculus (SOF)
  - Inferior occipitofrontal fasciculus (IOF)
  - Uncinate fasciculus (UF)
- Cingulum (CG)
- Fornix
- Stria terminalis

# Limbic Tracts

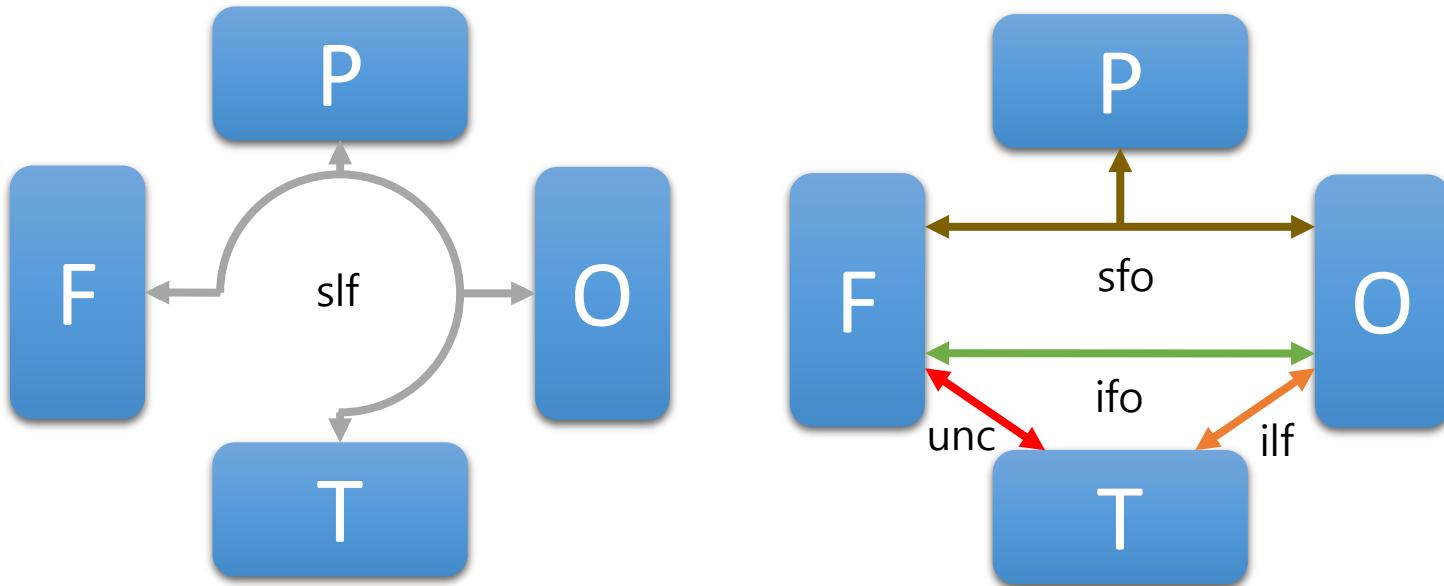




# Papez Circuit

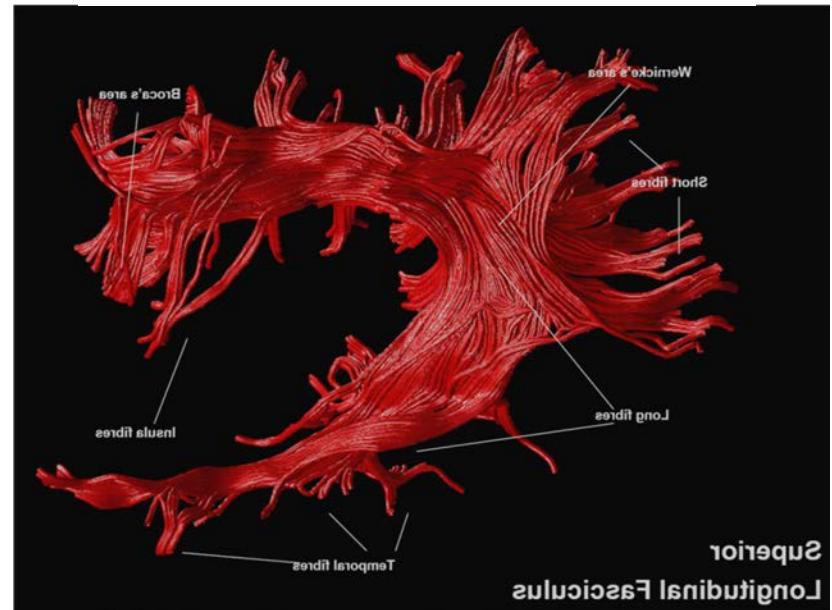
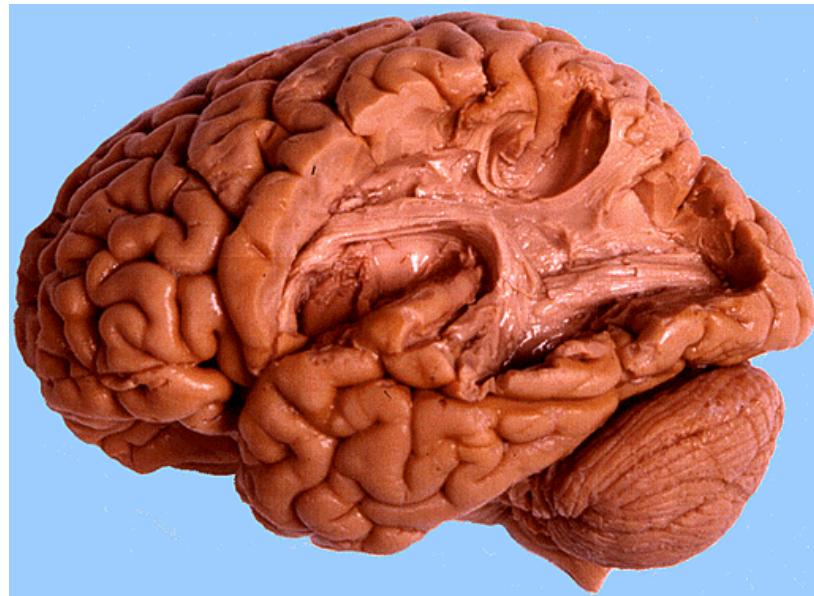
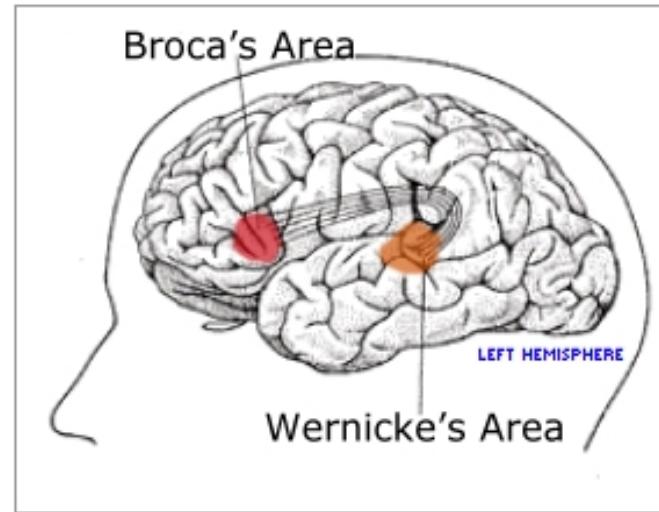


# Long Association Fibers

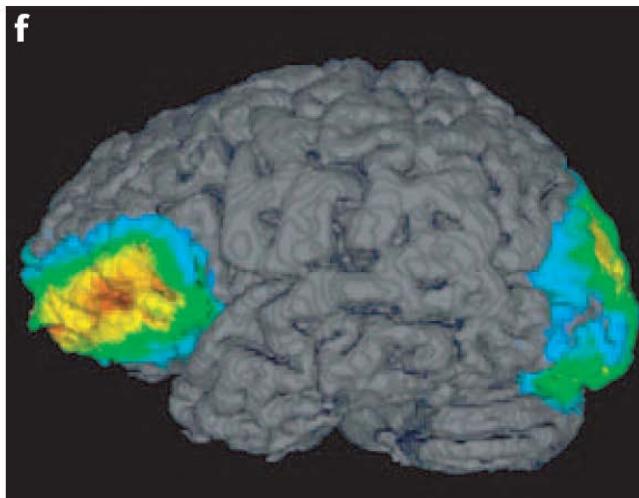
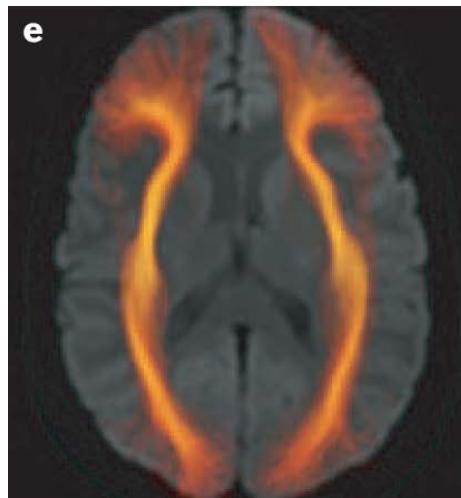
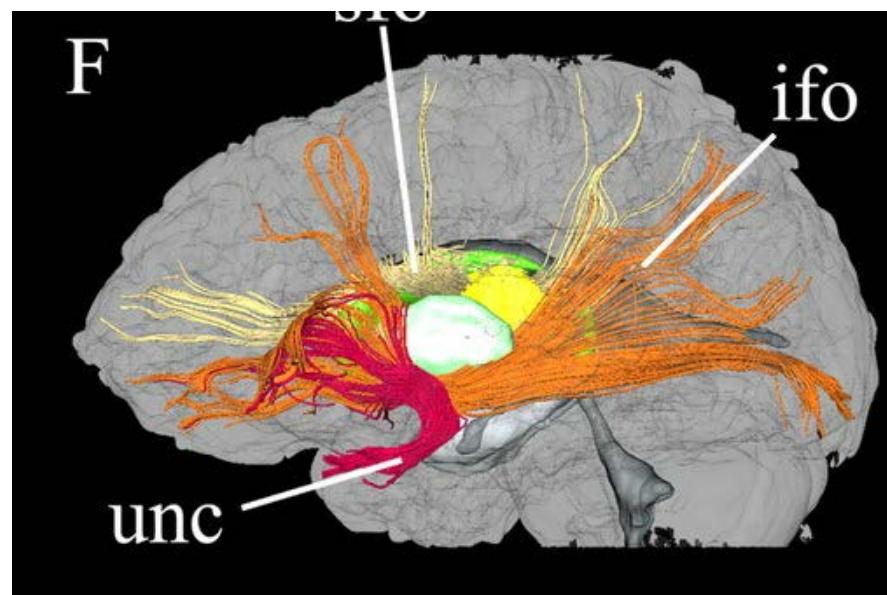


