UNIVERSITÀ DEGLI STUDI DI TRIESTE

DEPARTMENT OF MEDICINE, SURGERY AND HEALTH SCIENCES

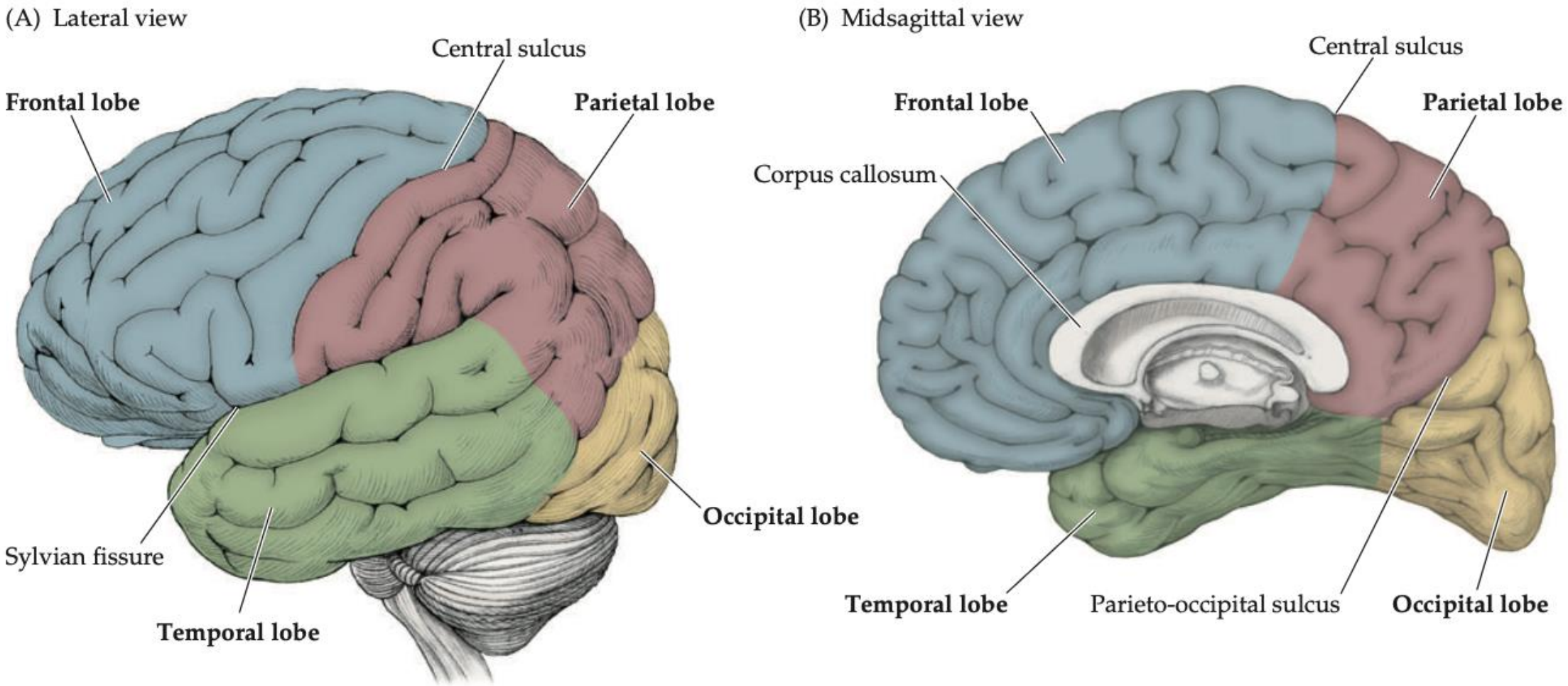
NEUROLOGY UNIT

Course of
Human Neuroanatomy

Master of Neuroscience, University of Trieste
2025-26

Dr/Prof. Federica Palacino

Cerebral Cortex



Lateralization

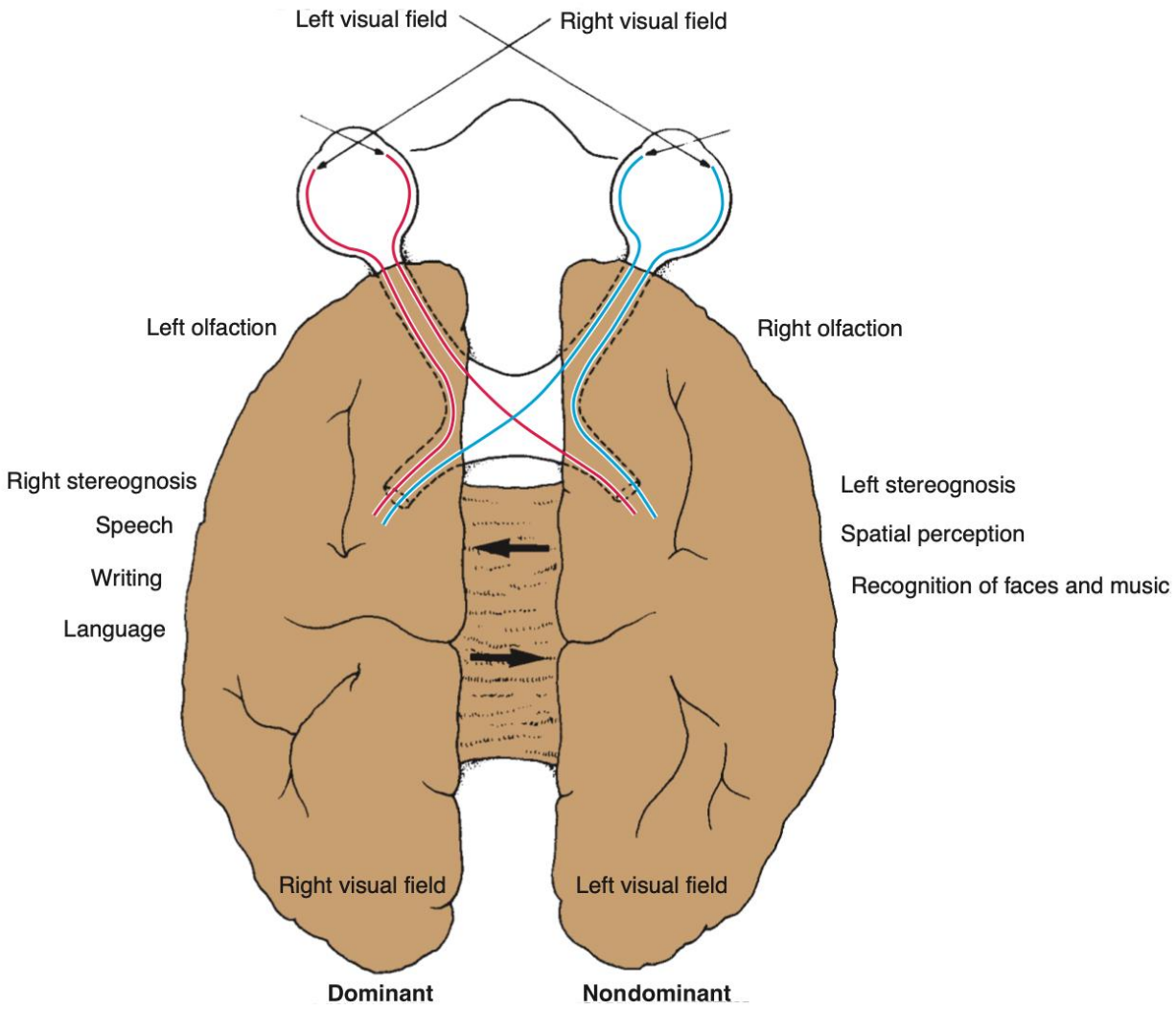


Figure 8-8 Nervous activities performed predominantly by dominant and nondominant hemispheres.

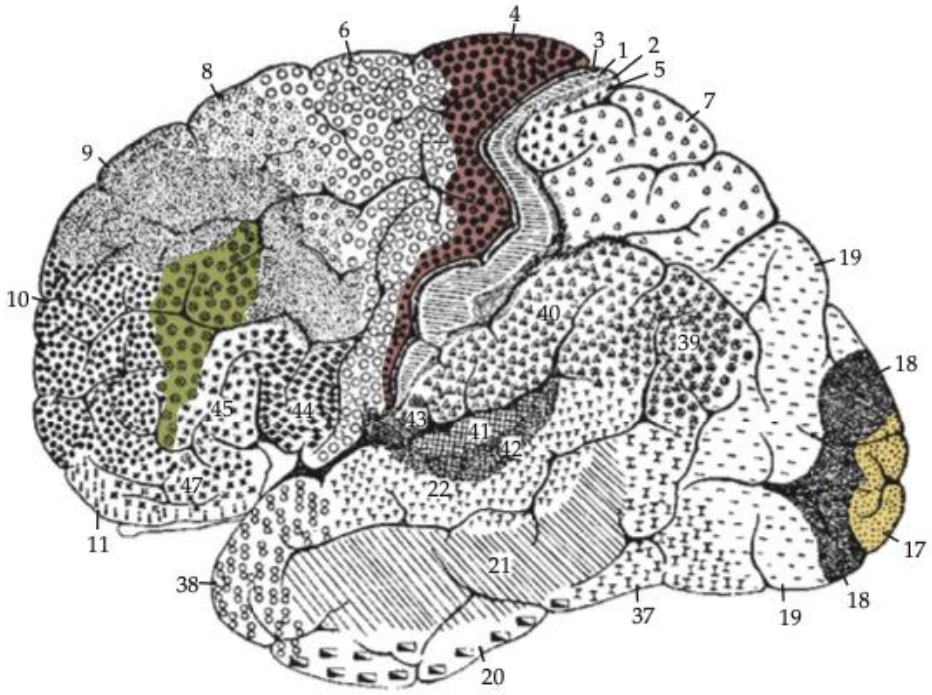
The left hemisphere generally dominates in language, logic, and sequential tasks.

The right hemisphere excels in spatial awareness, emotional processing, and holistic thinking.

The hemispheres communicate continuously via the corpus callosum, ensuring unified perception and action.

Lateralization enhances efficiency without sacrificing integration.

Cell Layers & regional classification



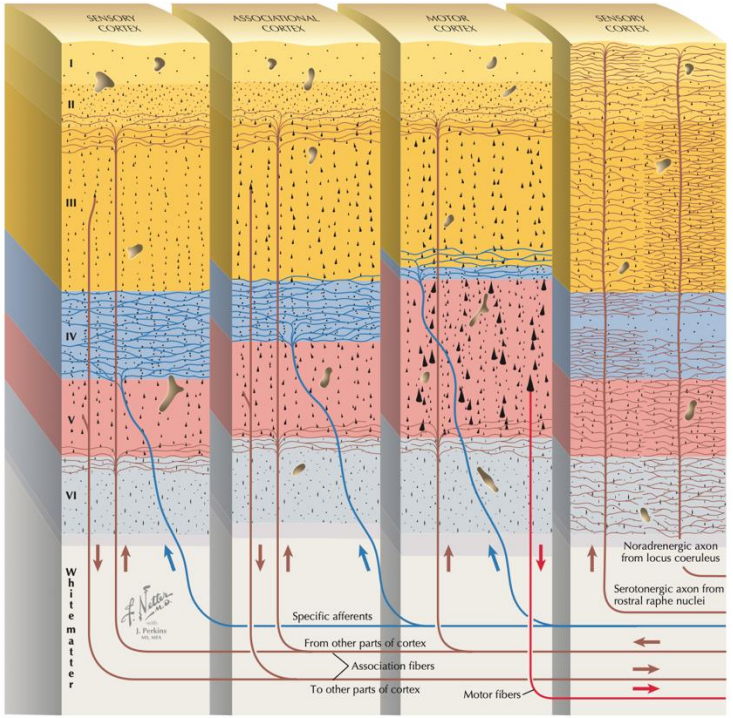
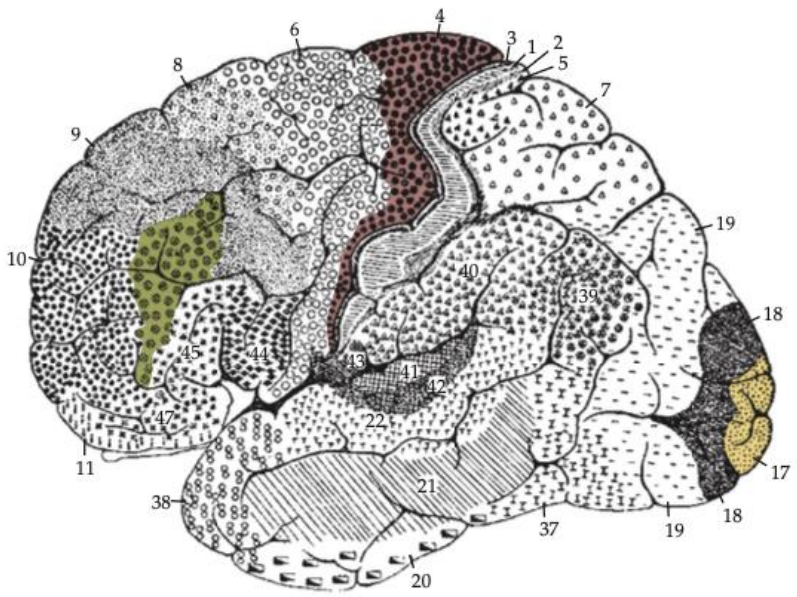
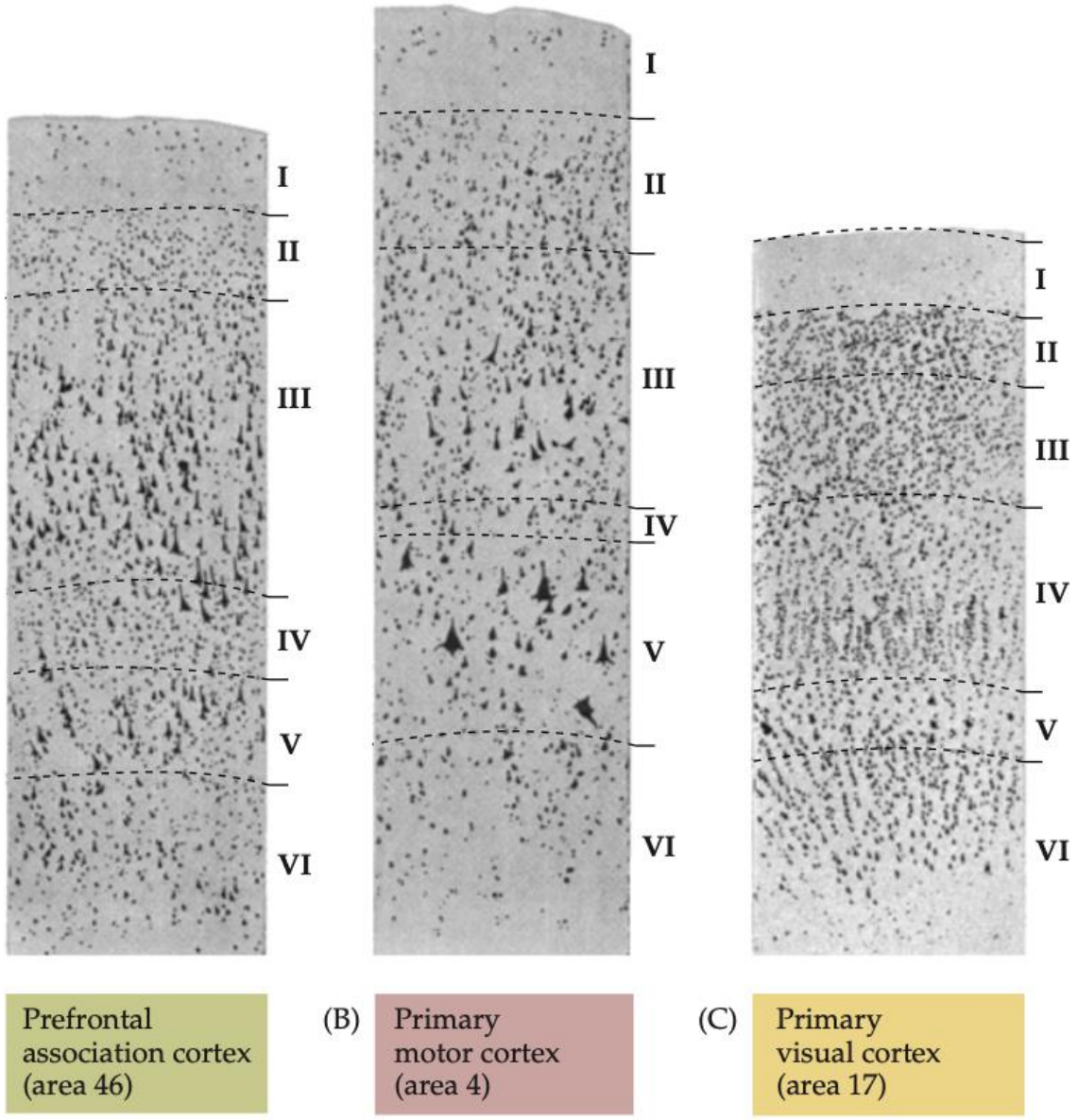


TABLE 2.3 Cell Layers of the Neocortex

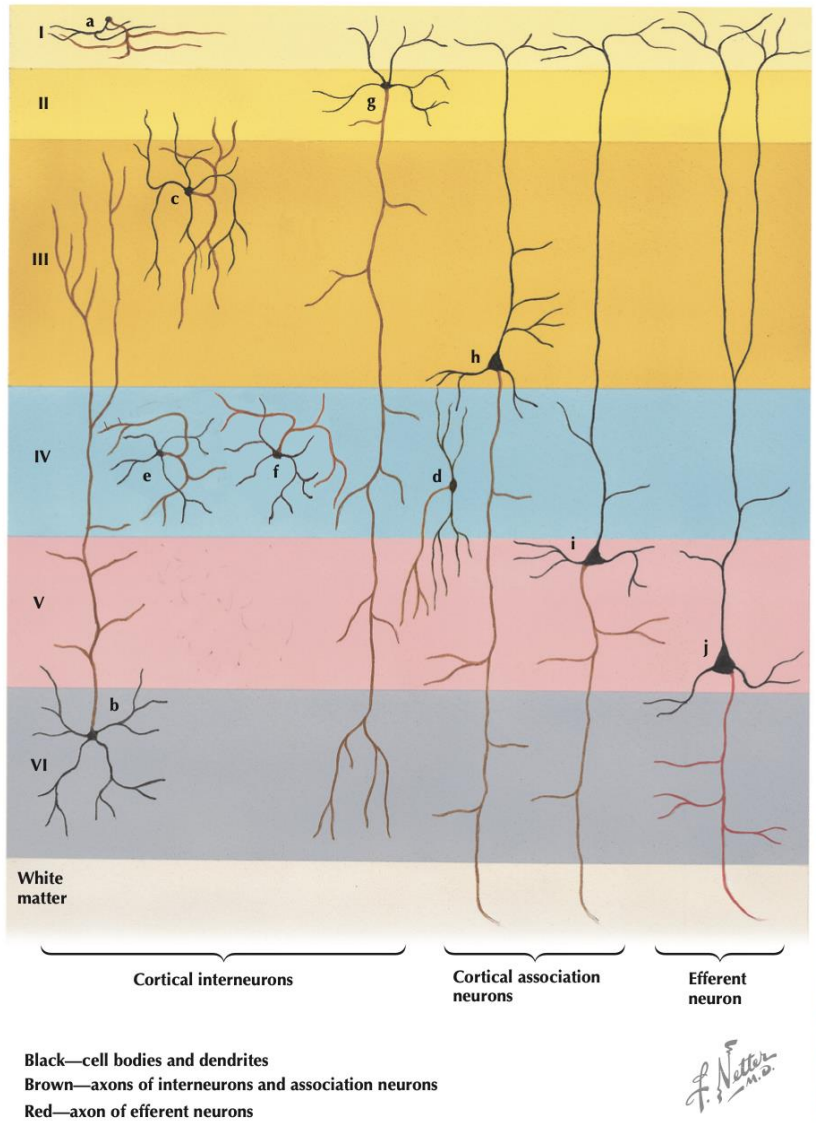
LAYER	NAME	ALTERNATIVE NAME	MAIN CONNECTIONS
I	Molecular layer		Dendrites and axons from other layers
II	Small pyramidal layer	External granular layer	Cortical–cortical connections
III	Medium pyramidal layer	External pyramidal layer	Cortical–cortical connections
IV	Granular layer	Internal granular layer	Receives inputs from thalamus
V	Large pyramidal layer	Internal pyramidal layer	Sends outputs to subcortical structures (other than thalamus)
VI	Polymorphic layer	Multiform layer	Sends outputs to thalamus

Cell Layers & regional classification



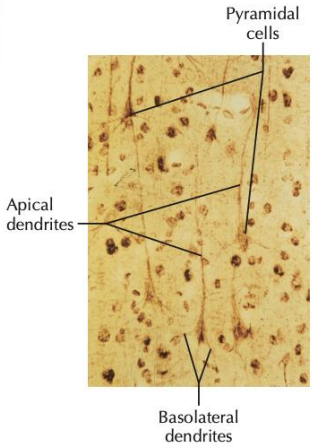


Cell layers & cell types

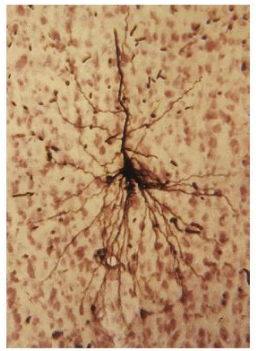


Key for Abbreviations

- **a** Horizontal cell
- **b** Cell of Martinotti
- **c** Chandelier cell
- **d** Aspiny granule cell
- **e** Spiny granule cell
- **f** Stellate (granule) cell
- **g** Small pyramidal cell of layers II, III
- **h** Small pyramidal association cell
- **i** Small pyramidal association and projection cells of layer V
- **j** Large pyramidal projection cell (Betz cell)



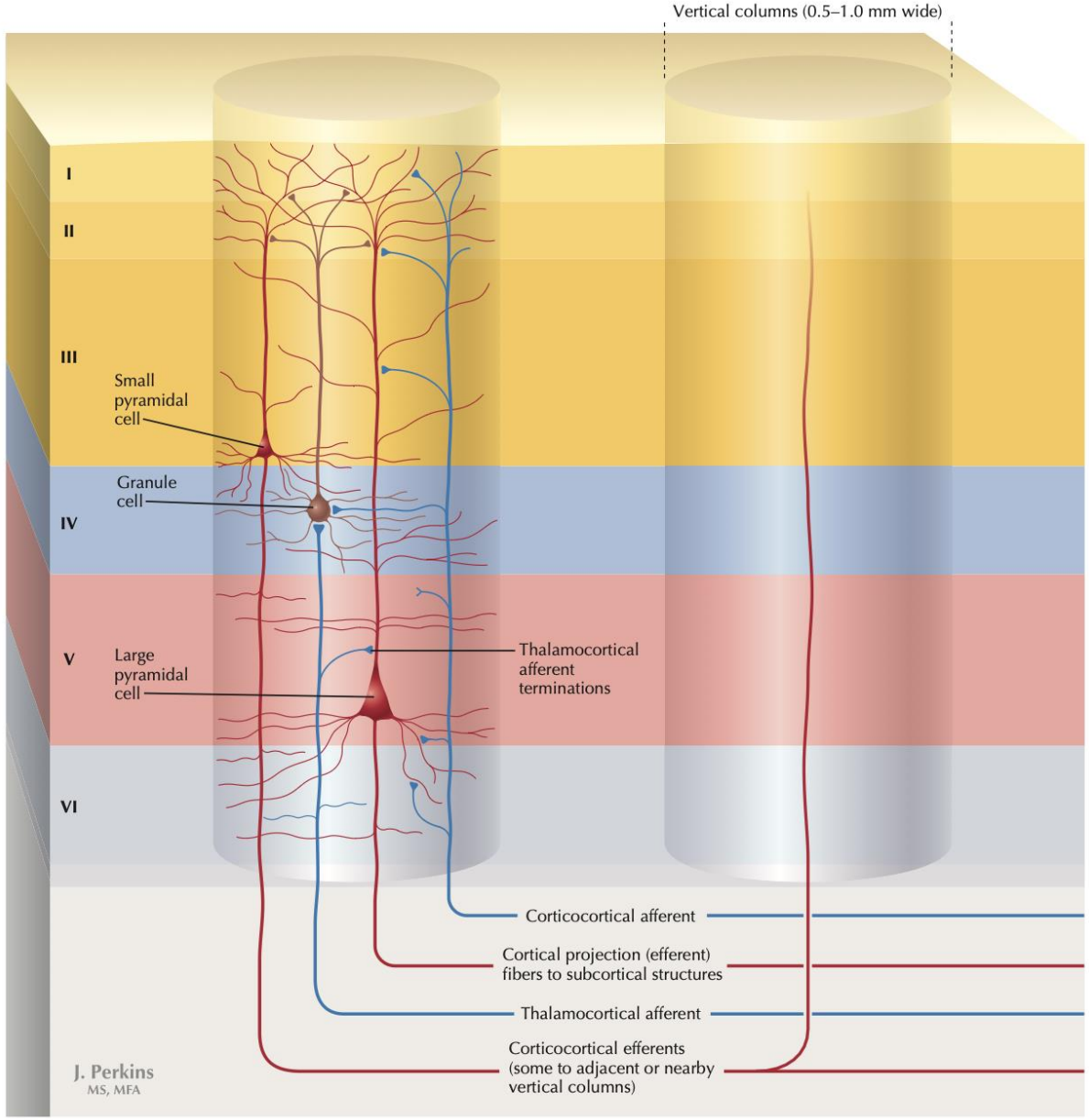
Multiple cortical pyramidal cells with conspicuous apical dendrites and basolateral dendrites, and other cortical cells. Fiber stain.



Pyramidal neuron with massive dendritic branching, particularly the basolateral dendrites. Golgi stain with background cell stain.

- Granule cells are local circuit neurons with small cell bodies, localized dendritic trees, and axons that distribute locally. Granule cells function as receiving neurons for thalamic and other inputs, and they modulate the excitability of other cortical neurons.
- Pyramidal cells possess more varied cell bodies that have large basolateral dendritic branching patterns and apical dendritic arborizations that run perpendicular to the cortical surface and arborize in upper layers. The axons of pyramidal cells, which function as projection neurons, leave the cortex and may extend for as long as a meter before synapsing on target neurons.

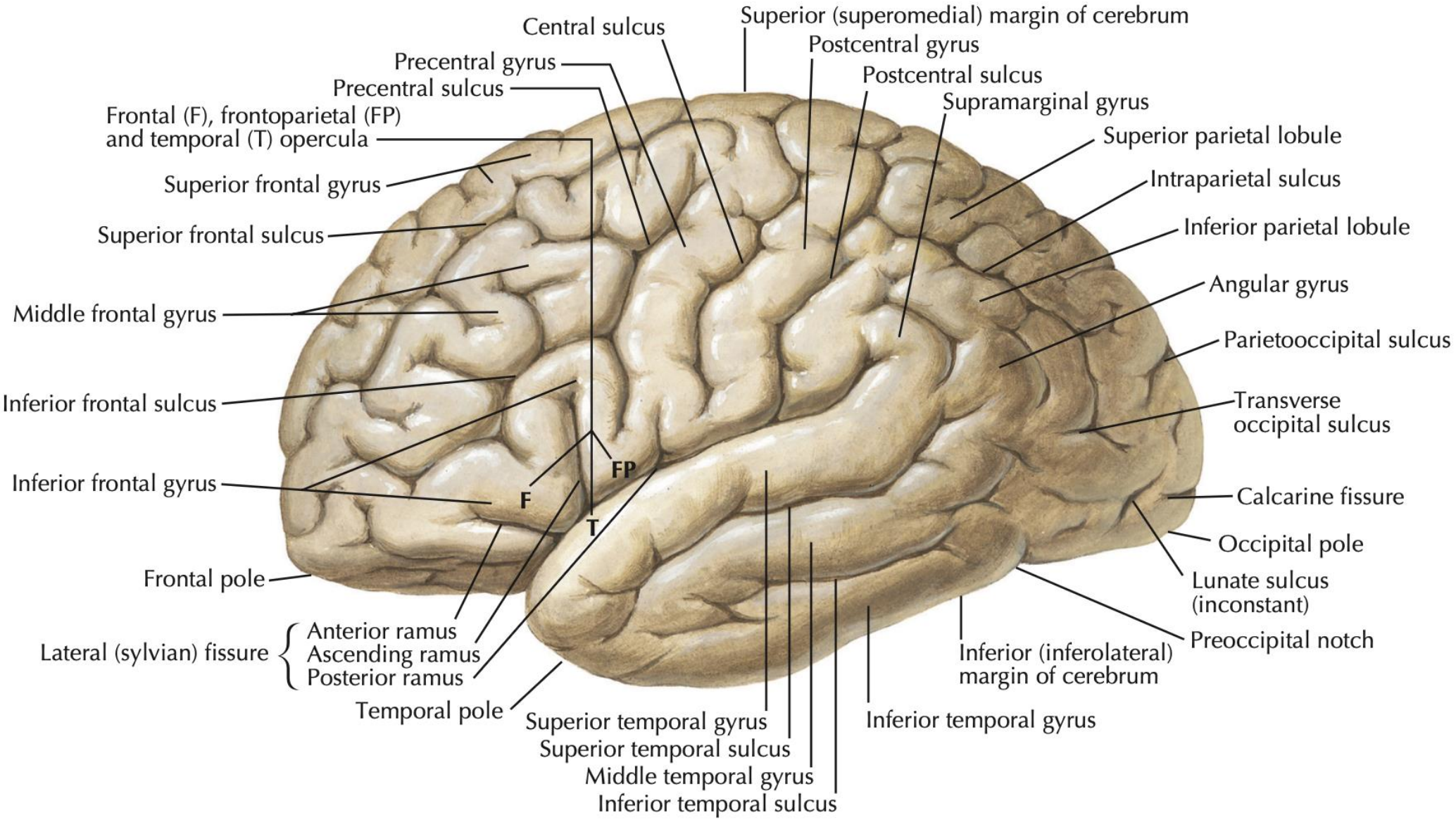
Vertical columns: functional units



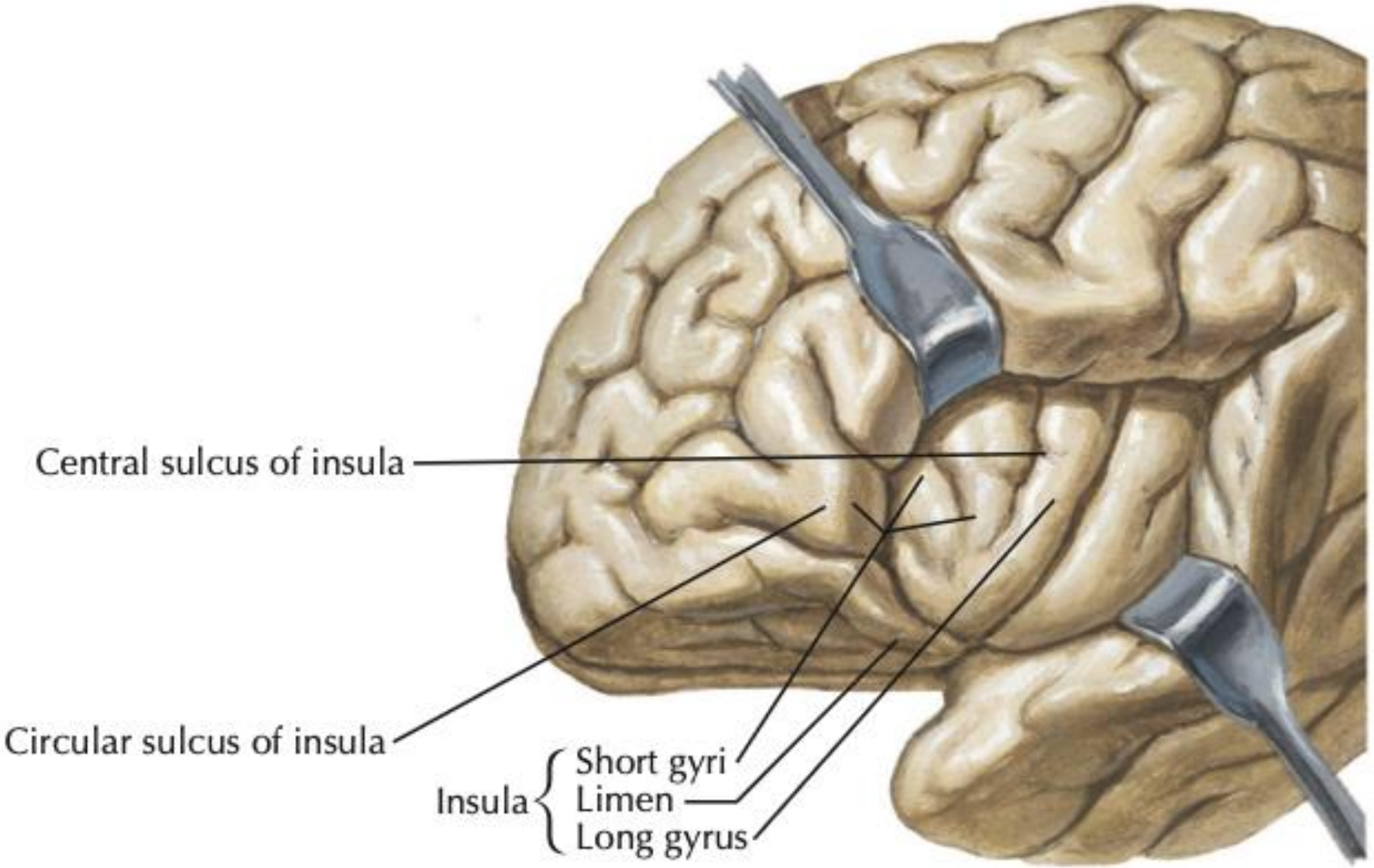
Both thalamic and cortical afferents arborize in the vertical column and synapse on both stellate (granule) cells and pyramidal neuron dendrites.

Information from a vertical column can be sent to an adjacent or nearby column via corticocortical efferents or can be sent to distant structures by commissural fibers (cortex on the other side) or by projection fibers (subcortical structures).

