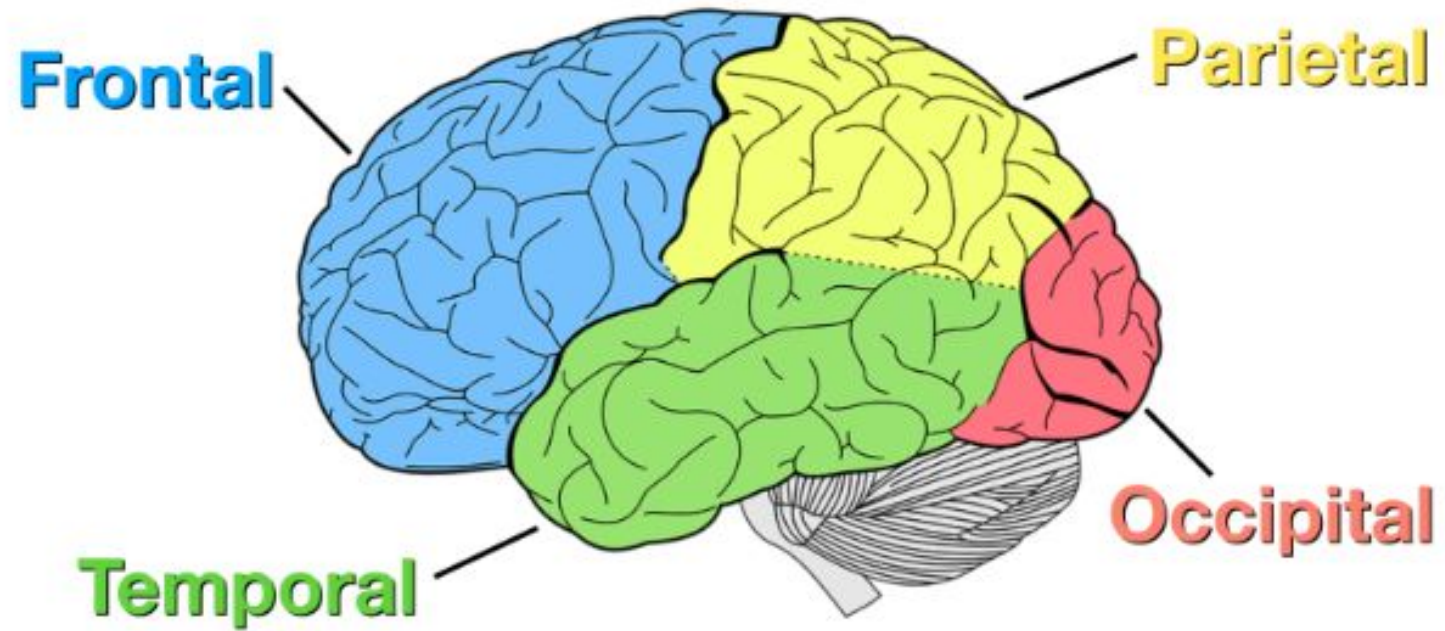