# Superior Longitudinal Fasciculus (SLF)

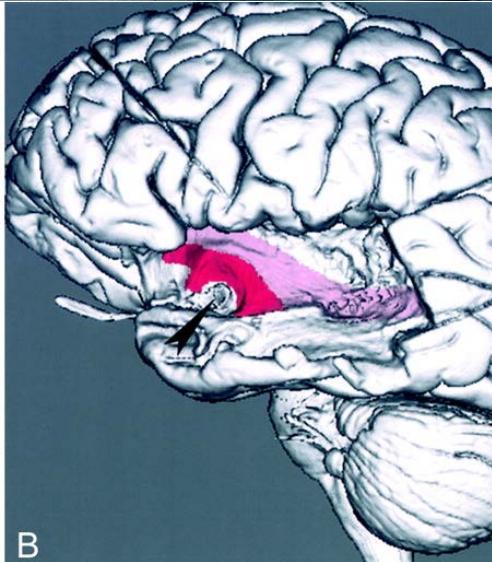
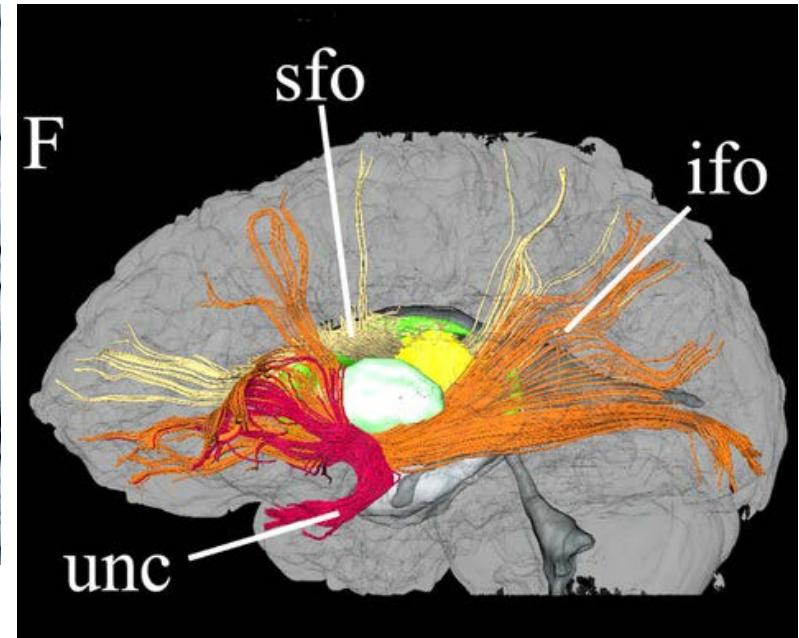
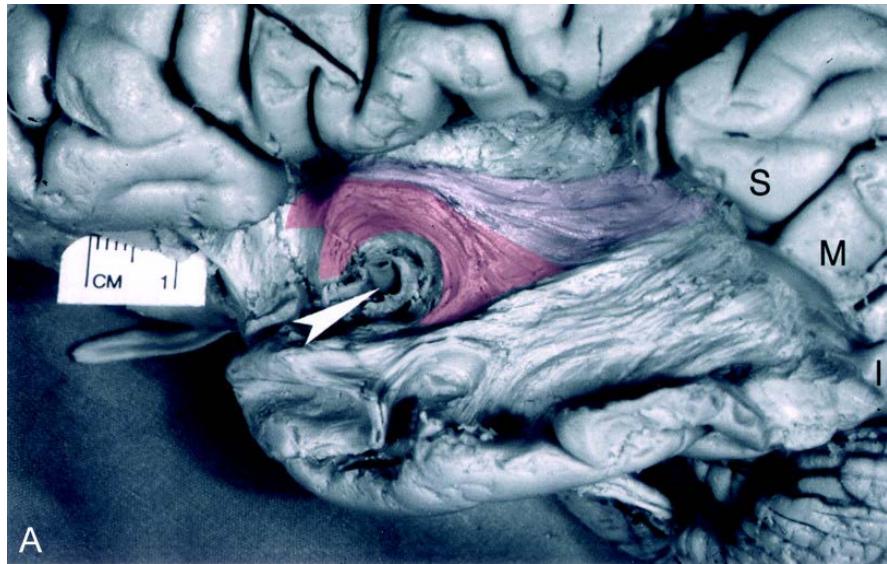
- Subdivisions
  - SLFI
  - SLFII
  - SLFIII
  - Arcuate fiber



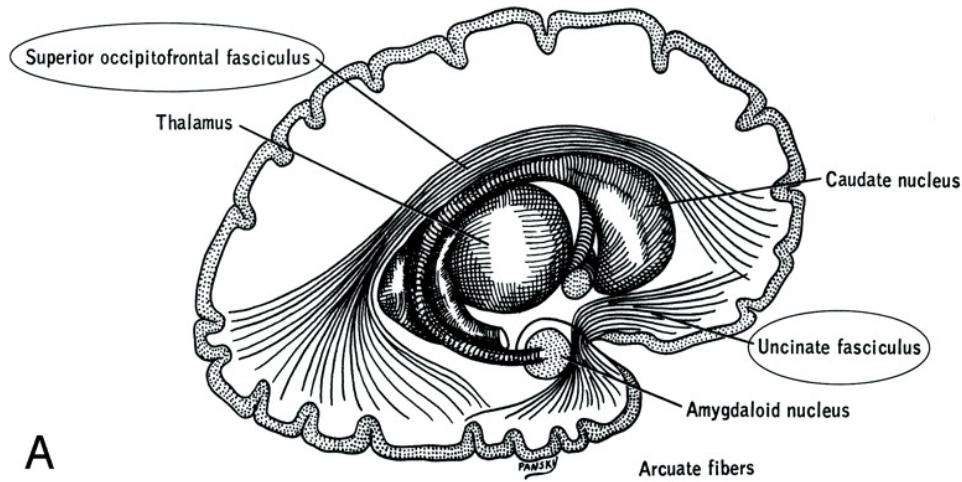
# Inferior Occipitofrontal Fasciculus (IOF)



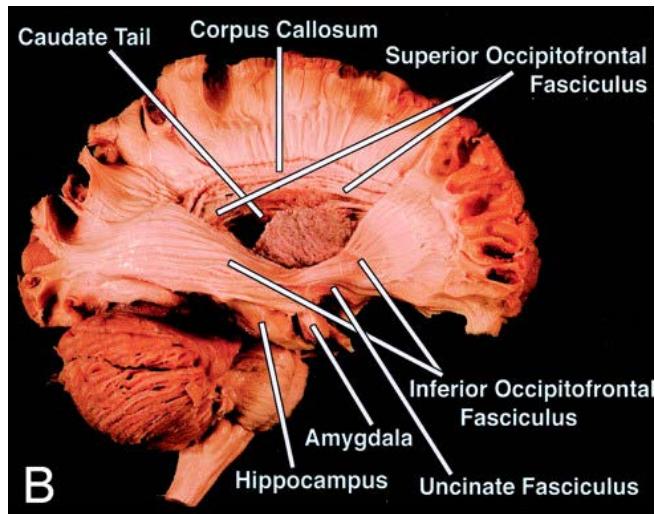
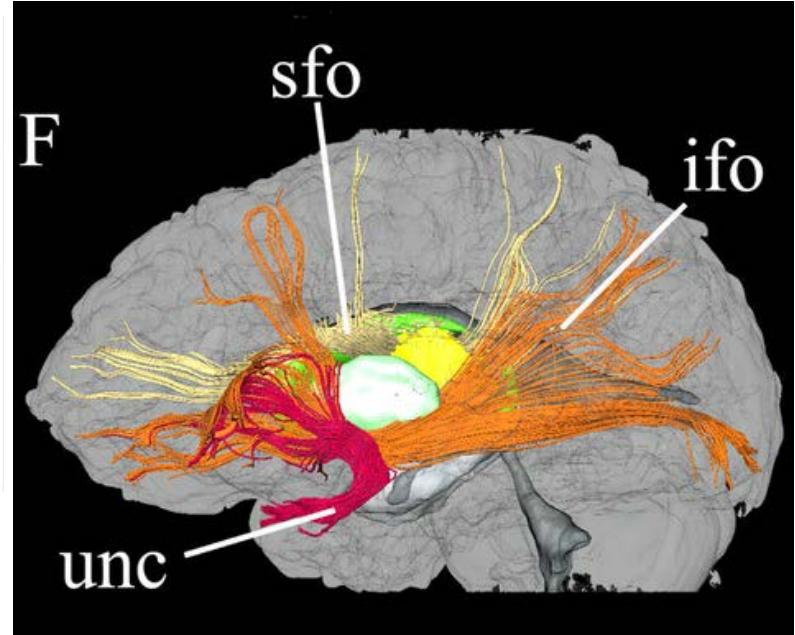
# Uncinate Fasciculus (UF)