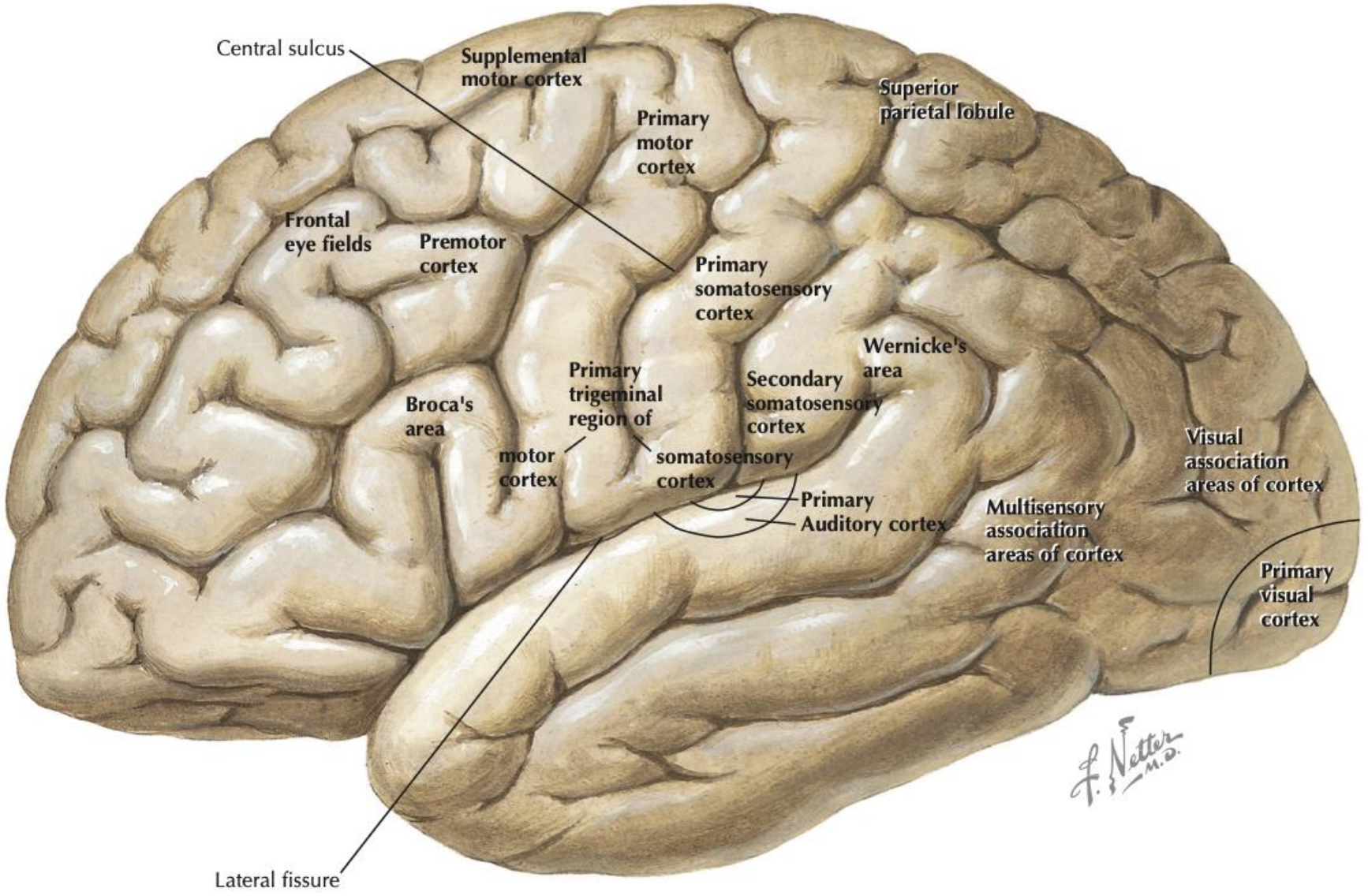
Cerebral cortex: description



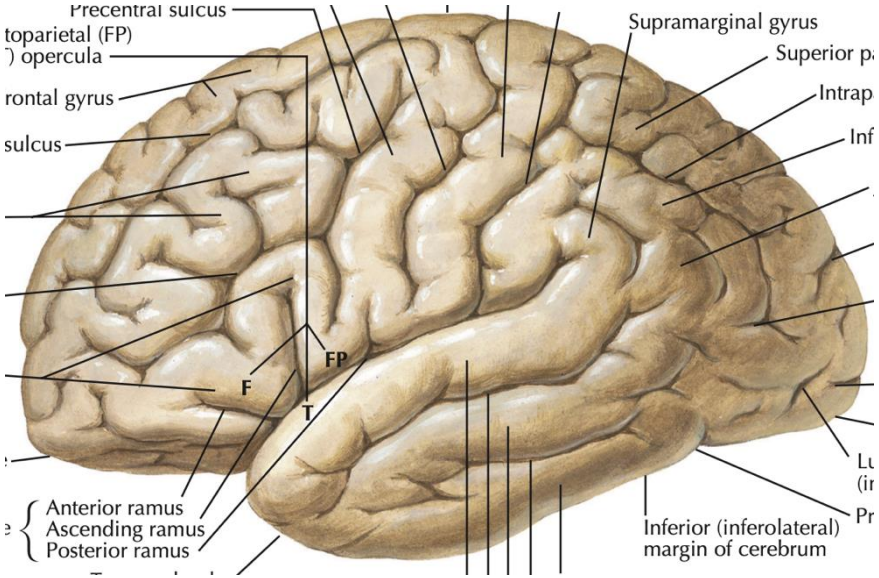
Cerebral cortex: description

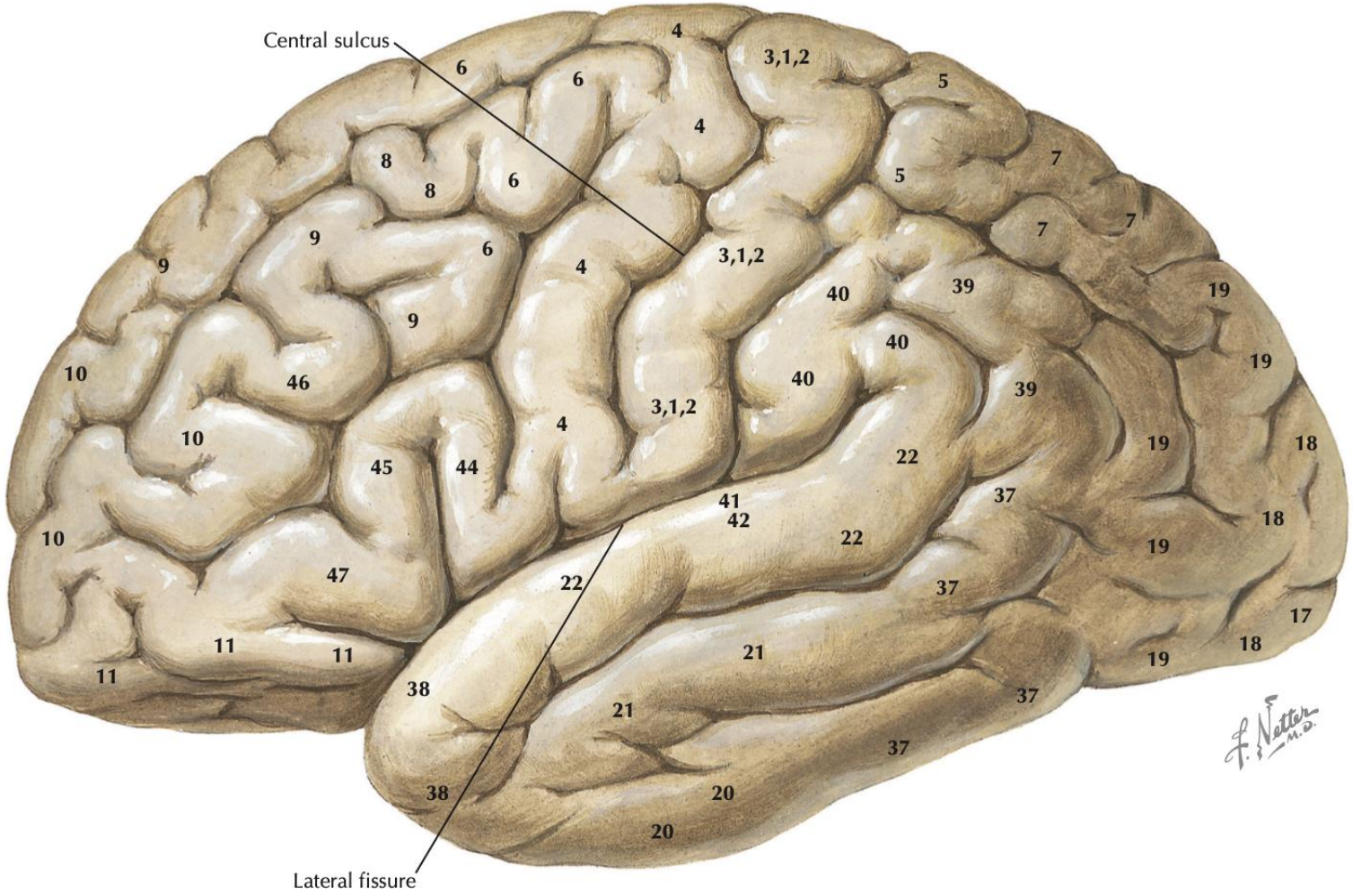


Cerebral cortex: description

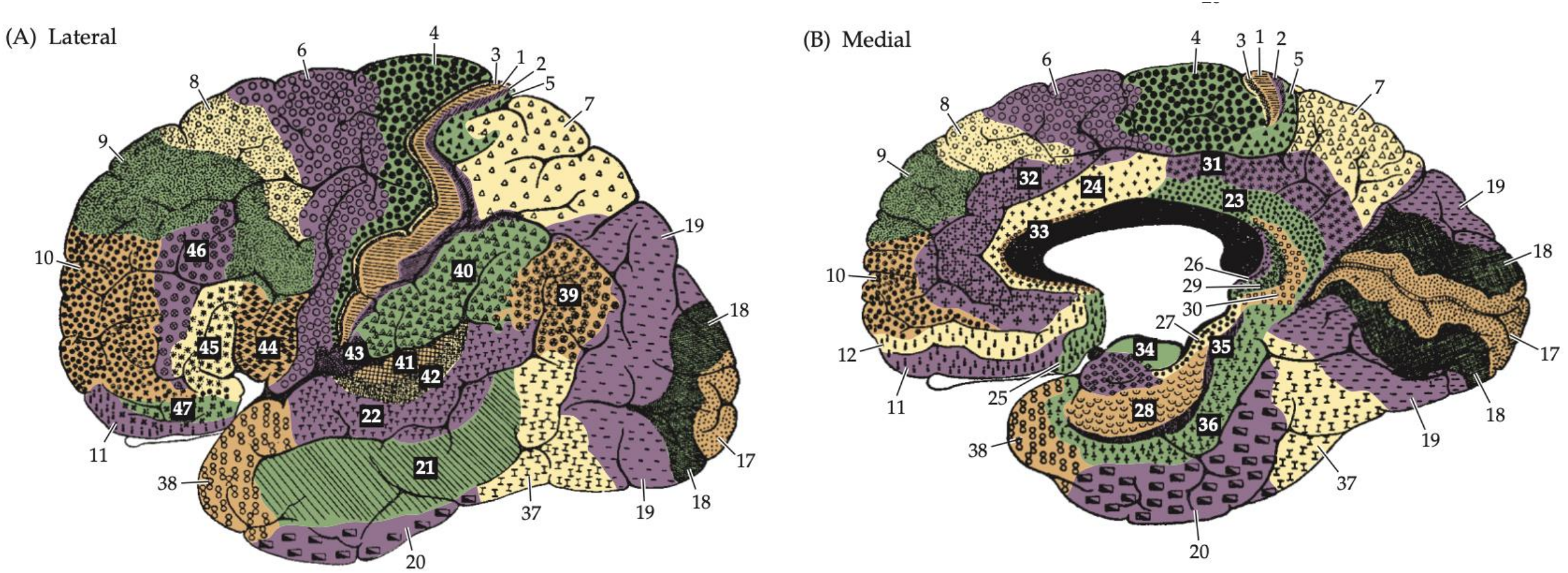


Brodmann's Cytoarchitectonic Areas





Brodmann's Cytoarchitectonic Areas

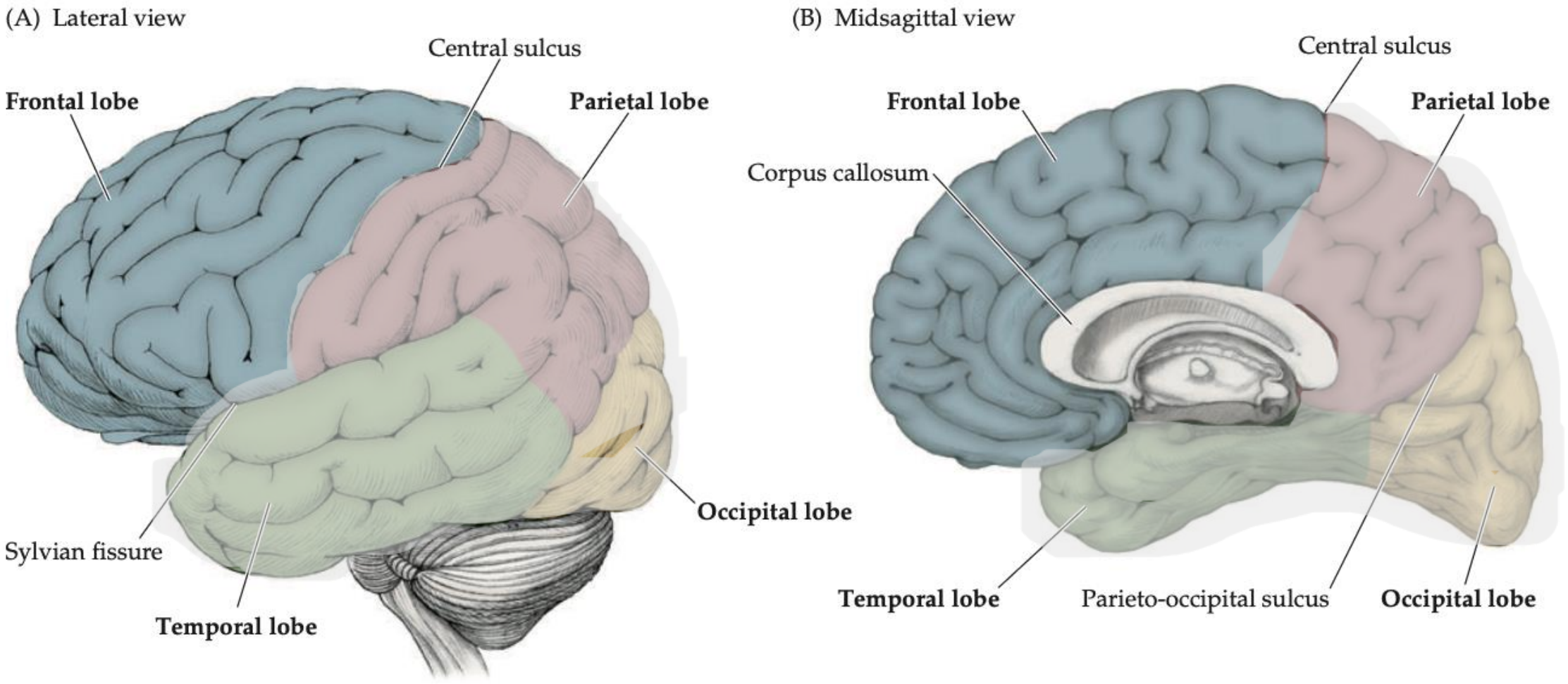


Brodmann's Cytoarchitectonic Areas

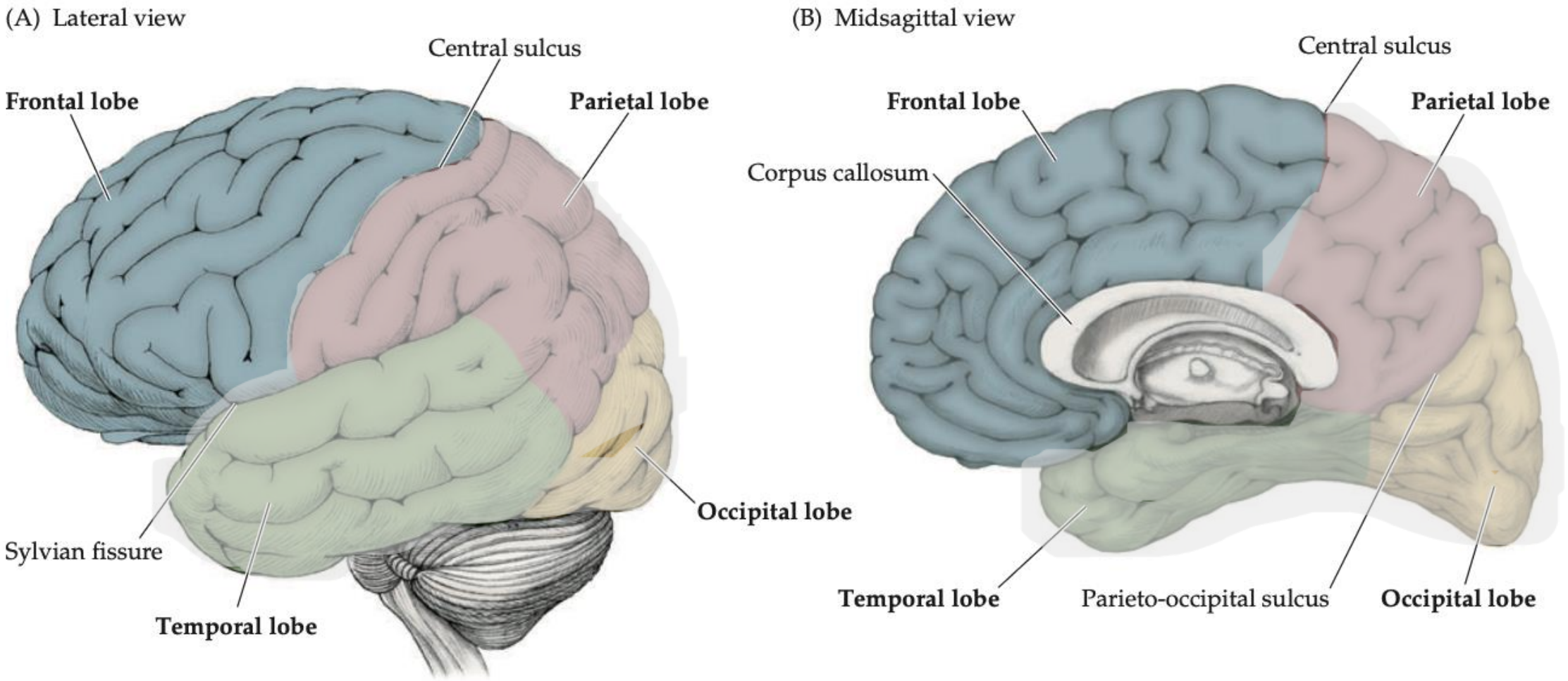
TABLE 2.4 Brodmann's Cytoarchitectonic Areas

BRODMANN'S AREA	FUNCTIONAL AREA	LOCATION	FUNCTION
1, 2, 3	Primary somatosensory cortex	Postcentral gyrus	Touch
4	Primary motor cortex	Precentral gyrus	Voluntary movement control
5	Tertiary somatosensory cortex; posterior parietal association area	Superior parietal lobule	Stereognosis
6	Supplementary motor cortex; supplementary eye field; pre-motor cortex; frontal eye fields	Precentral gyrus and rostral adjacent cortex	Limb and eye movement planning
7	Posterior parietal association area	Superior parietal lobule	Visuomotor; perception
8	Frontal eye fields	Superior, middle frontal gyri, medial frontal lobe	Saccadic eye movements
9, 10, 11, 12[a]	Prefrontal association cortex; frontal eye fields	Superior, middle frontal gyri, medial frontal lobe	Thought, cognition, movement planning
17	Primary visual cortex	Banks of calcarine fissure	Vision
18	Secondary visual cortex	Medial and lateral occipital gyri	Vision; depth
19	Tertiary visual cortex, middle temporal visual area	Medial and lateral occipital gyri	Vision, color, motion, depth
20	Visual inferotemporal area	Inferior temporal gyrus	Form vision
21	Visual inferotemporal area	Middle temporal gyrus	Form vision
22	Higher-order auditory cortex	Superior temporal gyrus	Hearing, speech
23, 24, 25, 26, 27	Limbic association cortex	Cingulate gyrus, subcallosal area, retrosplenial area, and parahippocampal gyrus	Emotions
28	Primary olfactory cortex; limbic association cortex	Parahippocampal gyrus	Smell, emotions
29, 30, 31, 32, 33	Limbic association cortex	Cingulate gyrus and retrosplenial area	Emotions
34, 35, 36	Primary olfactory cortex; limbic association cortex	Parahippocampal gyrus	Smell, emotions
37	Parietal–temporal–occipital association cortex; middle temporal visual area	Middle and inferior temporal gyri at junction of temporal and occipital lobes	Perception, vision, reading, speech
38	Primary olfactory cortex; limbic association cortex	Temporal pole	Smell, emotions
39	Parietal–temporal–occipital association cortex	Inferior parietal lobule (angular gyrus)	Perception, vision, reading, speech
40	Parietal–temporal–occipital association cortex	Inferior parietal lobule (supramarginal gyrus)	Perception, vision, reading, speech
41	Primary auditory cortex	Heschl's gyri and superior temporal gyrus	Hearing
42	Secondary auditory cortex	Heschl's gyri and superior temporal gyrus	Hearing
43	Gustatory cortex	Insular cortex, frontoparietal operculum	Taste
44	Broca's area; lateral premotor cortex	Inferior frontal gyrus (frontal operculum)	Speech, movement planning
45	Prefrontal association cortex	Inferior frontal gyrus (frontal operculum)	Thought, cognition, planning behavior
46	Prefrontal association cortex (dorsolateral prefrontal cortex)	Middle frontal gyrus	Thought, cognition, planning behavior, aspects of eye movement control
47[a]	Prefrontal association cortex	Inferior frontal gyrus (frontal operculum)	Thought, cognition, planning behavior

Cerebral Cortex: frontal lobe

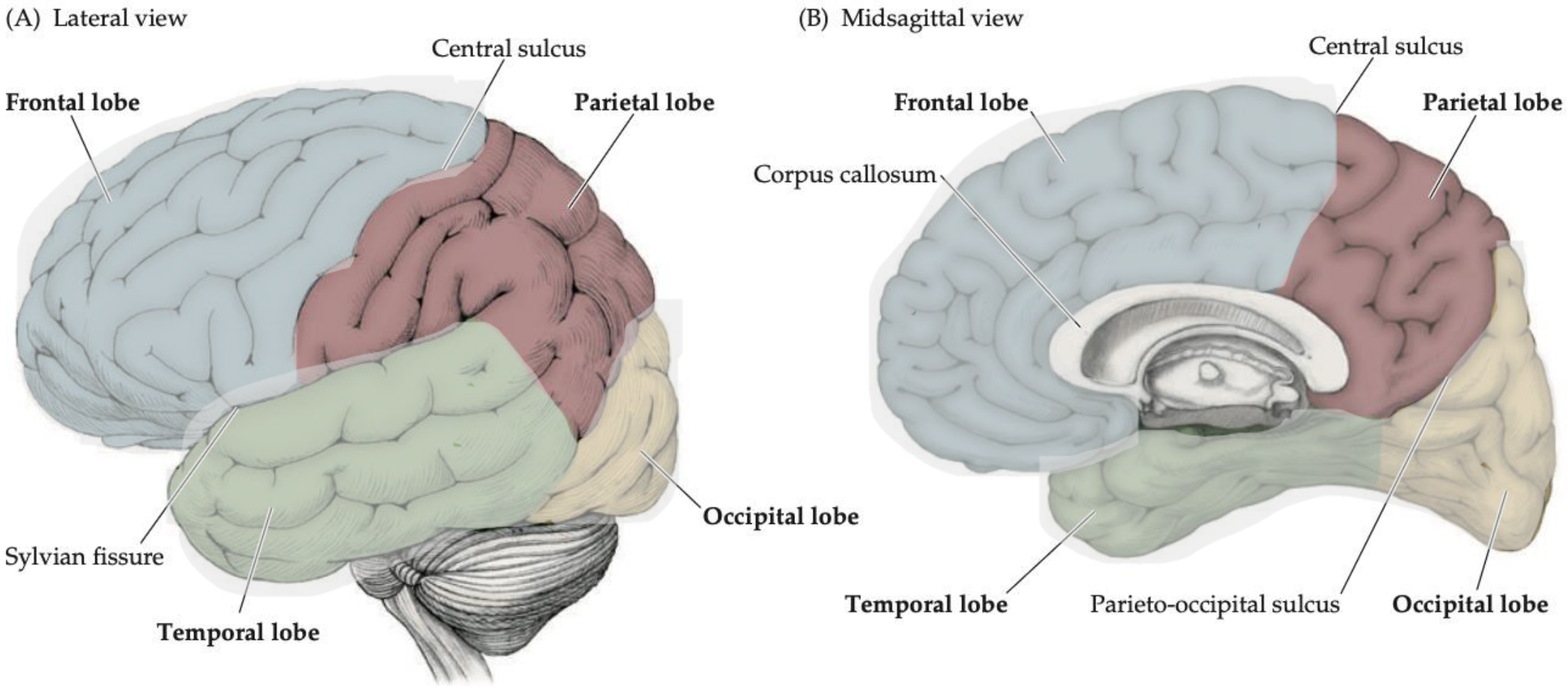


Cerebral Cortex: frontal lobe

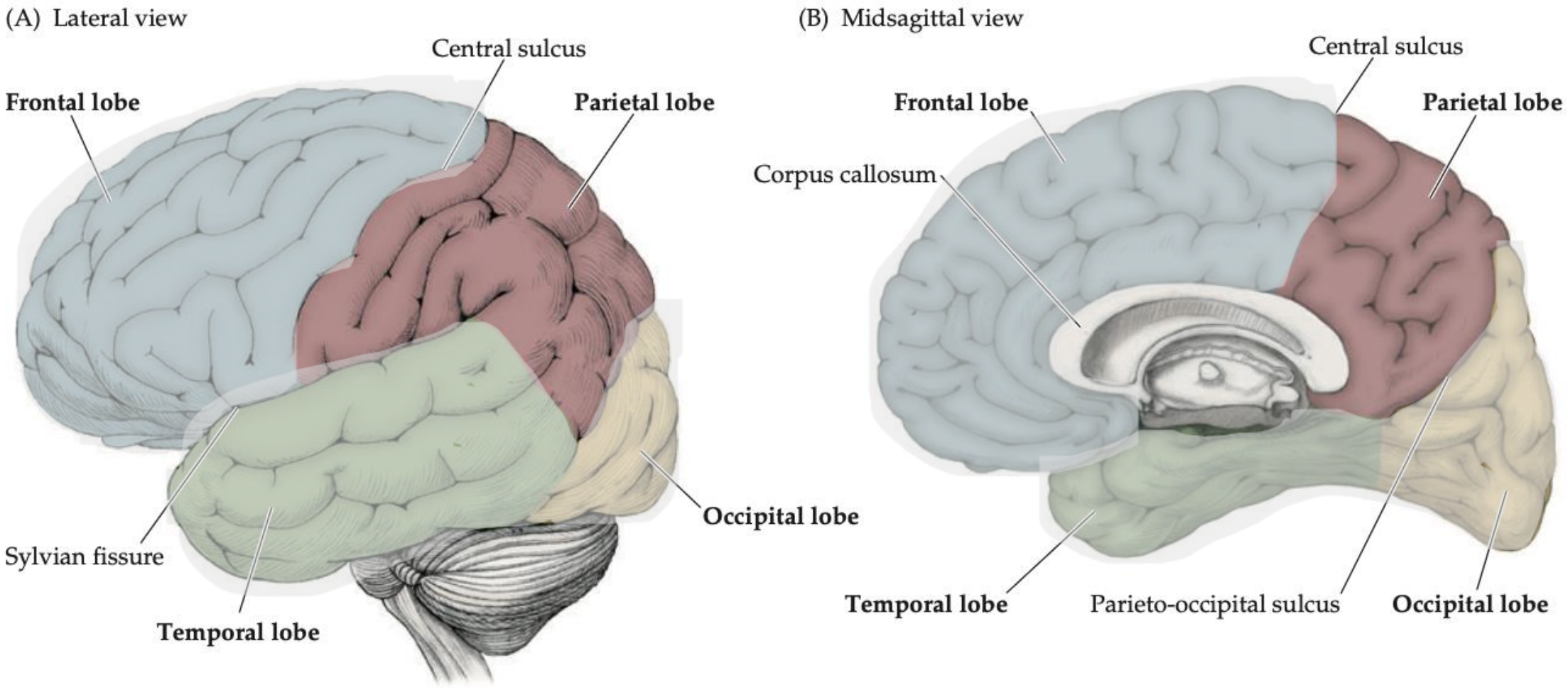


Damage to the neurons or tissue of the frontal lobe can lead to personality changes, difficulty concentrating or planning, and impulsivity

Cerebral Cortex: parietal lobe

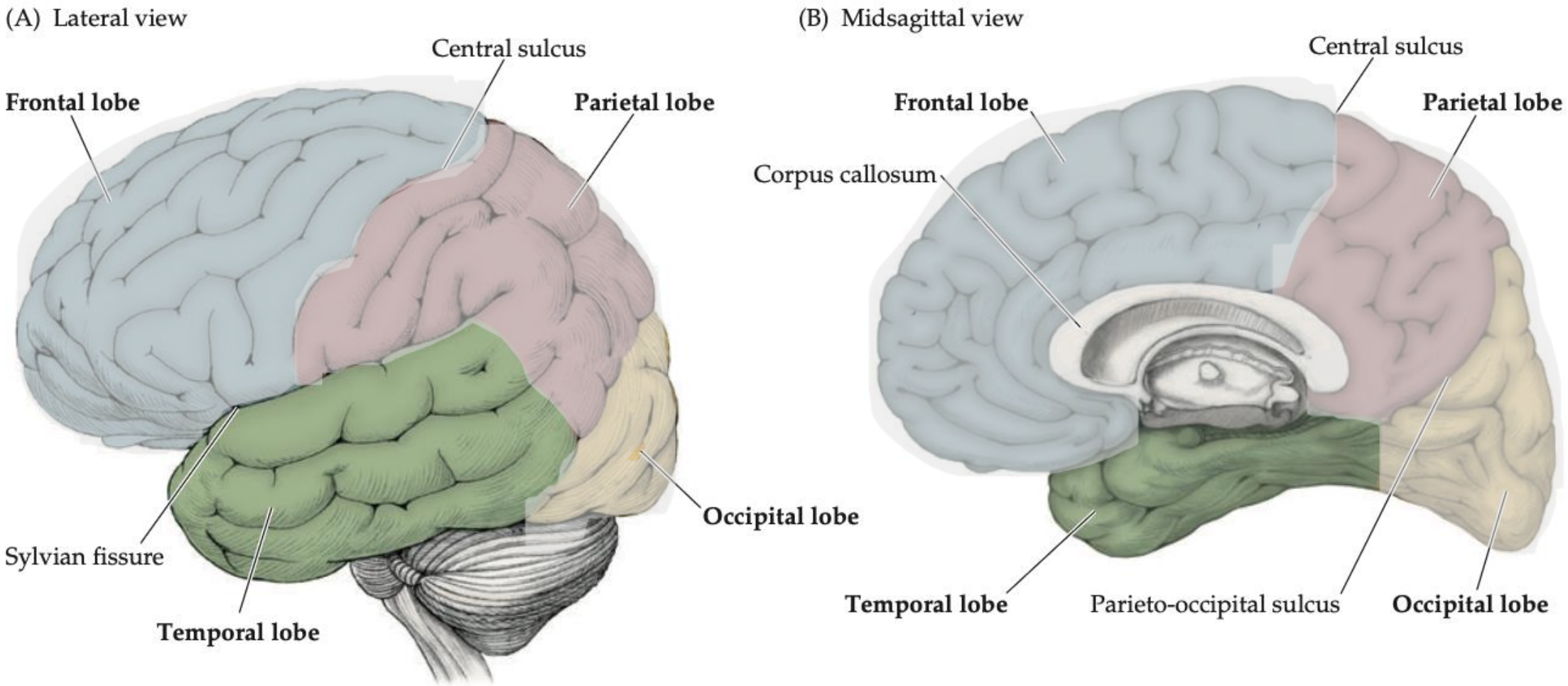


Cerebral Cortex: parietal lobe

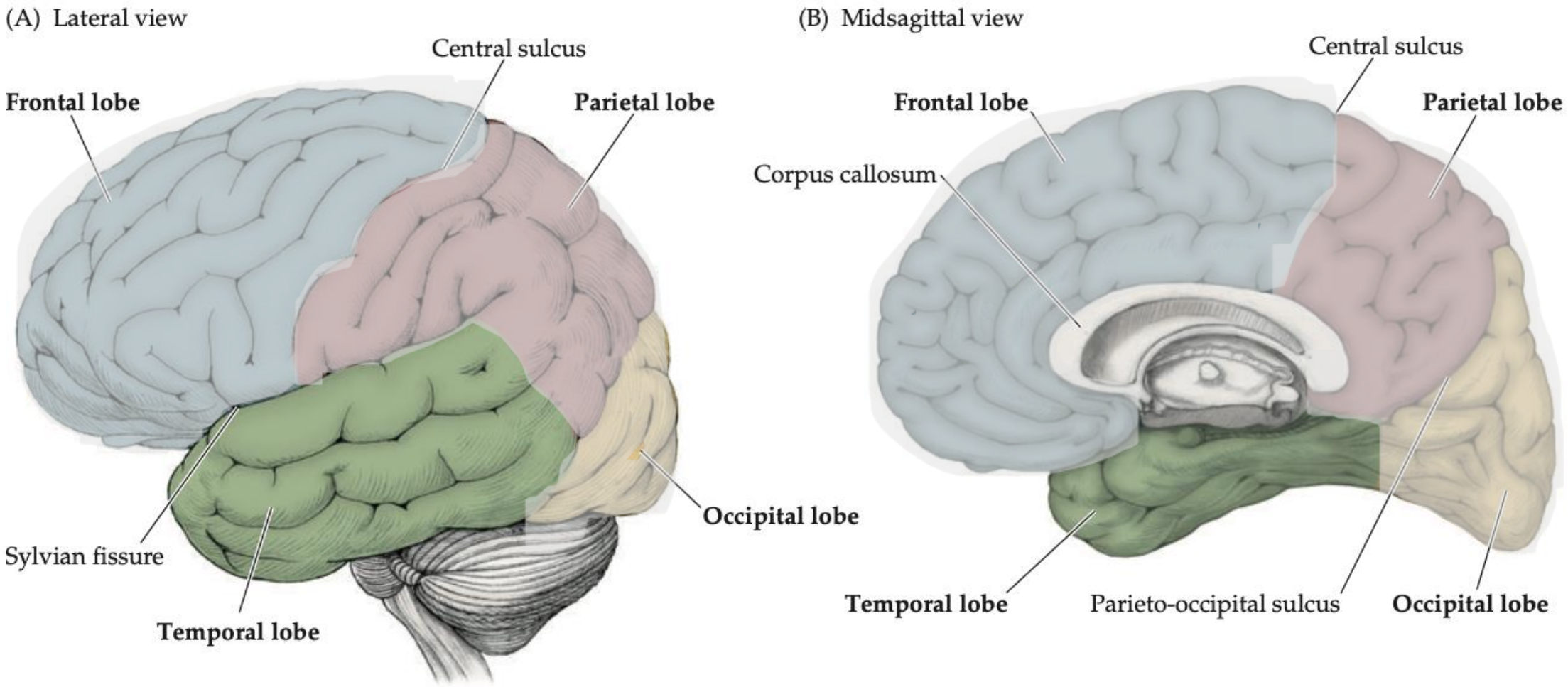


Damage to the neurons or tissue of the parietal lobe can lead to difficulties in spatial orientation, problems with perception of touch, impaired hand-eye coordination, and in some cases neglect of one side of the body.

Cerebral Cortex: temporal lobe

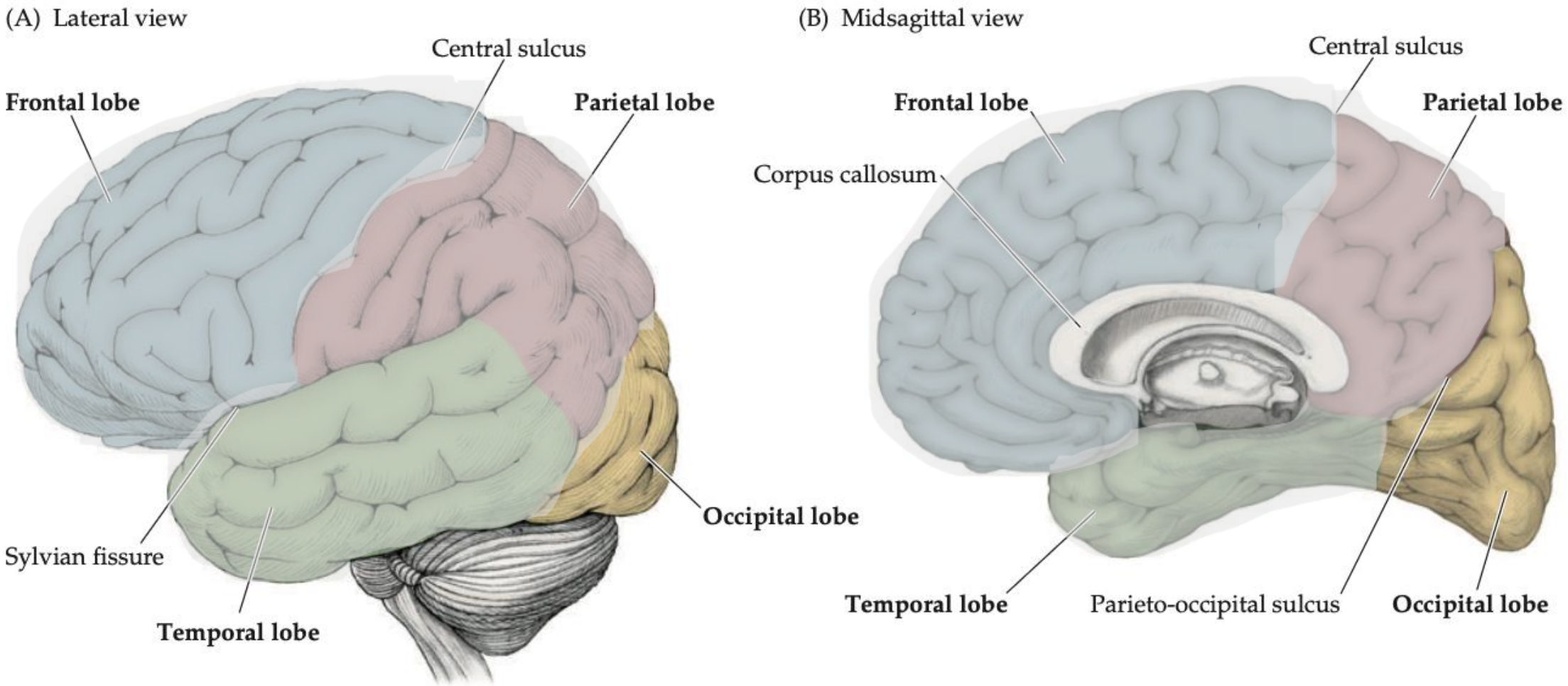


Cerebral Cortex: temporal lobe

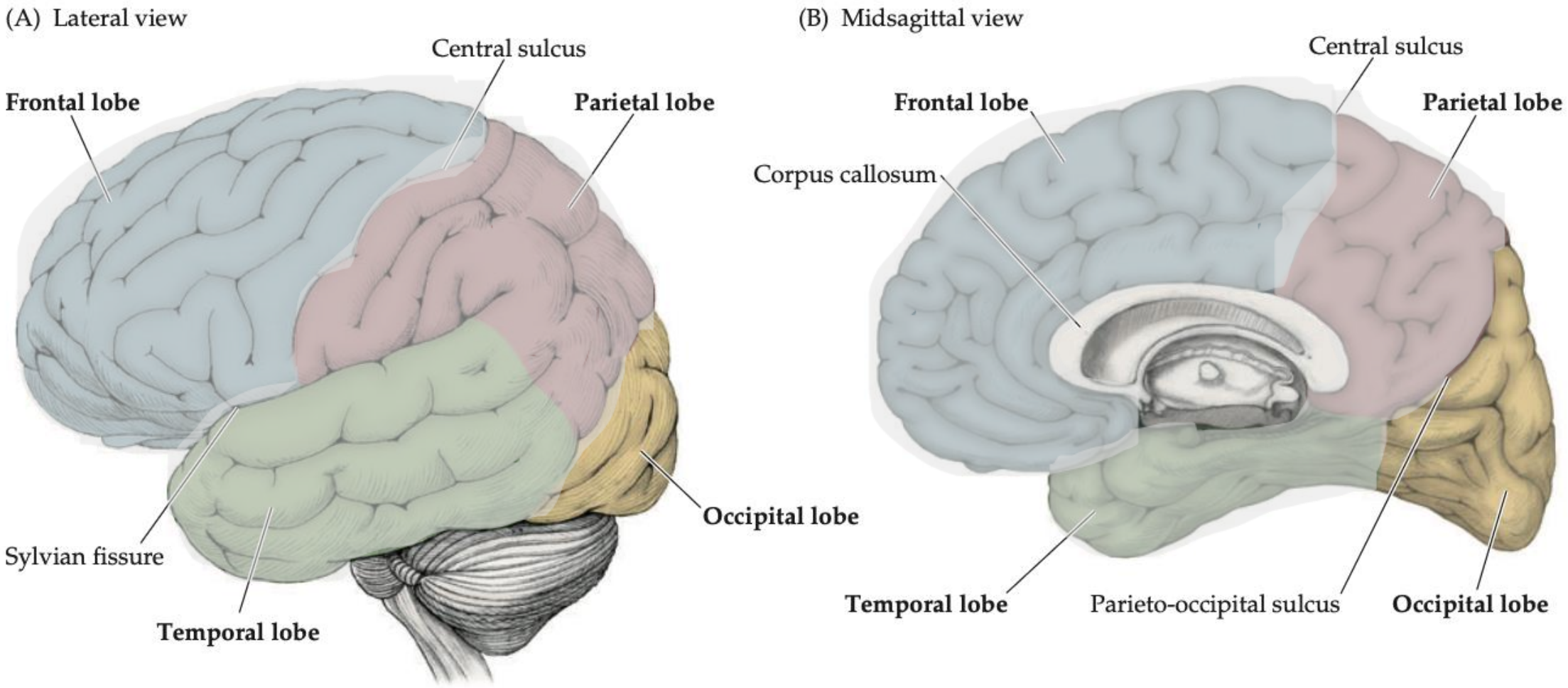


Damage to the neurons or tissue of the temporal lobe can lead to memory loss, difficulty understanding language, impaired recognition of sounds or faces, and emotional disturbances.

Cerebral Cortex: occipital lobe

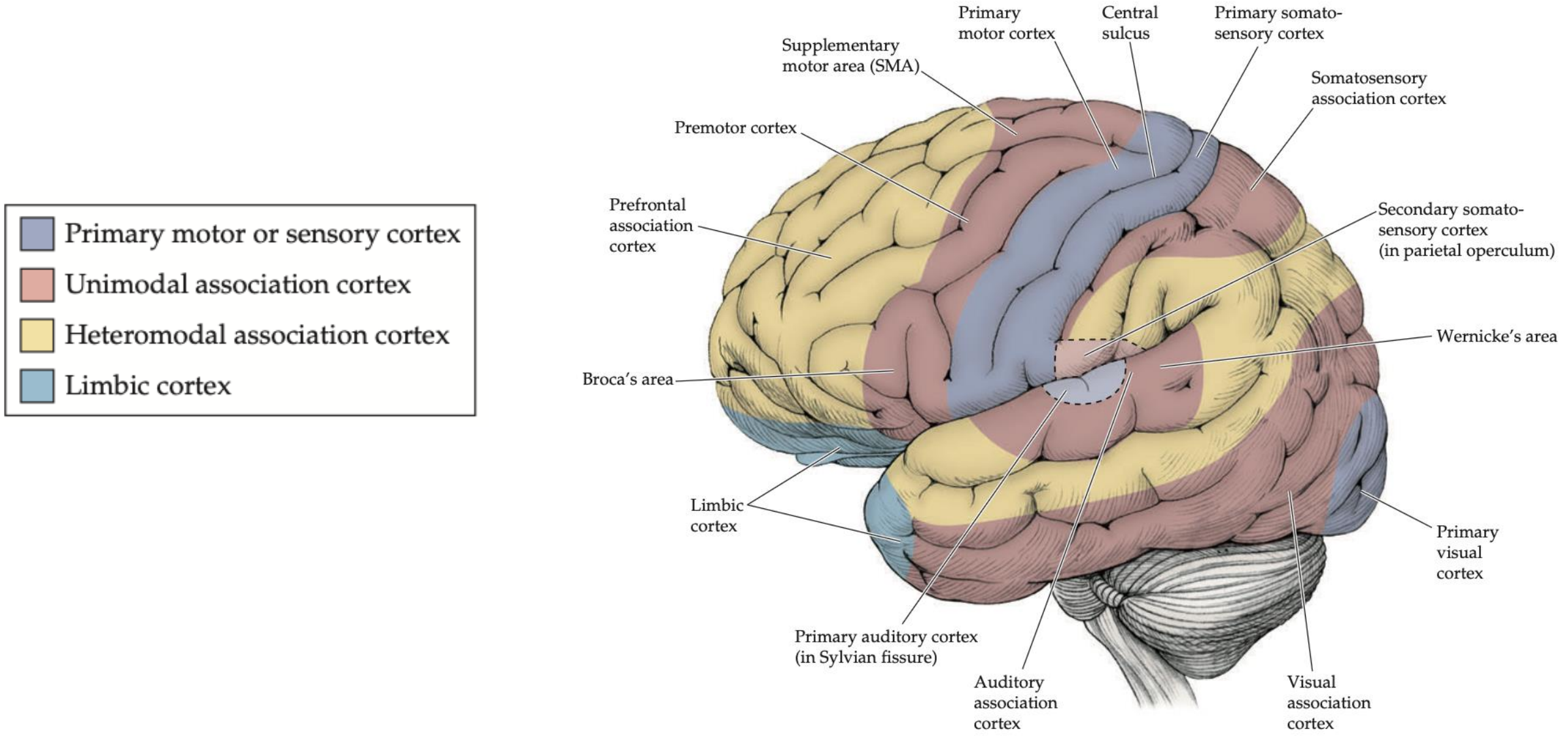


Cerebral Cortex: occipital lobe



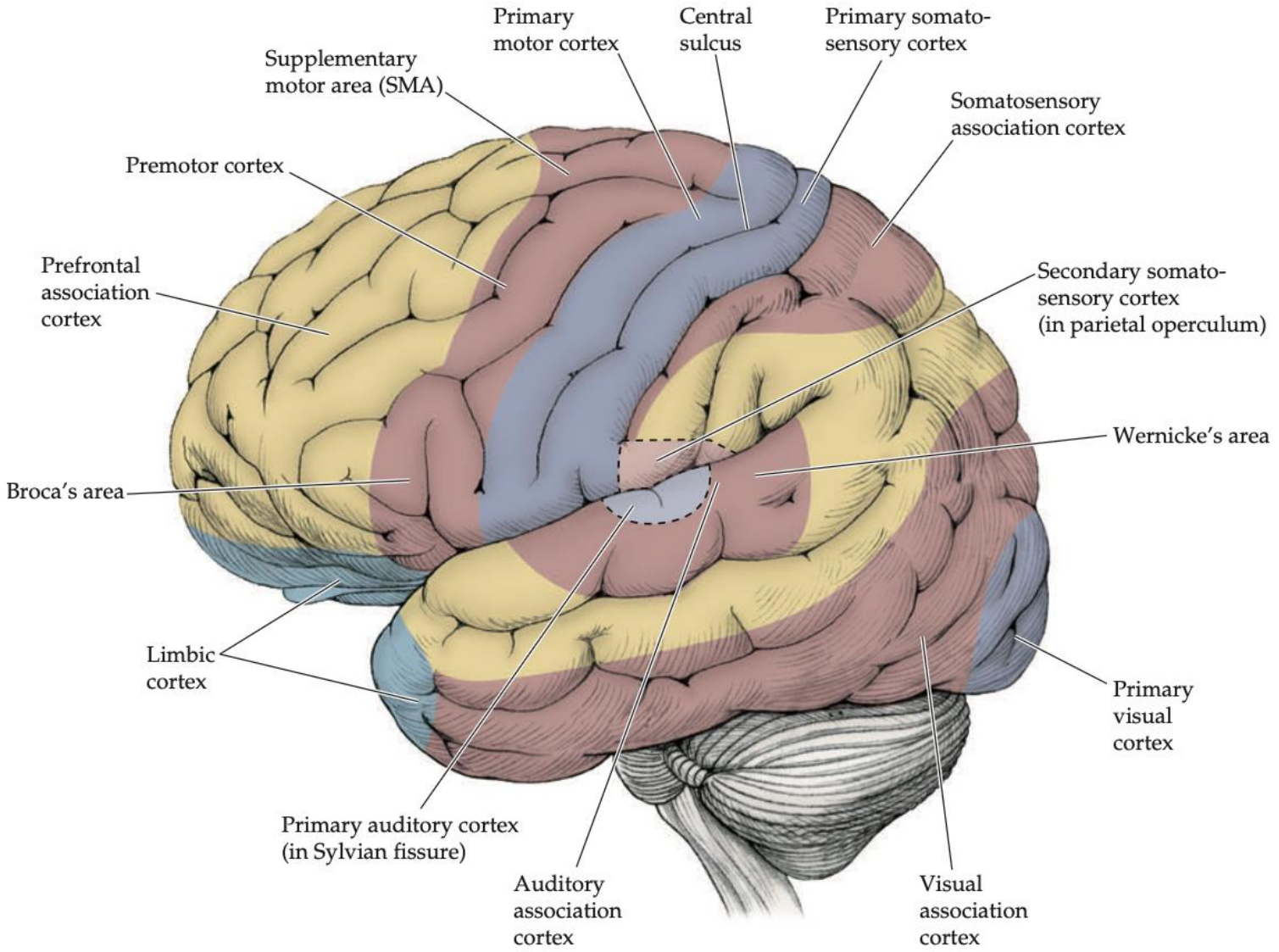
Damage to the neurons or tissue of the occipital lobe can lead to visual deficits such as partial or complete loss of vision, difficulty recognizing objects, and problems interpreting visual information.