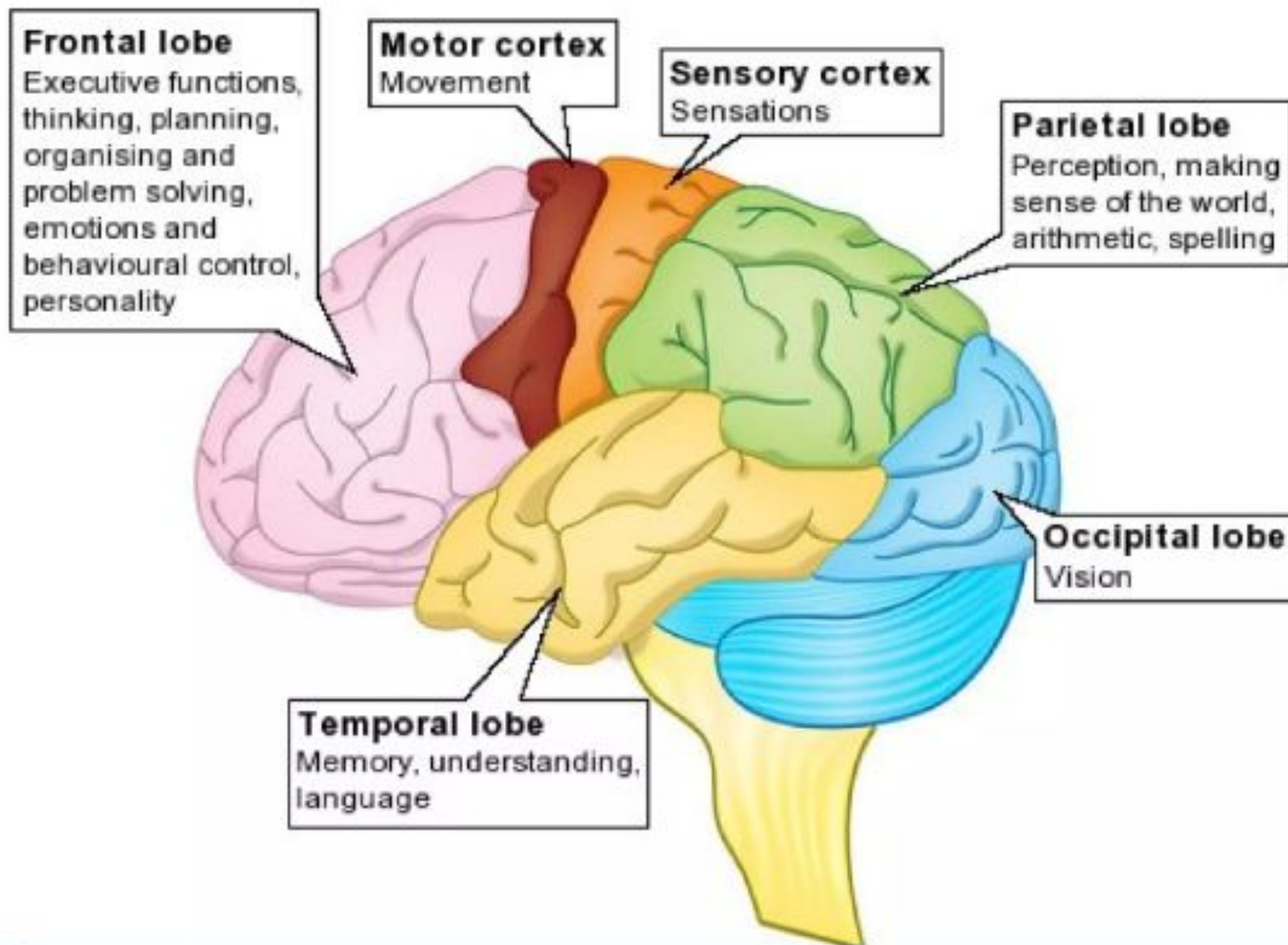