# Superior Occipitofrontal Fasciculus (SOF)

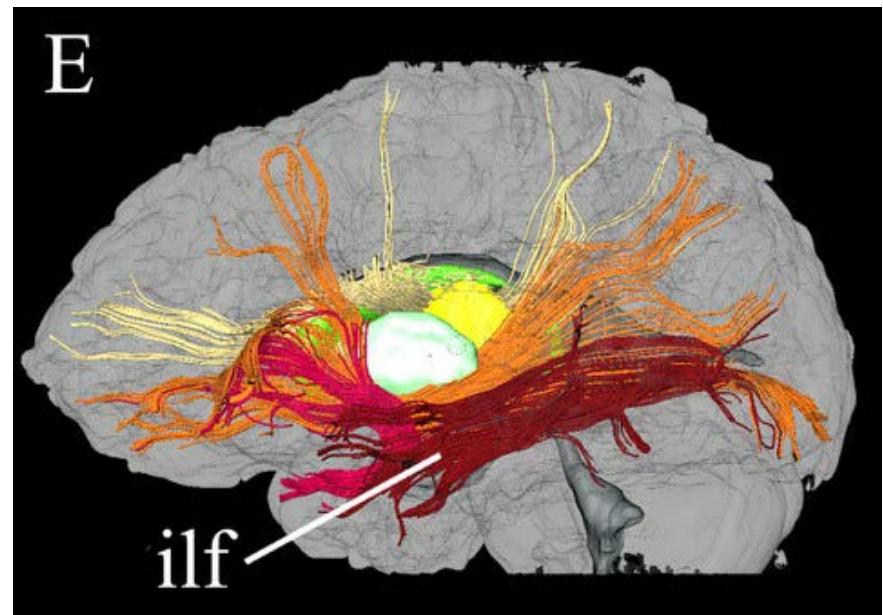
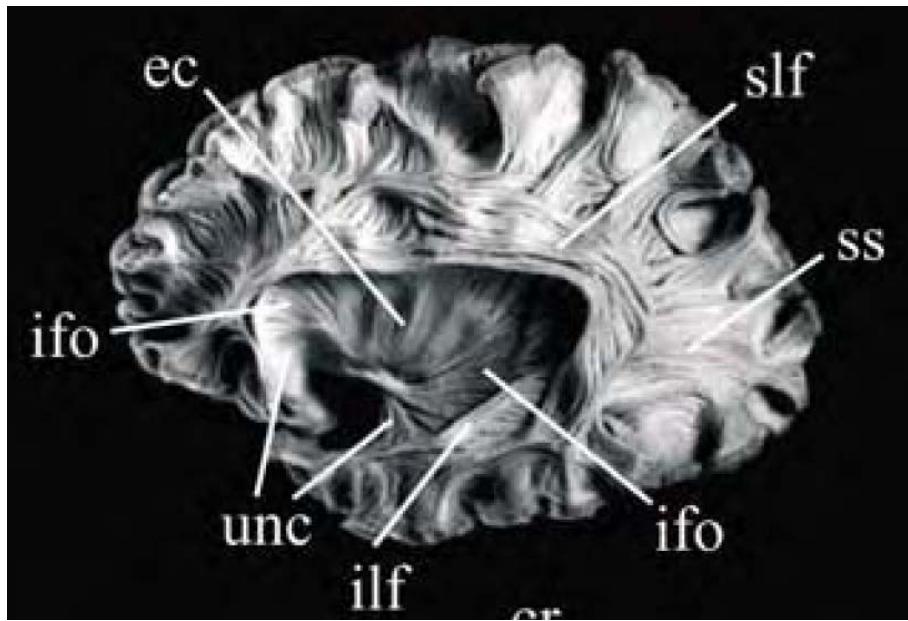


A

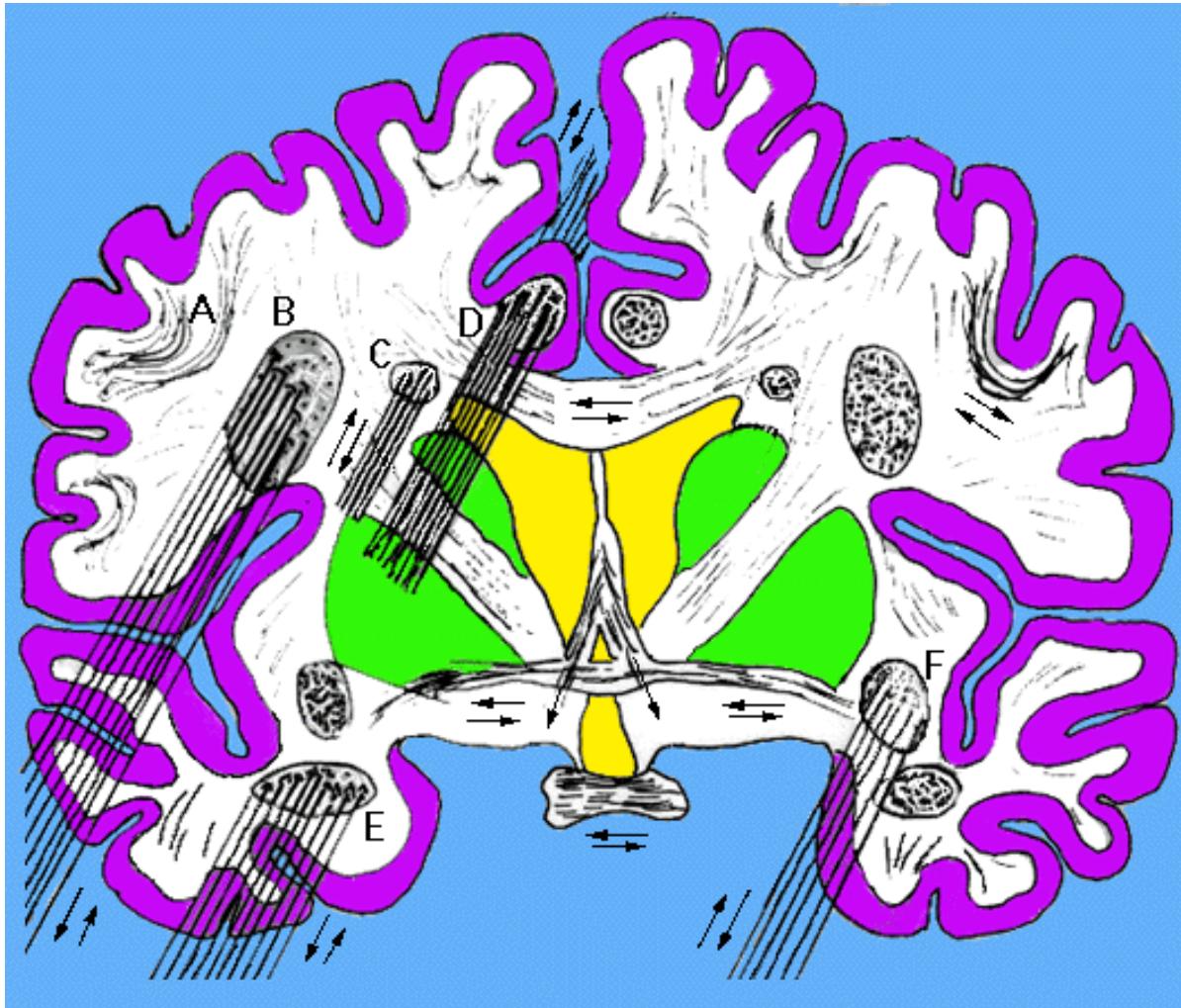


B

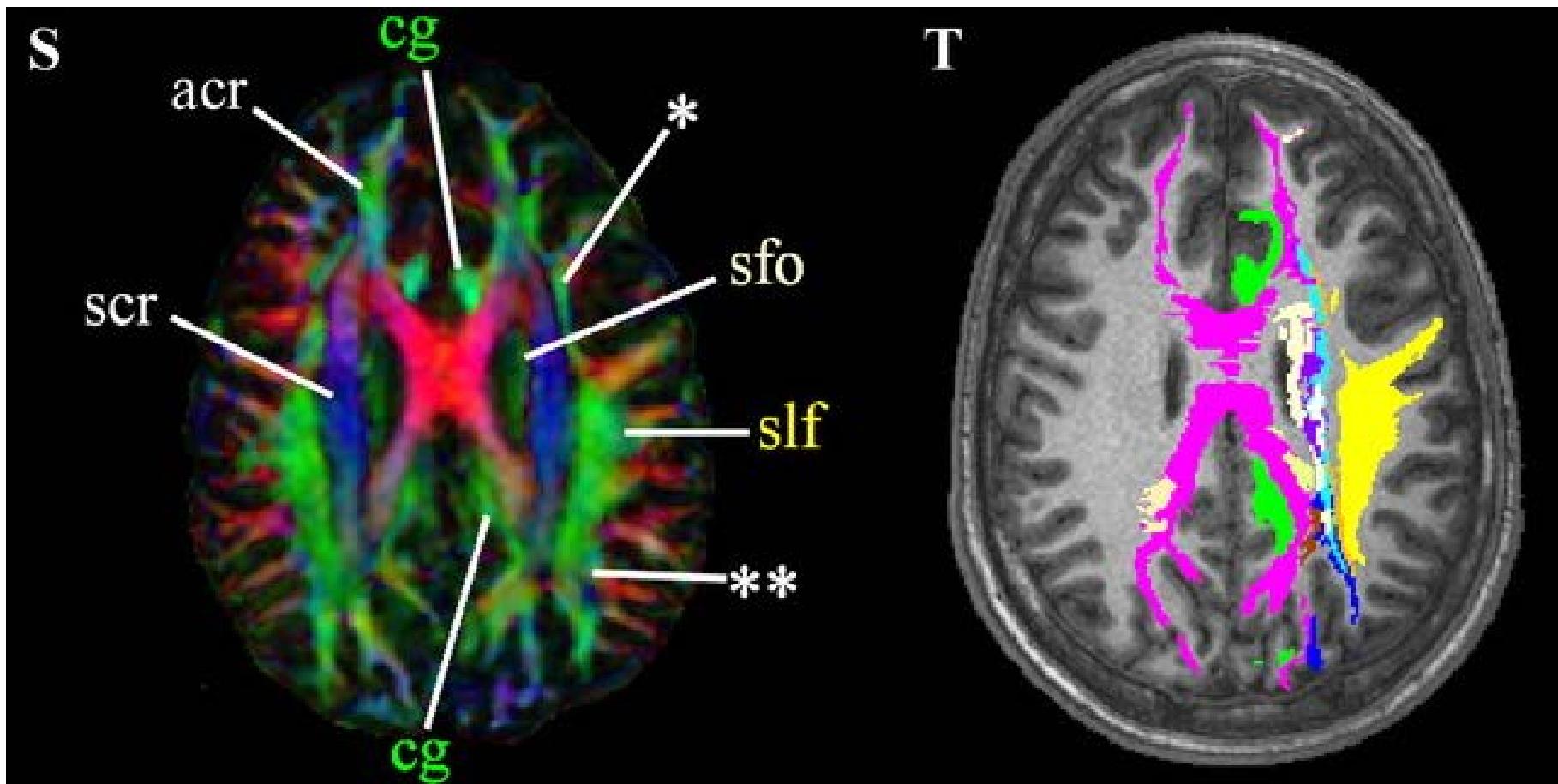
# Inferior Longitudinal Fasciculus (ILF)