Organization of cerebral cortex

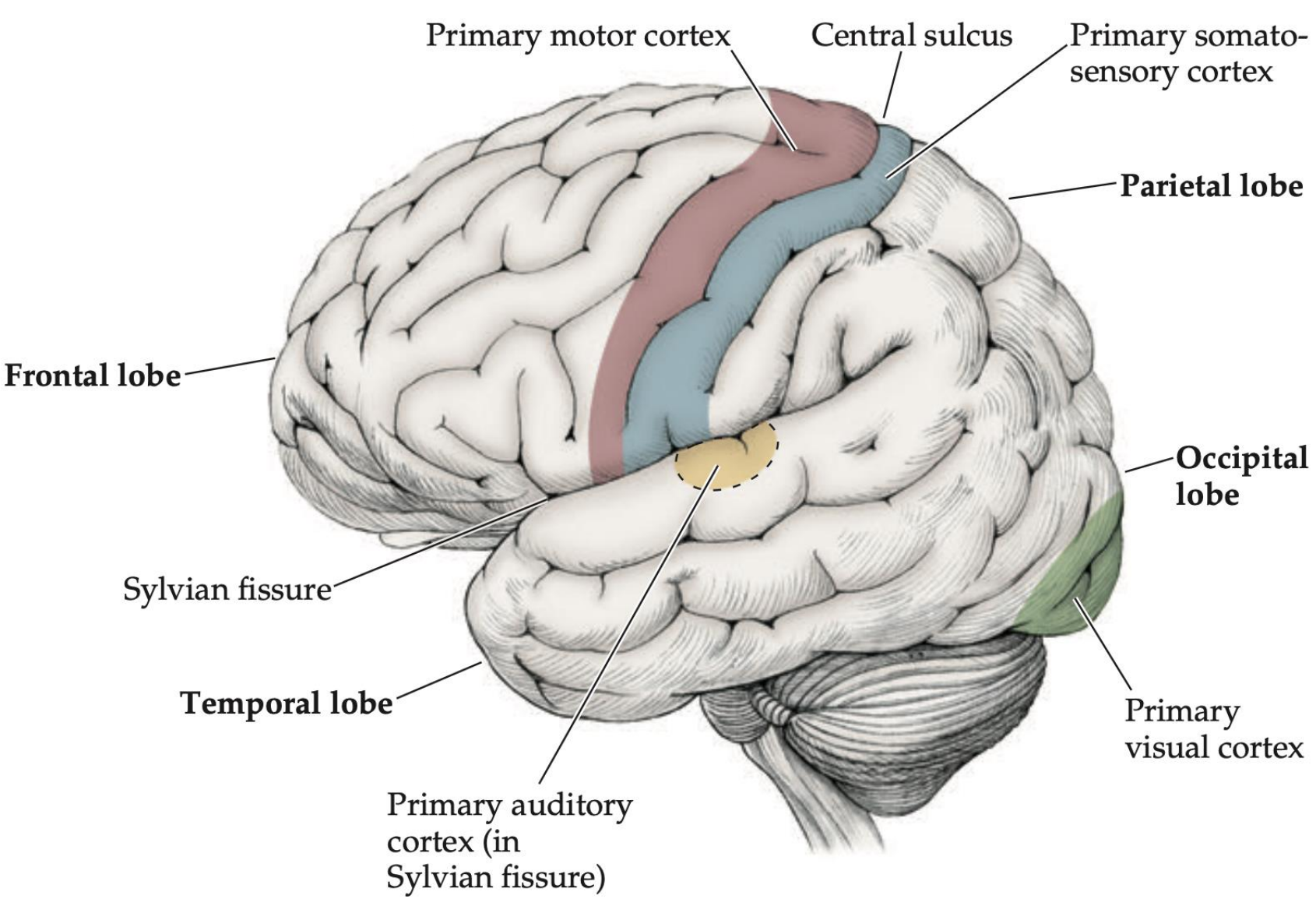


Primary Cortices

- Primary motor or sensory cortex
- Unimodal association cortex
- Heteromodal association cortex
- Limbic cortex



Primary Cortices



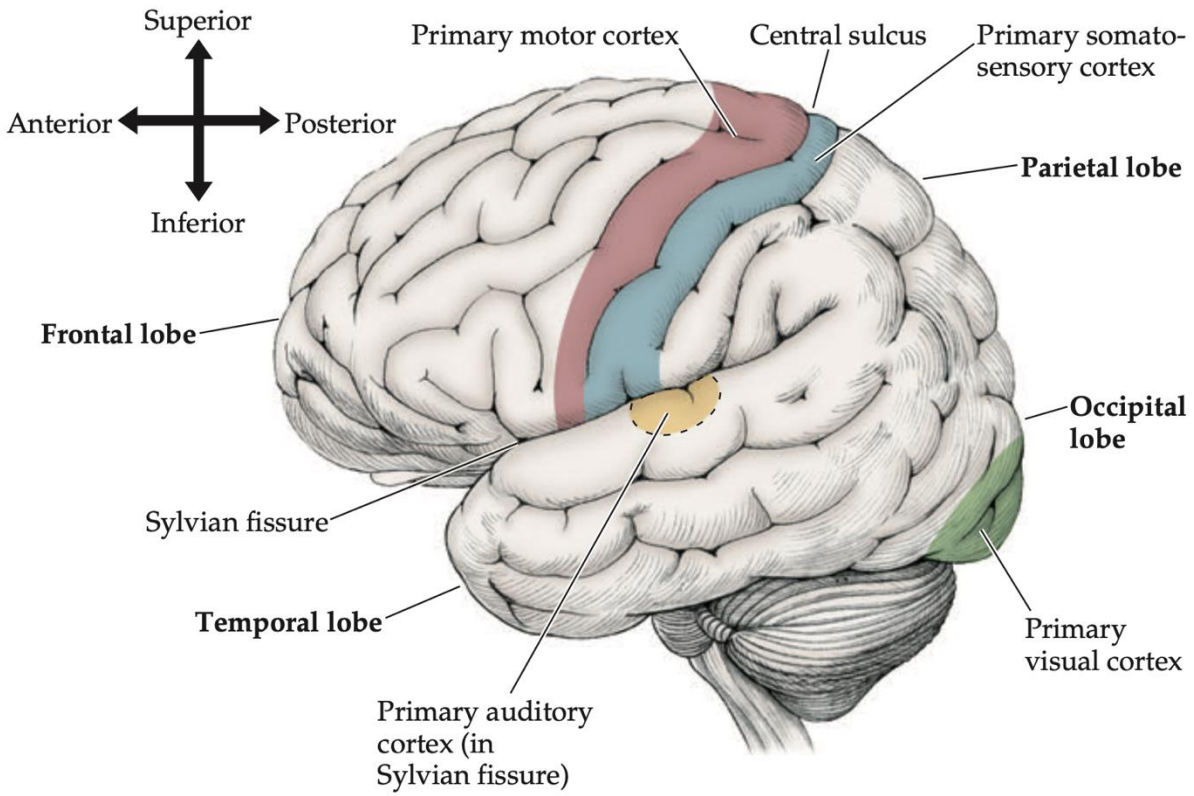
The primary motor cortex lies in the precentral gyrus in the frontal lobe. This area controls movement of the opposite side of the body.

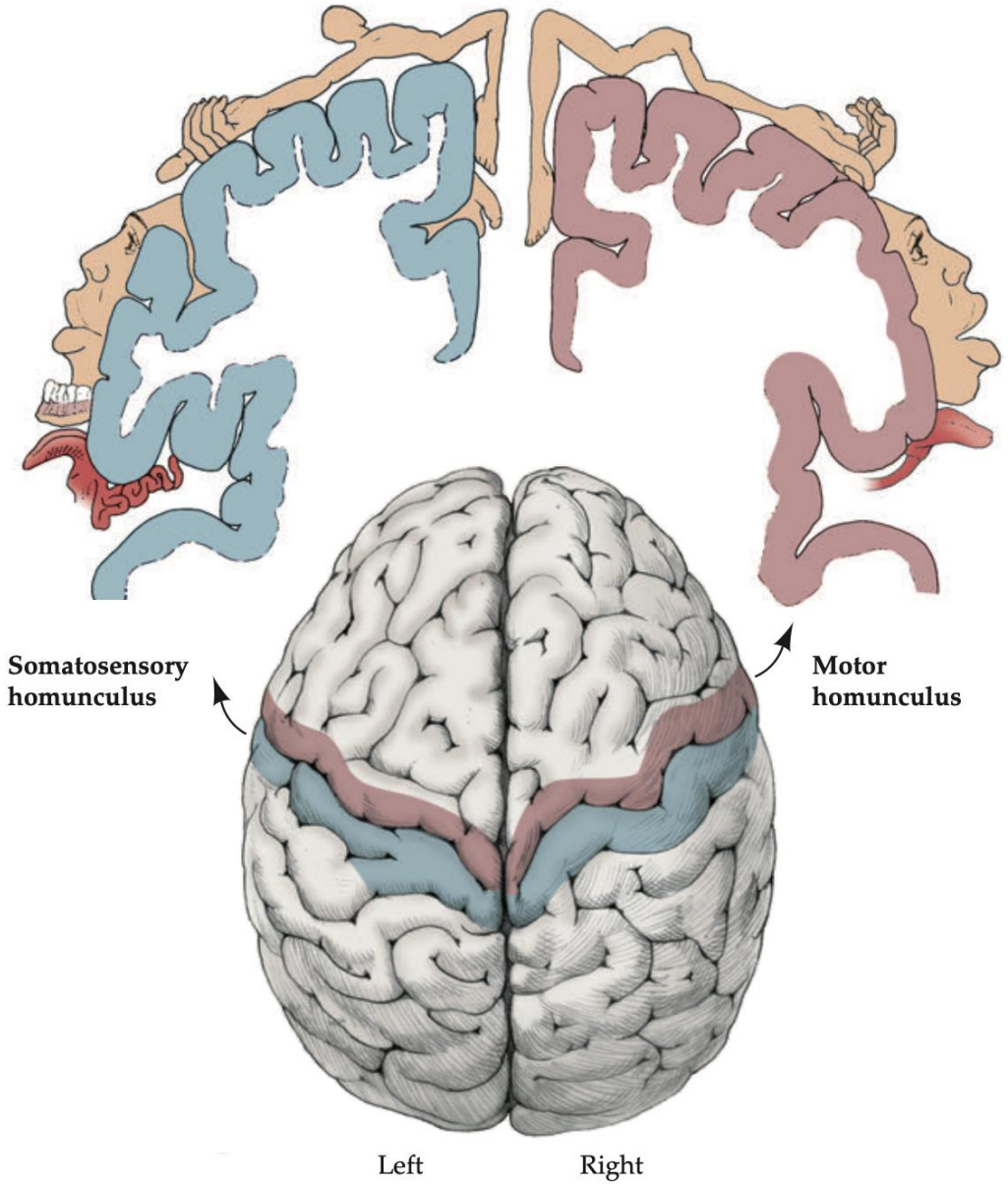
The primary somatosensory cortex is in the postcentral gyrus in the parietal lobe and is involved in sensation for the opposite side of the body.

The primary visual cortex is in the occipital lobes along the banks of a deep sulcus called the calcarine fissure

The primary auditory cortex is composed of the transverse gyri of Heschl, which are two fingerlike gyri that lie inside the Sylvian fissure on the superior surface of each temporal lobe.

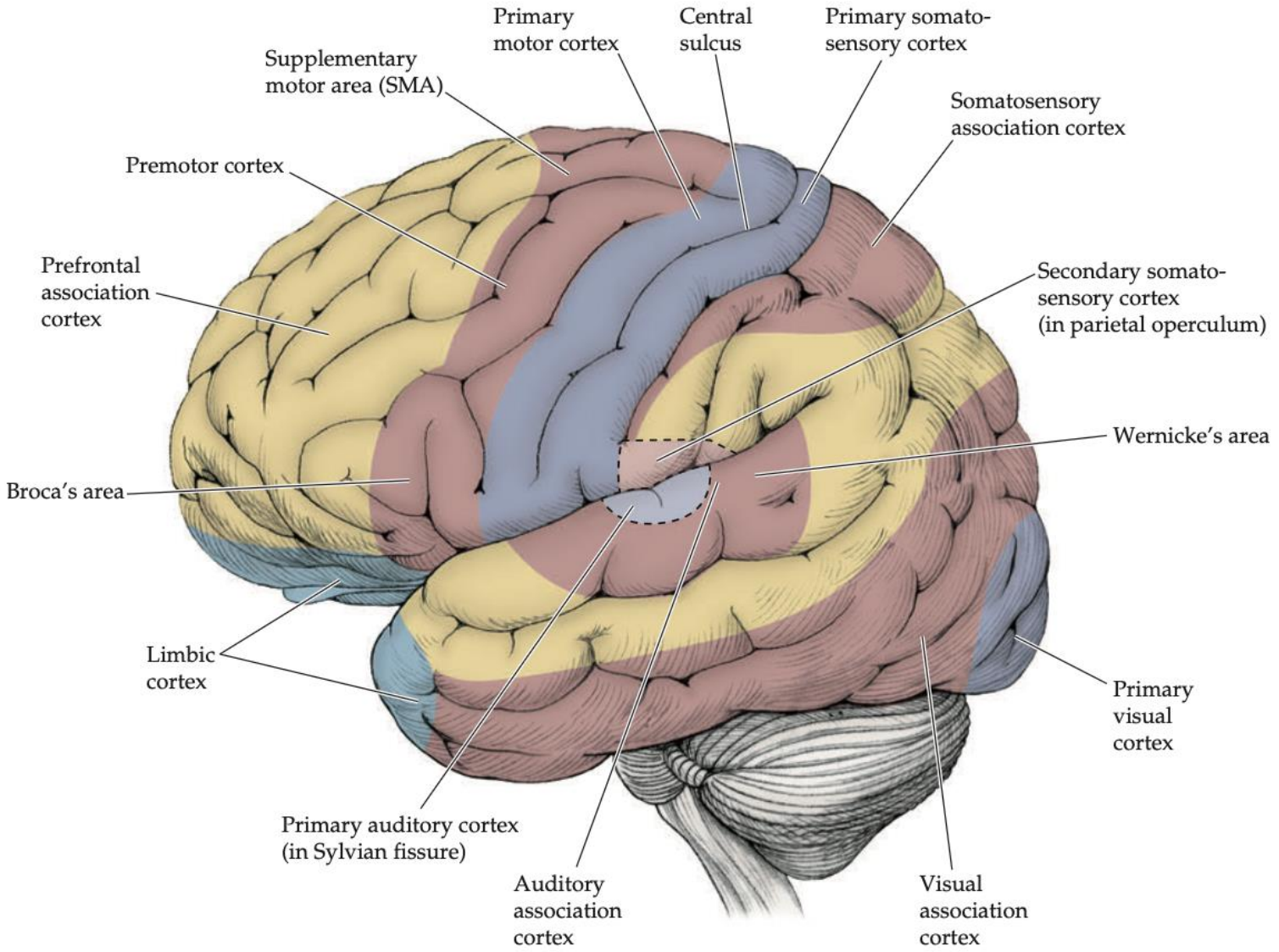
Somatotopic Maps in the Cortex



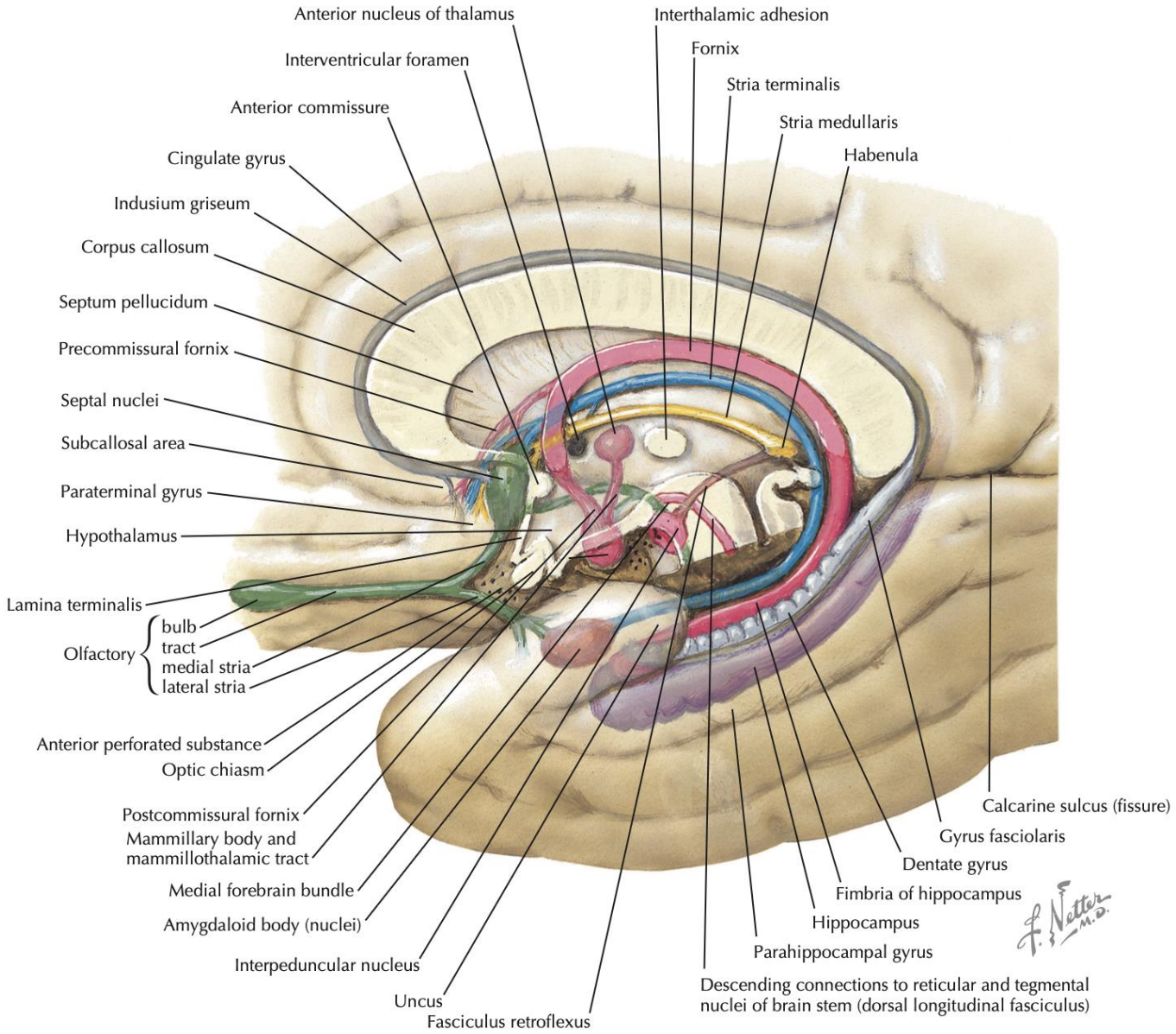


Limbic system

- Primary motor or sensory cortex
- Unimodal association cortex
- Heteromodal association cortex
- Limbic cortex



Limbic system



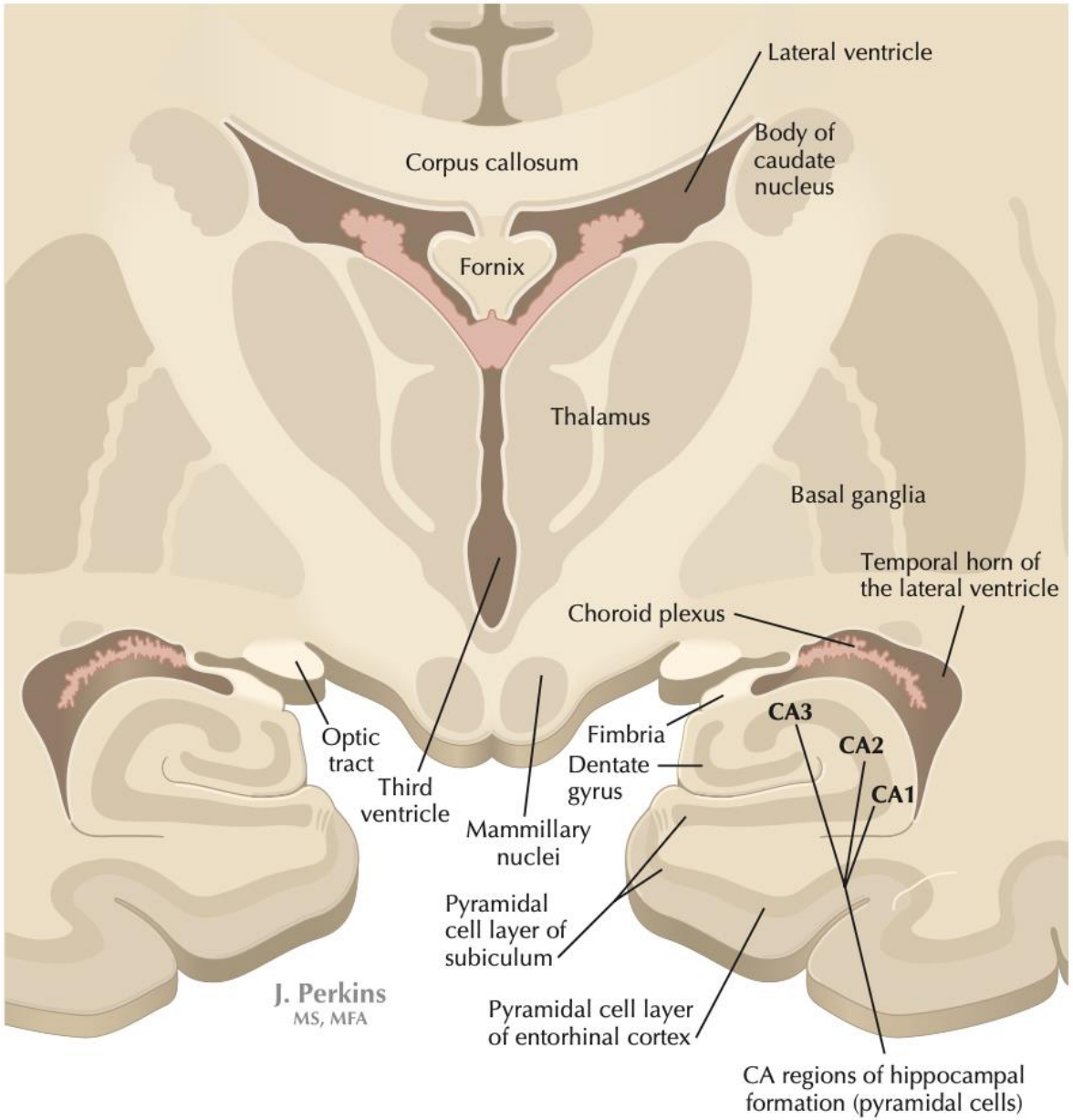
The hippocampal formation with its fornix and the amygdala with its stria terminalis, send C-shaped axonal projections through the forebrain, around the diencephalon, and into the hypothalamus and septal region.

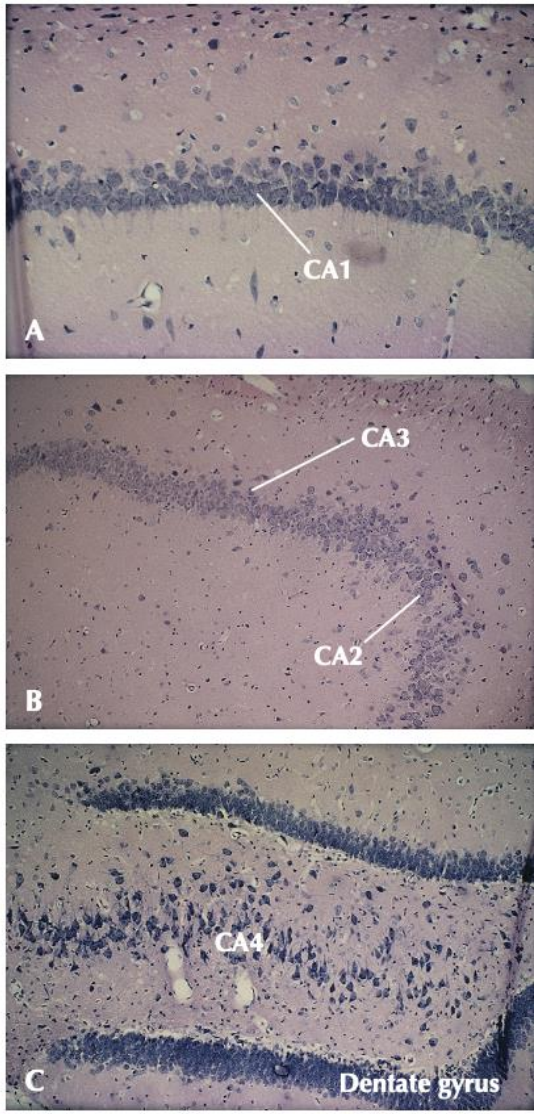
The amygdala also has a more direct pathway (the ventral amygdalofugal pathway) into the hypothalamus.

The septal nuclei sit just rostral to the hypothalamus and send axons to the habenular nuclei via the stria medullaris thalami.

The cingulate, prefrontal, orbitofrontal, entorhinal, and periamygdaloid areas of the cortex interconnect with subcortical and hippocampal components of the limbic forebrain and are often considered part of the limbic system.

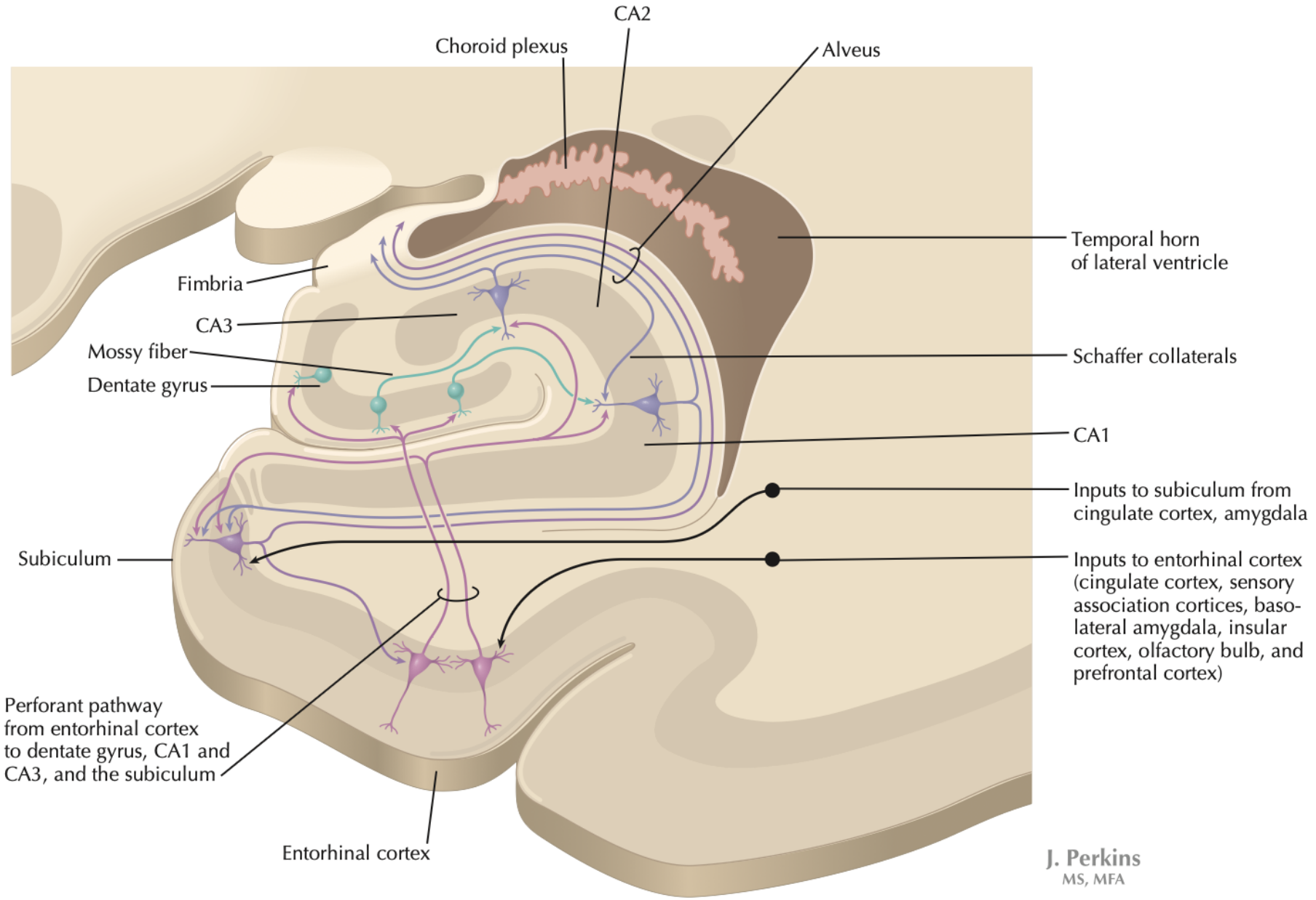
Limbic system: hippocampal formation





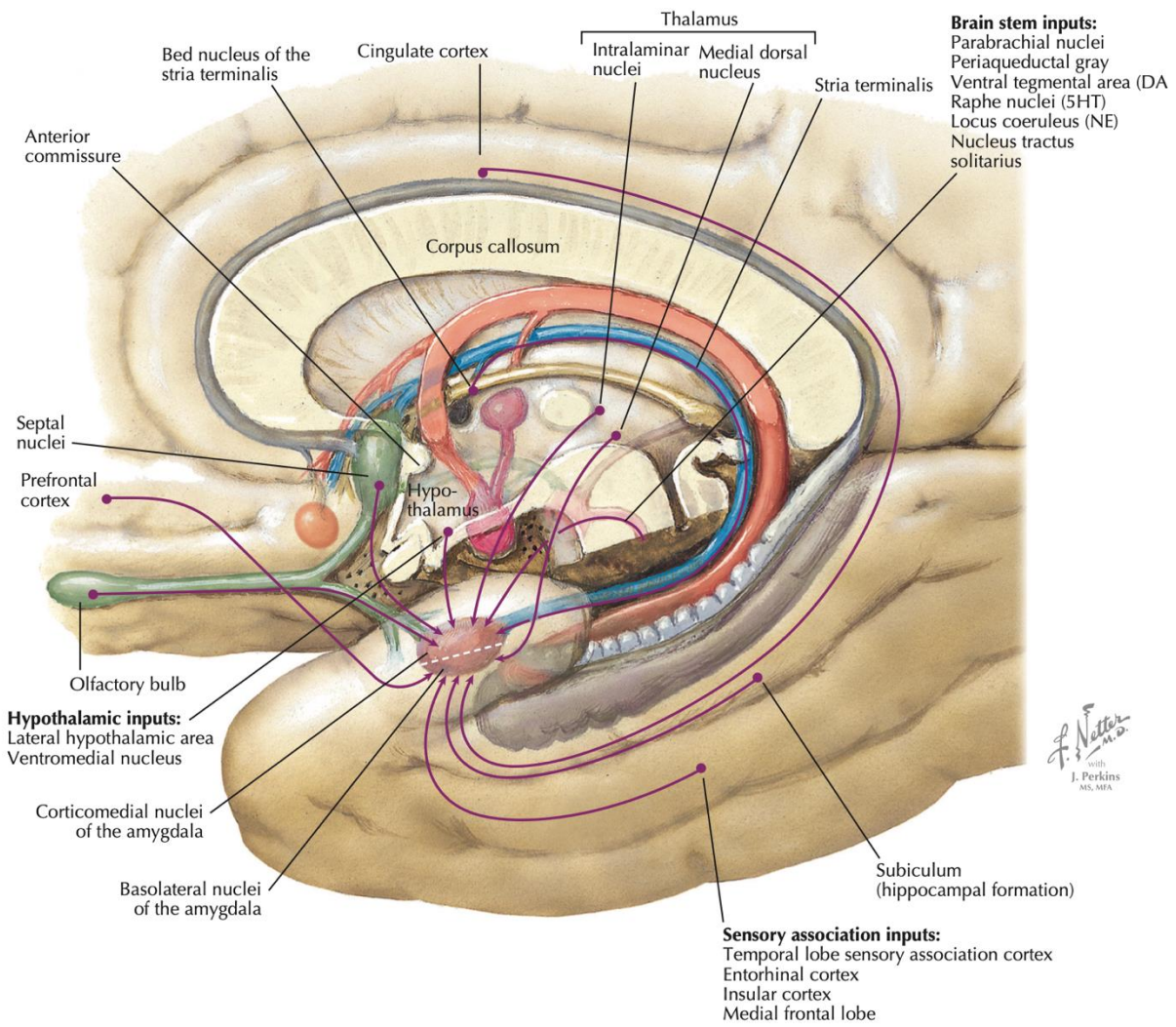
Hippocampal pyramidal neurons in CA1 (**A**), CA2 and CA3 (**B**) and CA4 (**C**) sectors of the hippocampus, and granule cells in the dentate gyrus (**C**). Cell stain.

Limbic system: hippocampal formation's connections

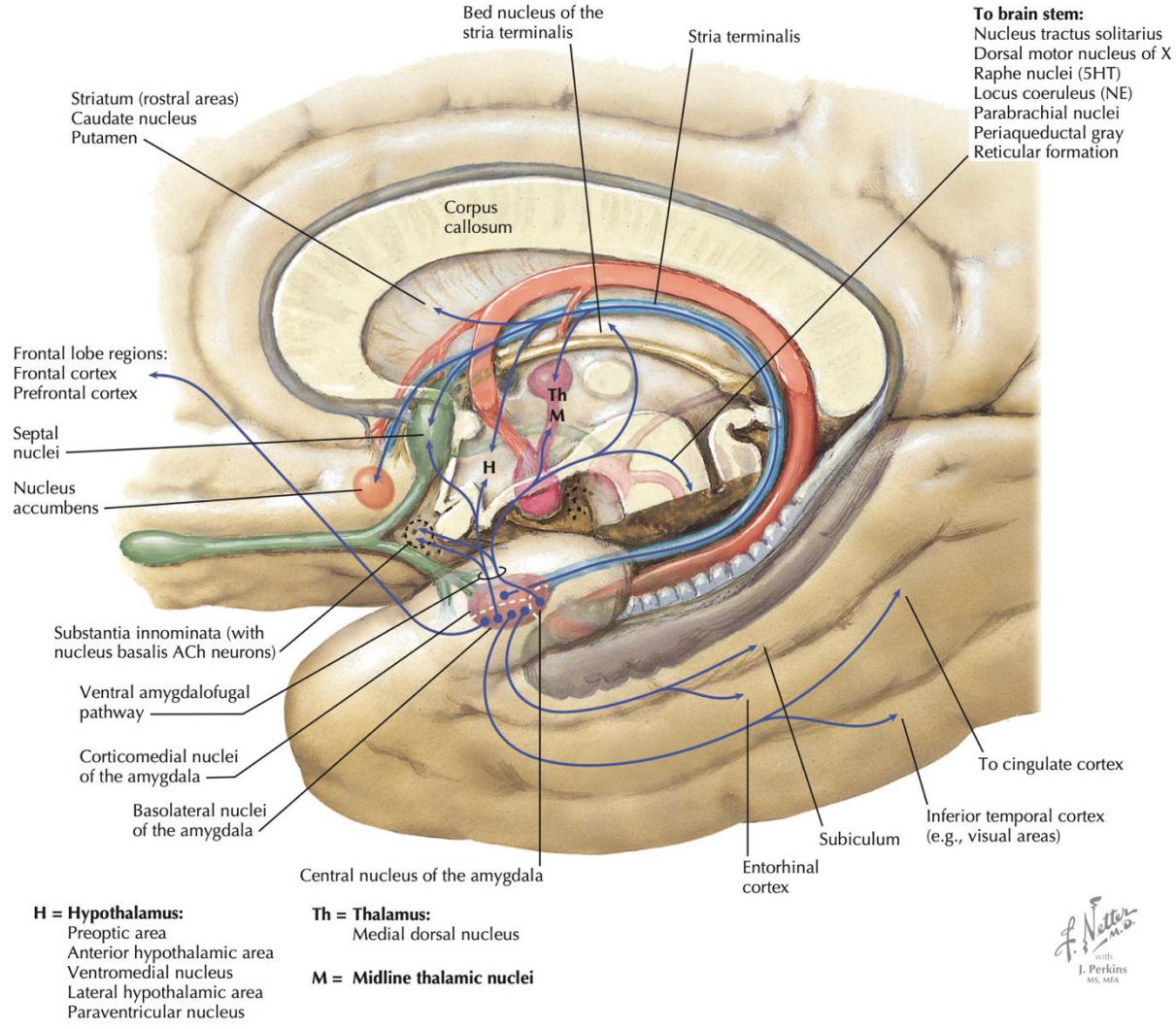


Limbic system: amygdala

MAJOR AFFERENT CONNECTIONS OF AMYGDALA



MAJOR EFFERENT CONNECTIONS OF AMYGDALA



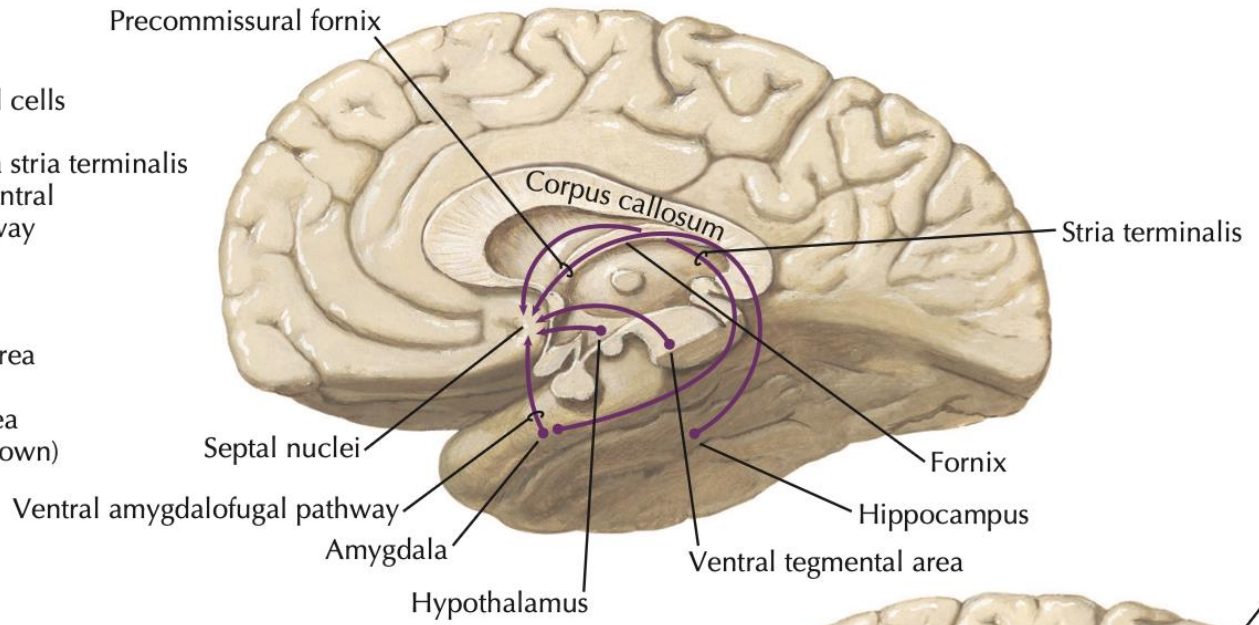
Limbic system: septal nuclei

AFFERENTS

Major afferents from:
Hippocampal CA pyramidal cells
Amygdaloid nuclei
- Corticomedial nuclei via stria terminalis
- Basolateral nuclei via ventral amygdalofugal pathway