Functional Localization of the cerebral cortex

Cerebral Cortex = Outer Grey Matter Layer

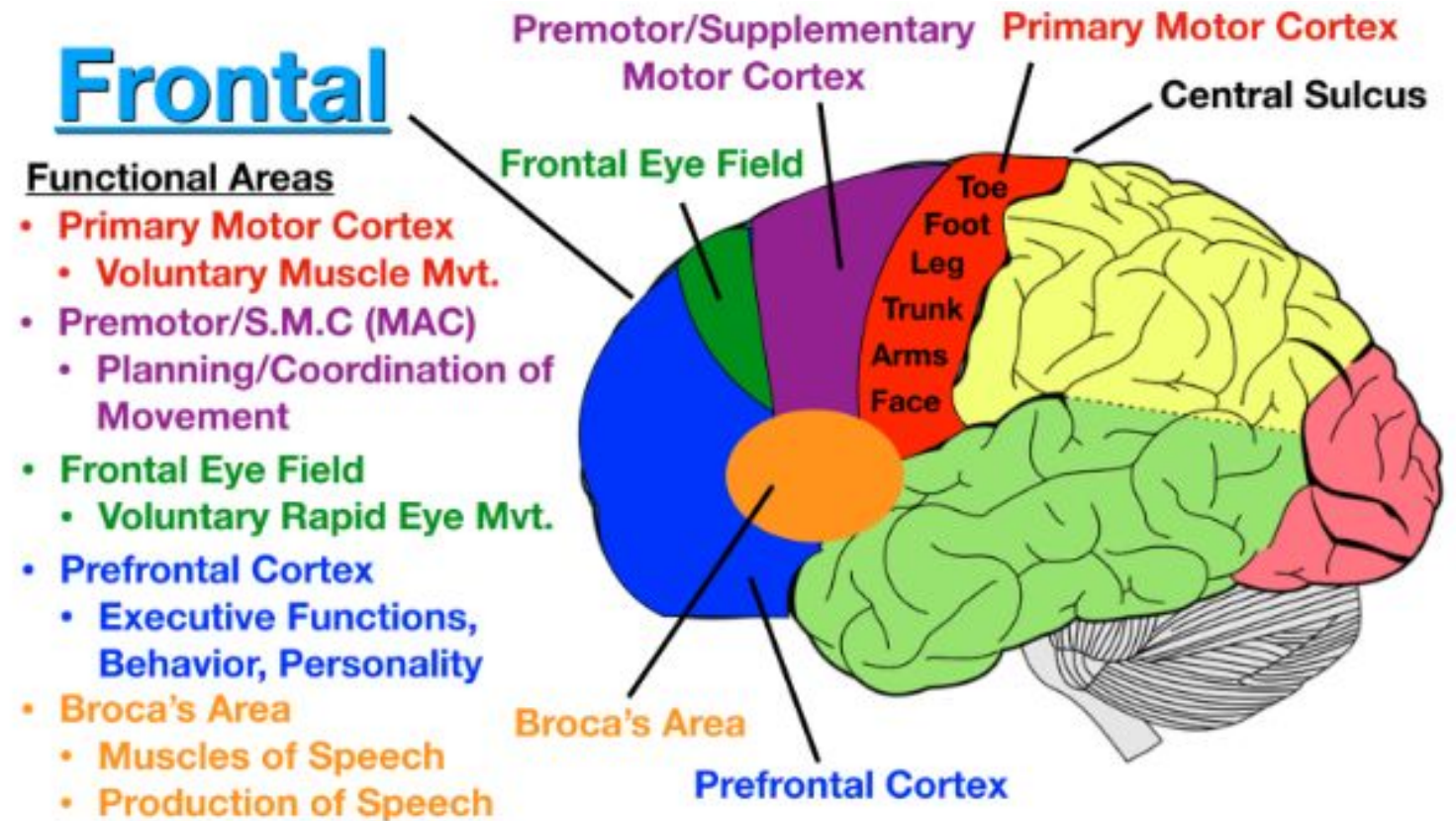




Frontal lobe