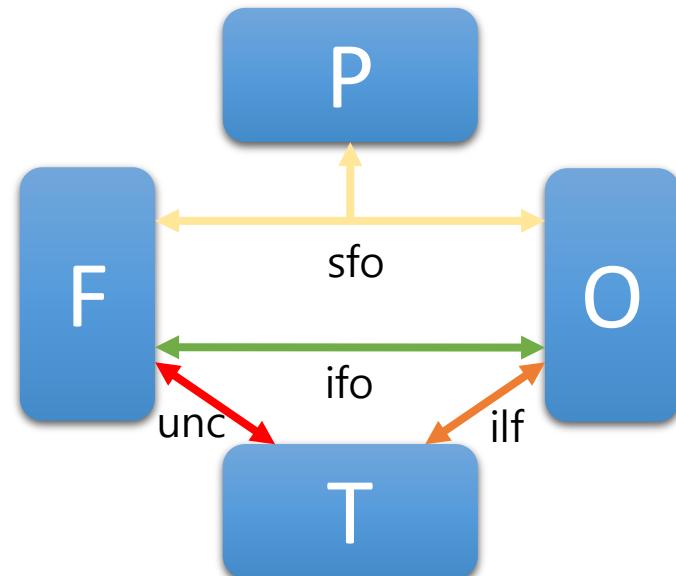
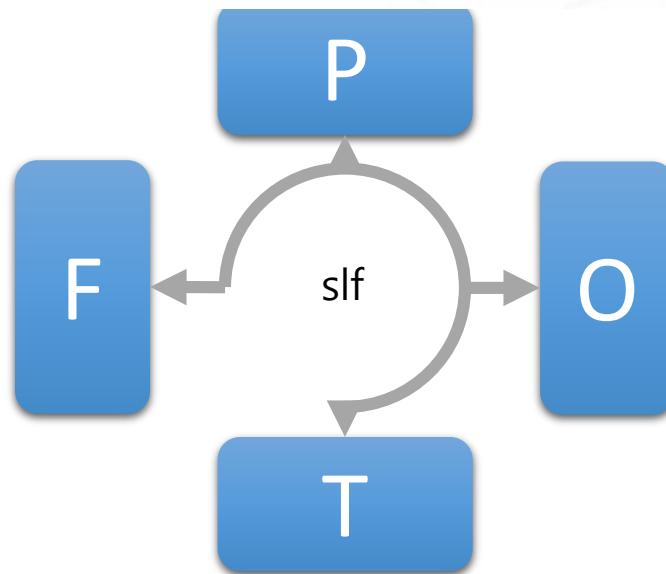
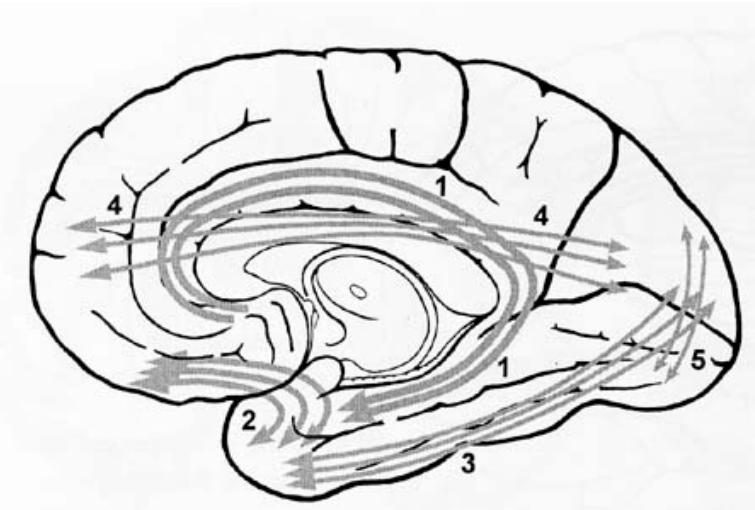
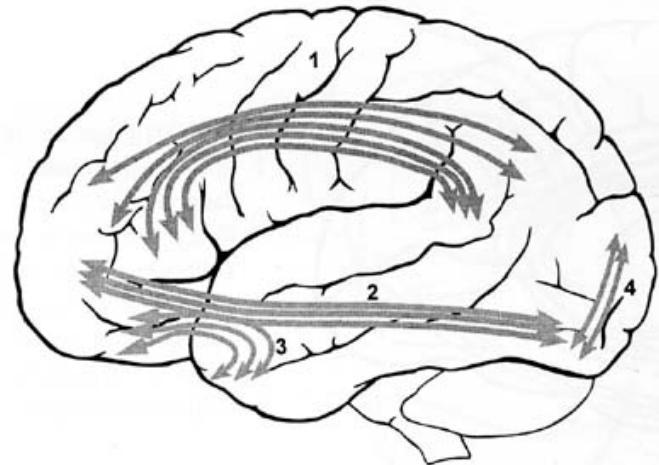
# Relative Location of Long Association Fibers



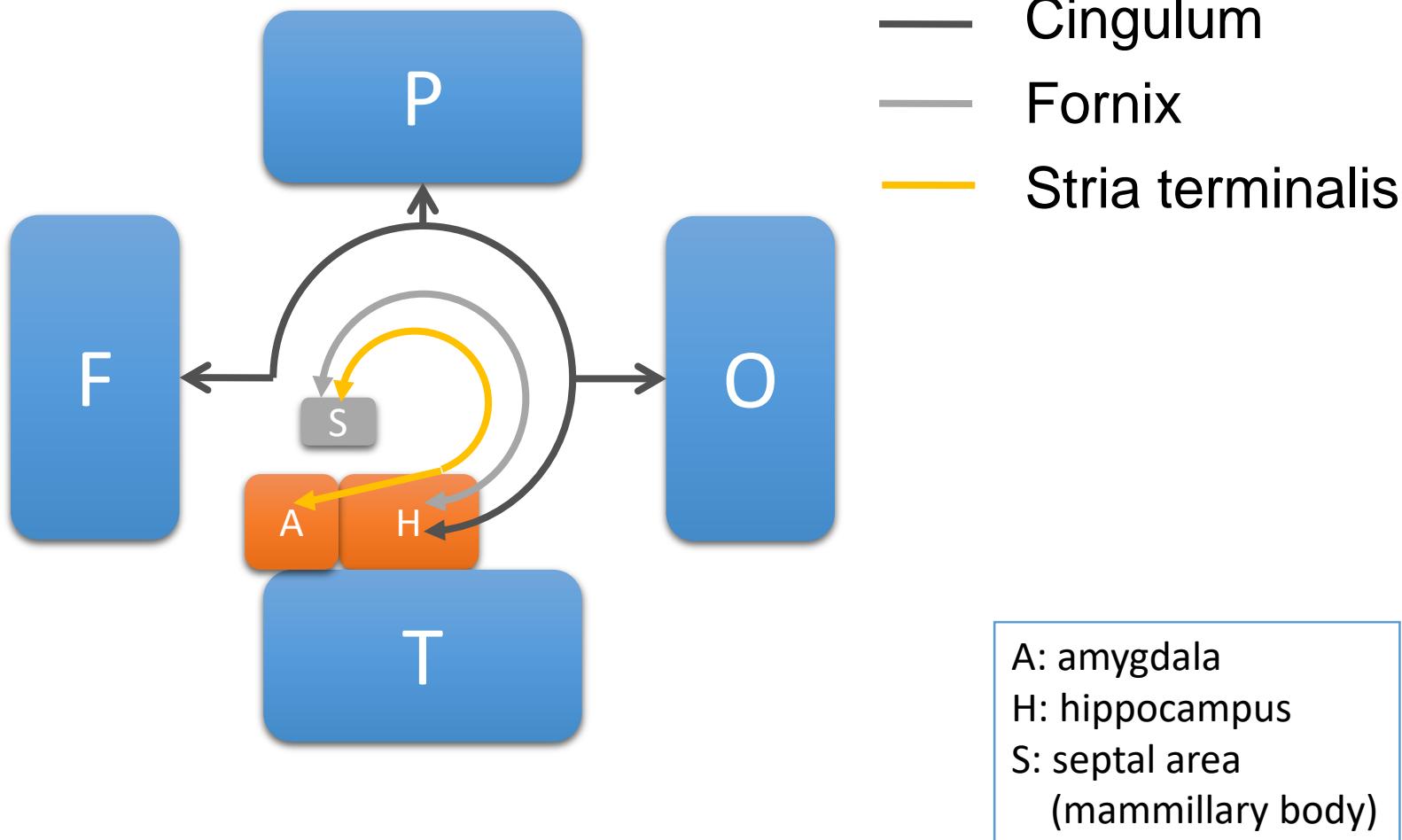
- A: U fiber
- B: SLF
- C: SOF
- D: Cingulum
- E: ILF
- F: IOF