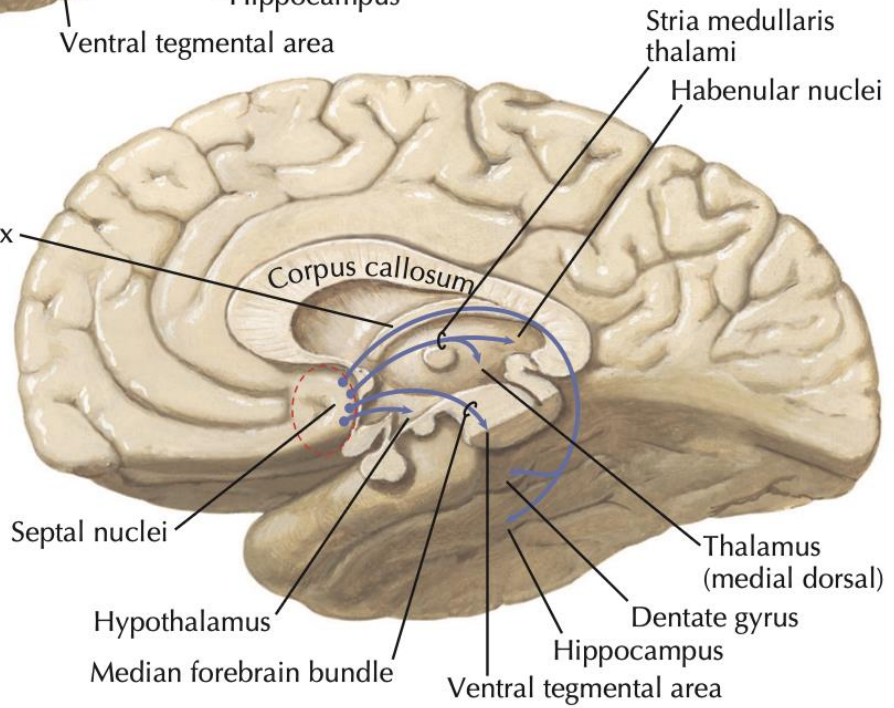
Ventral tegmental area
Hypothalamus
- Preoptic area
- Anterior hypothalamic area
- Paraventricular nucleus
- Lateral hypothalamic area

Locus coeruleus (NE; not shown)



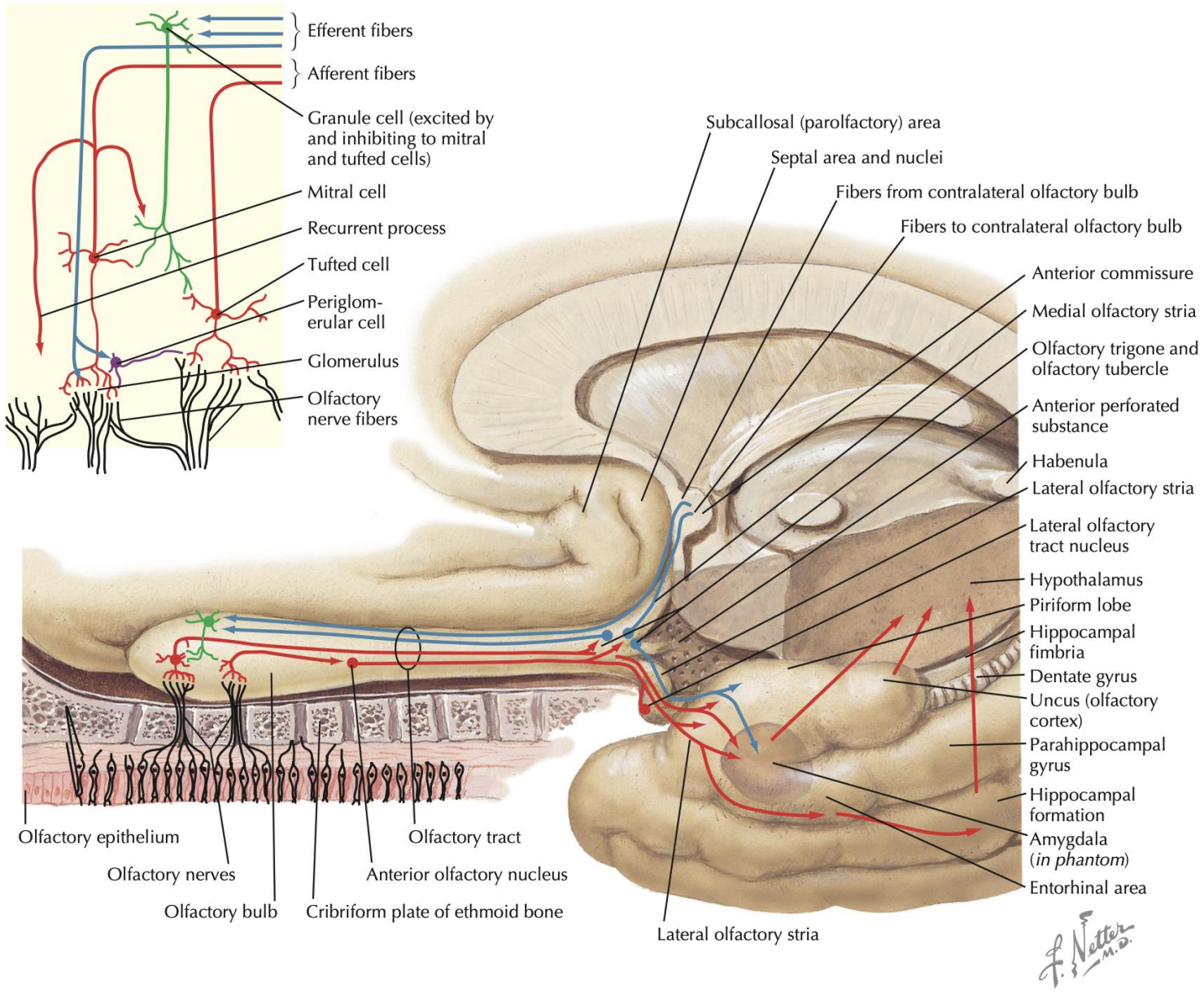
EFFERENTS

Major efferents to:
- Hippocampal CA regions, Dentate gyrus (ACh path) — Via fornix
- Habenular nuclei, Medial dorsal nucleus of the thalamus — Via stria medullaris thalami
- Ventral tegmental area — Via median forebrain bundle
- Hypothalamus
  - Preoptic area
  - Anterior hypothalamic area
  - Ventromedial nucleus
  - Lateral hypothalamic area

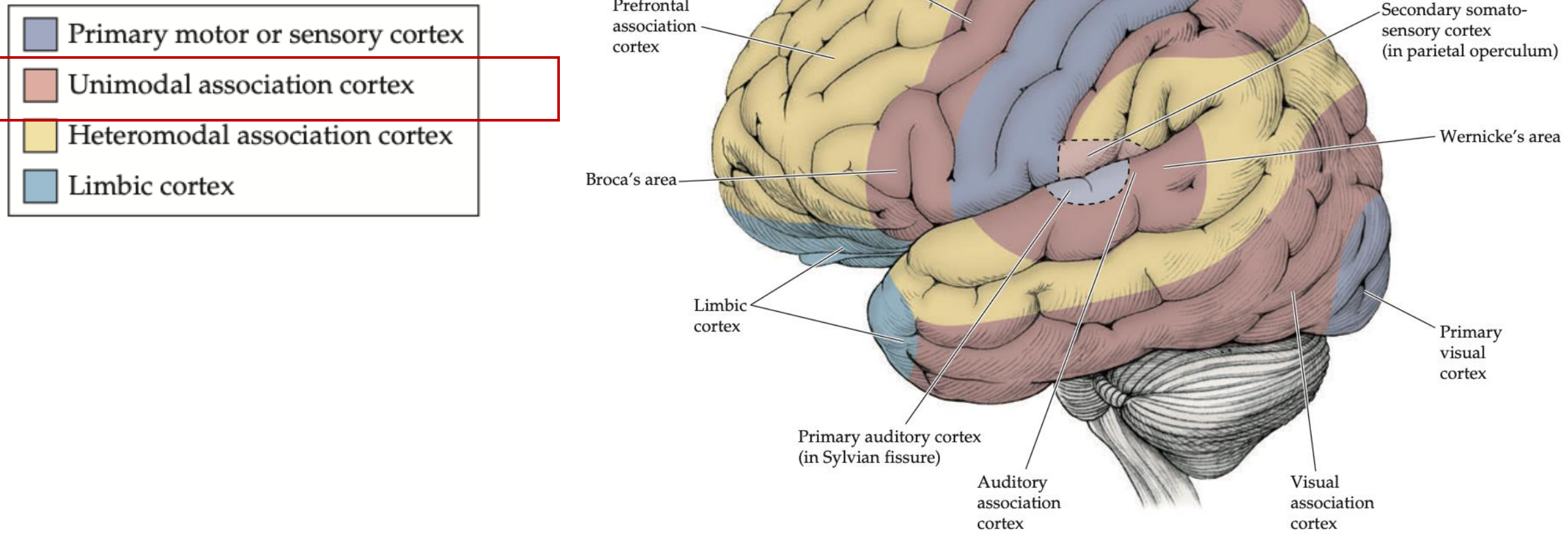


F. Netter M.D.
with
J. Perkins
MS, MFA

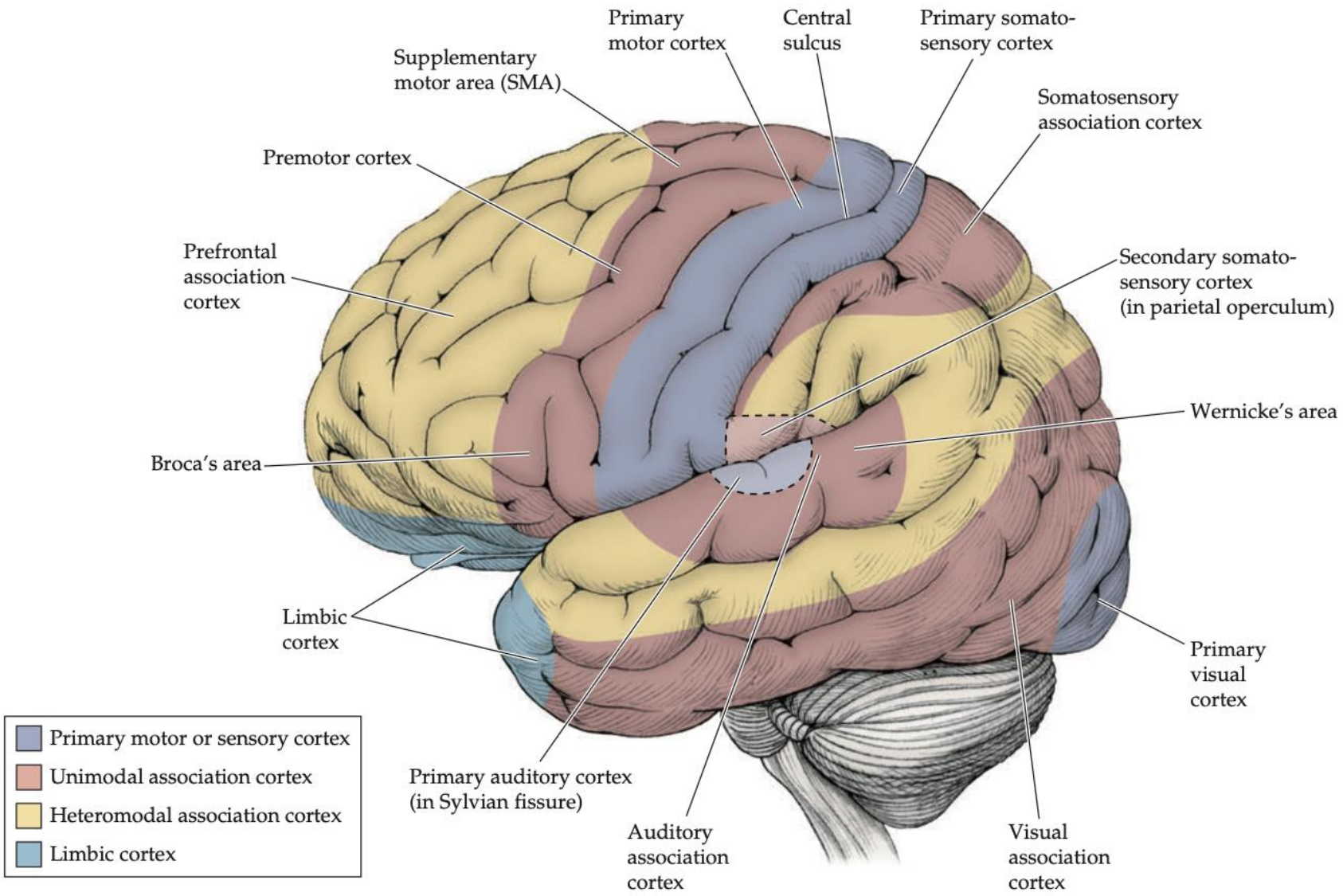
Limbic system: olfactory tract



Unimodal association cortex

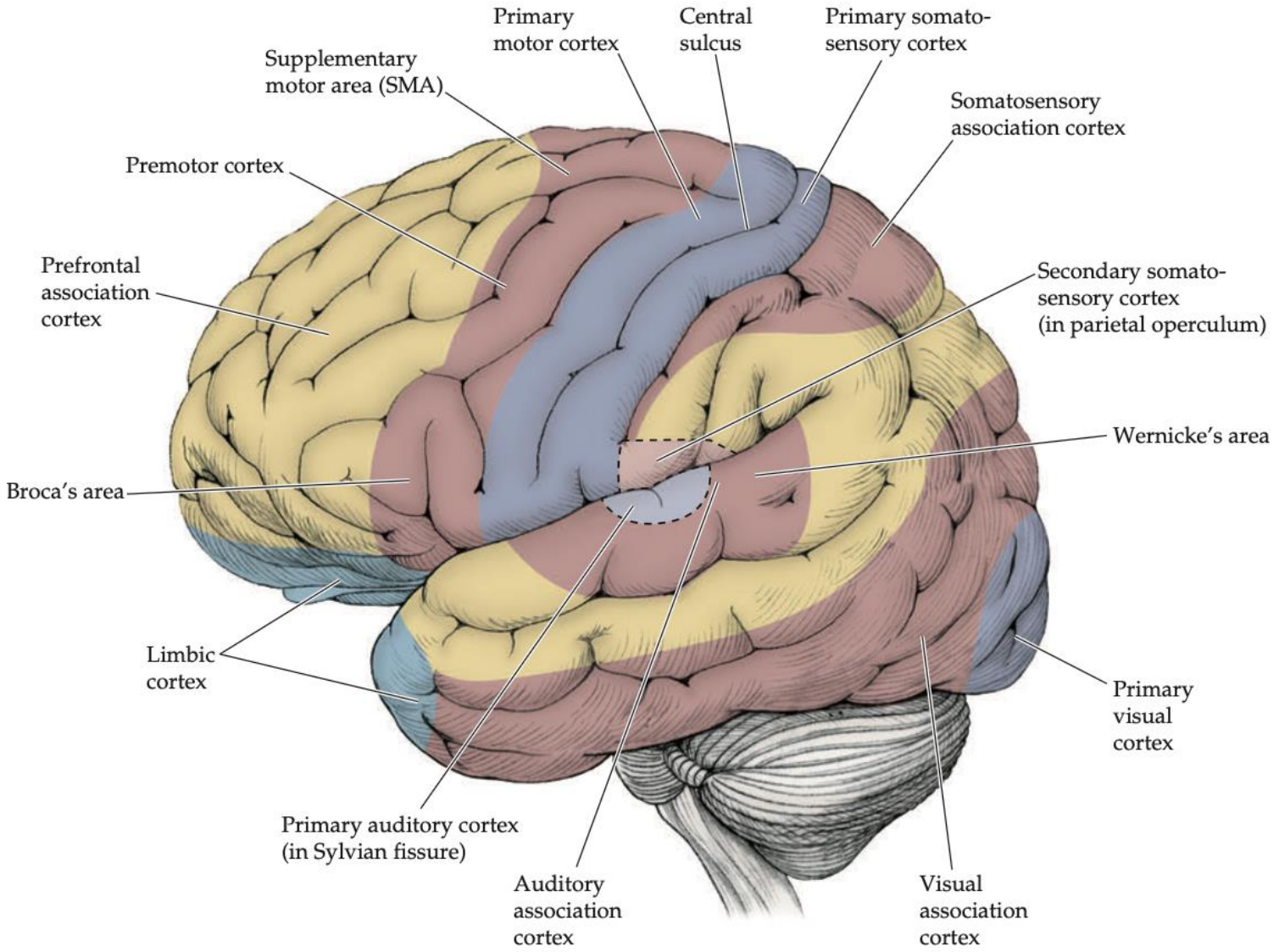


Unimodal association cortices

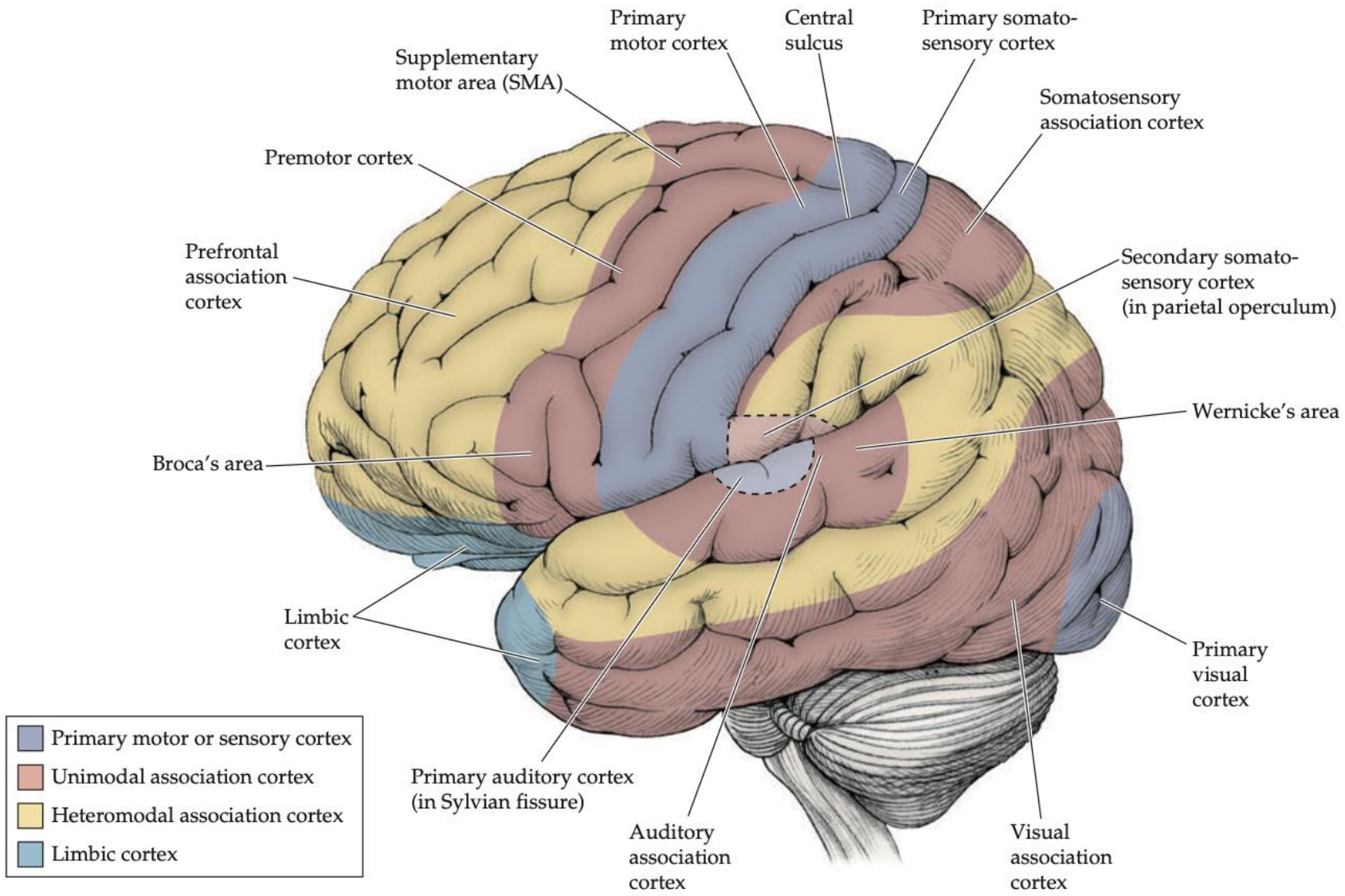


Heteromodal association cortex

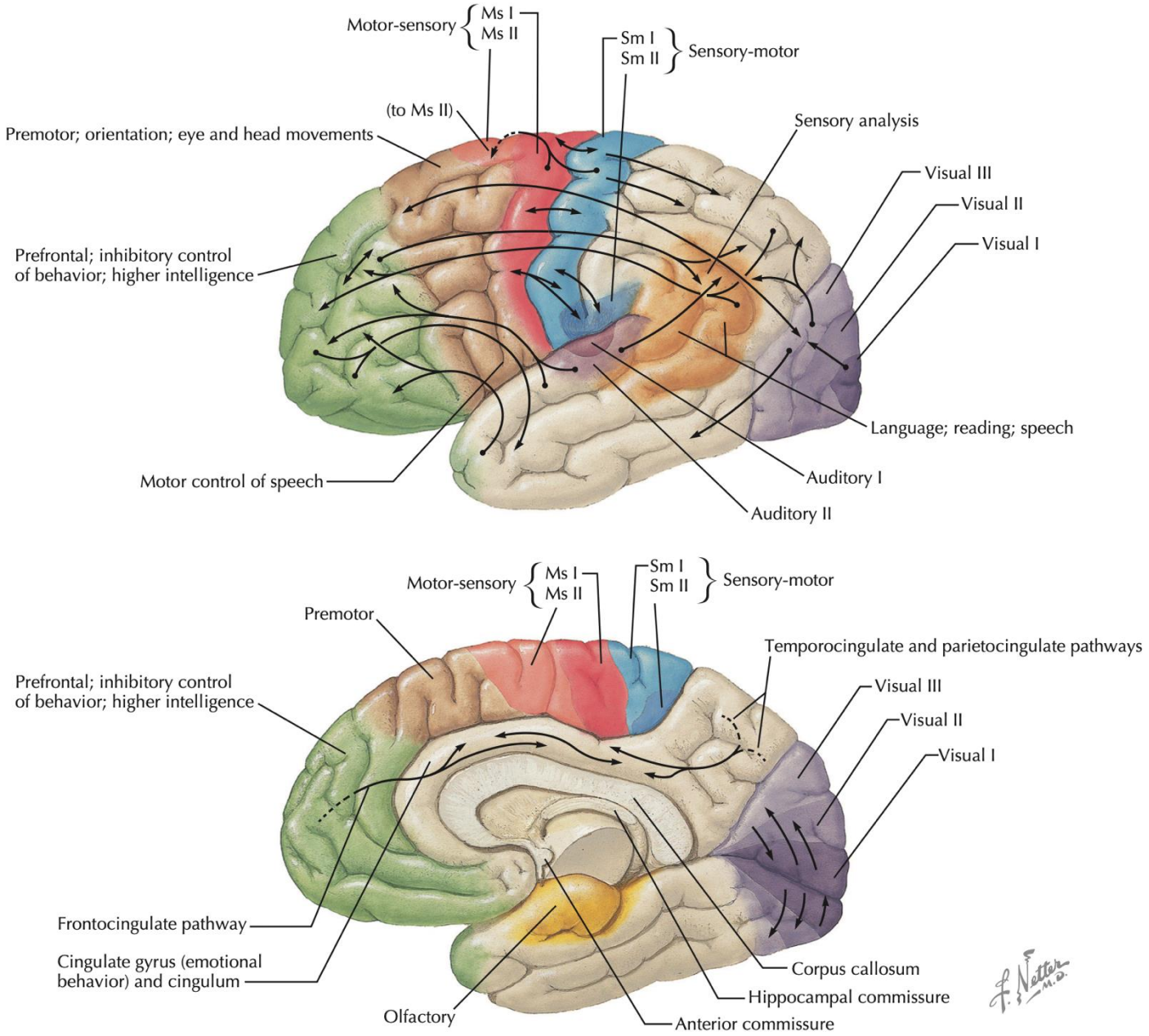
Primary motor or sensory cortex
Unimodal association cortex
Heteromodal association cortex
Limbic cortex



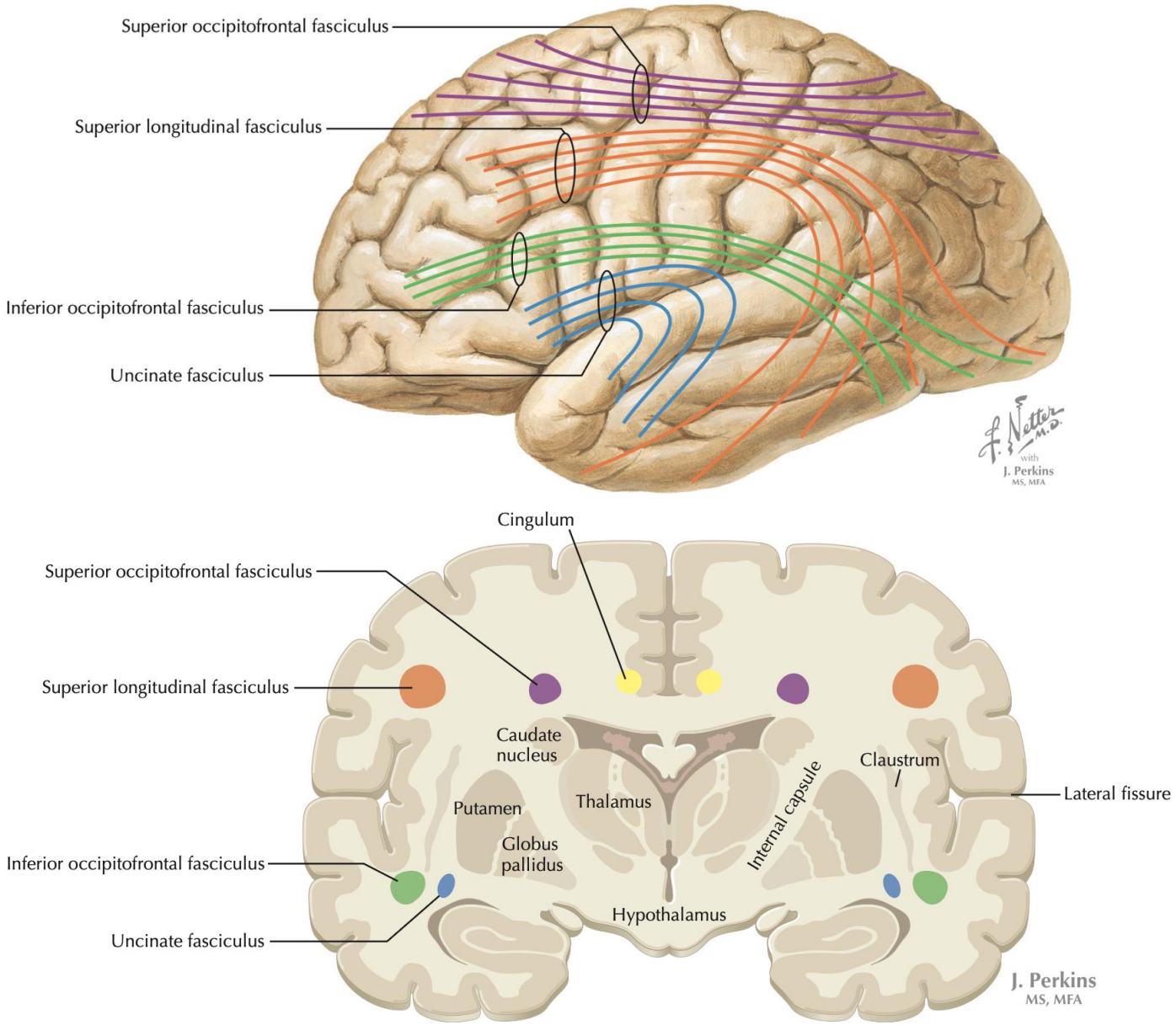
Heteromodal association cortices



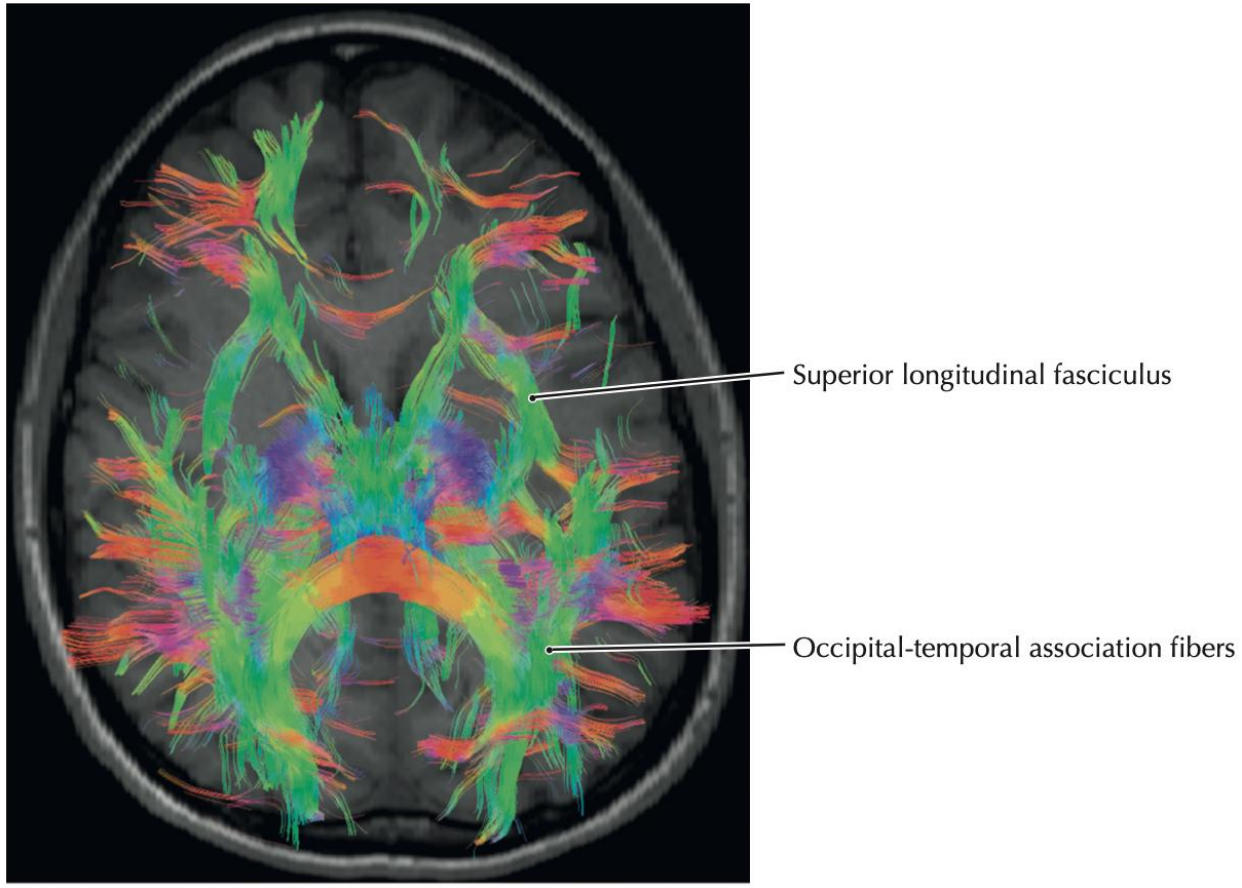
Cortical association pathways

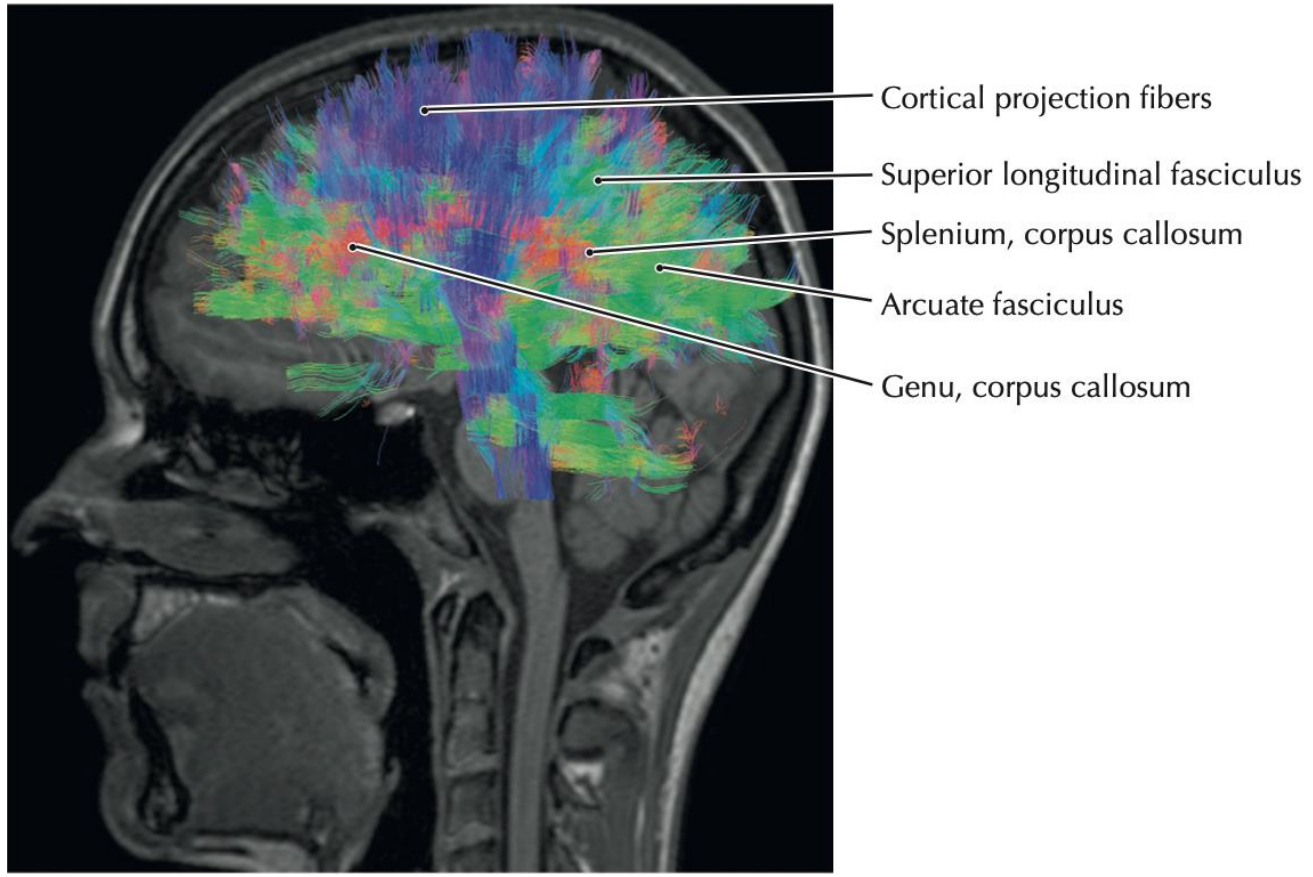


Major cortical association bundles

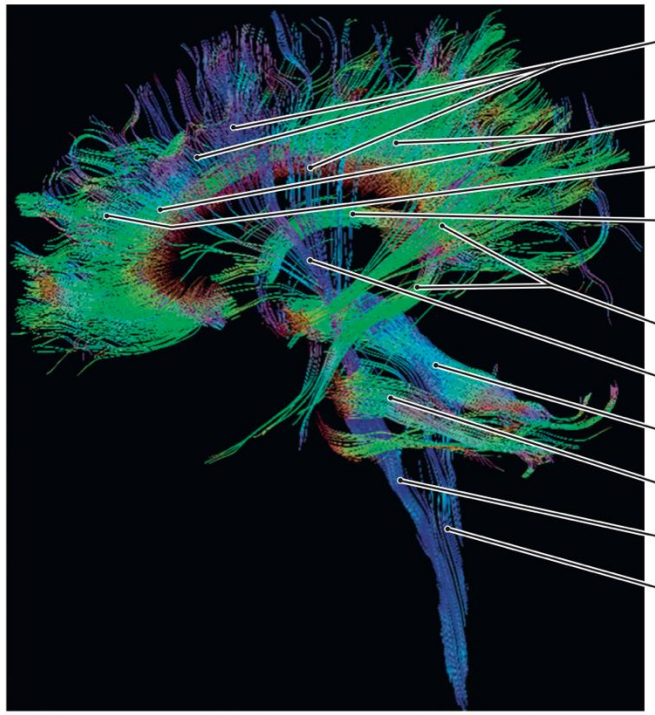


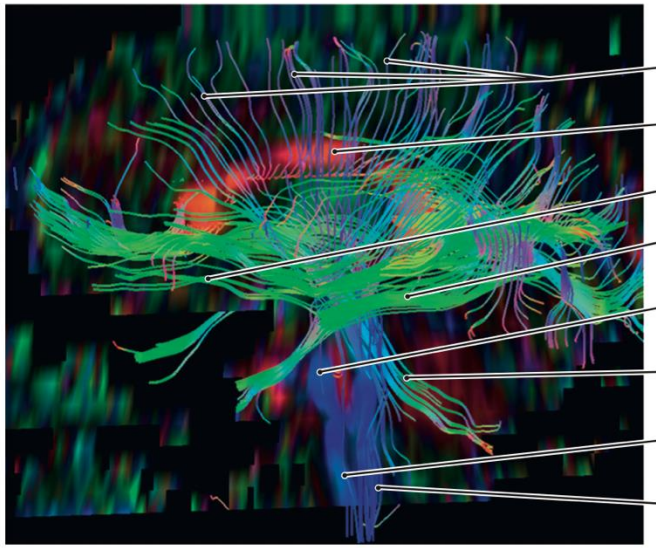
Cortical projection bundles



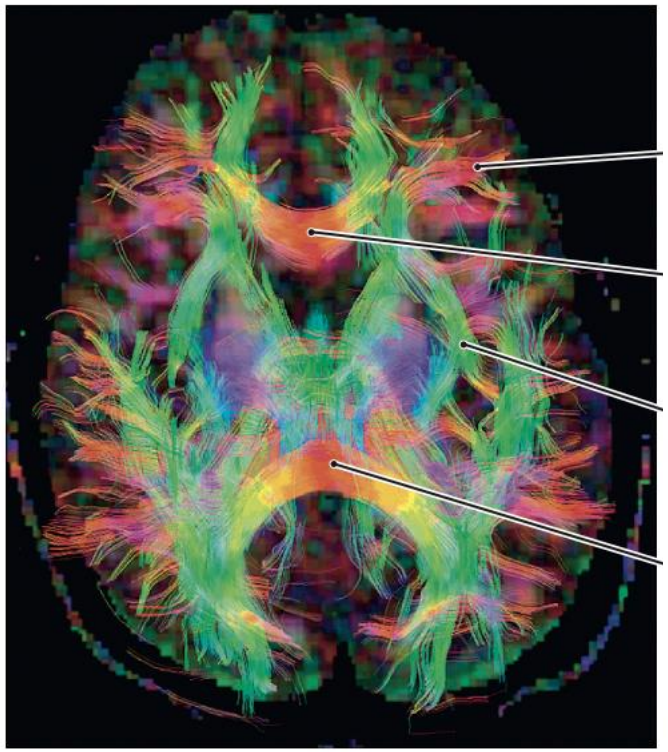


Cortical projection bundles

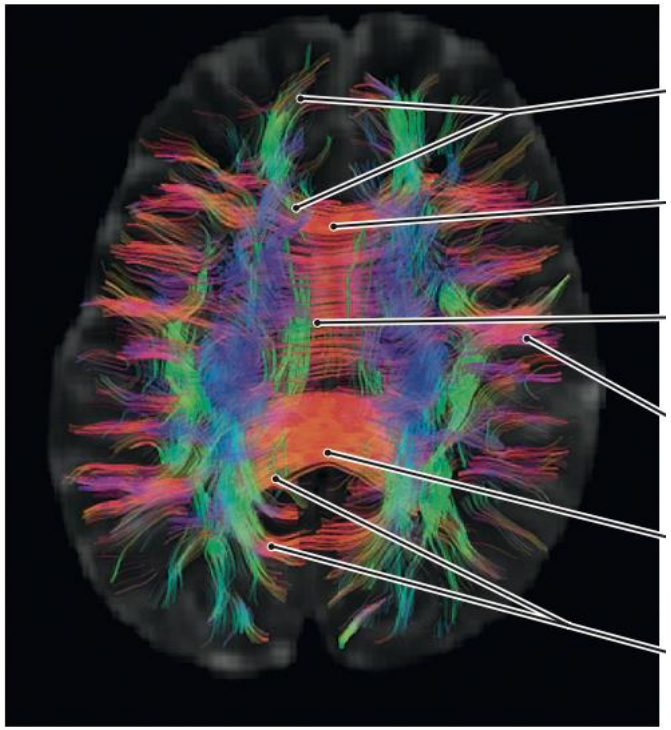




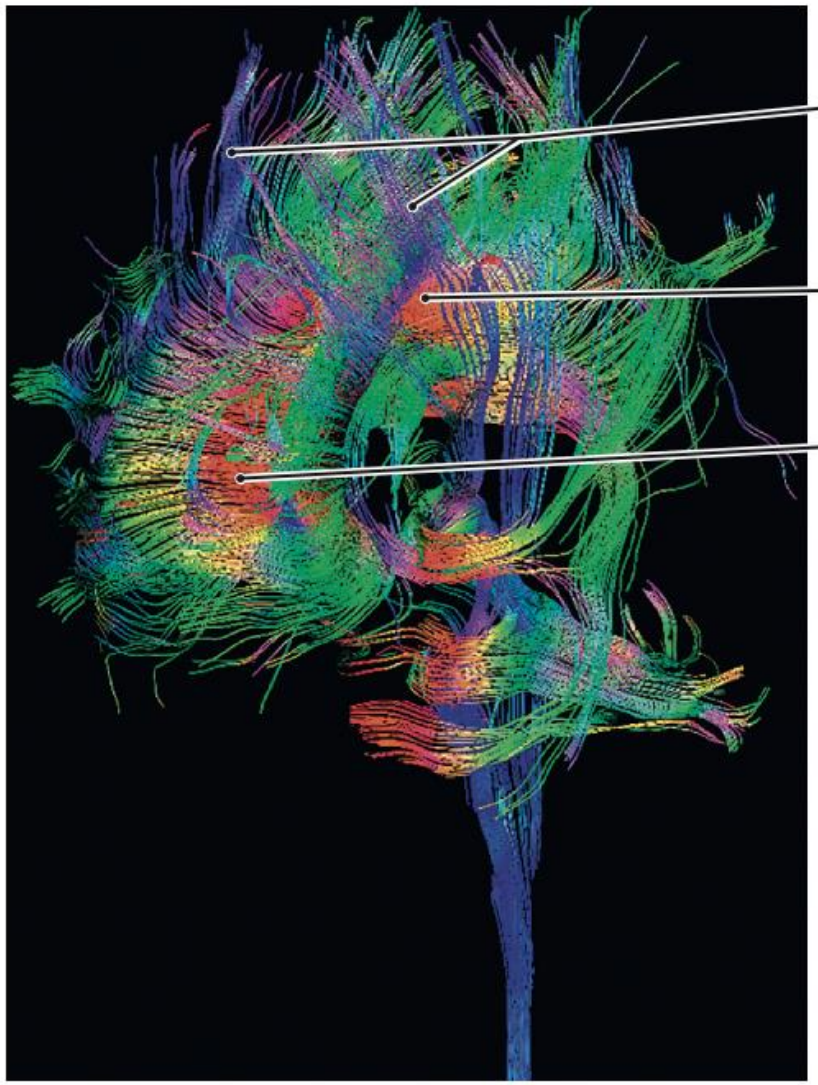
Cortical projection bundles: corpus callosum