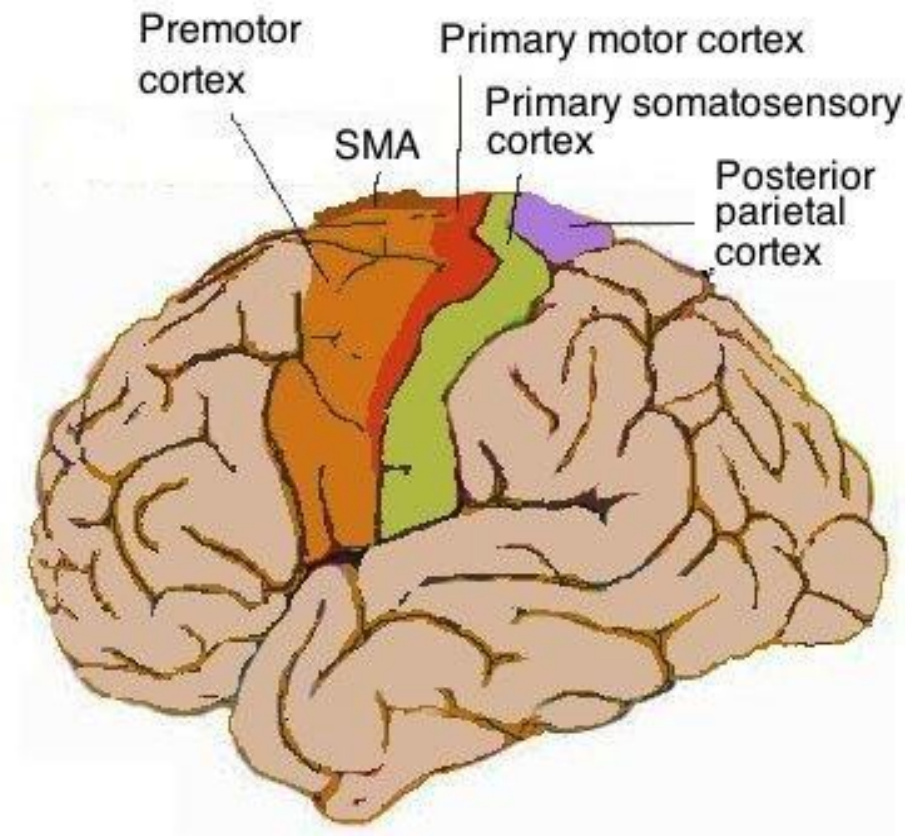
Main cortical areas:

- 1- Primary motor area
- 2- Motor association area
- 3- Frontal eye field
- 4- Prefrontal cortex
- 5- Broca's area