# Summary : Long association fibers



# Summary : Limbic tracts

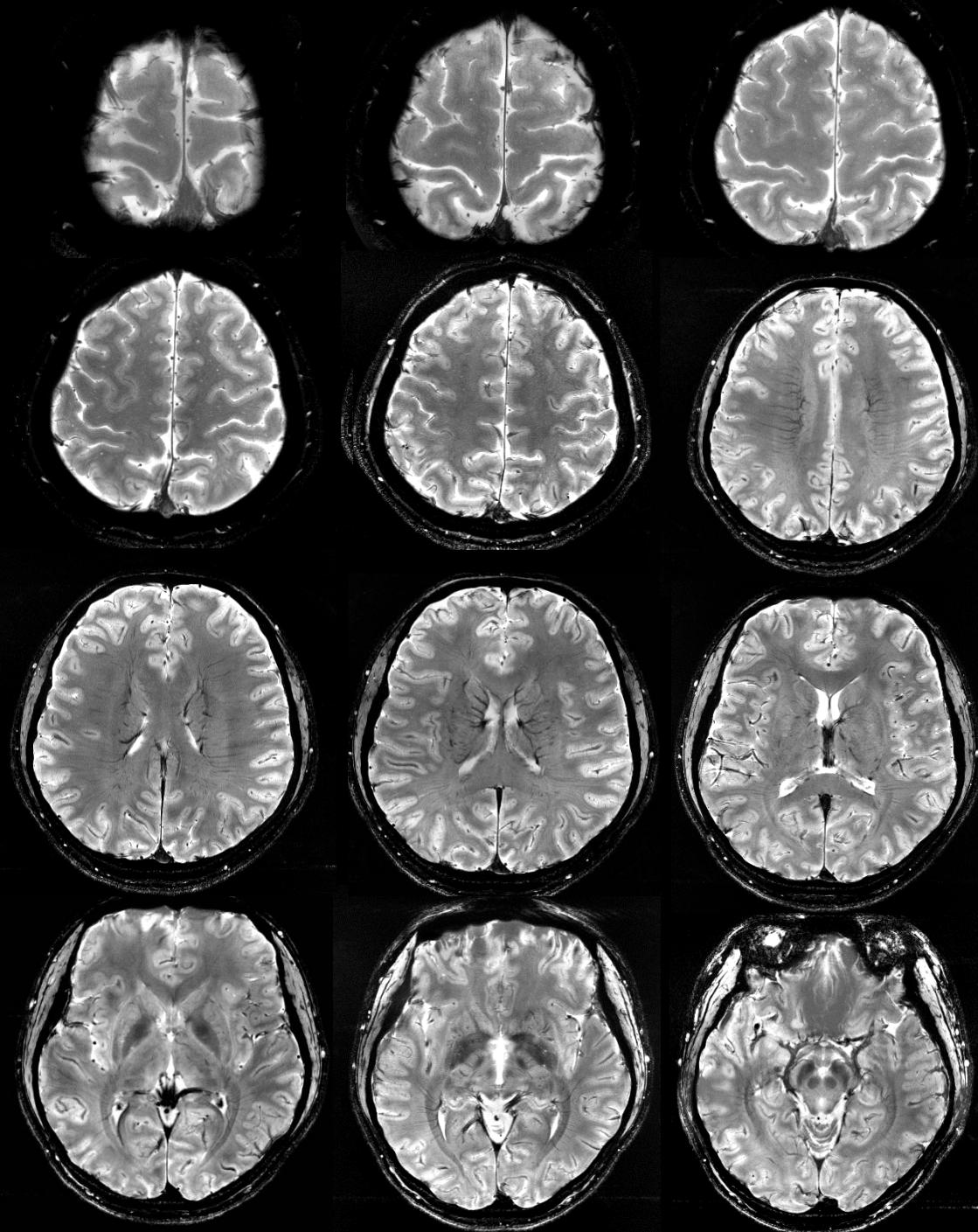


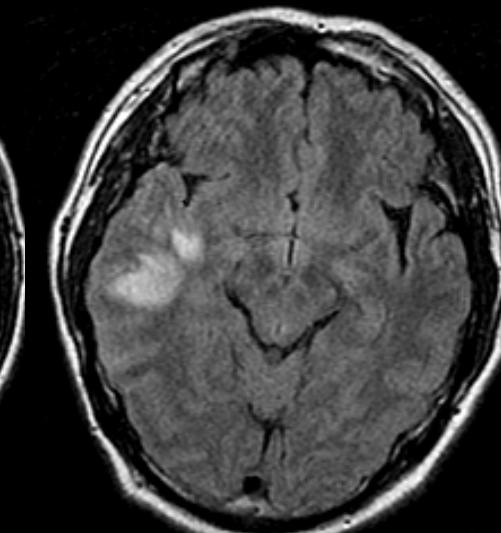
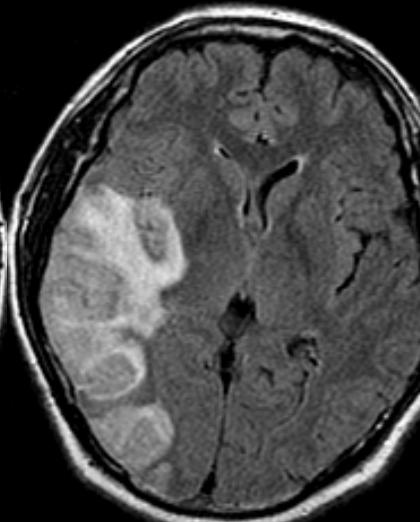
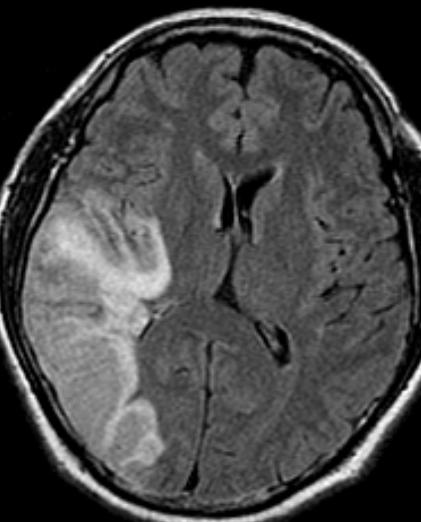
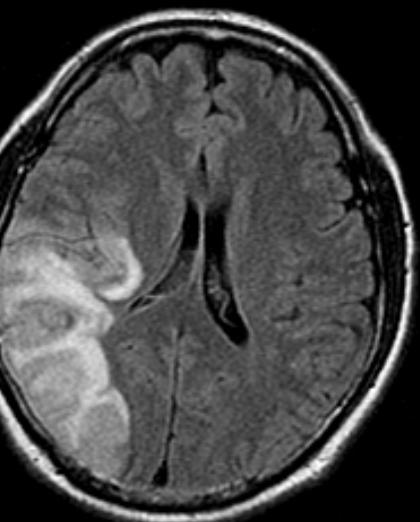
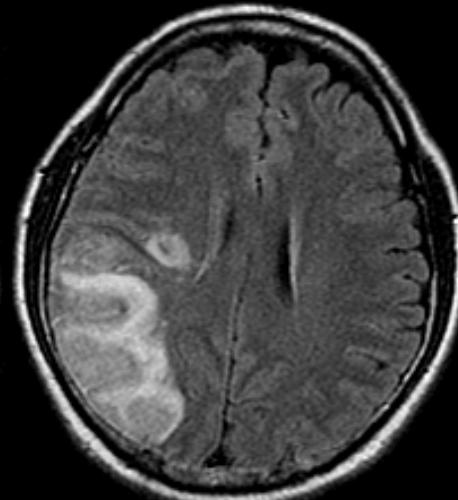
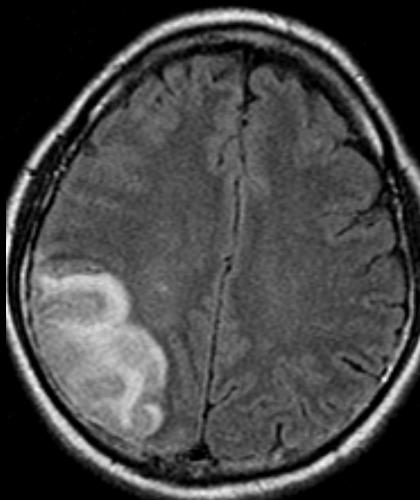
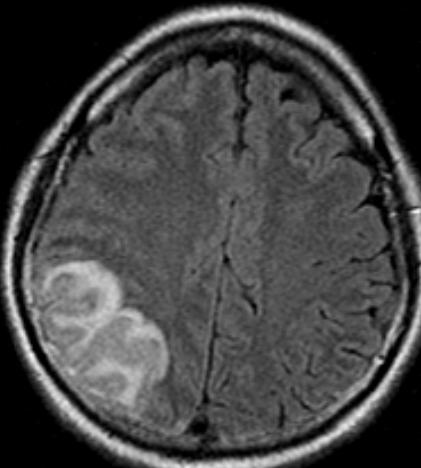
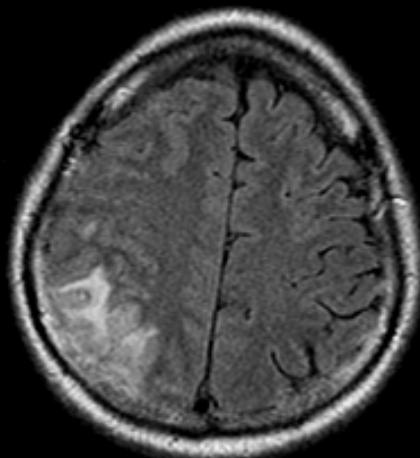
# **MRI Neuroanatomy**

**Structures in Axial images  
based on landmarks**

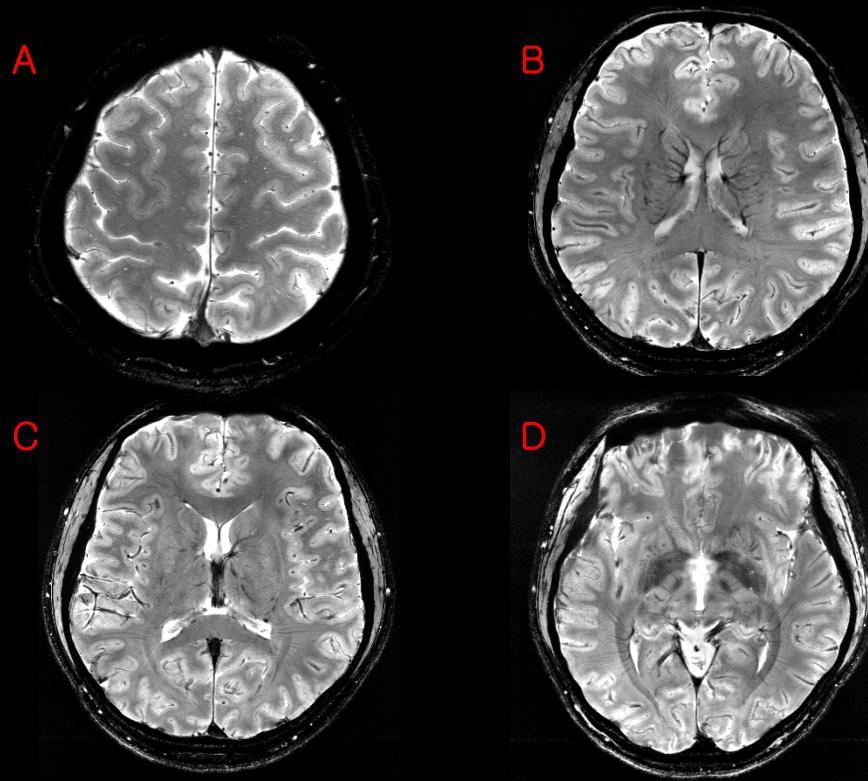
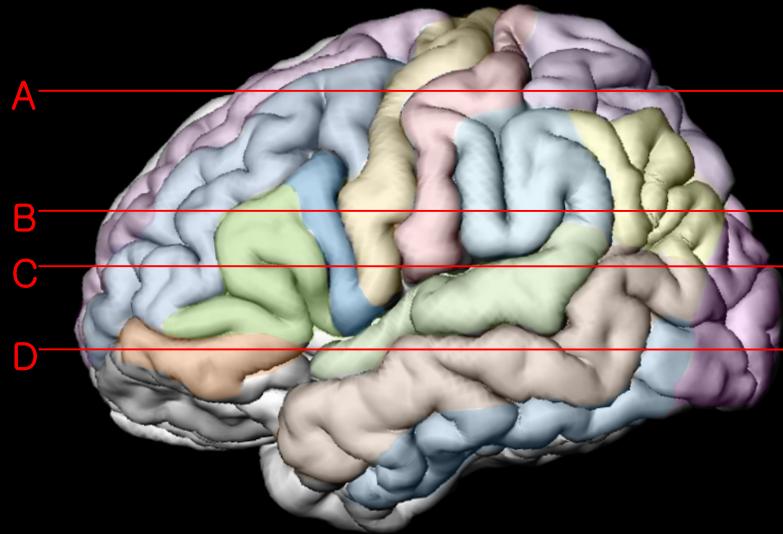