A. Axial view

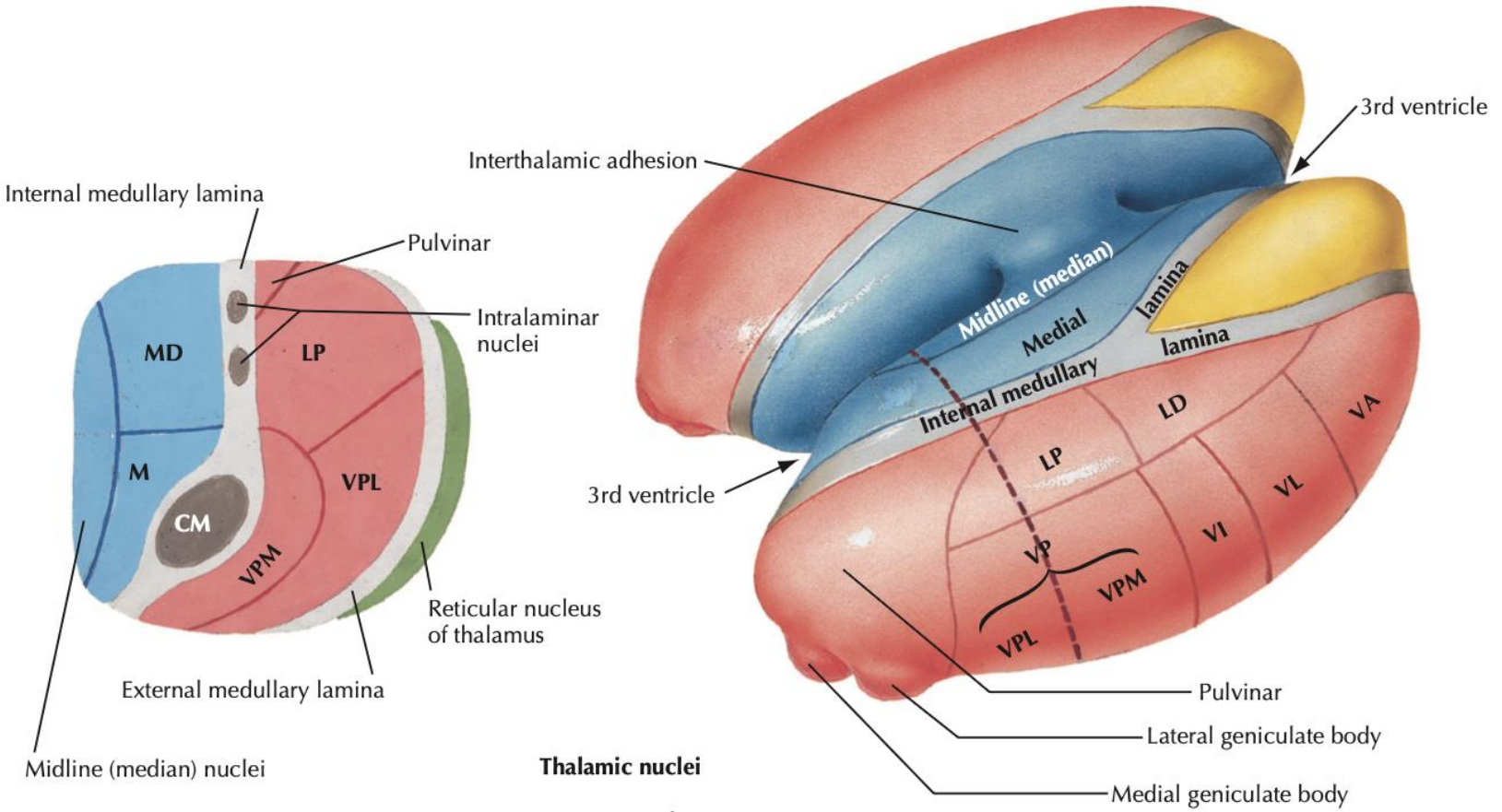


C. Axial view



B. Oblique sagittal view

Thalamic anatomy



Schematic section through thalamus
(at level of broken line shown in figure at right)

Thalamic nuclei

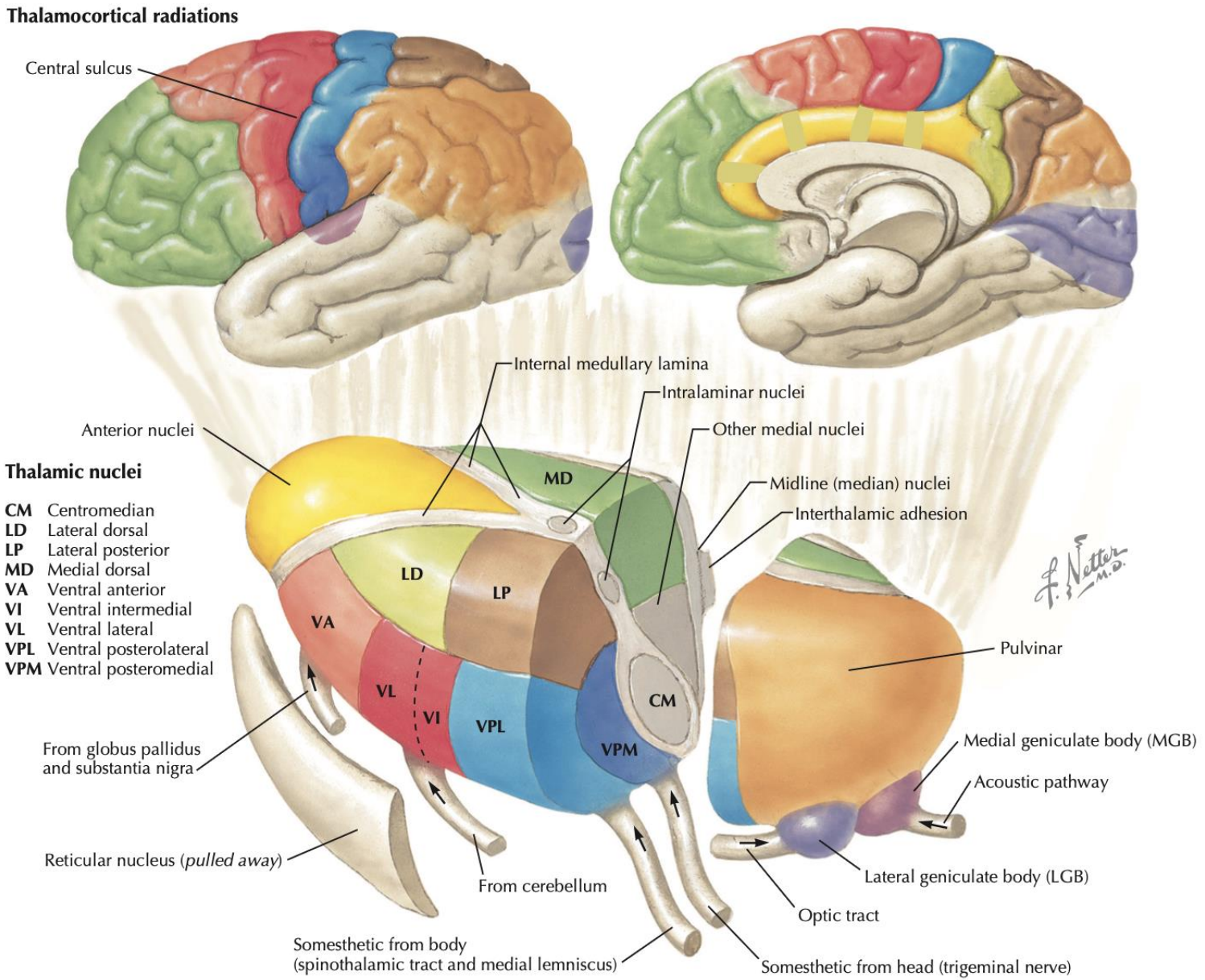
CM	Centromedian
LD	Lateral dorsal
LP	Lateral posterior
M	Medial group
MD	Medial dorsal
VA	Ventral anterior
VI	Ventral intermedial
VL	Ventral lateral
VP	Ventral posterior (ventrodorsal)
VPL	Ventral posterolateral
VPM	Ventral posteromedial

Schematic representation of thalamus
(external medullary lamina and reticular nuclei removed)

Lateral cell mass
Medial cell mass
Anterior cell mass

F. Netter M.D.

Thalamus: gateway to the cerebral cortex



1. Sensory projection nuclei -> VPL: somatosensory; VPM: tri-geminal; LGB: visual; MGB: auditory; pulvinar: sensory);
2. Motor-related nuclei -> VL and VI: cerebellum; VA and VL: basal ganglia);
3. Autonomic- and limbic-related nuclei anterior and LD -> cingulate cortex; MD: frontal and cingulate cortex;
4. Nuclei related to association areas -> pulvinar and LP: parietal cortex.
5. Nonspecific thalamic nuclei -> intralaminar nuclei, such as CM, parafascicular, and medial VA, send diffuse connections to widespread regions of cerebral cortex and to other thalamic nuclei
6. The reticular nucleus of the thalamus helps to regulate the excitability of thalamic projection nuclei.

Thalamus’ lesions

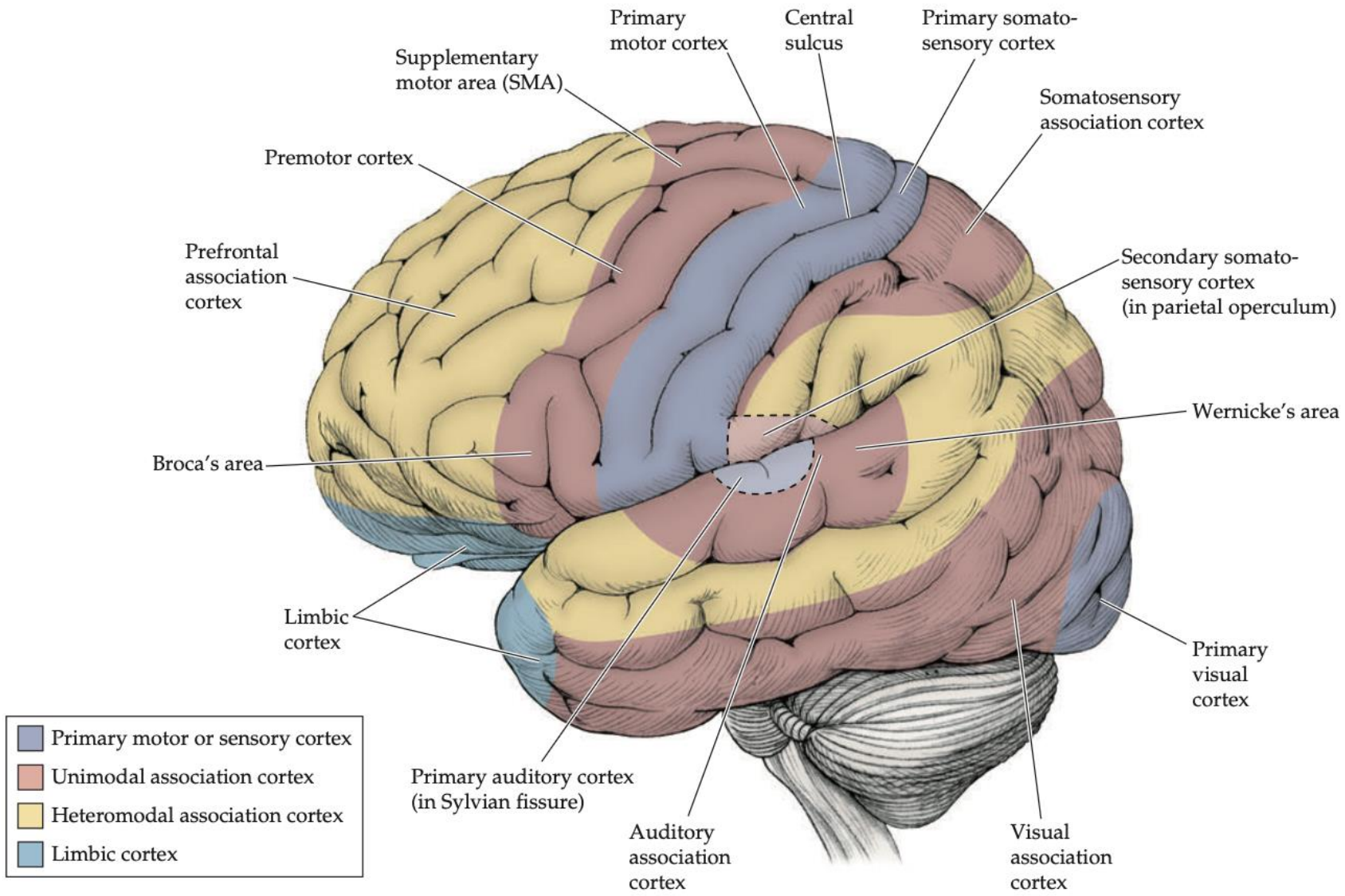
Lesions that affect one side of the thalamus seldom produce permanent deficits unless sensory nuclei are involved.
Thalamic lesions can result in:

- changes in consciousness and alertness (intralaminar, reticular nuclei);
- affective behavior (medial dorsal, ventral anterior, intralaminar nuclei);
- memory functions (midline, medial, mammillary, and possibly anterior nuclei);
- motor activity (ventrolateral, ventral anterior, posterior, other nuclei);
- somatic sensation (ventral posterolateral and posteromedial nuclei);
- vision (lateral geniculate nuclei);
- perceptions and hallucinations (dorsomedial, intralaminar nuclei)
- Medial dorsal lesions may produce a reciprocal disconnect with the prefrontal cortex and bring about a deficit in frontal functions.

Why are we studying all these structures?

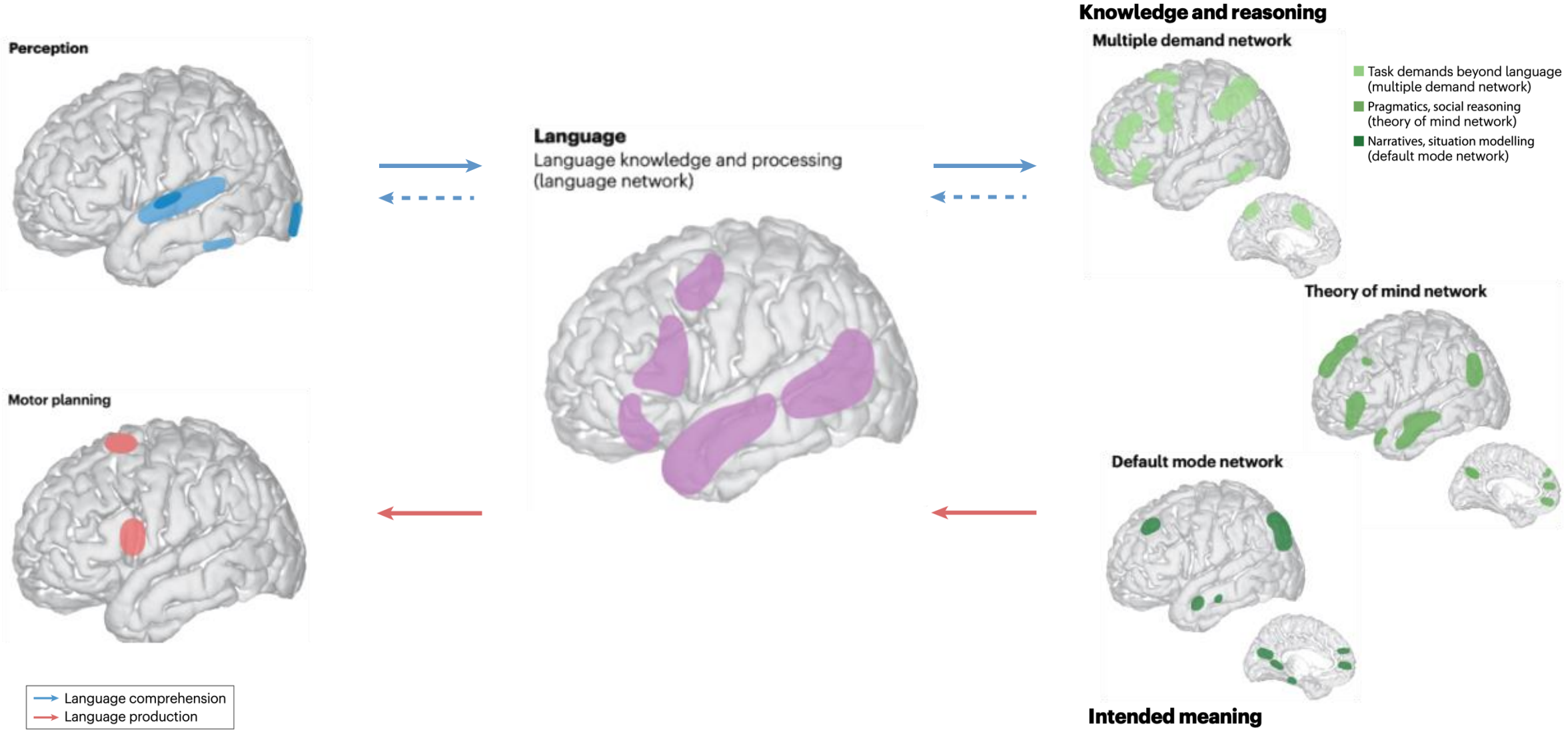
Which higher functions do they give rise to?

Heteromodal association cortices



Language

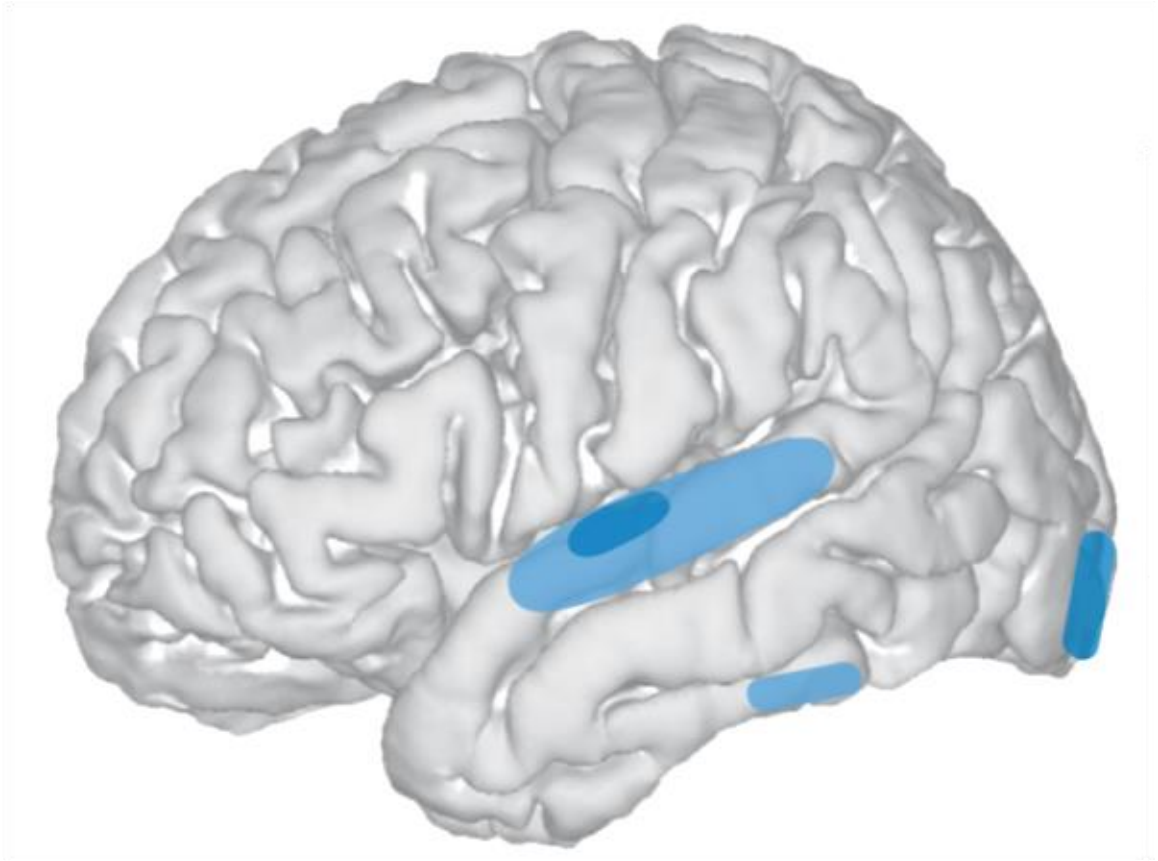
Language is key to communication, and as a result, the brain has evolved complex neural pathways to process and reply to written and spoken word.



Fedorenko , Nat Rev Neurosci, 2024

Language

Perception
Perception of the surface properties of linguistic input (for instance, speech perception area)

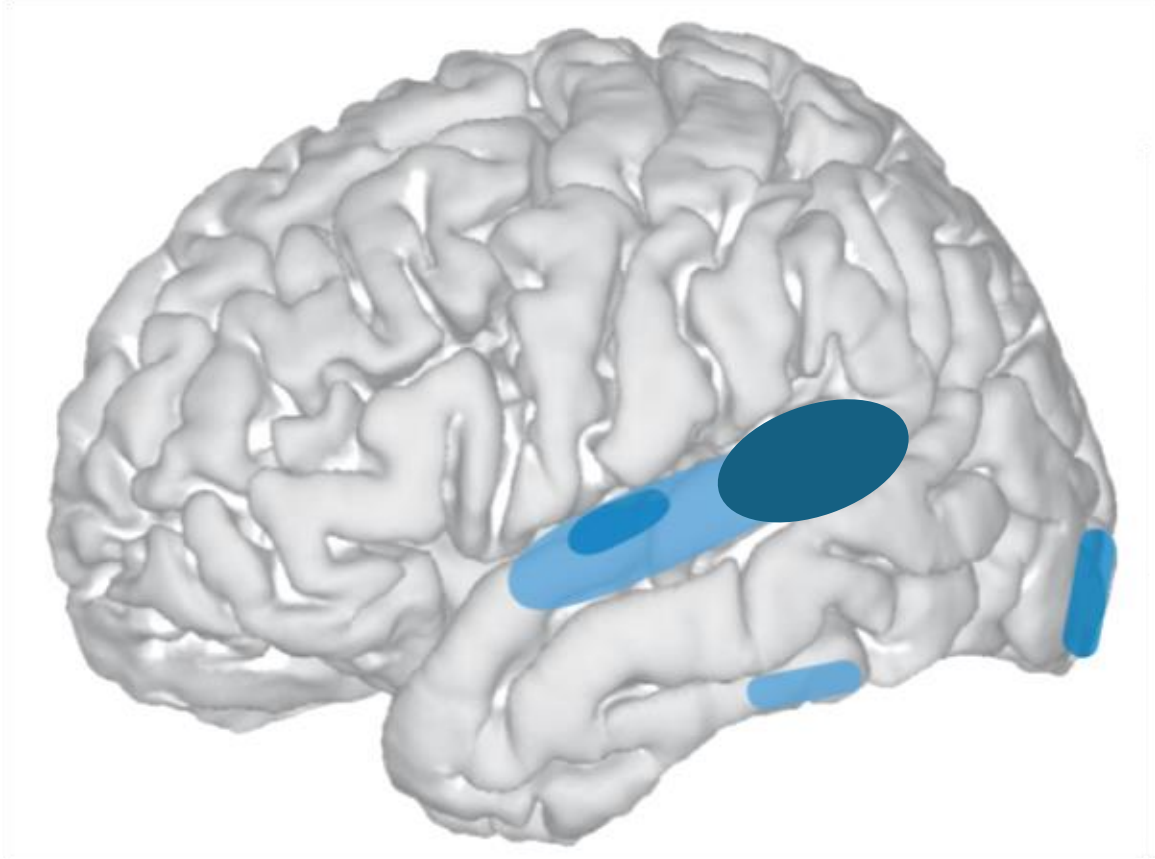


Language is perceived first by :
- The primary auditory when we are listening to speech
- The primary visual cortex in the occipital lobes when we are reading.

Fedorenko , Nat Rev Neurosci, 2024

Language

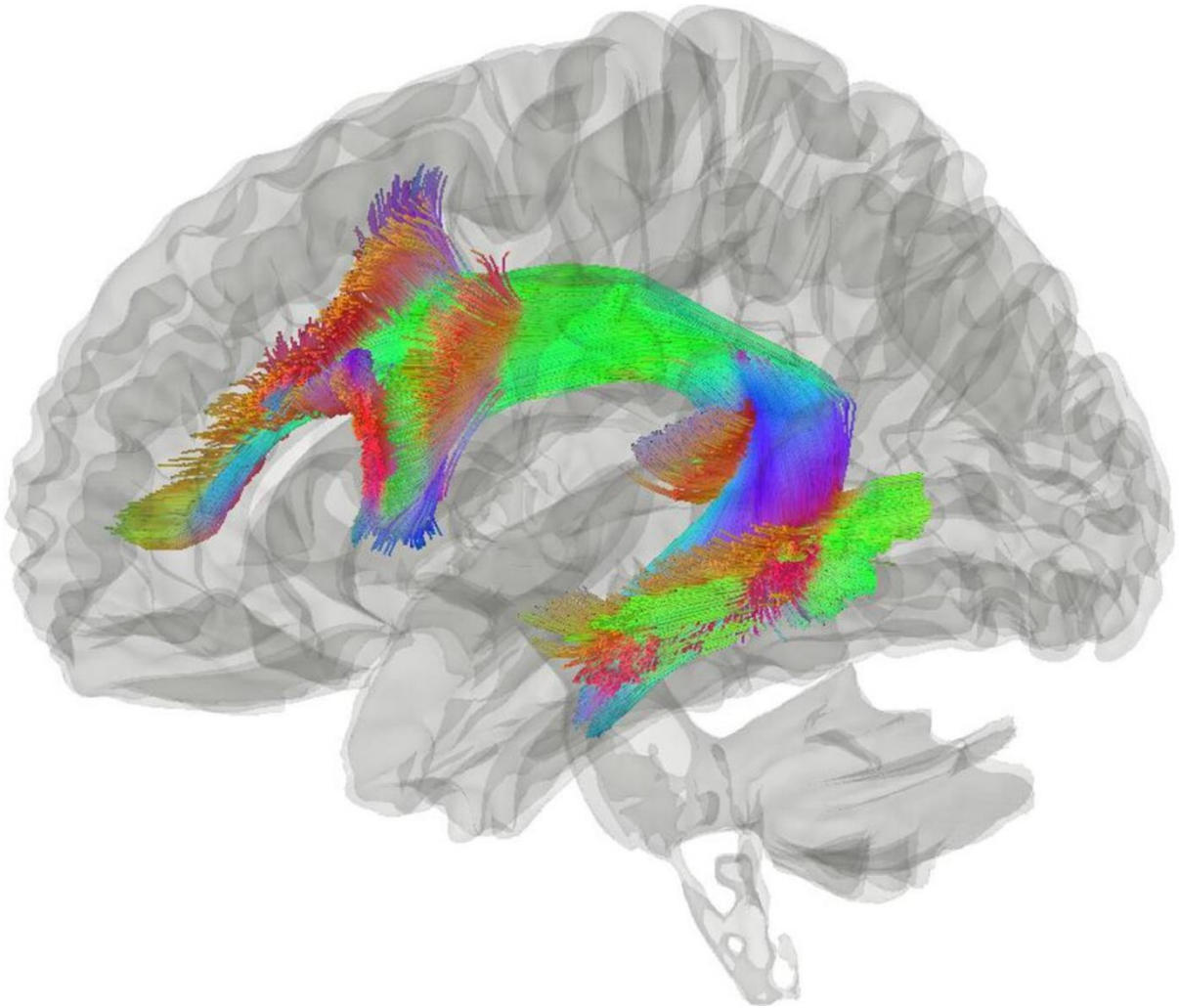
Perception
Perception of the surface properties of linguistic input (for instance, speech perception area)



From here, cortical–cortical association fibers convey information to Wernicke's area in the superior temporal gyrus in the dominant hemisphere

Fedorenko , Nat Rev Neurosci, 2024

Language

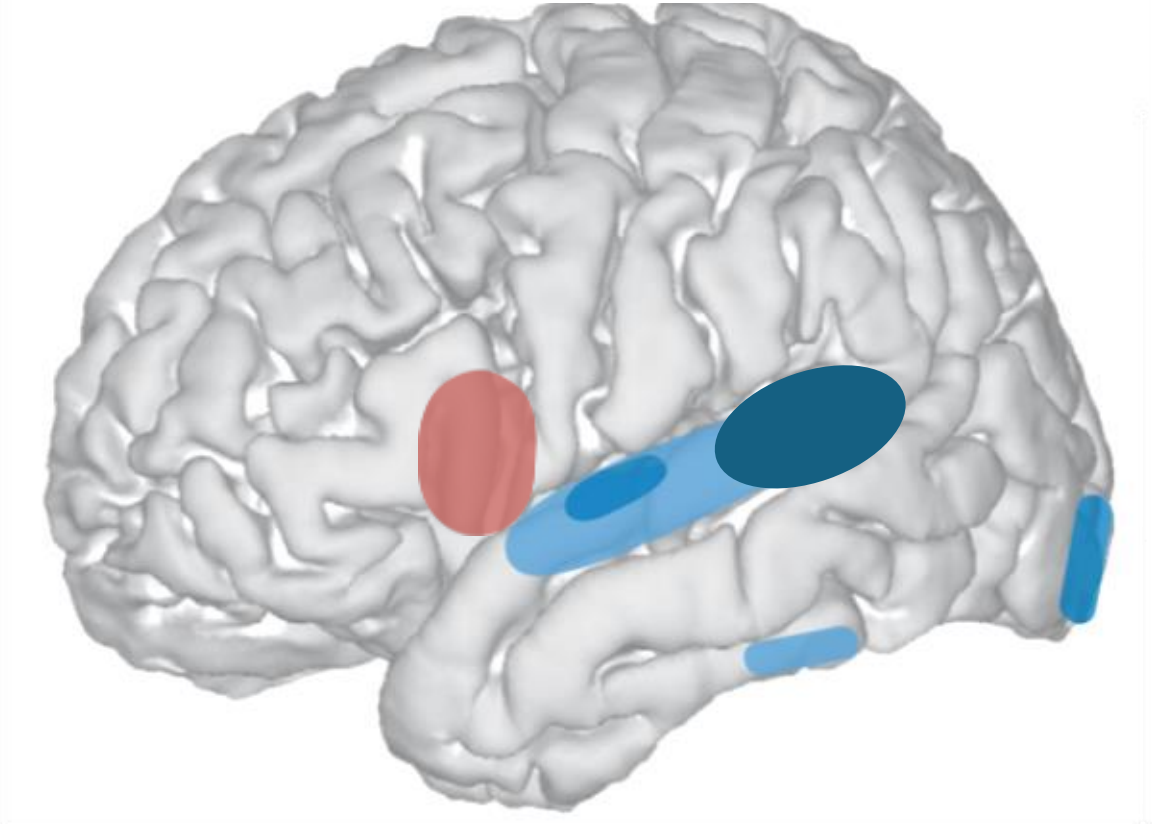


The arcuate fasciculus (from latin 'curved bundle') is a bundle of axons that generally connects Broca’s area and Wernicke’s area. It is an associatition fiber tract connecting caudal temporal lobe and inferior frontal lobe

Fedorenko , Nat Rev Neurosci, 2024

Language

Motor planning
Planning of the motor movements needed to realize linguistic output (for instance, Broca's area)

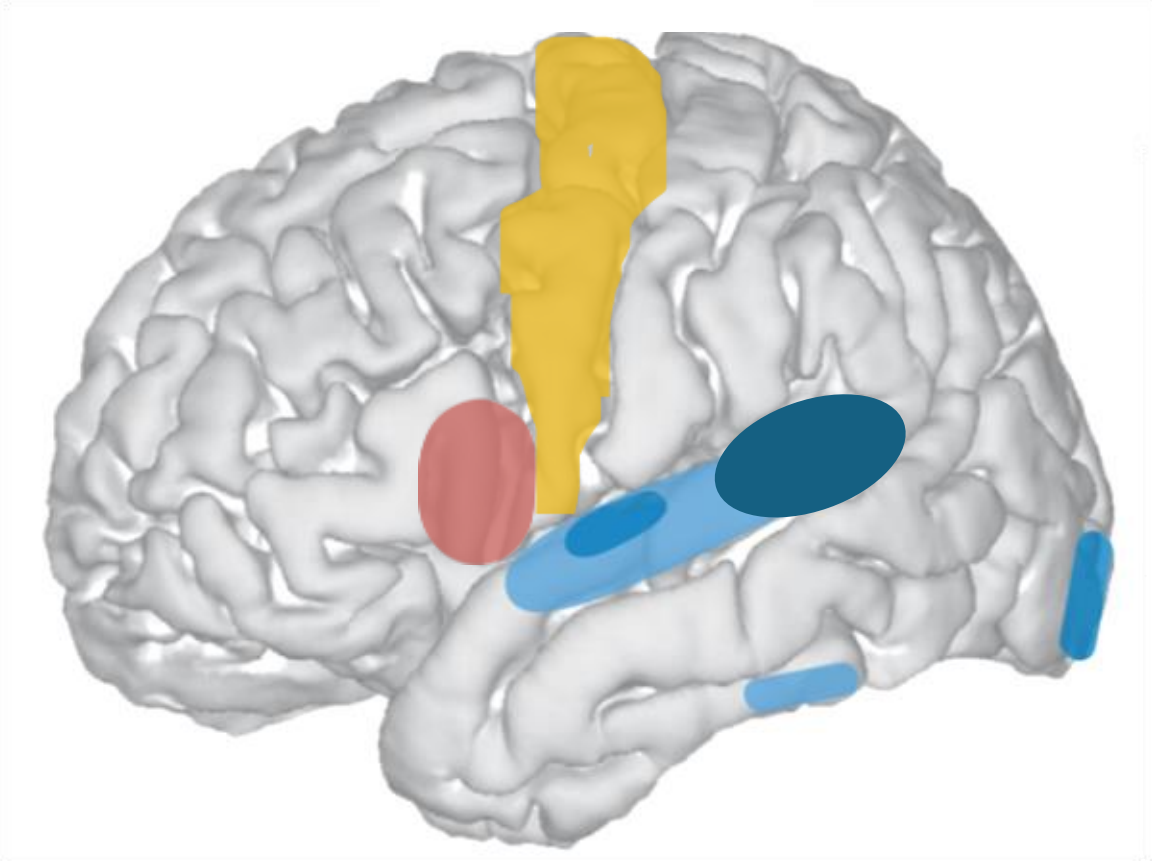


Broca's area (Brodmann areas 44 and 45) is located in the frontal lobe, also in the dominant hemisphere, adjacent to the areas of primary motor cortex involved in moving the lips, tongue, face, and larynx

Fedorenko , Nat Rev Neurosci, 2024

Language

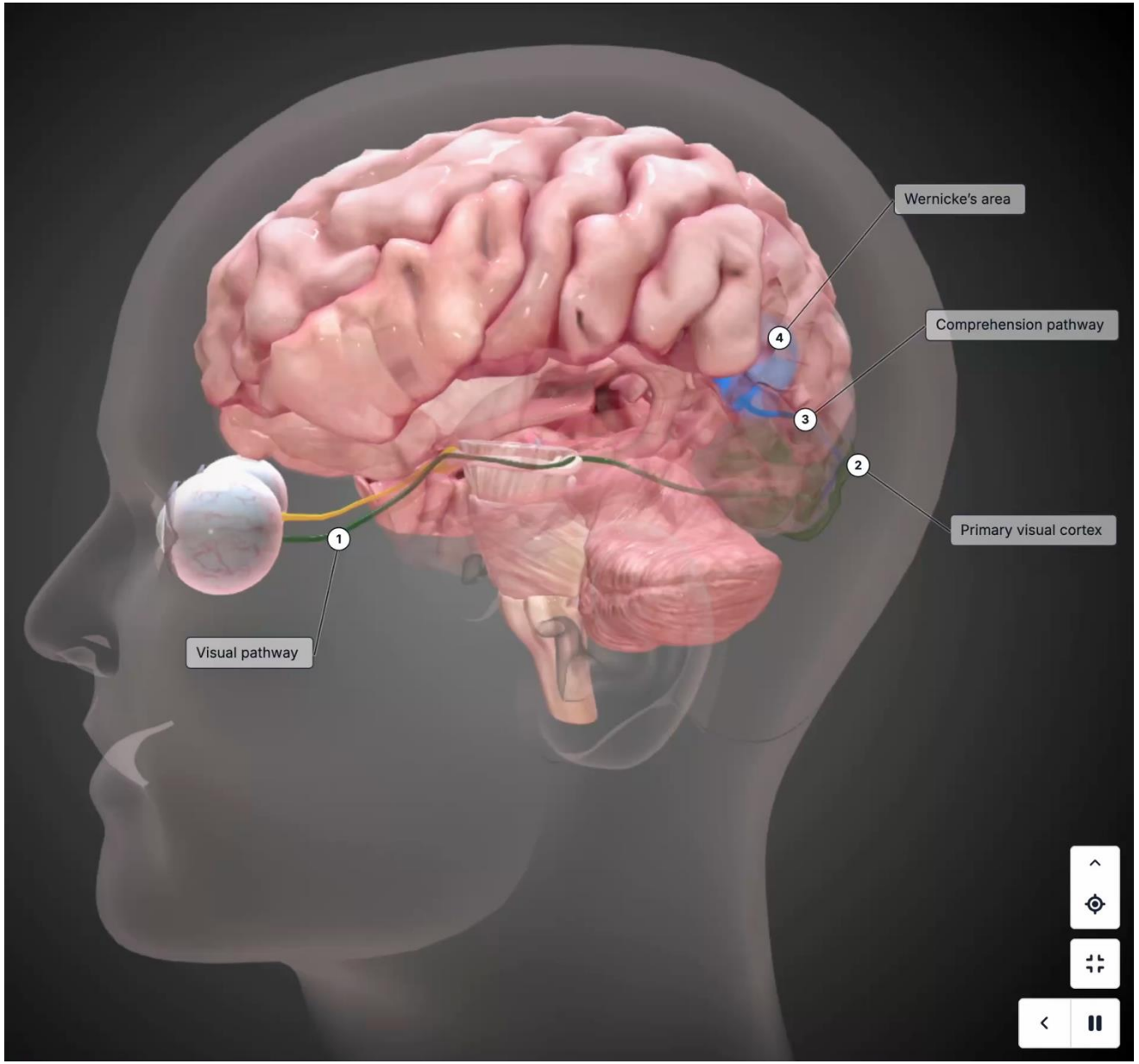
Language



From Broca's area the linguistic information is conveyed to the primary motor cortex in the dorsal part of the frontal lobe.

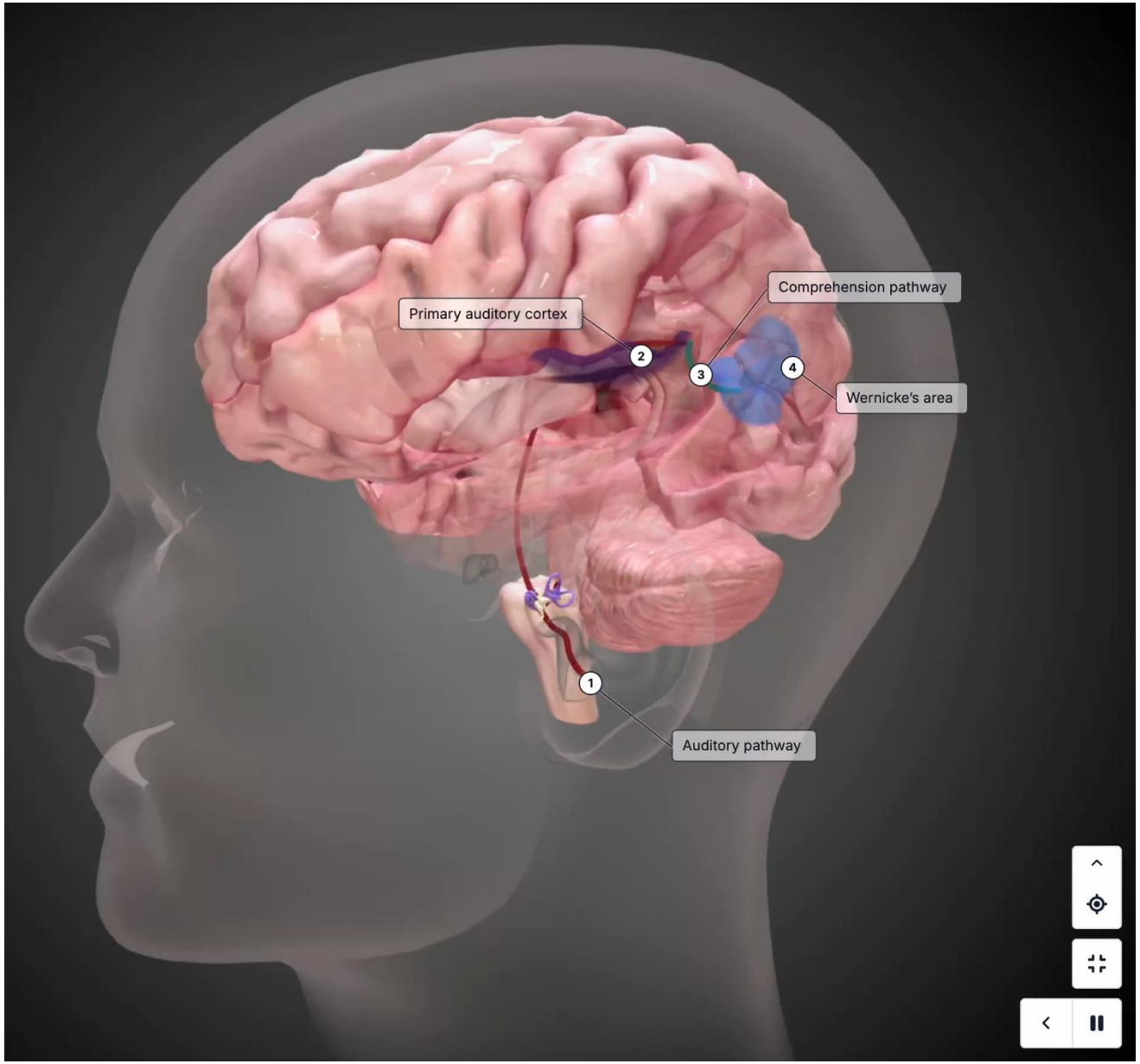
Fedorenko , Nat Rev Neurosci, 2024

Visual input to language system



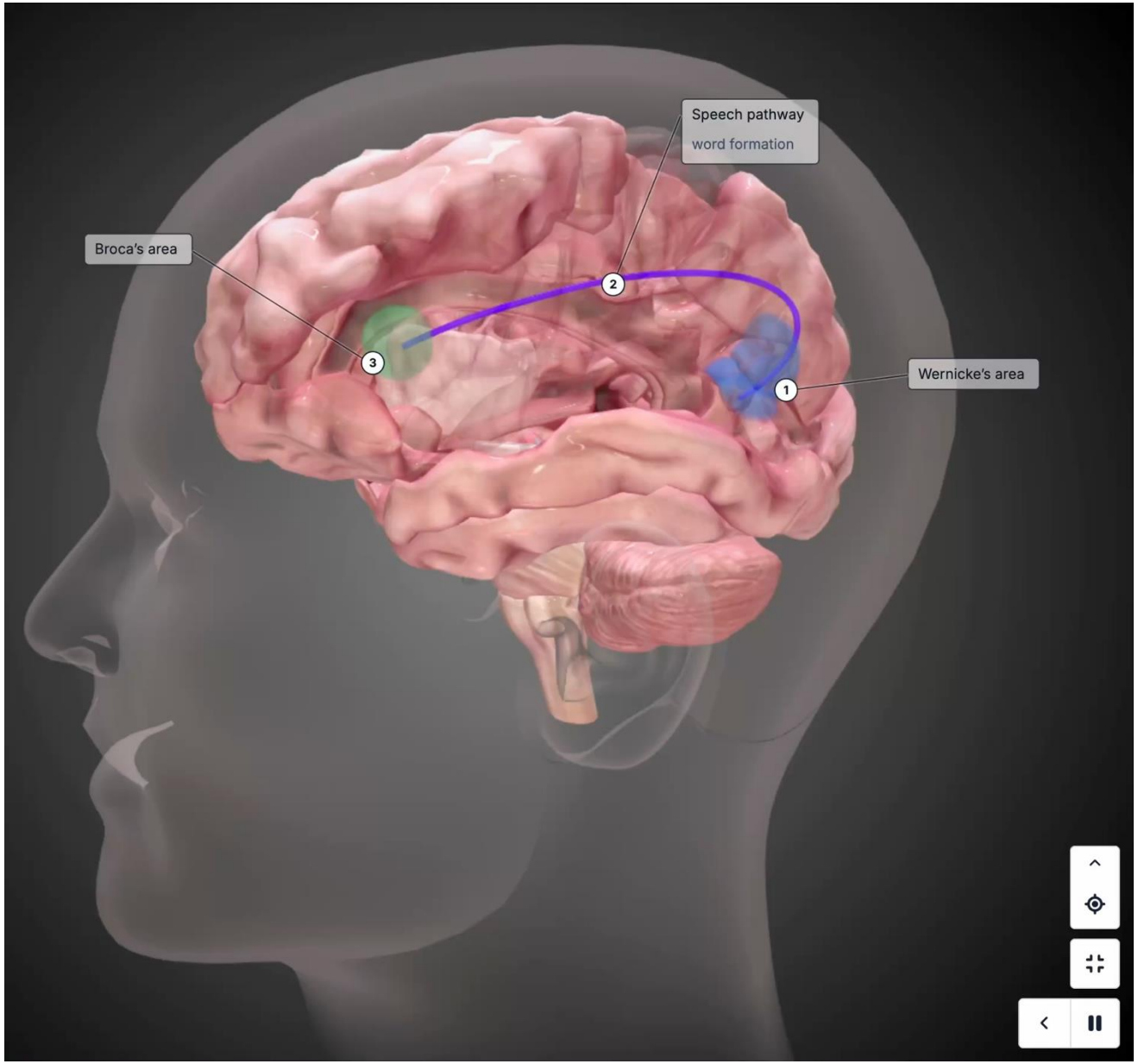
1. Primary visual cortex/ V1/ or Brodmann area 17.
2. Visual word form area (VWFA) in the left fusiform gyrus.
3. Wernicke's area (part of Brodmann area 22)

Auditory input to language system



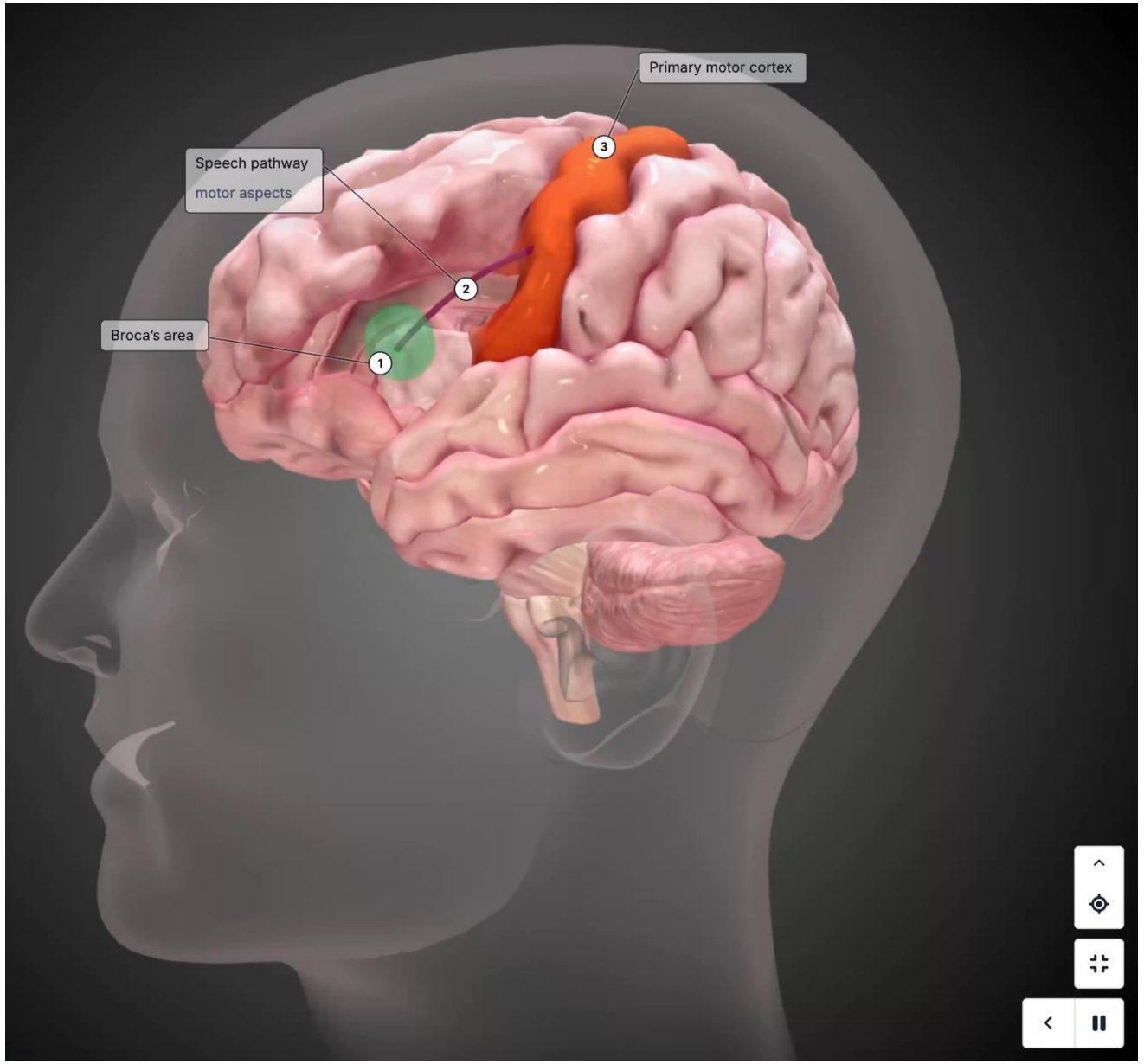
1. Primary auditory cortex/ A1/ or Brodmann area 41 and 42.
2. Wernicke's area (part of Brodmann area 22)

Speech pathway I : word understanding & formation



1. Wernicke's area (part of Brodmann area 22)
2. Arcuate fasciculus
3. Broca's area (Broadmann area 44 and 45)

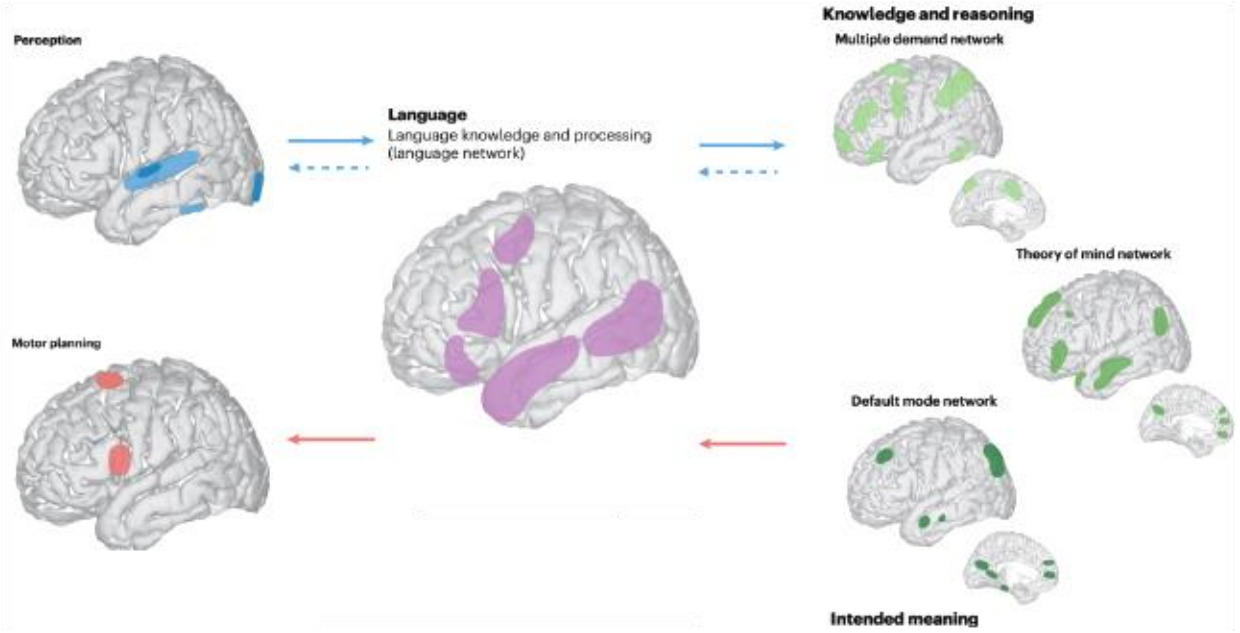
Speech pathway II : producing speech

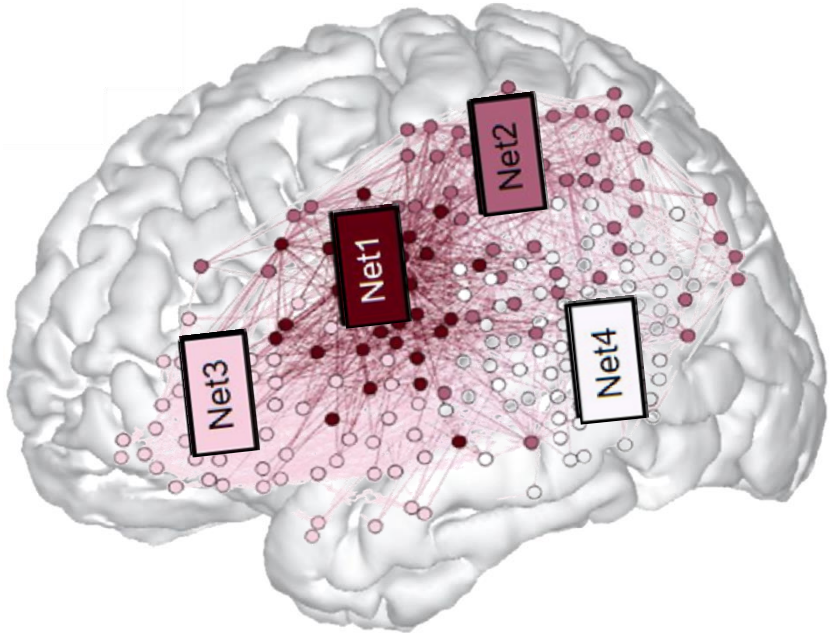


1. Broca's area (Broadmann area 44 and 45)
2. Primary motor cortex (Broadmann area 4)

Language

Language: The Hidden System Behind Words





Net1 Coding-Decoding

Net2 Control-Executive

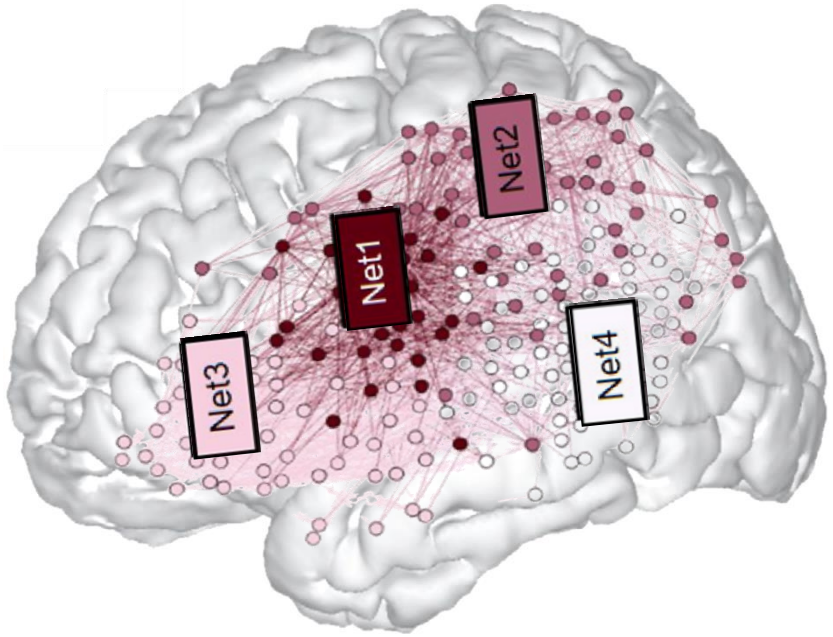
Net3 Abstract-Knowledge

Net4 Sensori-Motor

Fedorenko, Nat Rev Neurosci, 2024
Roger, Neuroimage, 2022

Introduction

Language: The Hidden System Behind Words



Net1 Coding-Decoding
Net2 Control-Executive
Net3 Abstract-Knowledge
Net4 Sensori-Motor

Net1 – Encoding-Decoding System represents an auditory-verbal system specialized for linguistic processing. It includes

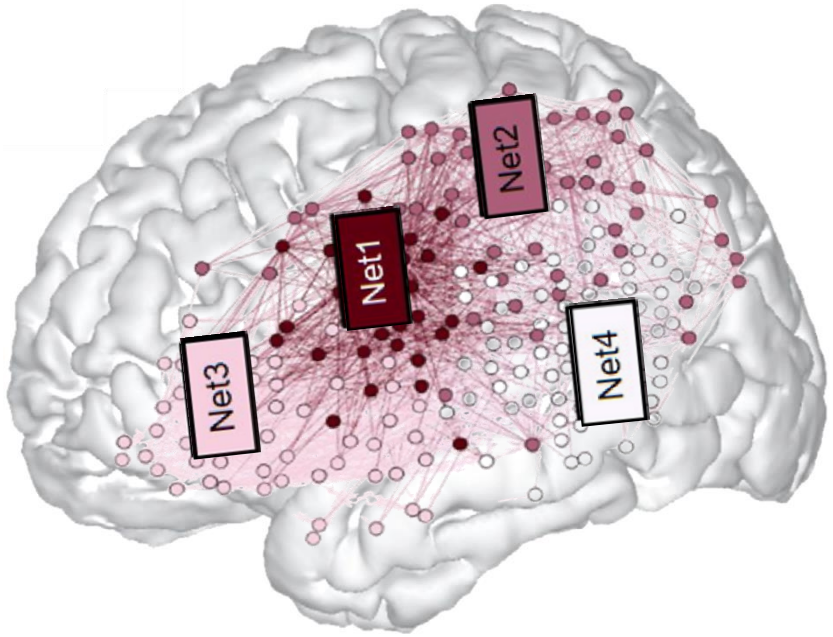
- the anterior superior temporal gyrus (STGa),
- the posterior inferior frontal gyrus (pars triangularis, BA45/44),
- the posterior middle frontal/premotor gyrus (pMFG),
- the inferior parietal cortex
- the supramarginal gyrus,
- temporoparieto-occipital junction (TPOJ).

It is lateralized to the left and supported by long-range white matter tracts (arcuate fasciculus, superior longitudinal fasciculus III, inferior longitudinal fasciculus, and superior premotor tracts), which ensure efficient communication between comprehension and production systems

Fedorenko, Nat Rev Neurosci, 2024
Roger, Neuroimage, 2022

Language

Language: The Hidden System Behind Words



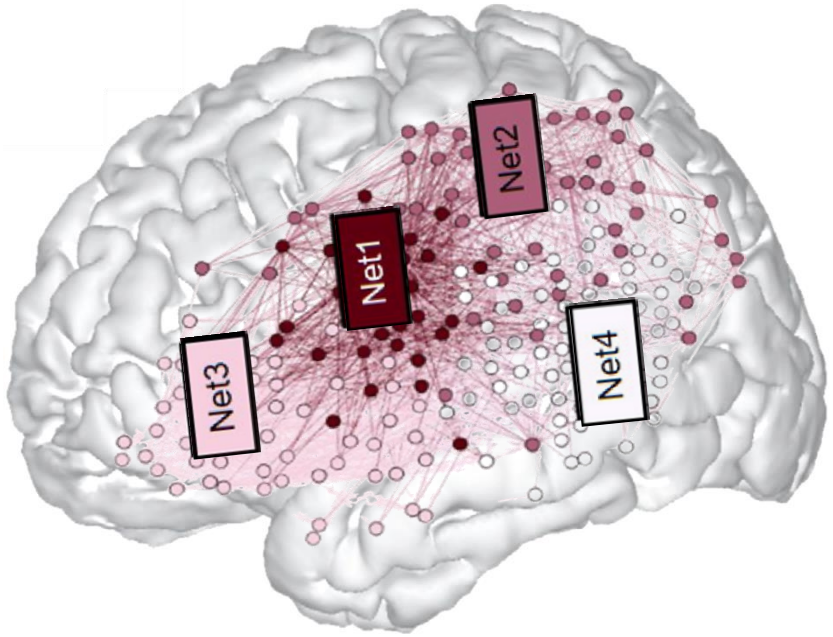
Net2 – Executive Control System, adjacent to Net1, is a language network dominated by the cingulo-opercular and fronto-parietal networks.
Structurally, it is supported by long-range associative tracts.
It mediates attentional regulation, conflict monitoring, and working memory maintenance, enabling exogenous and endogenous linguistic control.

Net1 Coding-Decoding
Net2 Control-Executive
Net3 Abstract-Knowledge
Net4 Sensori-Motor

Fedorenko, Nat Rev Neurosci, 2024
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Language

Language: The Hidden System Behind Words



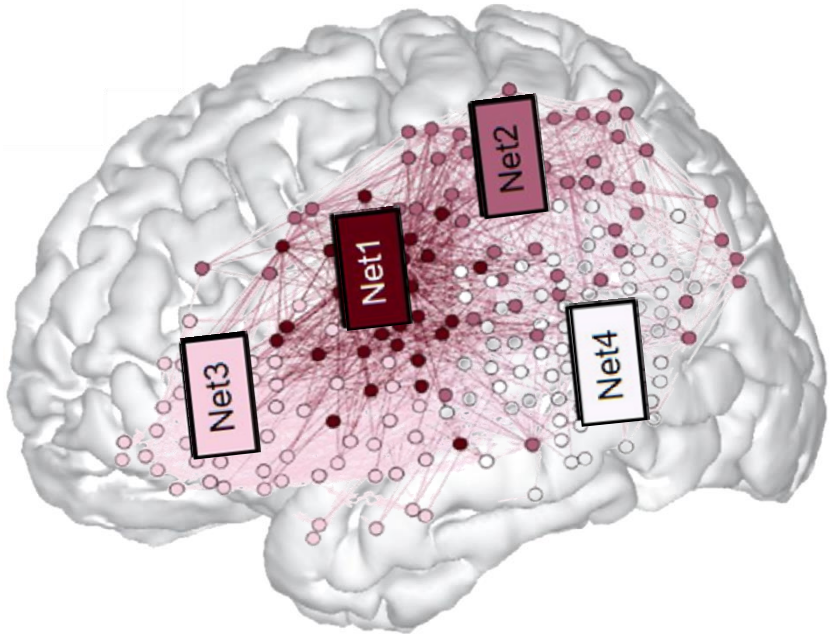
Net3 – Abstract Knowledge System is largely overlapping with the Default Mode Network (DMN).
It is involved in complex comprehension tasks and the generation of conceptual knowledge that connects language to personal experience.

Net1 Coding-Decoding
Net2 Control-Executive
Net3 Abstract-Knowledge
Net4 Sensori-Motor

Fedorenko, Nat Rev Neurosci, 2024
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Language

Language: The Hidden System Behind Words

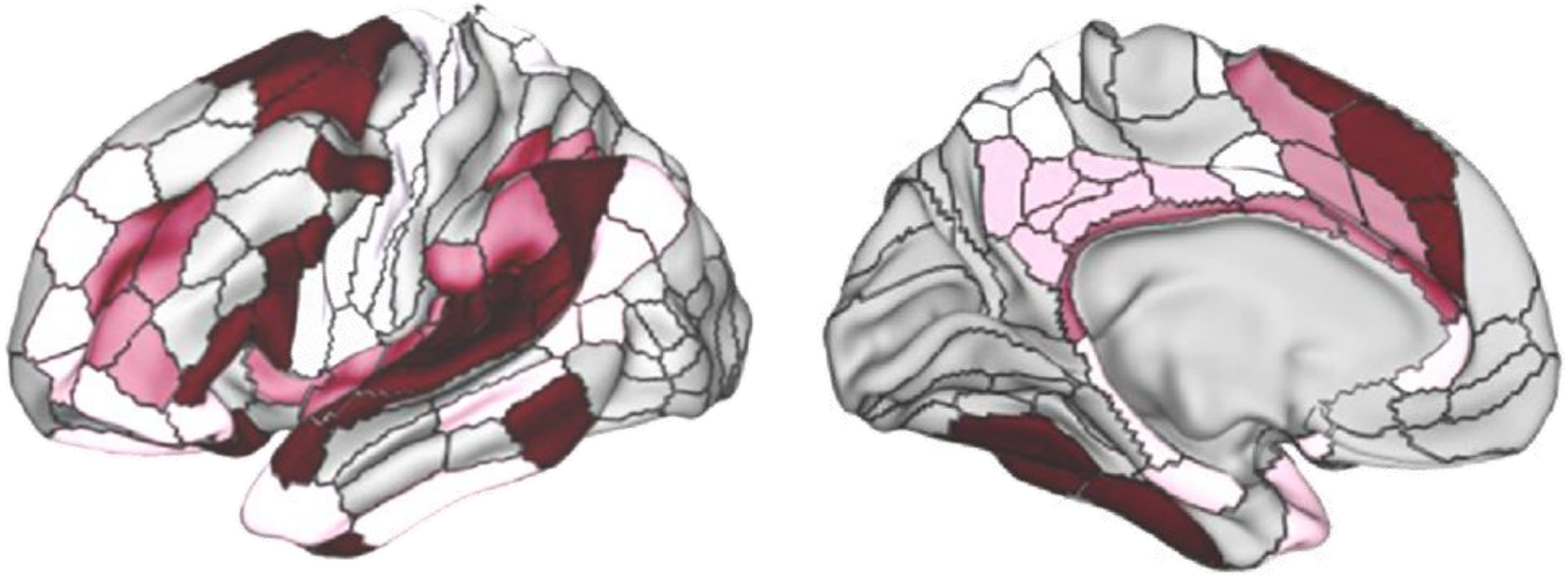


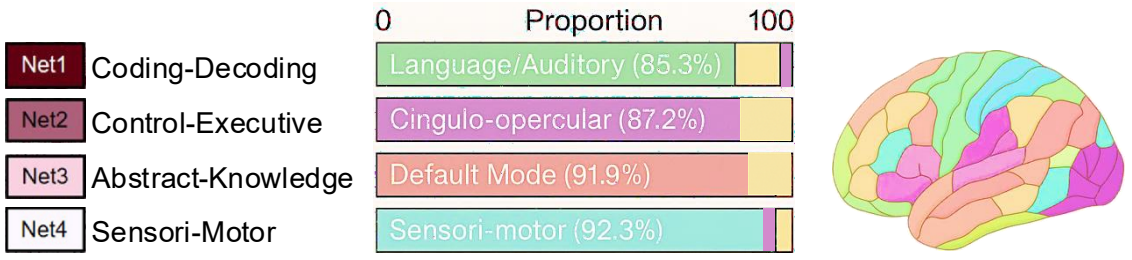
Net4 – Sensorimotor system includes bilateral cortico-subcortical sensorimotor regions, distinct but functionally complementary to the auditory-verbal components of Net1.

Net1 Coding-Decoding
Net2 Control-Executive
Net3 Abstract-Knowledge
Net4 Sensori-Motor

Fedorenko, Nat Rev Neurosci, 2024
Roger, Neuroimage, 2022

Language



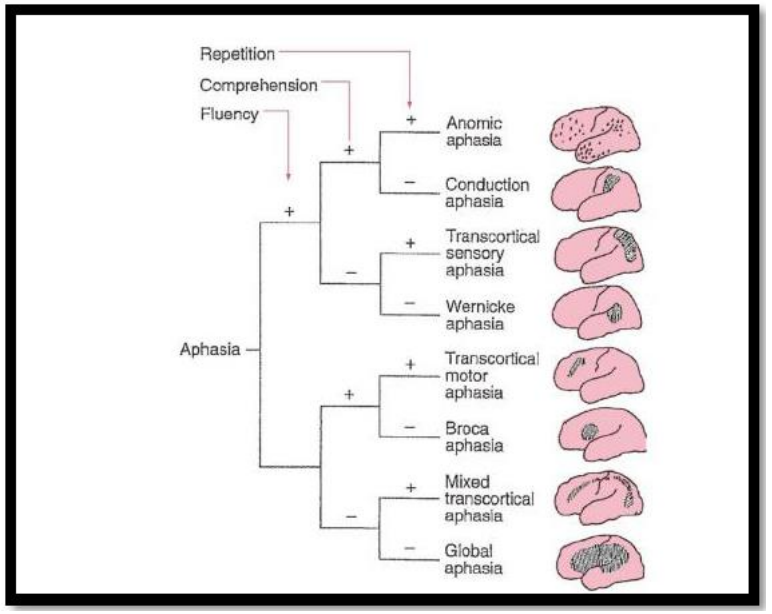

0
Proportion
100
Net1
Coding-Decoding
Net2
Control-Executive
Net3
Abstract-Knowledge
Net4
Sensori-Motor
Language/Auditory (85.3%)
Cingulo-opercular (87.2%)
Default Mode (91.9%)
Sensori-motor (92.3%)

Language

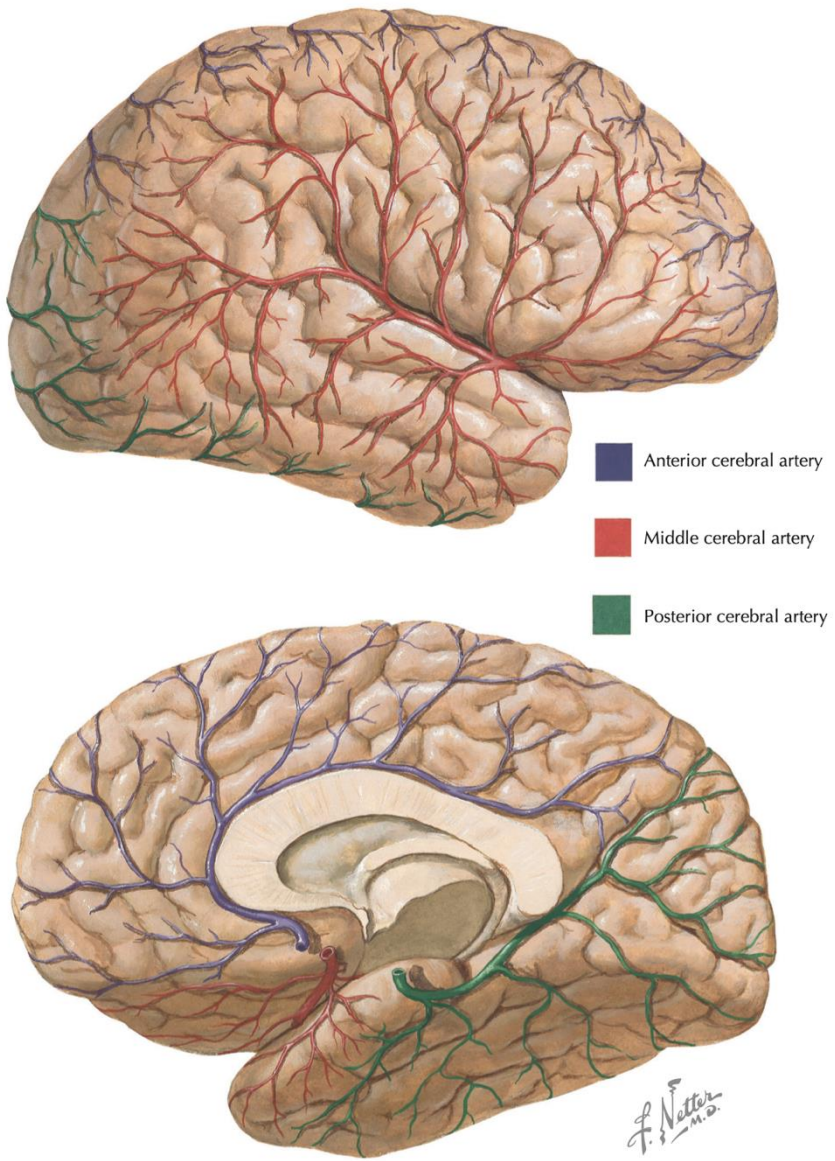
1. Spontaneous speech. Note the patient's fluency, including phrase length rate, and abundance of spontaneous speech. Also note tonal modulation and paraphasic errors, neologisms, or errors in grammar.
2. Comprehension. Can the patient understand simple questions and commands?
3. Naming, either for easy objects or more difficult-to-name objects Repetition.
4. Reading.
5. Writing. Ask the patient to write their name and write a sentence.

Language

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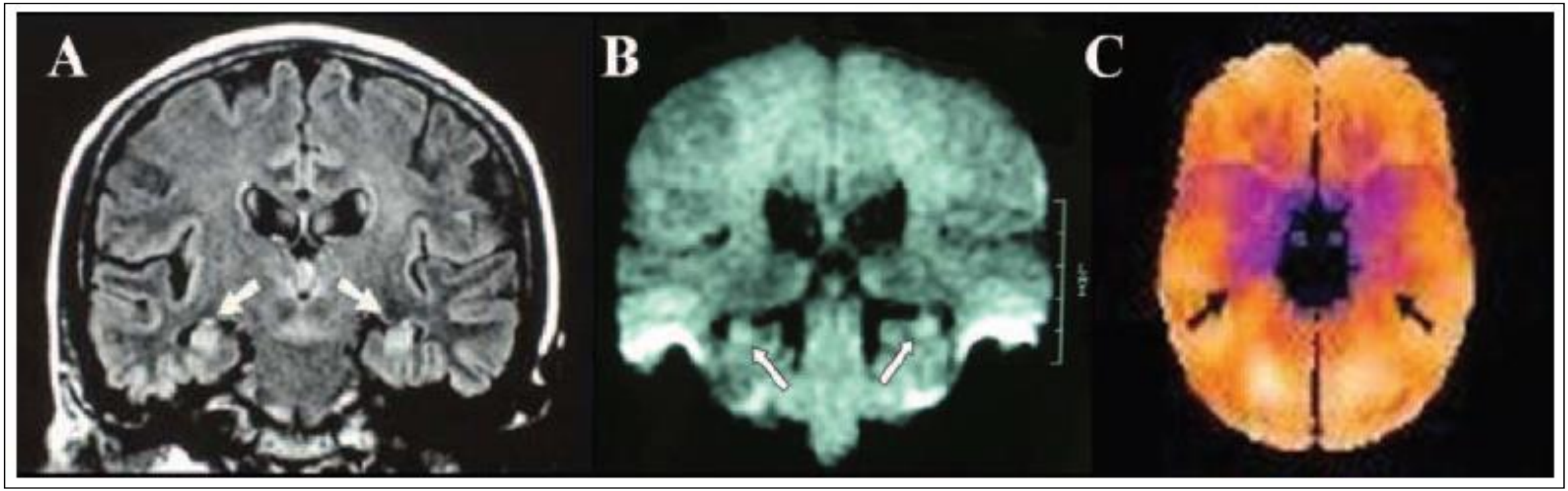
Language



Infarct, surface	Infarct, coronal section	Clinical manifestations
		**Broca aphasia (if on left side)** Contralateral hemiplegia, hemisensory loss, gaze palsy, spatial neglect  Patient trying to find words but only producing nonfluent effortful, slow, halting speech
		**Wernicke aphasia (if on left side)** Contralateral hemianopsia or upper quadrantanopsia Constructional dyspraxia (if on right side)  Fluent phonemic mixed syllables verbally incorrect words (i.e., paraphrase errors/ "word salad")
		**Global aphasia (if on left side)** Contralateral gaze palsy, hemiplegia, hemisensory loss, spatial neglect, hemianopsia May lead to decreased consciousness and even coma secondary to edema  Right-handed patient with severe hemisphere deficit unable to utter any language or comprehend with hemiplegia individual

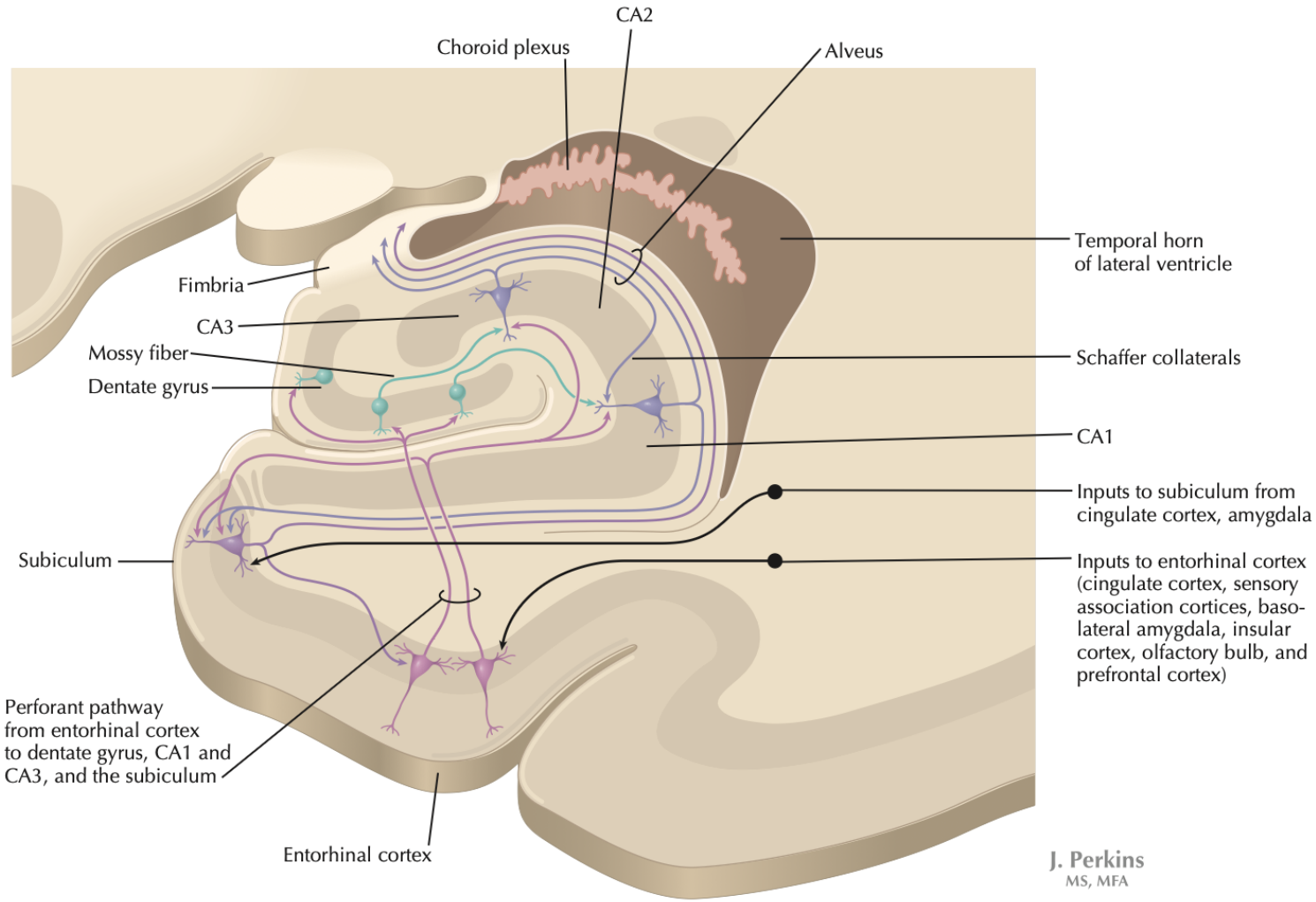
Memory

One of the most fascinating properties of the brain is represented by its ability to encode and retain memories



Di Filippo, Neurology, 2007

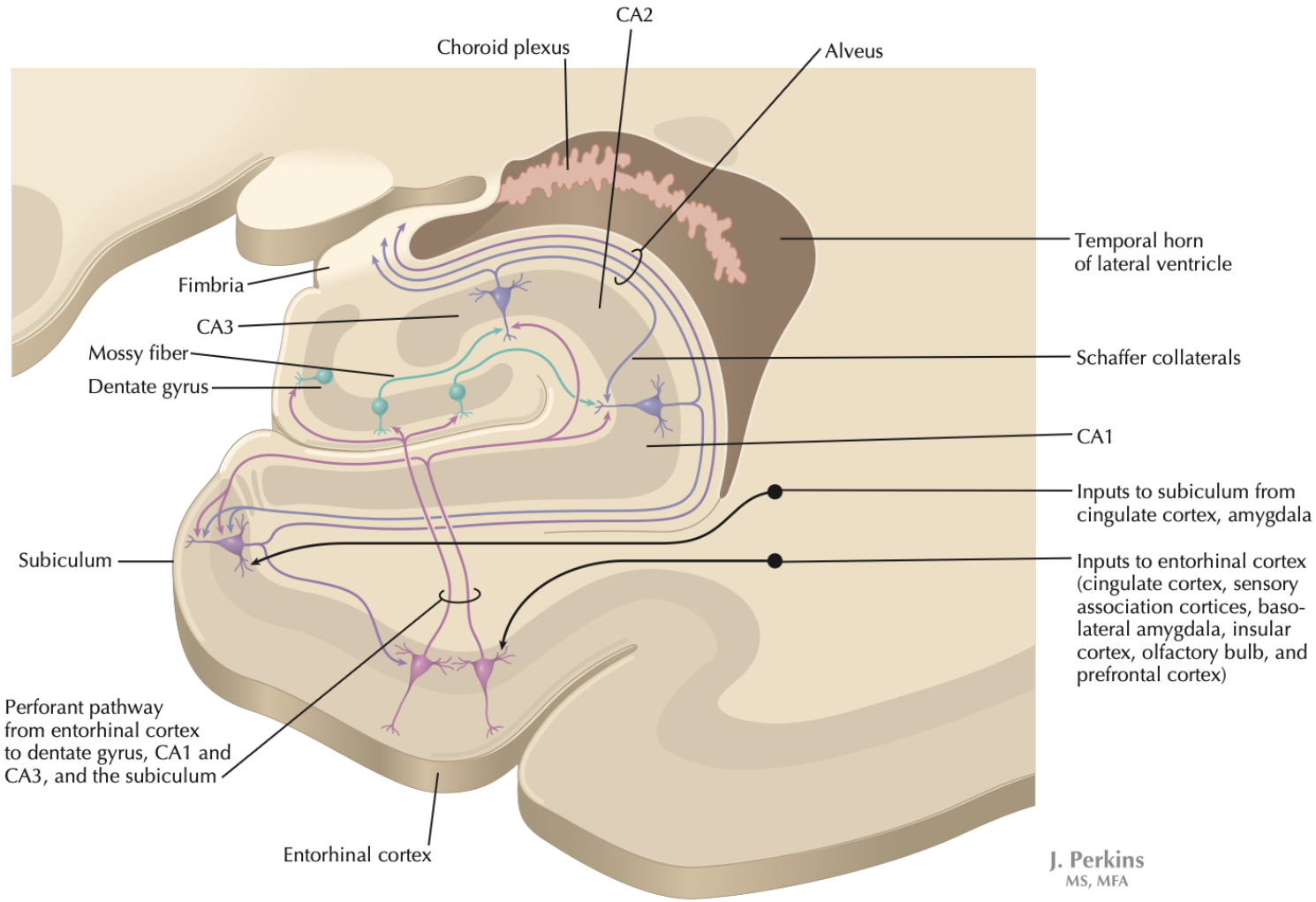
Memory



Explicit memory is acquisition of information about objects, stimuli, and information that are consciously noted and recallable. It includes information about personal events, factual knowledge, and information about which cognitive assessment takes place.