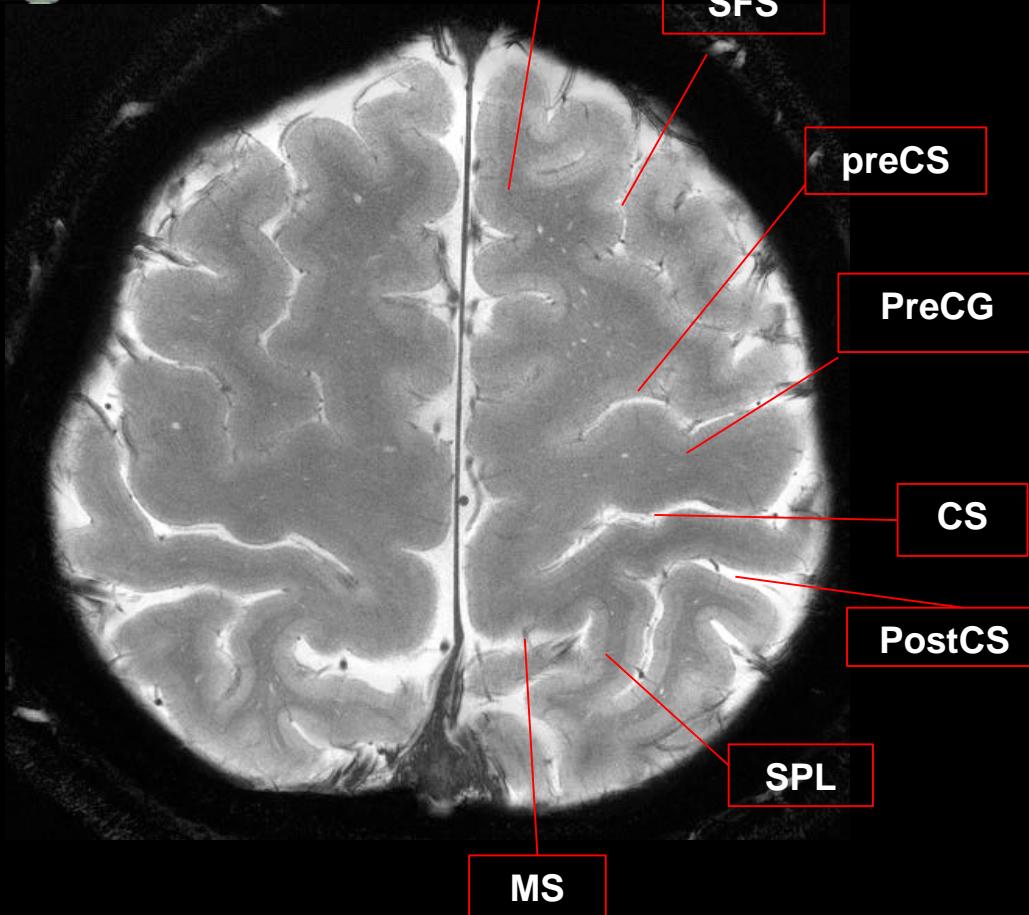
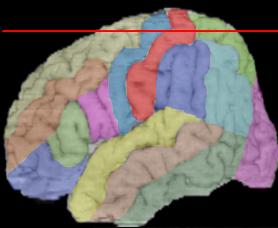
AC-PC Line





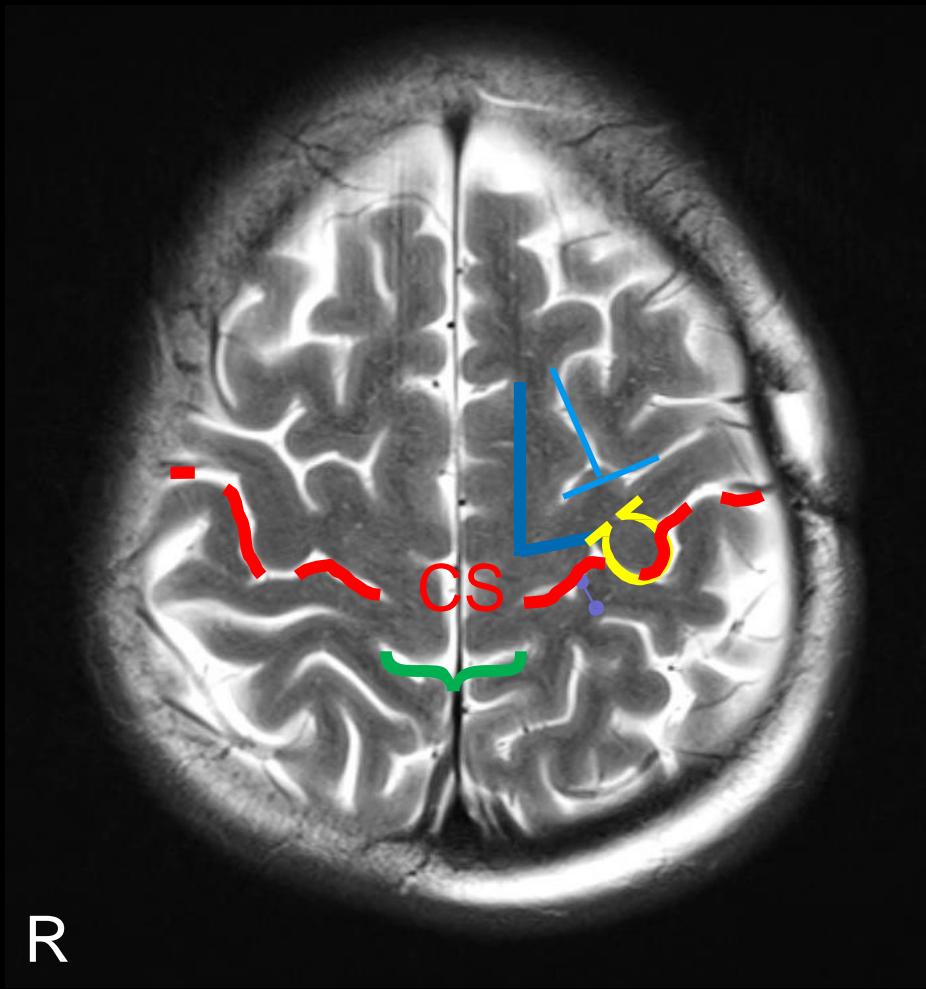




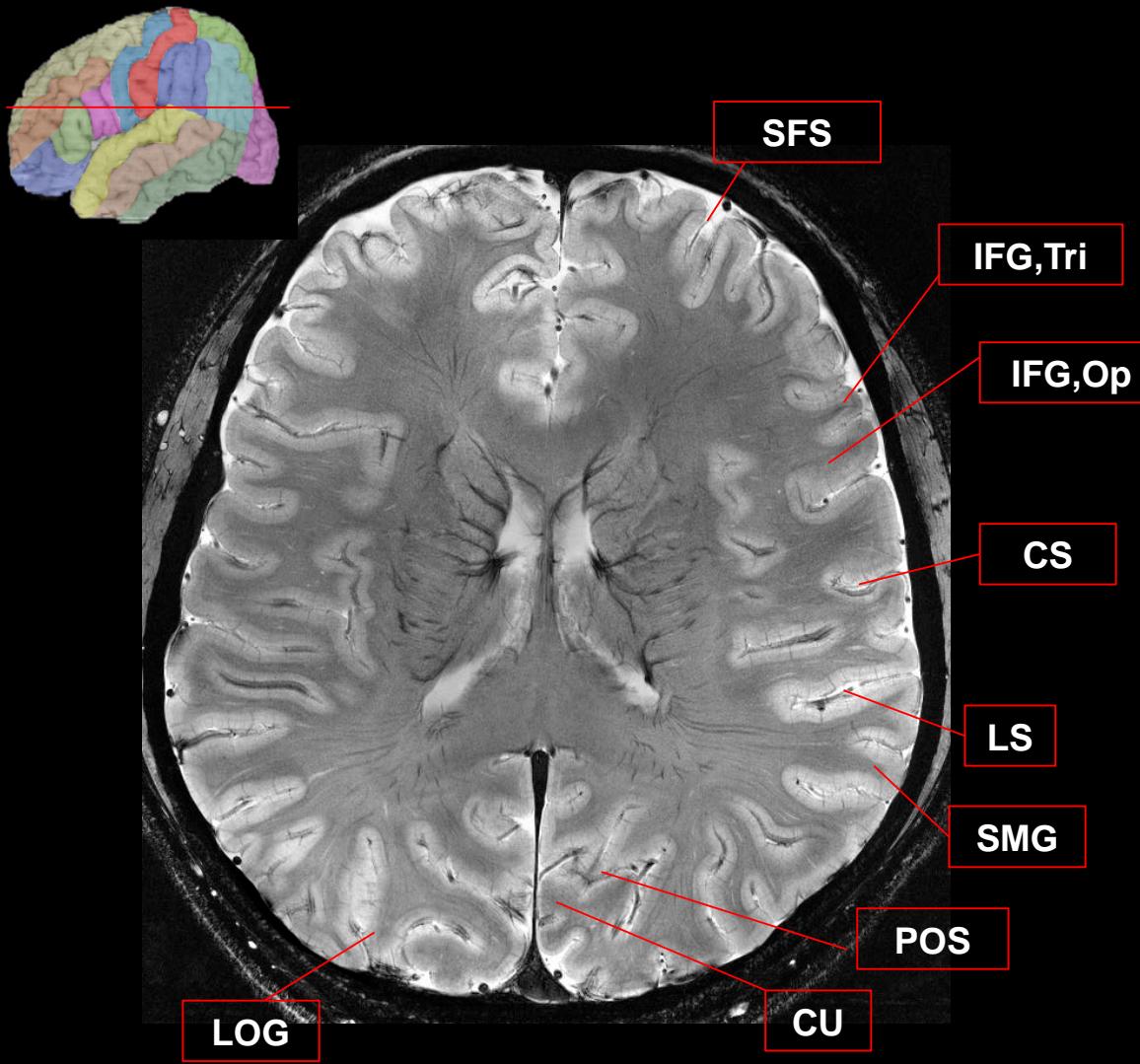


1. Central sulcus ?
2. Frontal lobe / Superior parietal lobule
3. Occipital lobe은 보이지 않는다.
4. Midline 구조물: Marginal sulcus/ precuneus

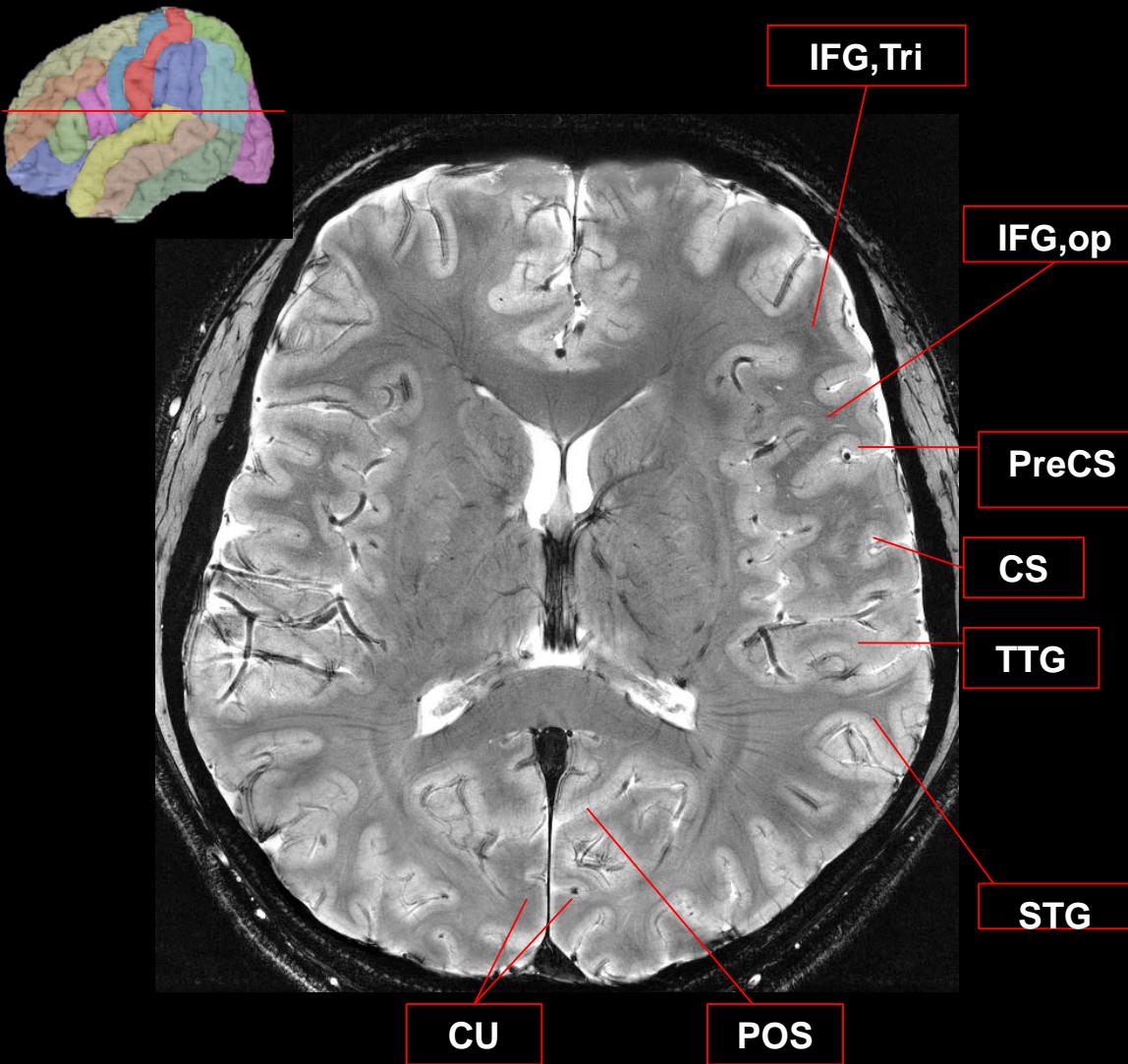
## Central region



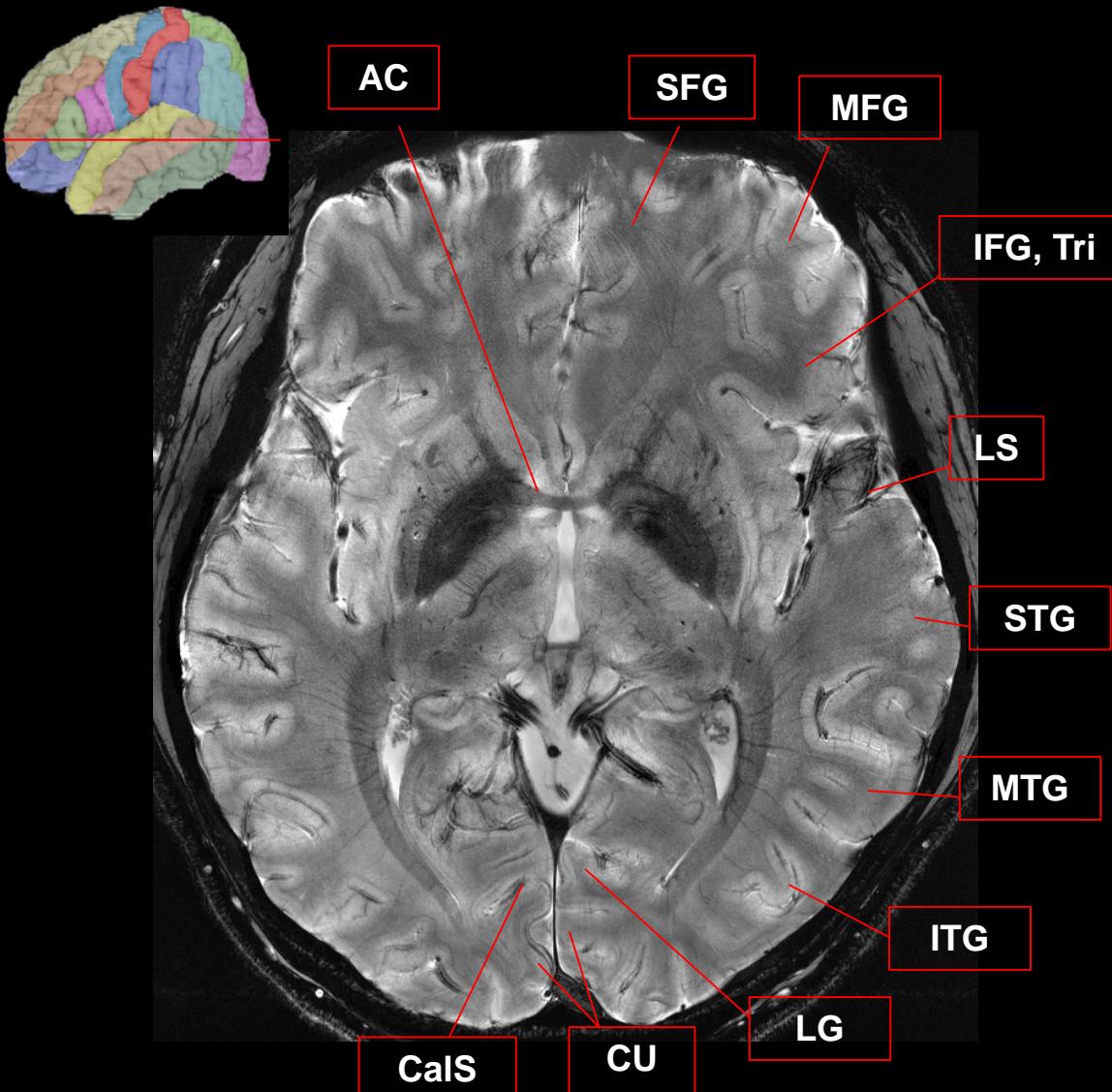
- bracket sign 
- „L“ or „T“ sign 
- omega or handknob sign 



1. 여덟 팔 (八)의 끝자락은 angular gyrus, 그 앞에는 superior temporal and supramarginal gyrus의 junction.
2. Inferior frontal gyrus의 triangular part도 나오기 시작
3. P-O sulcus가 뚜렷하게 보이고 그 뒤는 cuneus, 앞쪽의 sulcus는 subparietal sulcus.