Implicit memory is the process of learning how to perform tasks or acquire skills that are not recallable by conscious processes.

Memory



Explicit memory recall depends upon reassembly of information stored in the brain and involves reconstruction that depends upon sensory perceptions.

Explicit memory requires the formation of new synaptic connections and gene expression for new sets of neuronal proteins.

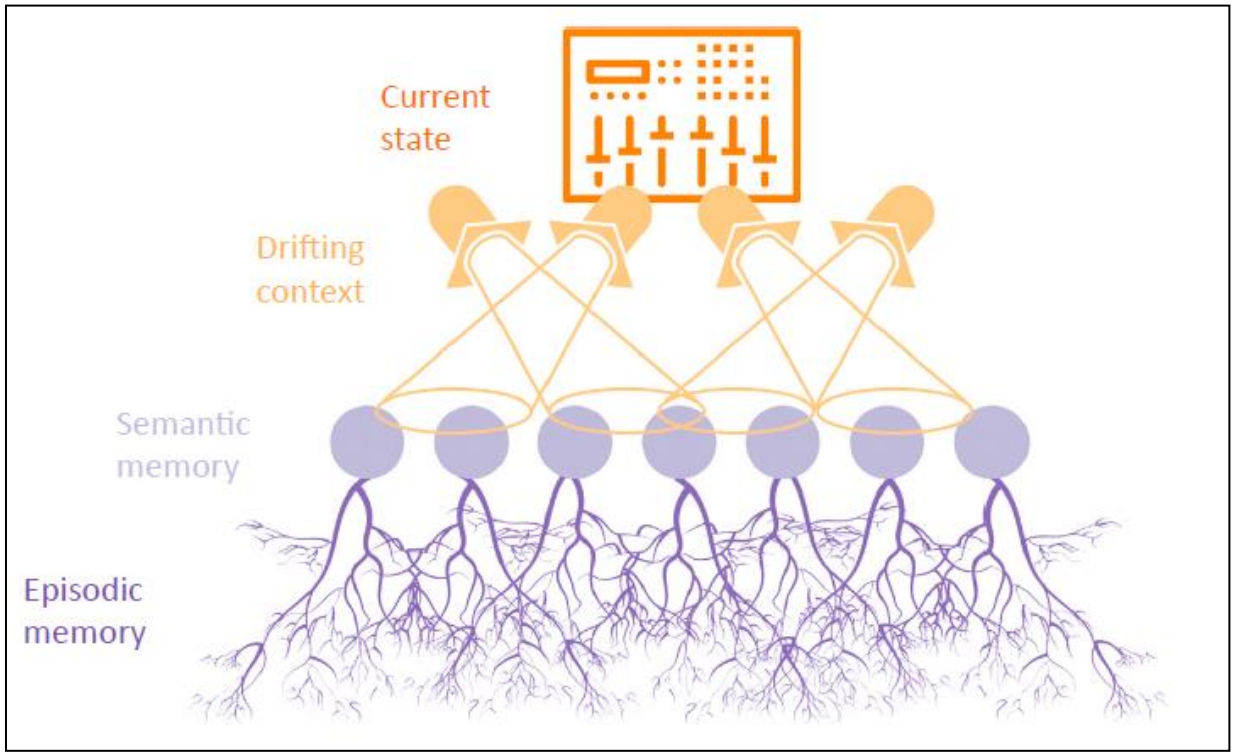
The consolidation of immediate and short-term explicit memory into long-term traces involves a process of long-term potentiation, which involves a burst of activity in a specific temporal pattern from an incoming axon.

Memory

Episodic memory is the memory of specific personal experiences, including the "what," "when," and "where" of an event.

Semantic memory is the long-term memory of general knowledge, facts, and concepts.

Computational models of memory explain how the stream of thought flows through the landscape of memory.

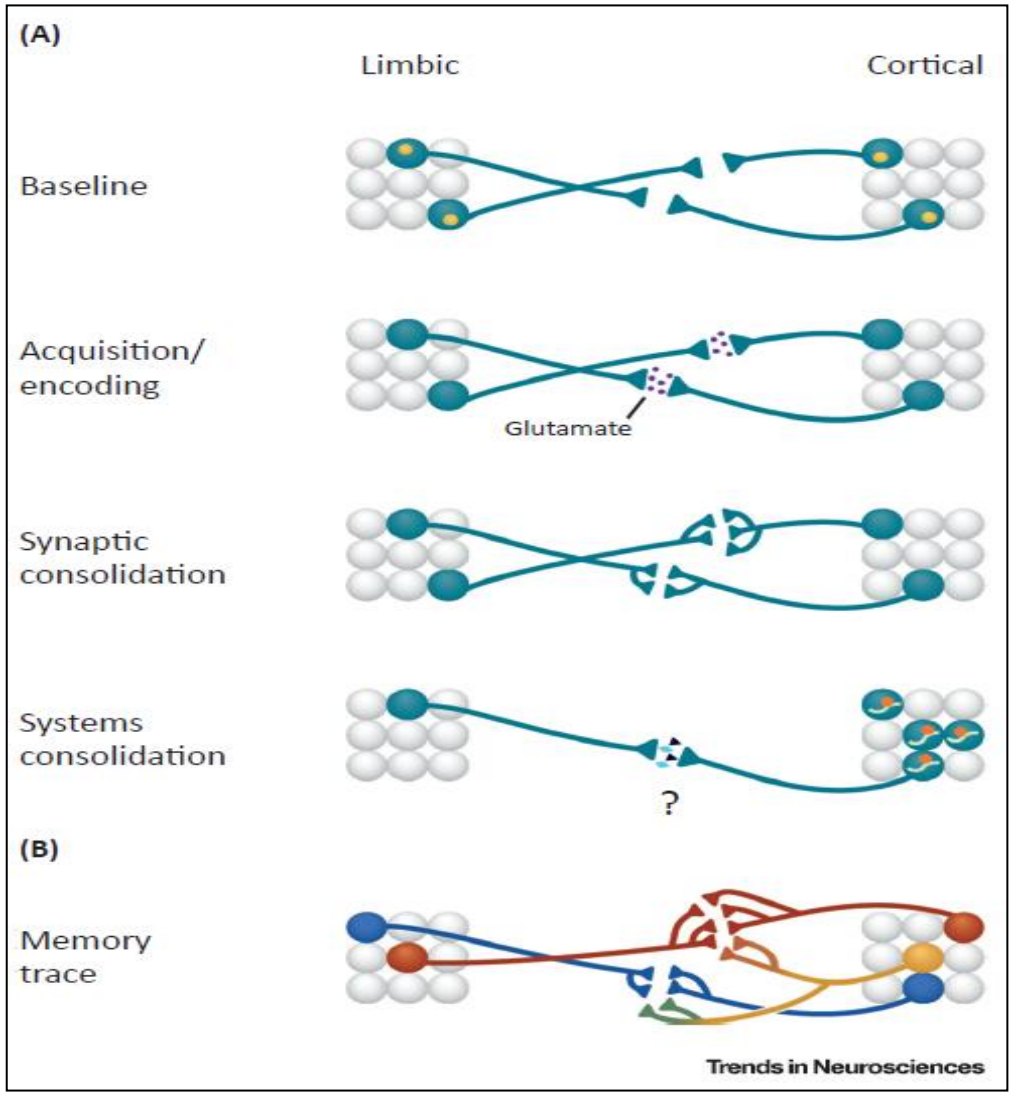


Mildner and Tamir, Trends in Neuroscience, 2020

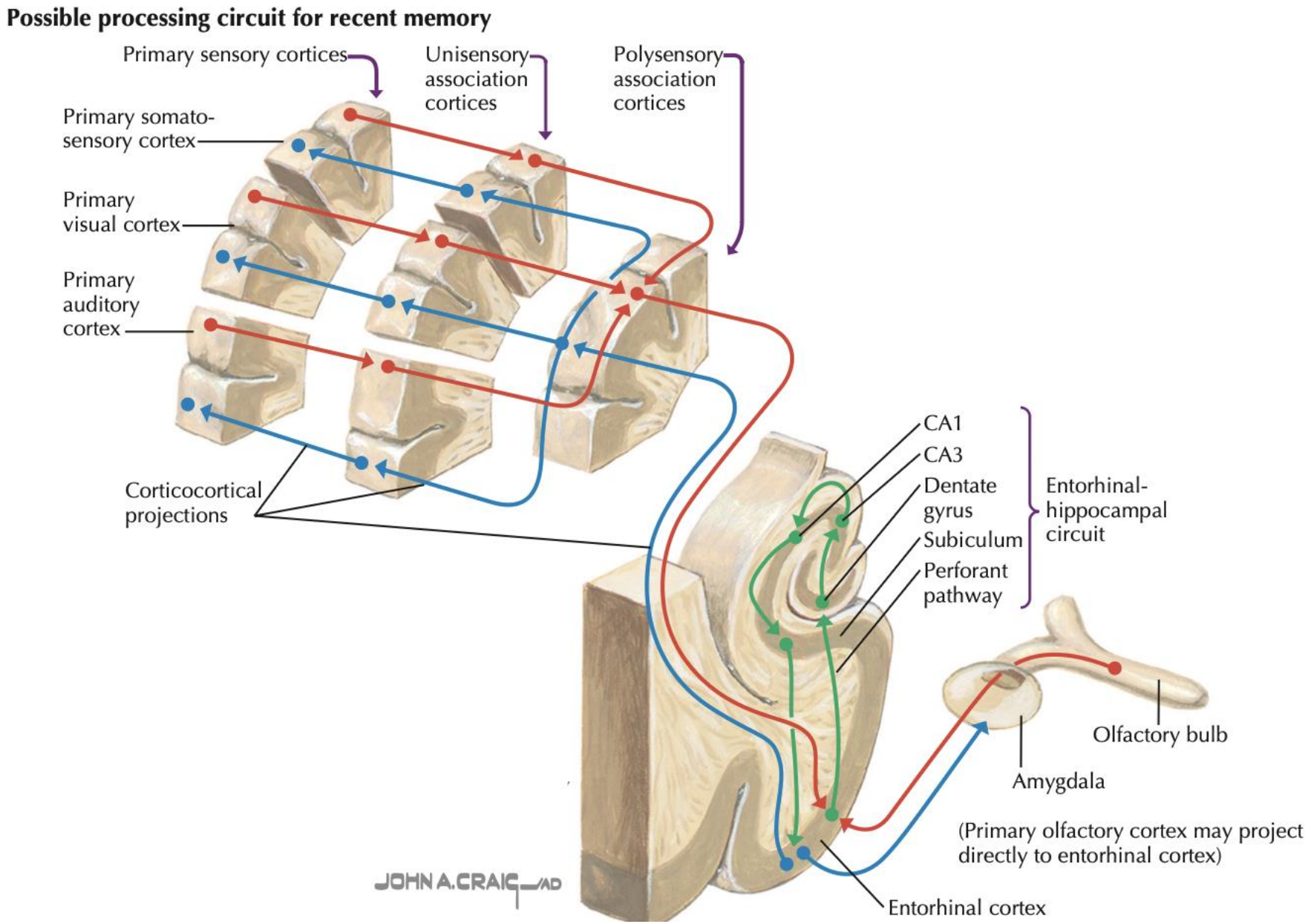
Memory

The biological structure for memory are engrams and circuits.

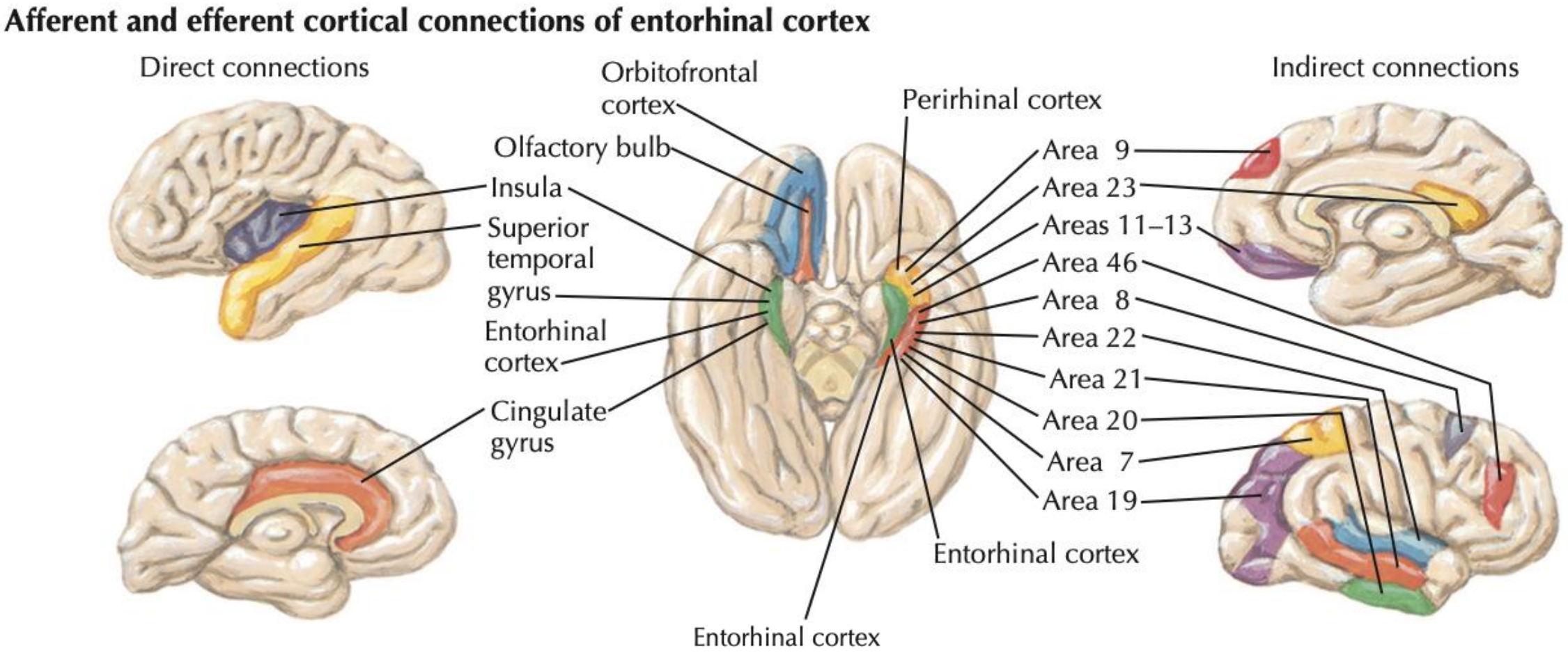
Engrams refers primarily to the physical or biochemical trace of memory in the brain.



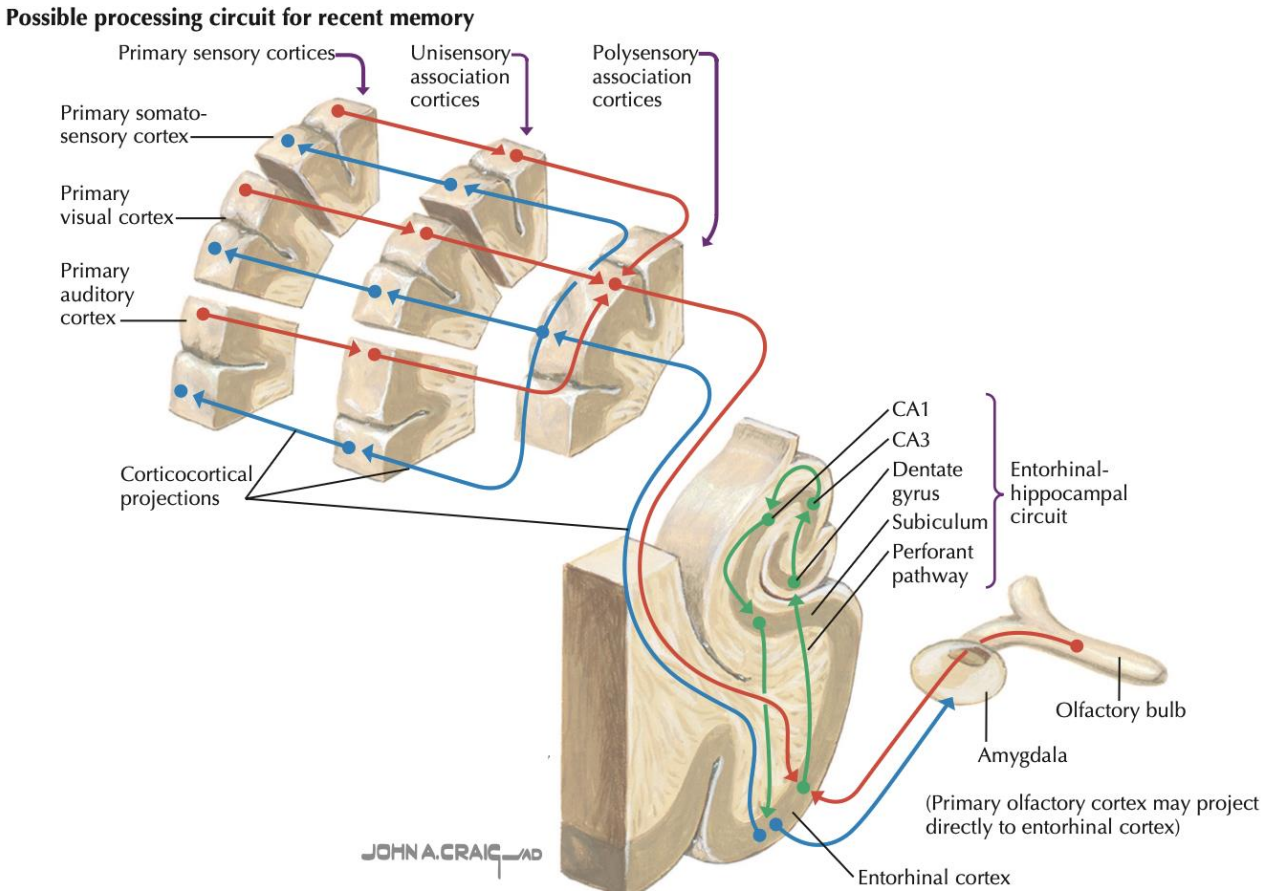
Memory


Possible processing circuit for recent memory
Primary sensory cortices
Unisensory association cortices
Polysensory association cortices
Primary somato-sensory cortex
Primary visual cortex
Primary auditory cortex
Corticocortical projections
CA1
CA3
Dentate gyrus
Subiculum
Perforant pathway
Entorhinal-hippocampal circuit
Olfactory bulb
Amygdala
(Primary olfactory cortex may project directly to entorhinal cortex)
Entorhinal cortex
JOHN A. CRAIG AD

Memory

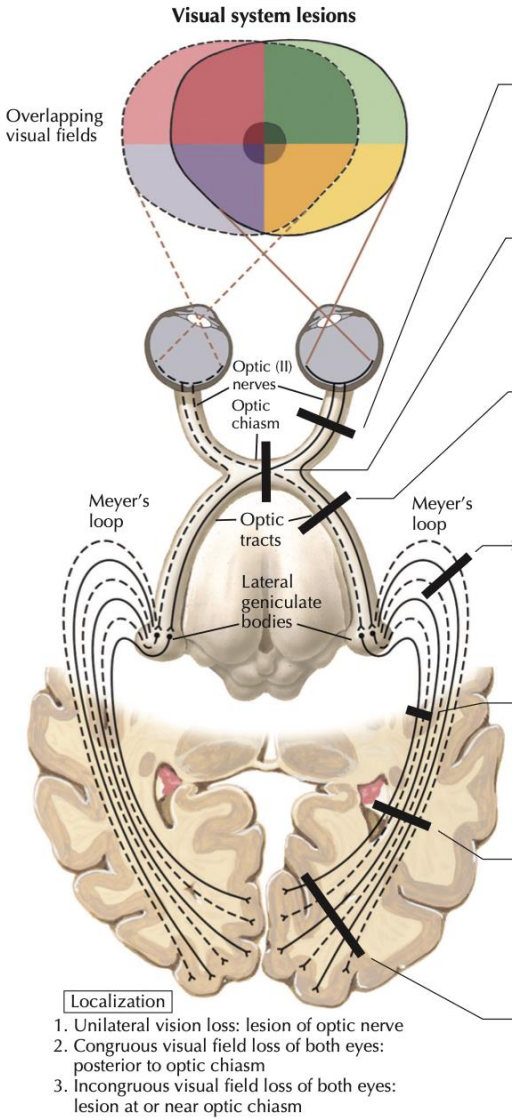

Afferent and efferent cortical connections of entorhinal cortex
Direct connections
Orbitofrontal cortex
Olfactory bulb
Insula
Superior temporal gyrus
Entorhinal cortex
Cingulate gyrus
Entorhinal cortex
Perirhinal cortex
Area 9
Area 23
Areas 11–13
Area 46
Area 8
Area 22
Area 21
Area 20
Area 7
Area 19
Entorhinal cortex
Indirect connections

Memory deficits



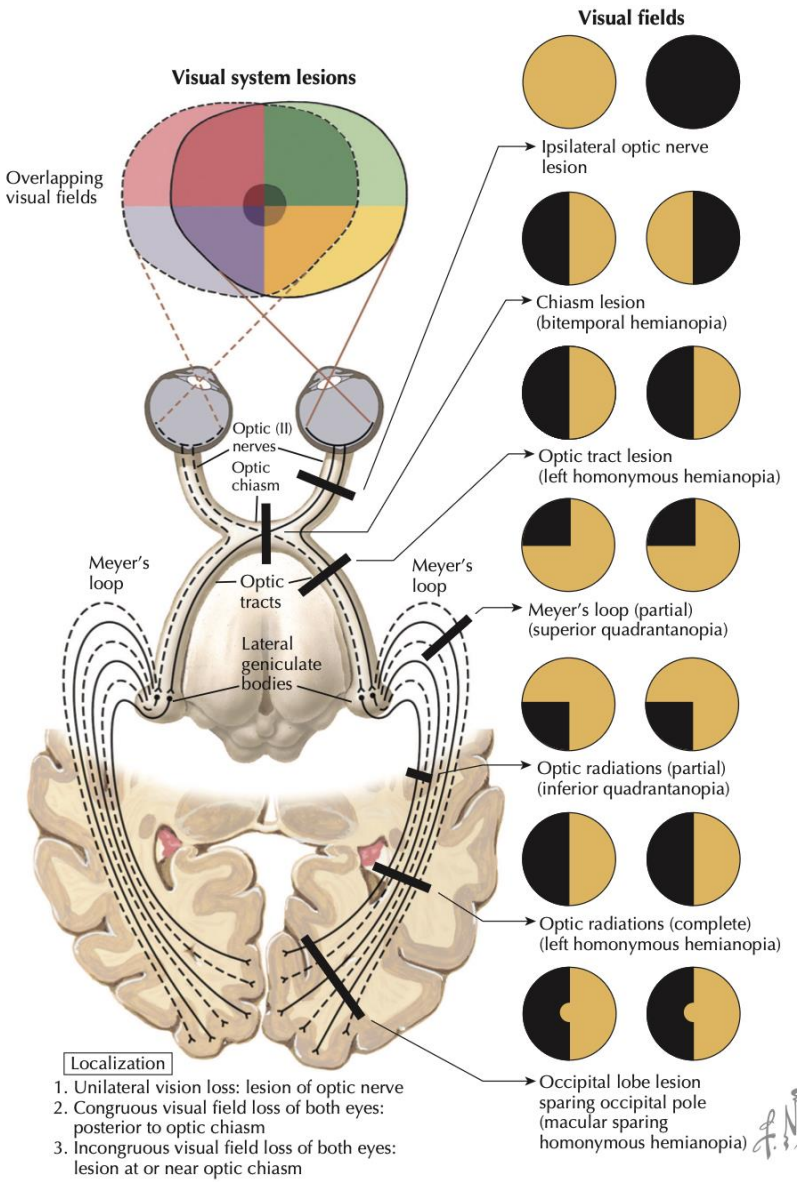
- Impaired ability to register and recall something within a few seconds after it was said is an abnormality that blends into the category of impaired attention.
- If immediate recall is intact, then difficulty with recall after about 1 to 5 minutes usually signifies damage to the limbic memory structures located in the medial temporal lobes and medial diencephalon
  - Anterograde amnesia, is difficulty remembering new facts and events occurring after lesion onset,
  - Retrograde amnesia, is impaired memory of events for a period of time immediately before lesion onset, with relative sparing of earlier memories.
- Loss of memory which does not fit the typical anterograde/retrograde pattern may signify damage to areas other than the medial temporal and medial diencephalic structures and can also occur in psychogenic amnesia.

Vision

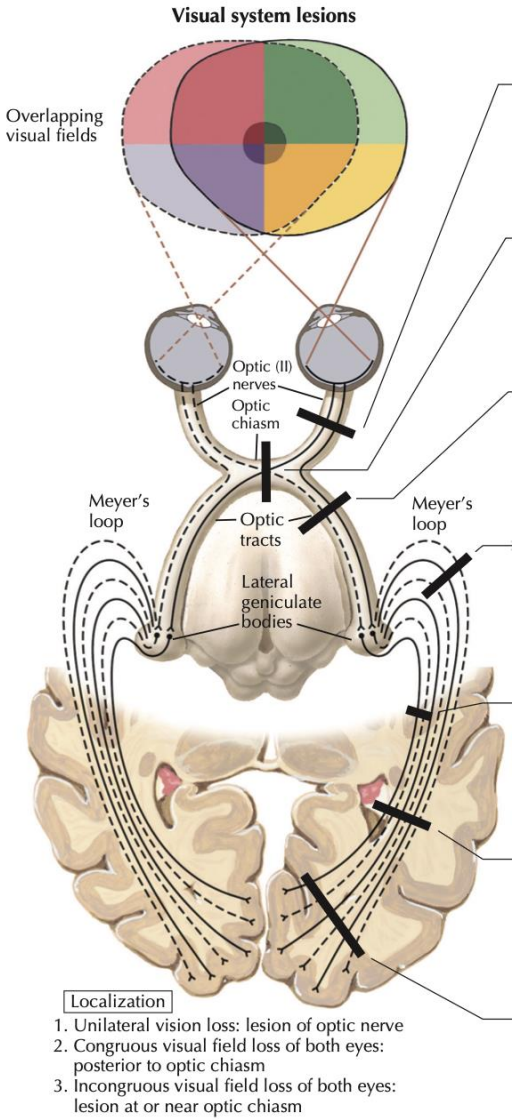


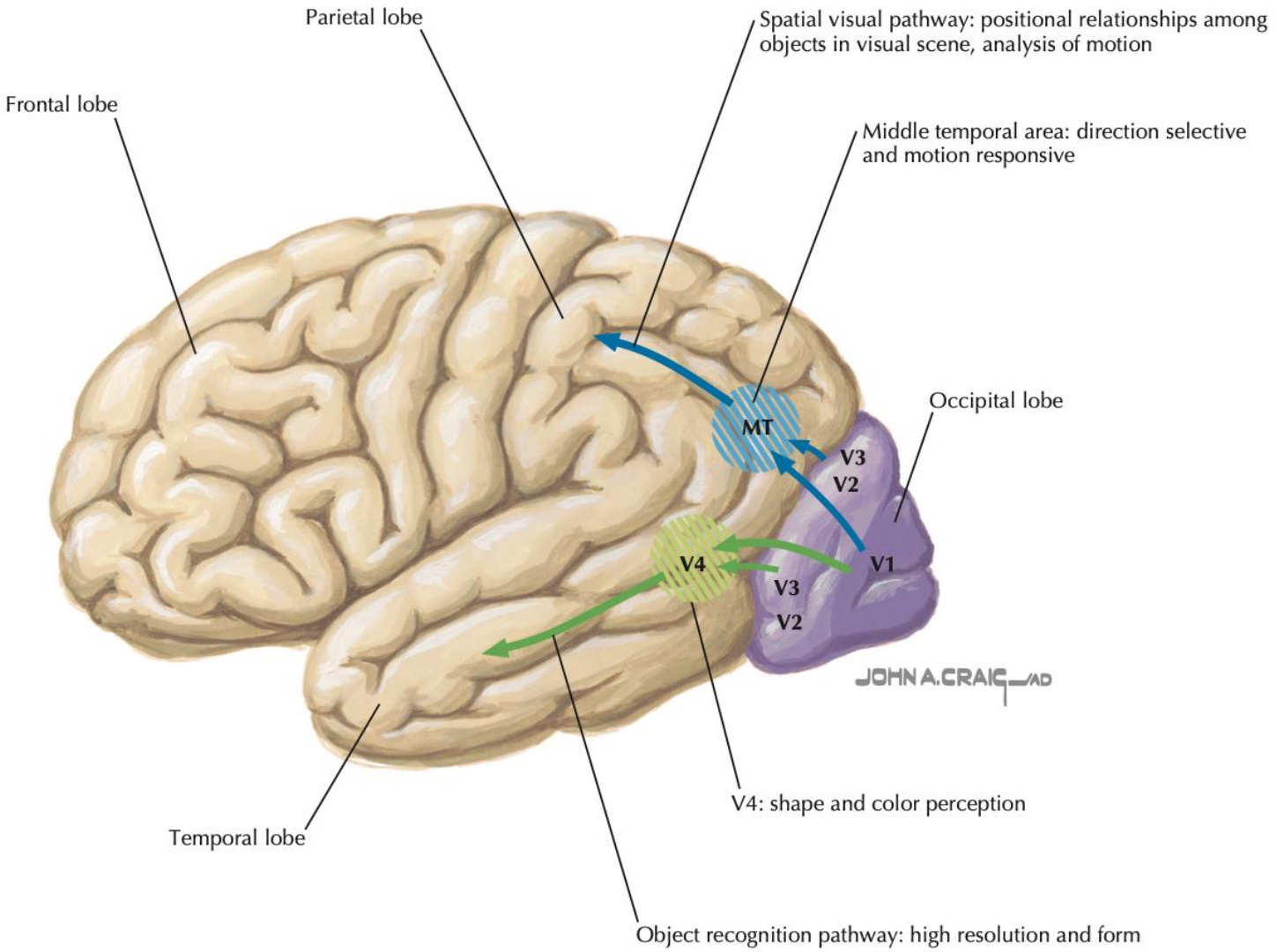
… It's your time

Vision

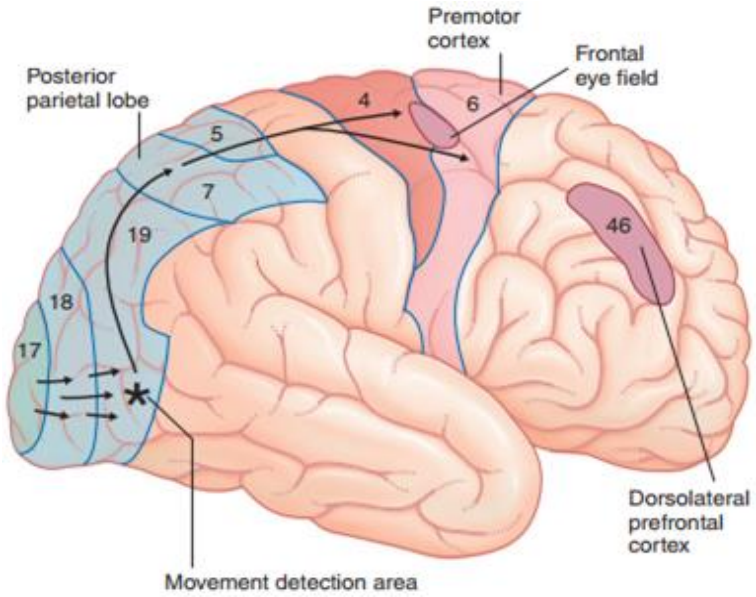

Visual system lesions
Visual fields
Overlapping visual fields
Optic (II) nerves
Optic chiasm
Optic tracts
Meyer's loop
Meyer's loop
Lateral geniculate bodies
Ipsilateral optic nerve lesion
Chiasm lesion (bitemporal hemianopia)
Optic tract lesion (left homonymous hemianopia)
Meyer's loop (partial) (superior quadrantanopia)
Optic radiations (partial) (inferior quadrantanopia)
Optic radiations (complete) (left homonymous hemianopia)
Occipital lobe lesion sparing occipital pole (macular sparing homonymous hemianopia)
Localization
1. Unilateral vision loss: lesion of optic nerve
2. Congruous visual field loss of both eyes: posterior to optic chiasm
3. Incongruous visual field loss of both eyes: lesion at or near optic chiasm

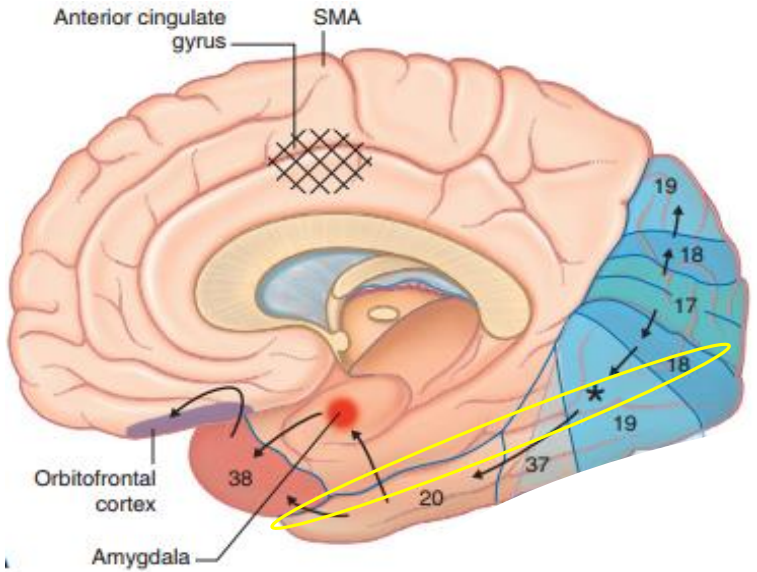
Vision


Visual system lesions
Overlapping visual fields
Optic (II) nerves
Optic chiasm
Meyer's loop
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Parietal lobe
Spatial visual pathway: positional relationships among objects in visual scene, analysis of motion
Frontal lobe
Middle temporal area: direction selective and motion responsive
Occipital lobe
MT
V3
V2
V4
V1
V3
V2
JOHN A. CRAIG, MD
Temporal lobe
V4: shape and color perception
Object recognition pathway: high resolution and form

Vision





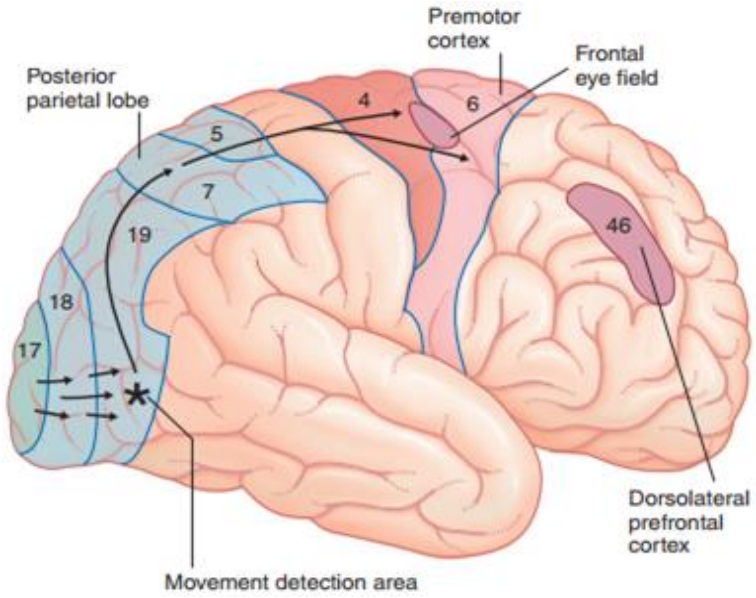
‘**Where**?’ pathway:

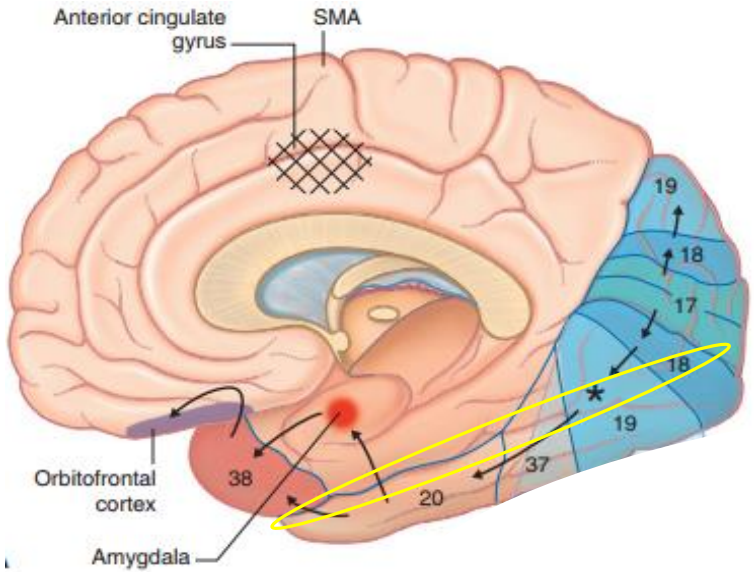
- Responsive to **movement** and involved in spatial sense.
- Projects to posterior parietal cortex (area 7) → increases firing rate in frontal eye field and premotor cortex, enabling covert attention (movement is not directly produced, but it will be more precise and ready).
- When items of special interest appear in the field of view, information is also sent to the dorsolateral prefrontal cortex (DLPFC), a decision-making area for approach vs withdrawal behaviors, which in turn activates the anterior cingulate gyrus.