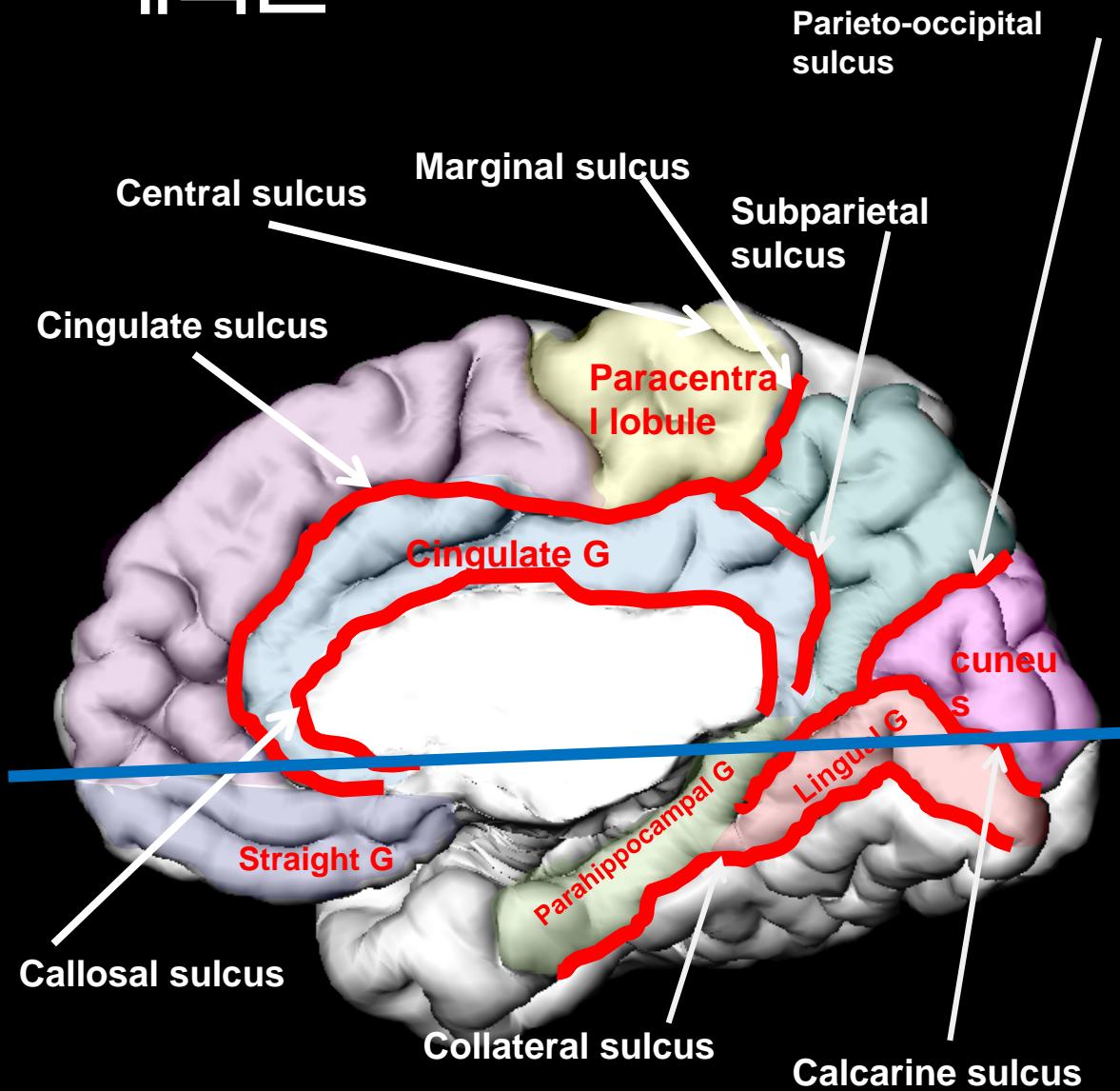
1. 두 군데의 언어영역 (Broca's and Wernicke's area).
  - 먼저 central sulcus를 찾는다.
  - CS앞에는 preCG. 그 앞에 Broca's area
  - Wernicke's area는 Lateral sulcus 바로 뒤쪽.
2. Heschl's gyrus, planum temporale
3. P-O sulcus뒤에는 cuneus.

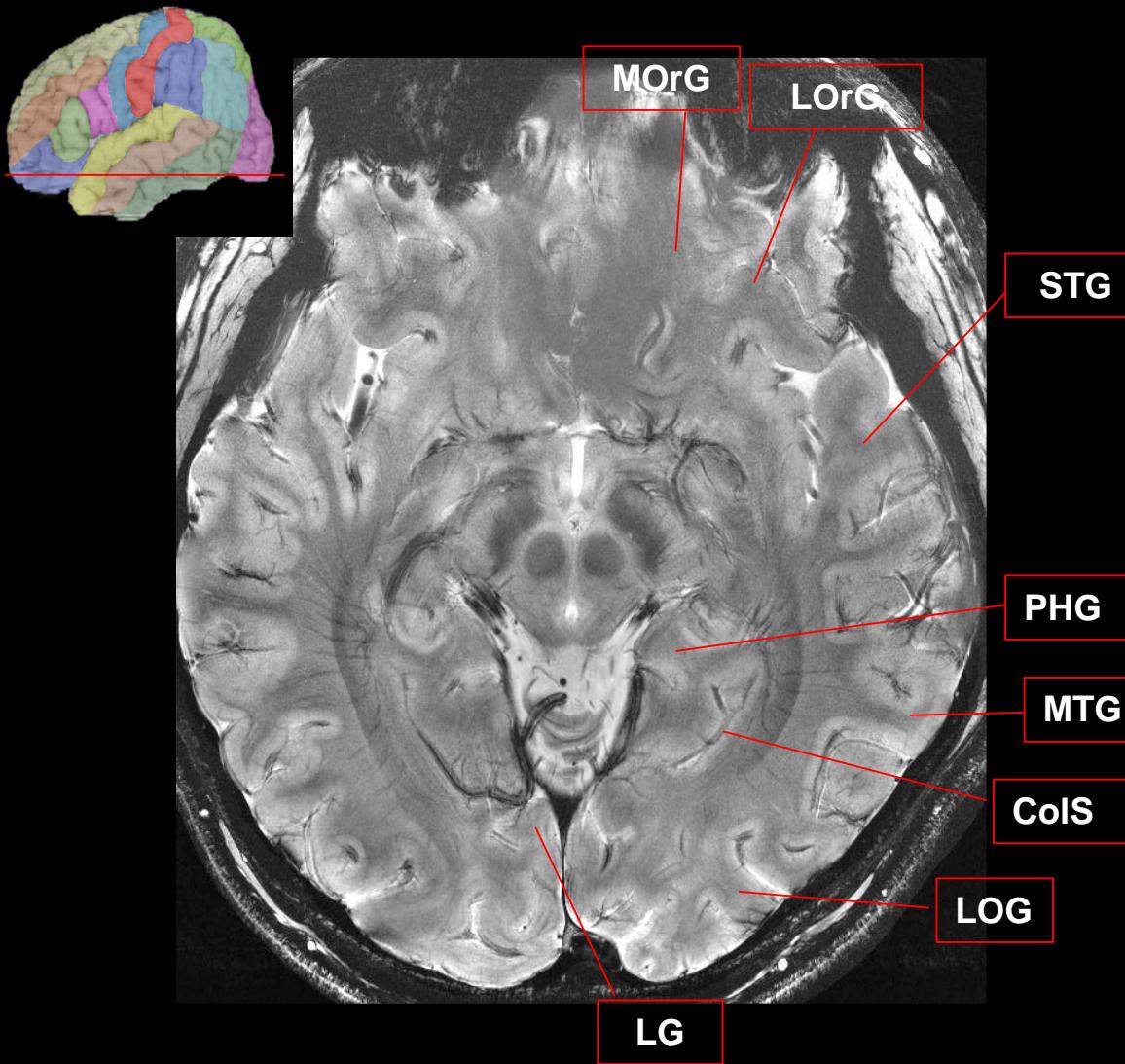


1. Anterior commissure를 관통.
2. 3개의 temporal gyrus.
3. Inferior frontal gyrus는 주로 triangular part.
4. Occipital lobe의 midline은 lingual gyrus가 대부분.

# 주요 이랑 및 고랑

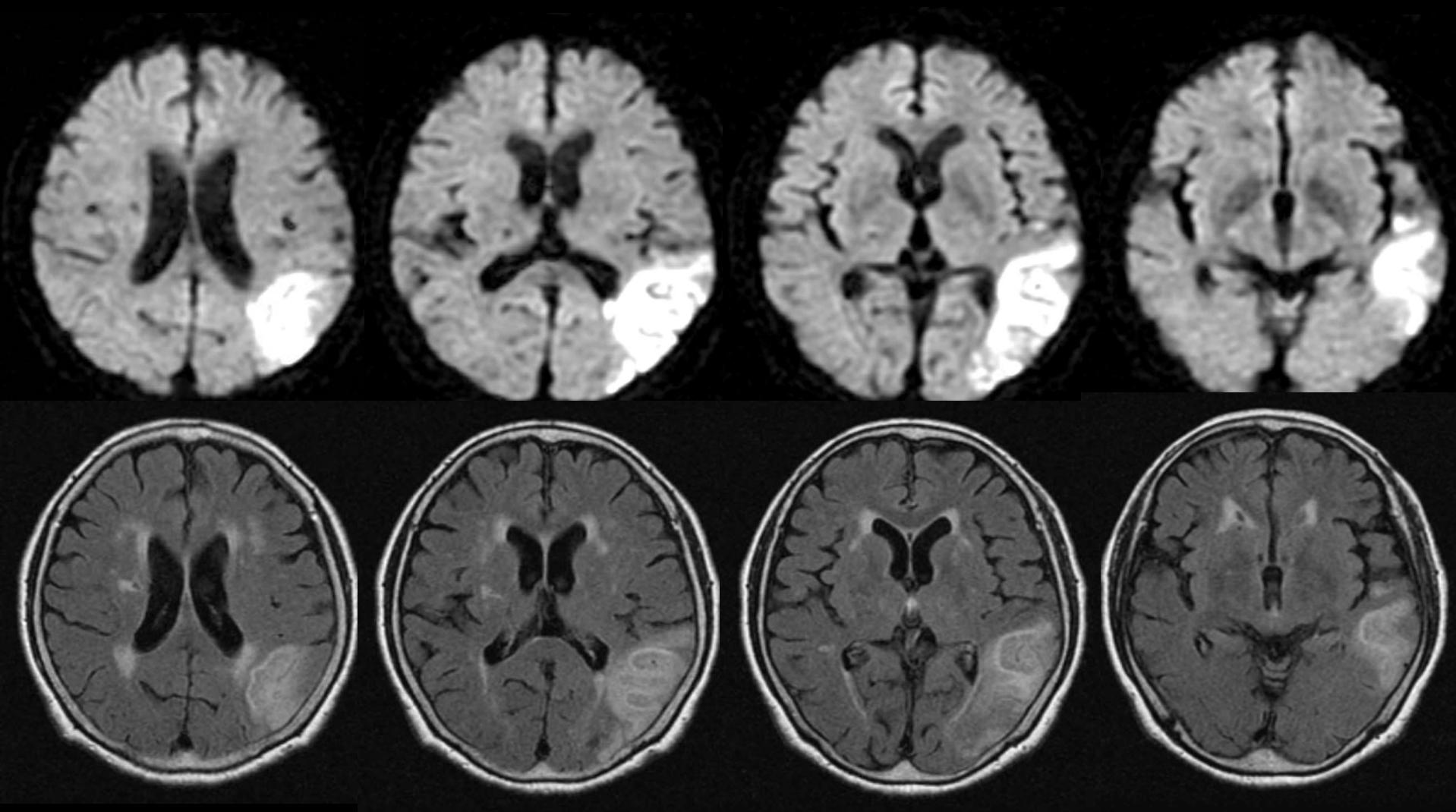
내측면





1. Midbrain, red nucleus가 보이는 컷
2. Frontal은 orbitofrontal and straight gyrus
3. Basal temporal area: collateral sulcus안쪽은 PG, 바깥쪽은 fusiform gyrus
4. 이 단면 이하에서는 cuneus는 거의 보이지 않는다.

# 연습문제





# 강의 개요

- General Overview
- Anatomy of cerebral cortex
- Anatomy of subcortical structures
- Anatomy of white matter tracts
- MRI Neuroanatomy

경청해 주셔서 감사합니다.