‘**What**?’ pathway:

- Responsible for 3 kinds of general visual identification: **shapes** human **faces**, **colors.** Lesions → achromatopsia, prosopagnosia.
- Integration of further nonsensory cognitive and behavioural variables:
  - threatening sights cause amygdala activation;
  - during visual searching, the frontal lobe activate memory stores within the visual association areas, so that the relevant memories are held online during the search.
  - attention and expectation circuits interact with earlier steps of visual processing, allowing stabilization and interpretation of the visual scene and attributing a meaning.

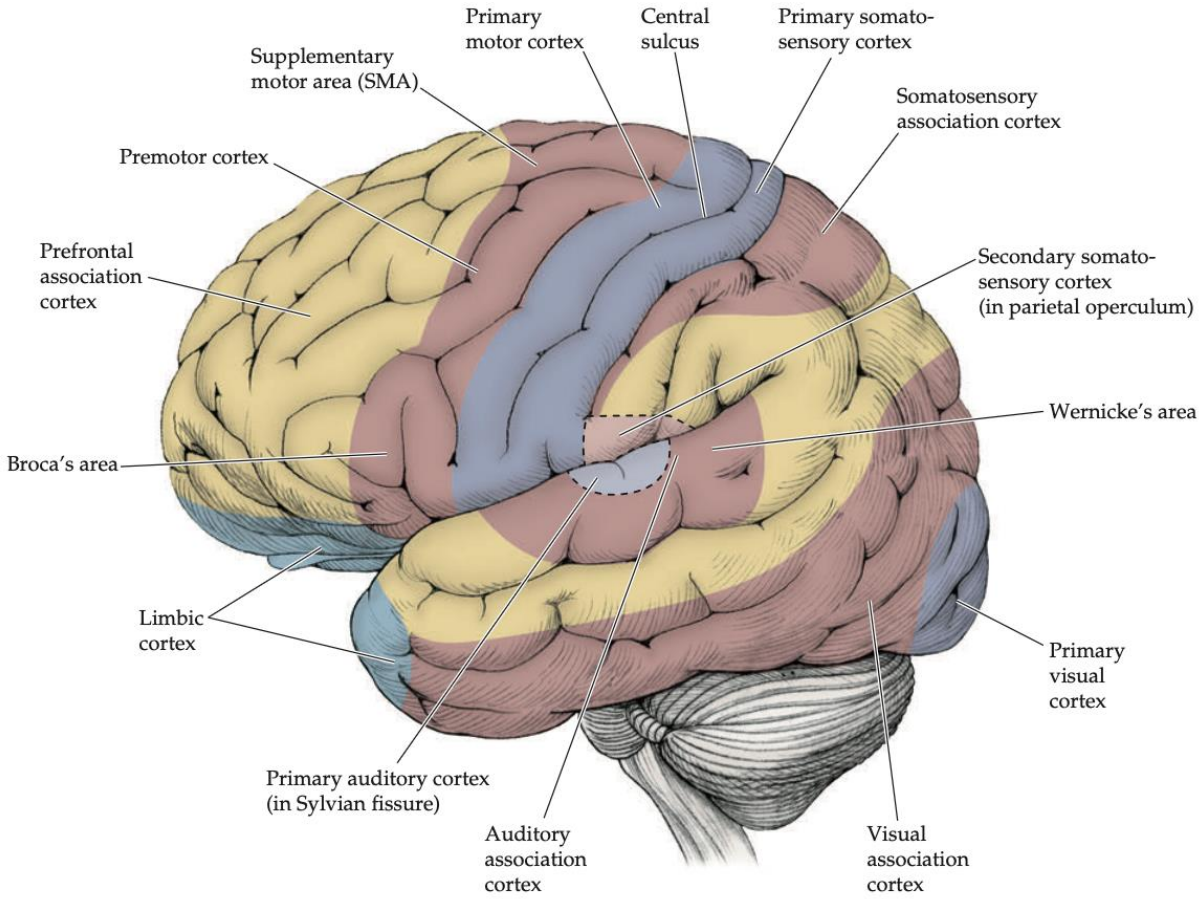
Vision deficits





- Visual agnosias happen with lesions in the occipito-temporal visual pathway. Visual agnosias are particularly common with lesions in the dominant mesial portion of the occipital cortex; they accompany a right homonymous hemianopia.
- Achromatopsia (cortical color blindness) also can occur with lesions in the occipito-temporal visual pathway, through V4.
- Prosopagnosia, the inability to recognize faces, occur with some specific lesions of the occipito-temporal pathway, especially when bilateral,
- Inability to distinguish between animate and inanimate objects may occurs with some lacunar infarcts in this pathway
- Visual-spatial disorientation, appearing clinically as impaired ability to see, occurs with lesions in the occipito-parietal visual pathway, particularly in the nondominant hemisphere
- Palinopsia, the persistence or reappearance of an object viewed earlier, occurs with lesions in the occipito-parietal visual pathway.

Frontal lobes impairments

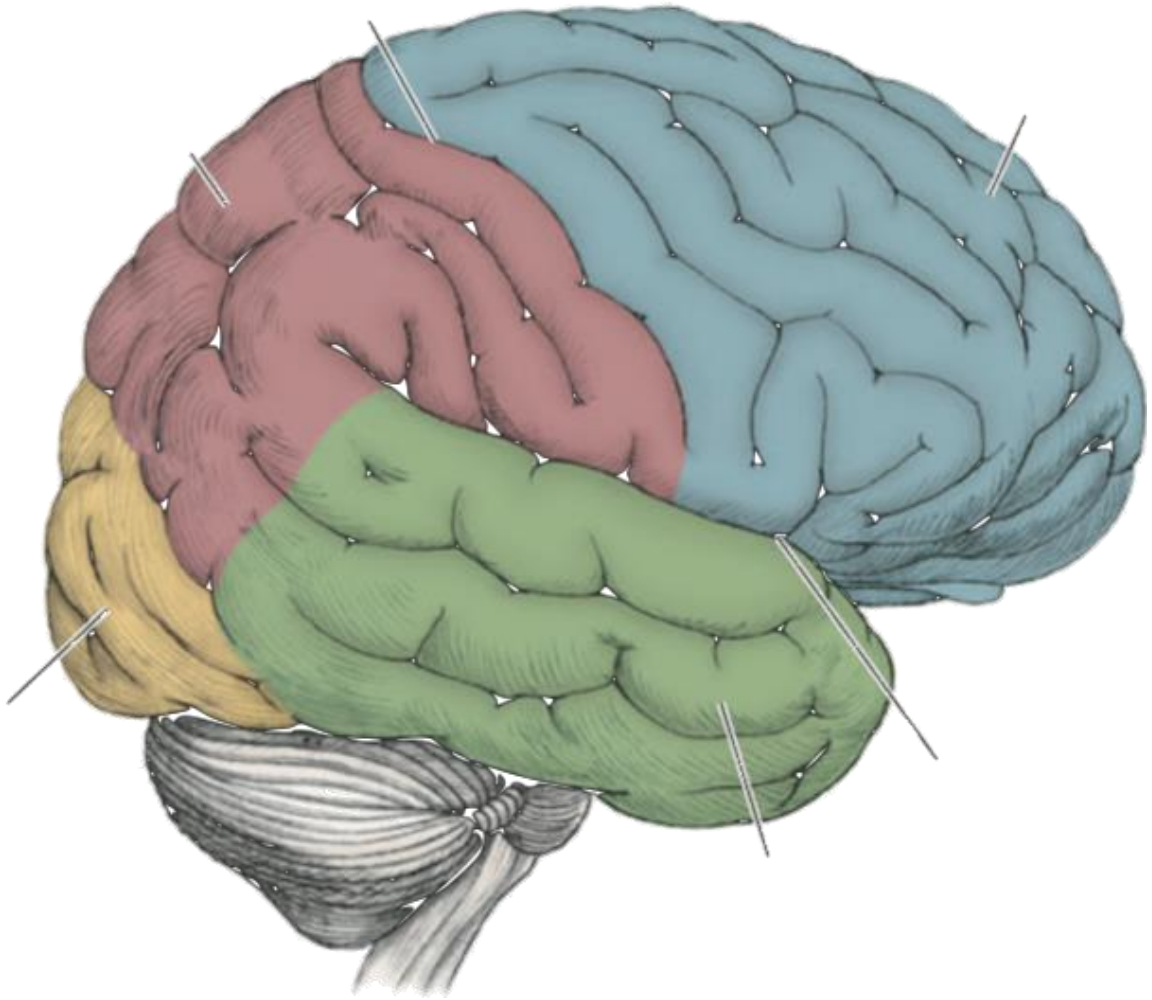


Lesions in the frontal lobes cause a variety of disorders in personality and cognitive functioning.

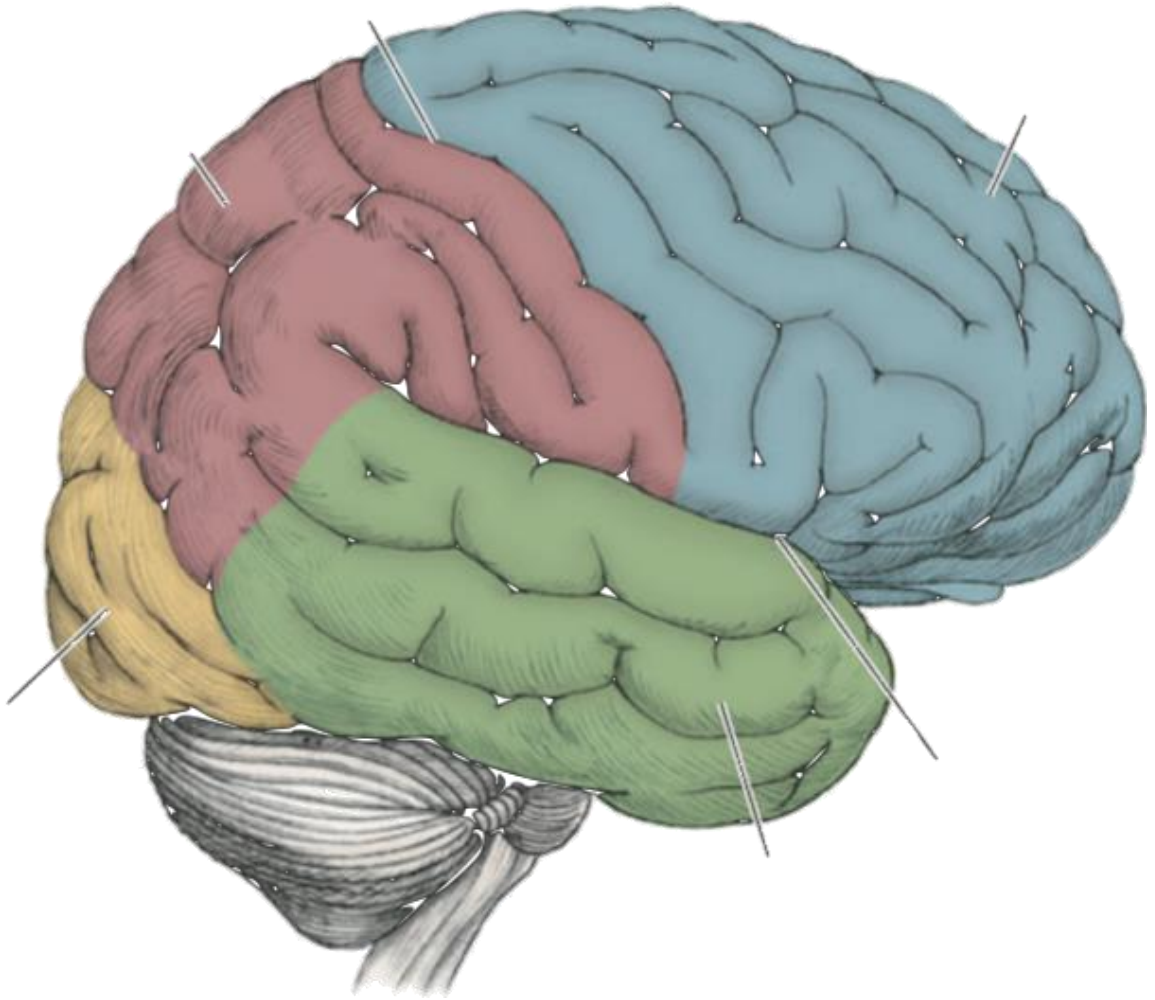
- Appearance of frontal release signs («primitive" reflexes that are normal in infants, such as grasp, root, suck, and snout reflexes)
- Difficulty when asked to perform a sequence of actions repeatedly or to change from one activity to another.
- Personality changes, such as impaired judgment, lack of concern about one's illness, inappropriate joking, and other disinhibited behaviors.
- Abulia: tendency to stare passively and to respond to commands only after a long delay.
- Characteristic unsteady magnetic gait, in which the feet shuffle close to the floor
- Urinary incontinence.

Praxia

The neurological ability to plan, organize, and execute voluntary and learned movements to achieve a specific goal



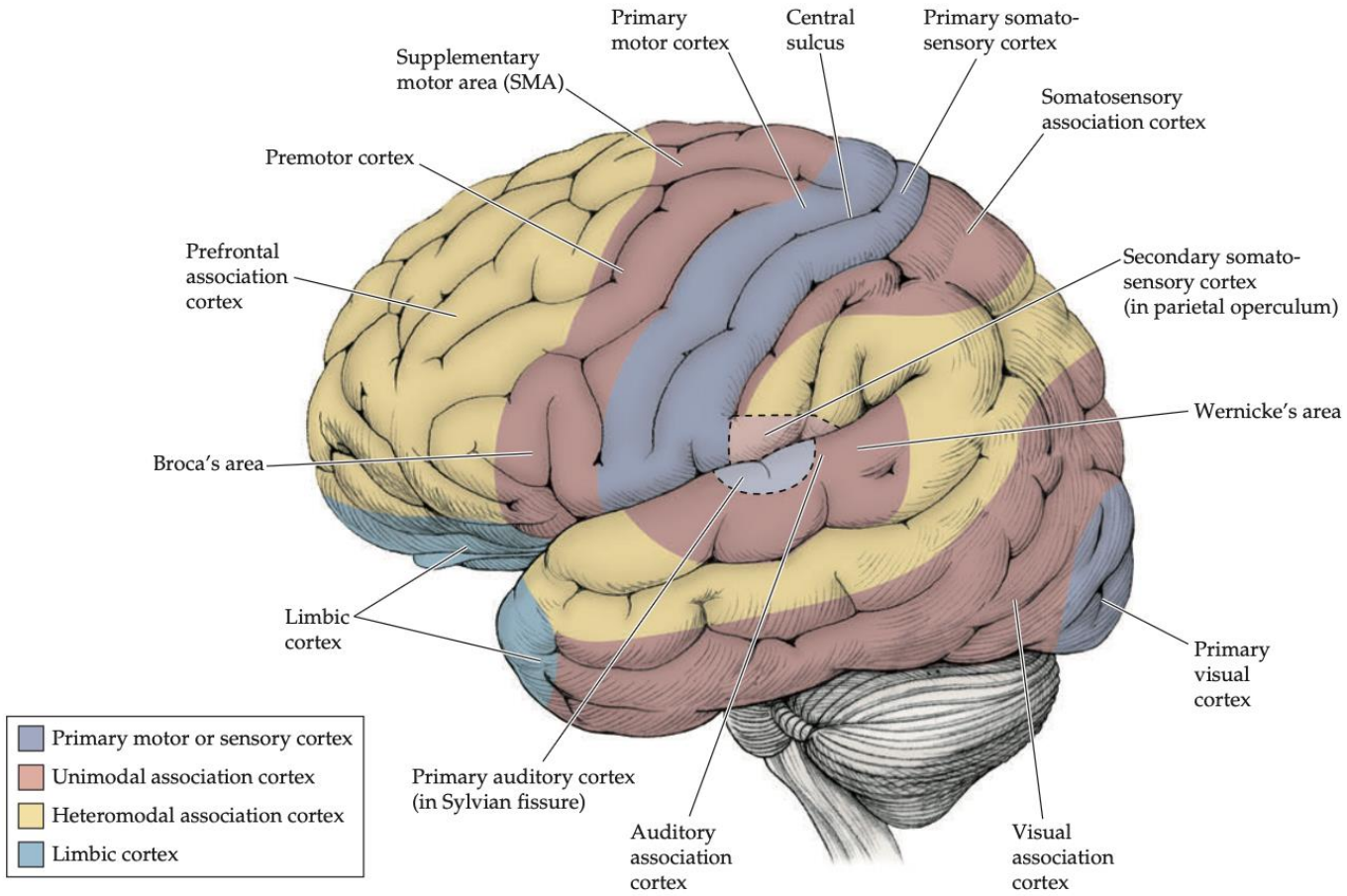
Apraxia



Apraxia is the disorder in the execution of intentional movements in the absence of impaired attention, sensory, or motor deficits.

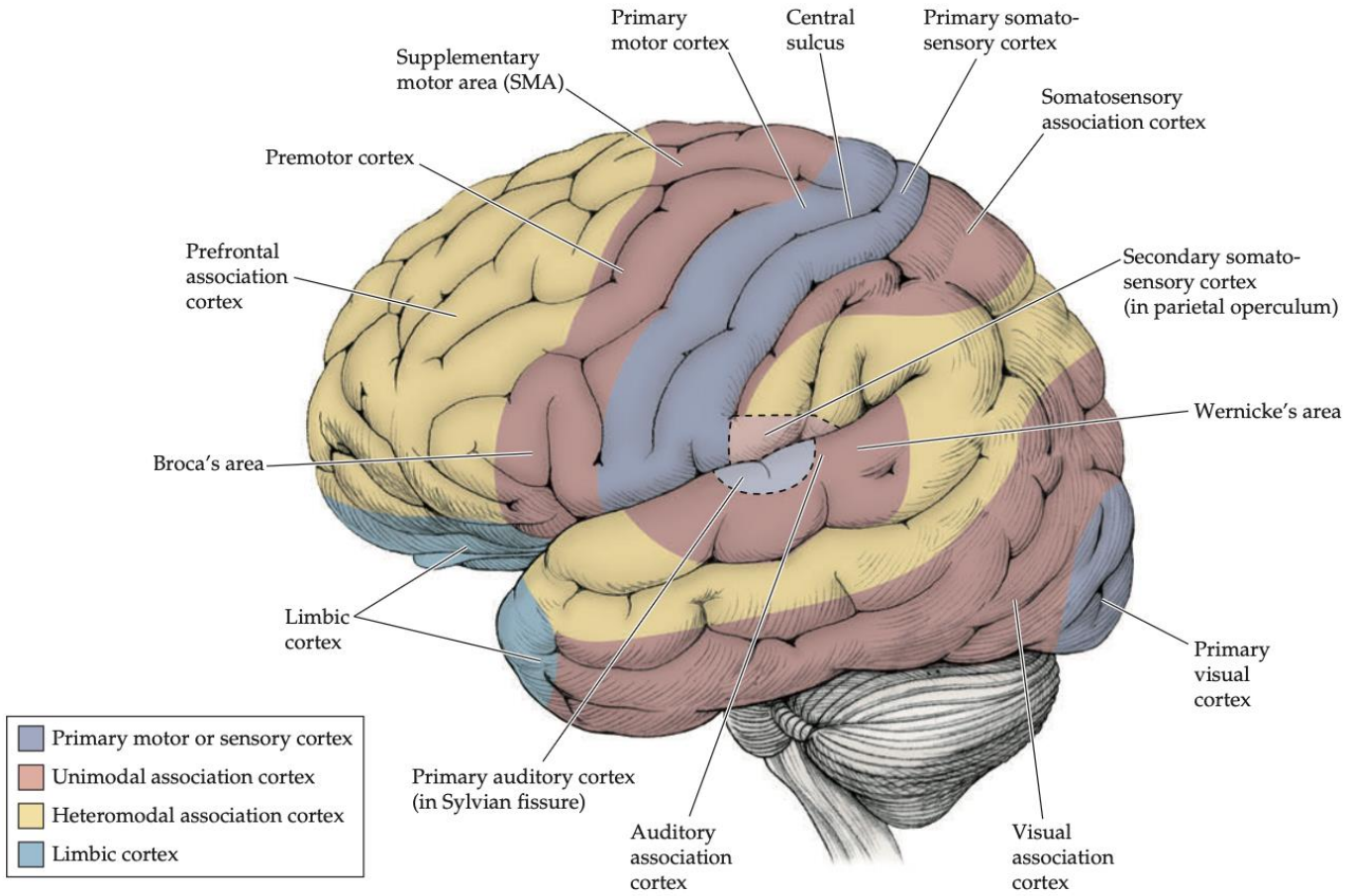
- **Ideational Apraxia,** is the inability to formulate the general plan of movement. Lesion of the left temporoparietal cortex. Generally involves both limbs. If it involves only the left hand, a lesion of the corpus callosum occurs.
- **Ideomotor Apraxia** is the **i**ncorrect formulation of the motor plan, errors in the execution phase. Lesion of the temporoparietal cortex or pathways connecting it to the premotor cortex.
- **Motor Apraxia** is the lack of fluidity in the execution of the gesture. Lesion of the premotor area. Constructive Apraxia: Deficit in understanding spatial relations. Apraxia of dressing, drawing. Right parietal lesion

Gnosia



Gnosia is tha ability to recognize and interpret sensory stimuli, including objects, sounds, and emotional sensations.

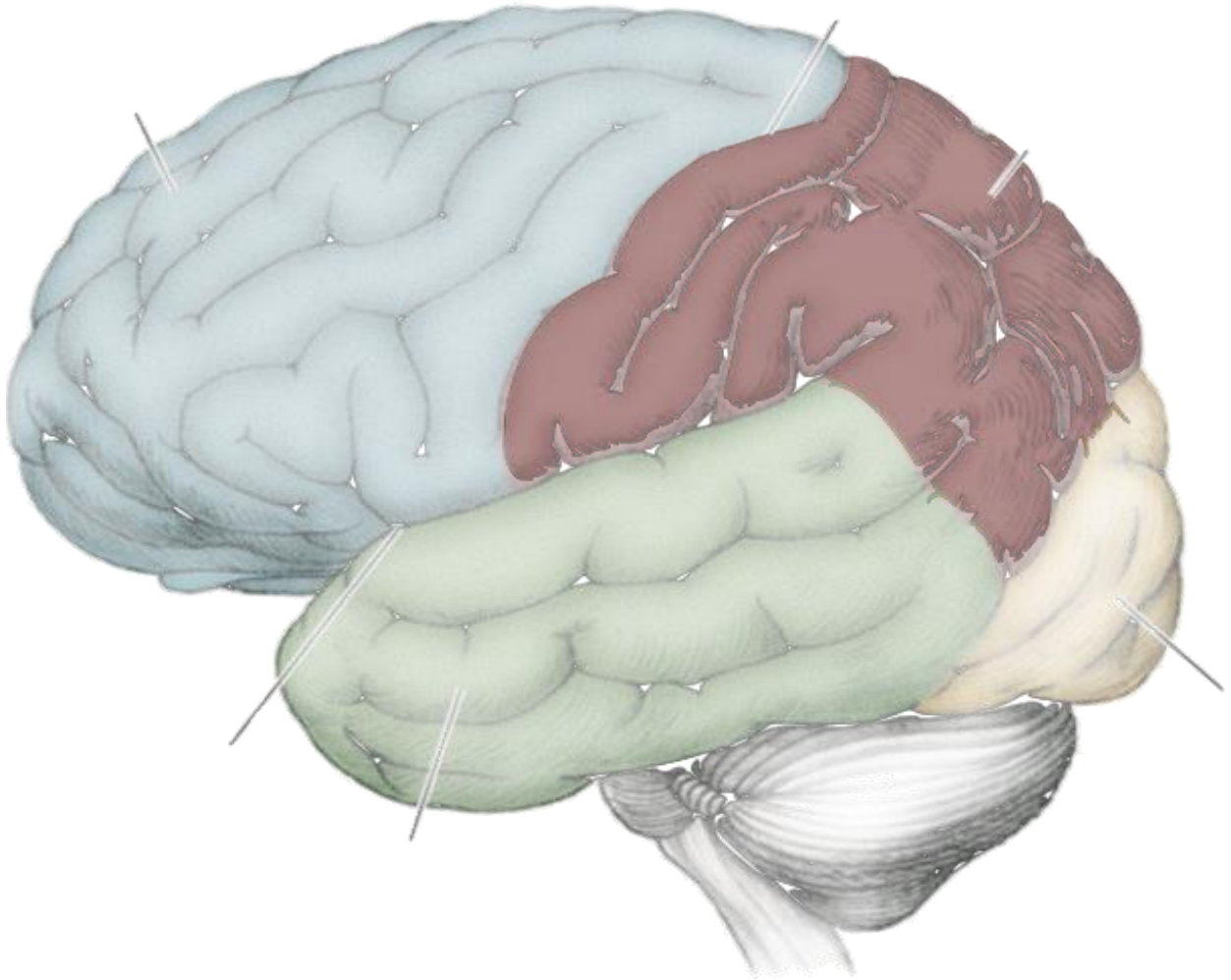
Agnosia



Agnosia is the disorder in object recognition, specific to a sensory channel (somatosensory, visual, auditory, etc.), in the absence of attentional or elementary sensory deficits.

- **Apperceptive agnosia**: The patient discriminates the fine degrees of sensations but cannot "describe" the object, cannot deduce its shape, size, etc. Astereognosia
- **Associative agnosia**: The patient can describe the object perfectly but cannot relate it to the image of a known object, "cannot recognize" it. Tactile asymbolism
- **Somatoagnosia**: Impaired recognition of one's own body (Right parietal lesion).
- **Anosognosia** : unawareness of a deficit.

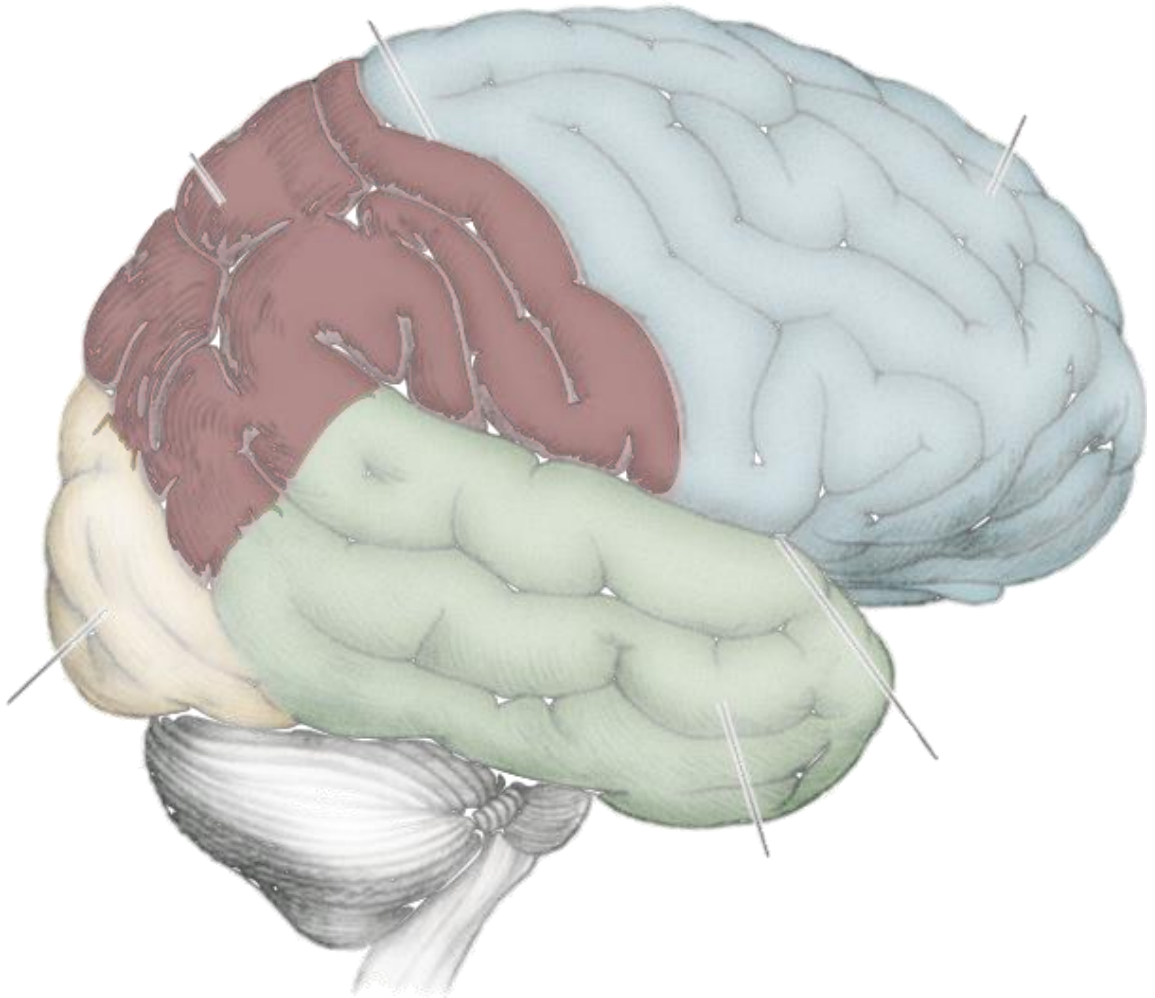
Gerstmann’s syndrome



Functions of inferior parietal lobule:
Calculations, right–left discrimination, ability to identify fingers by name, capacity to read written language, capaticy to write.

Gerstmann’s syndrome, caused by **l**esions in the inferior parietal lobule in the left hemisphere:
Acalculia
Right–left confusion
Finger agnosia
Alexia
Agrafia

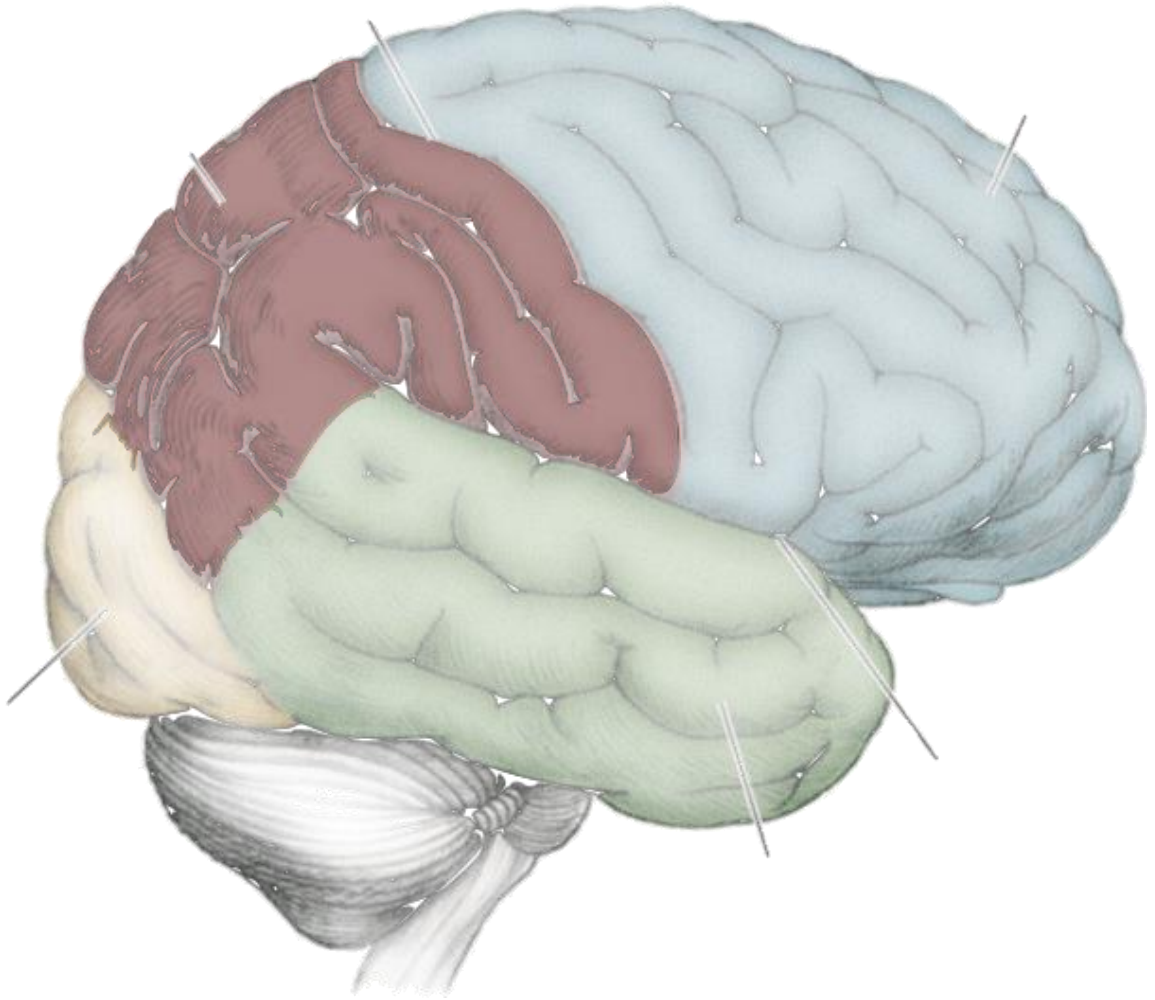
Spatial awareness



Spatial awareness is the ability to perceive, understand, and interact with the environment, recognizing the position of one's body and objects in relation to themselves and each other.

Key components include spatial perception, visualization, mental rotation, and spatial memory

Neglect & Extinction



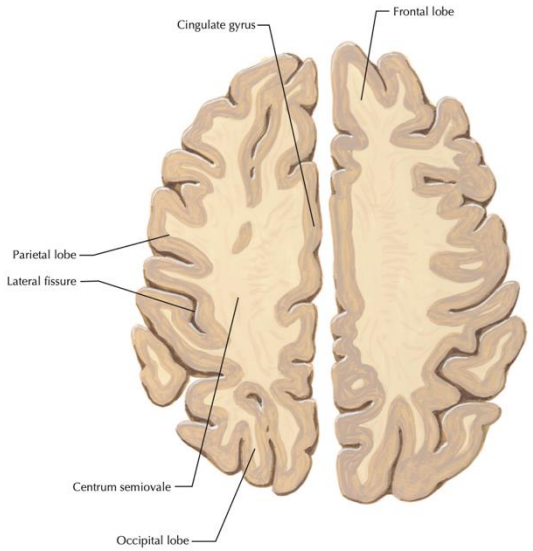
Distortion od perceived space and neglect of controlateral side: lesions in the parietal lobe, especially in the non-dominant

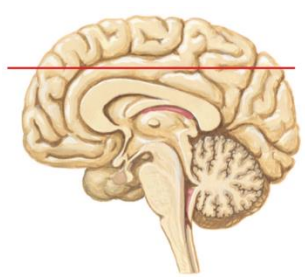
Hemineglect: patients ignore objects in their left visual field, but they may see them if their attention is strongly drawn to that side.
They may also be completely unaware of the left side of their body, thinking, for example, that their left arm belongs to someone else, and they may be unaware of any weakness or other deficits on that side.

Extinction: the deficit where a tactile or visual stimulus is perceived normally when it is presented to one side only, but when it is presented on the side opposite the lesion simultaneously with an identical stimulus on the normal side, the patient neglects the stimulus on the side opposite the lesion.

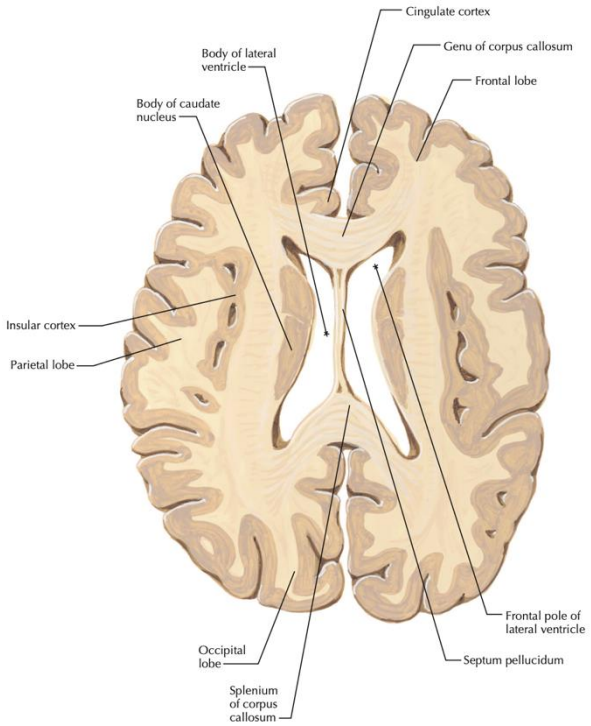
Axial sections of brain

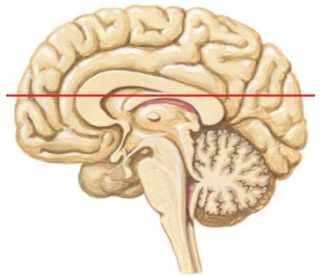
Level of section
: Centrum Semiovale



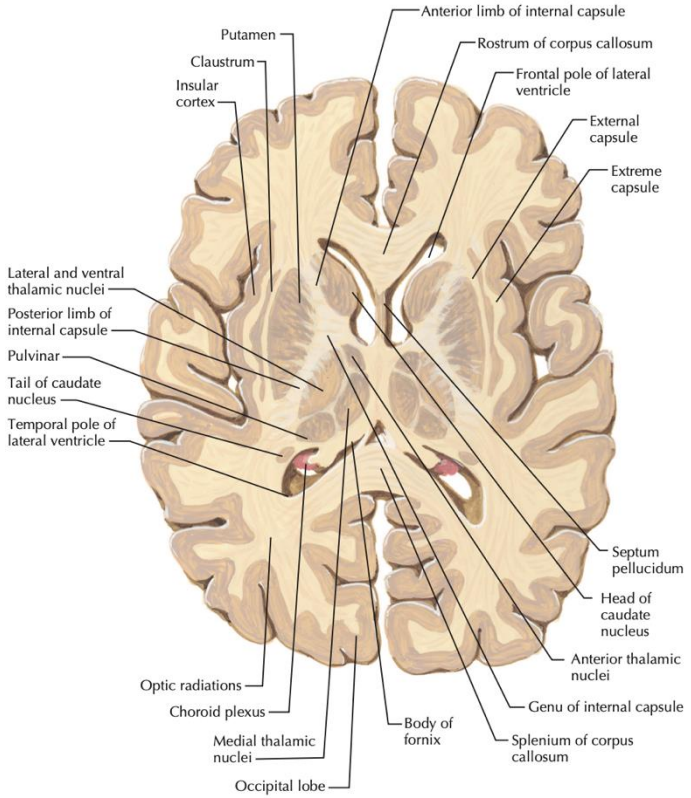


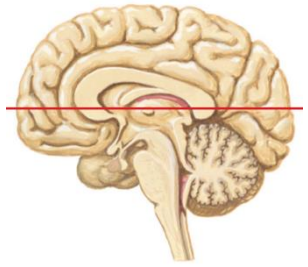
Level of section
(dorsal caudate, splenium, and genu of corpus callosum)



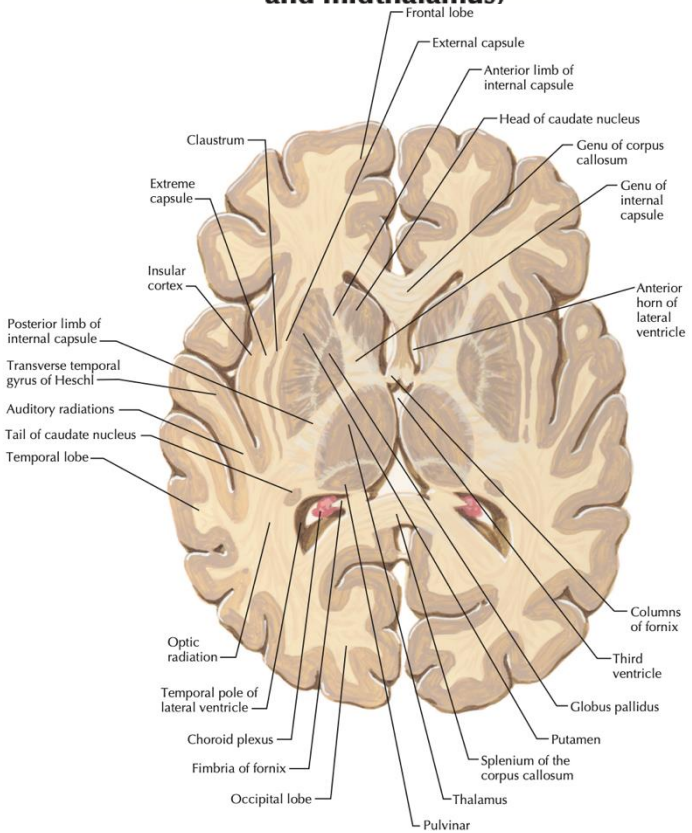


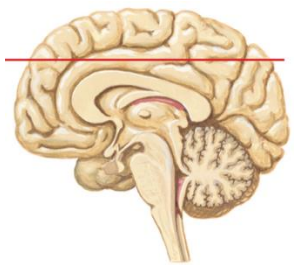
Level of section
(basal ganglia and internal capsule)





Level of section
(head of caudate and midthalamus)





Axial sections of brain