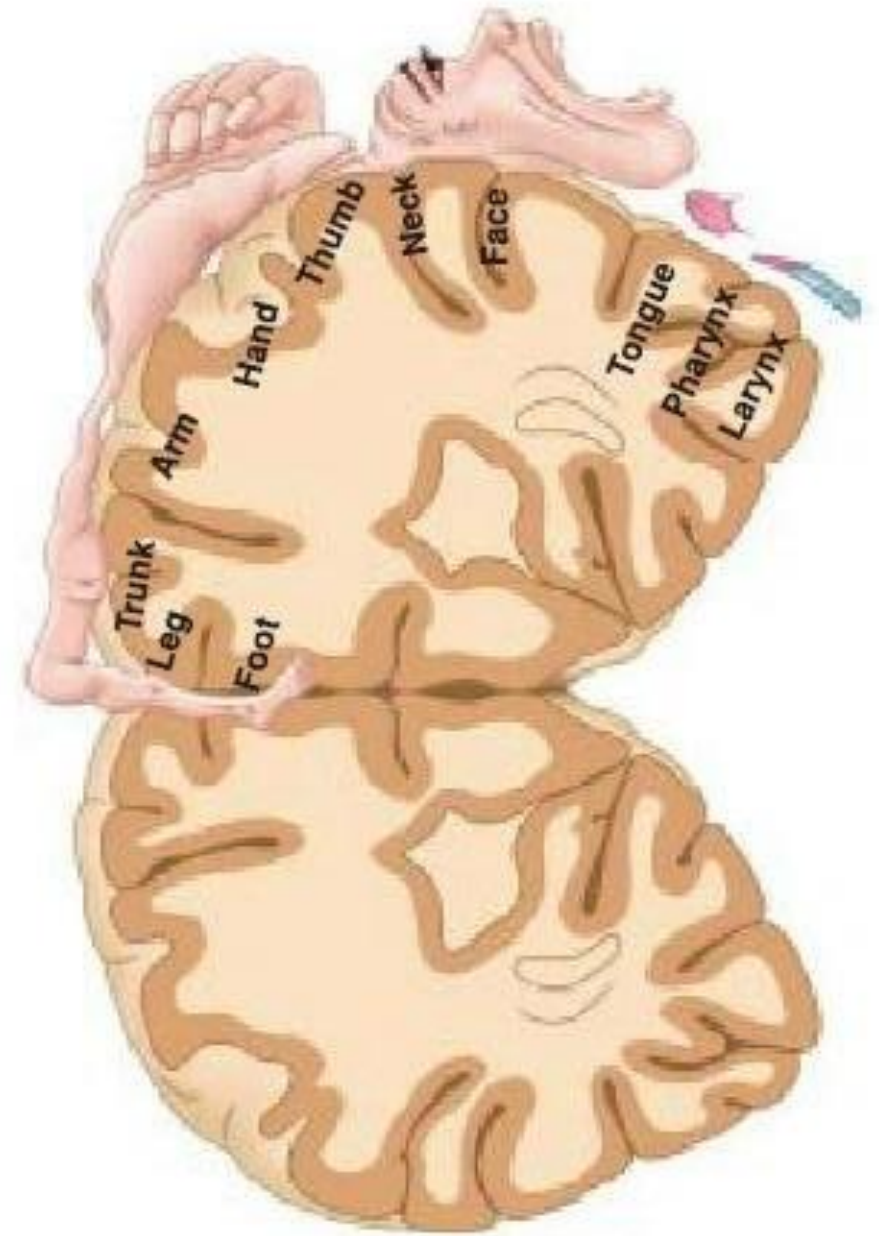


Primary Motor area (area 4)

- Lies in the first convolution of the frontal lobes anterior to the central sulcus. It begins laterally in the Sylvian fissure, spreads superiorly to the uppermost portion of the brain, and then dips deep into the longitudinal fissure.
- More than one-half of the primary motor cortex is concerned with controlling the muscles of the hands and speech muscles.
- Excitation of single motor cortex neuron usually excites a specific movement rather than one specific muscle.



- If the primary motor area is electrically stimulated, it produces **isolated movements on the opposite side of the body** and **contraction of muscle groups that perform a specific movement**. Isolated ipsilateral movements don't happen, bilateral movements of the extraocular muscles, the muscles of the upper part of the face, the tongue, and the mandible, and the larynx and the pharynx do.
- The movement areas of the body are represented in **inverted form** in the precentral gyrus. area of the cortex controlling a particular movement is proportional to the skill involved in performing the movement and is unrelated to the mass of muscle participating in the movement:

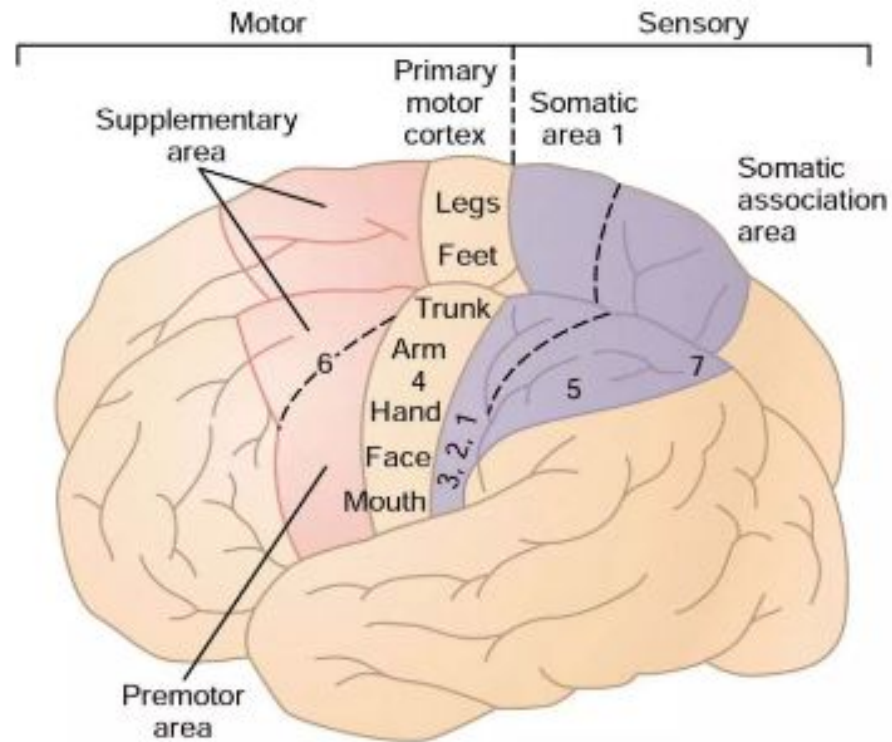
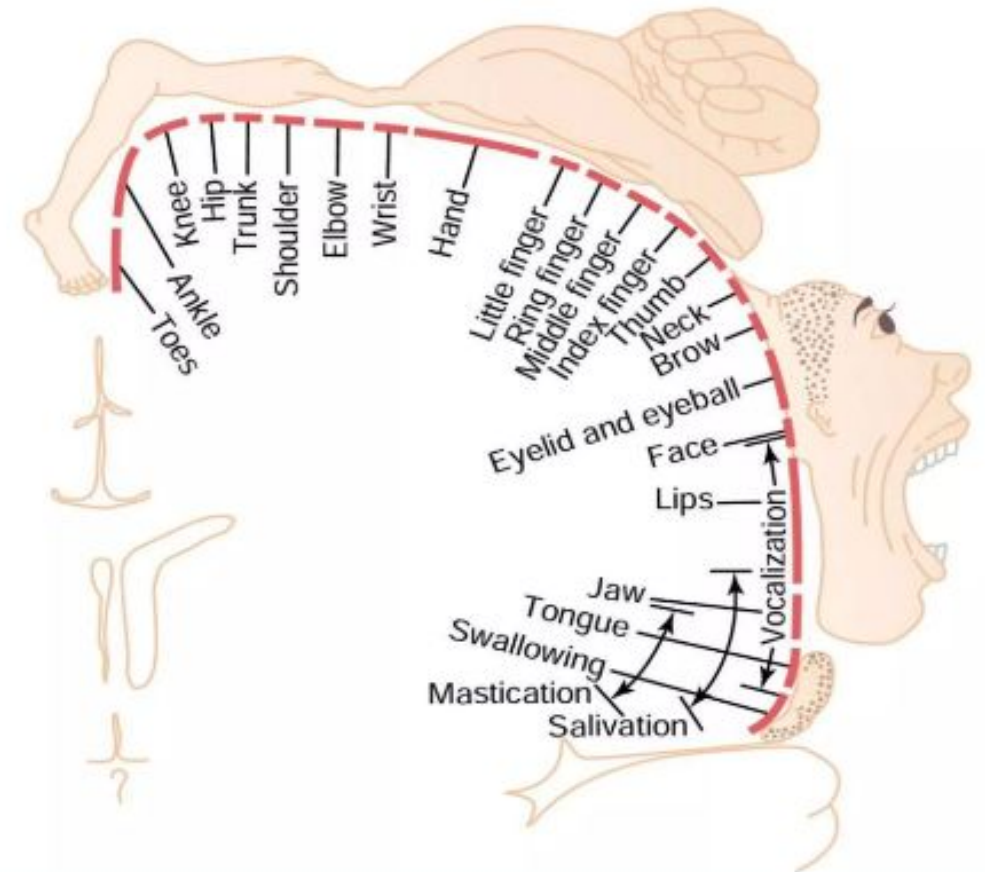


-
- Structures involved in swallowing and the tongue, jaw, lips, larynx, eyelid, and brow.
 - Extensive region for movements of the fingers, especially the thumb, hand, wrist, elbow, shoulder, and trunk.
 - Movements of the hip, knee, and ankle are represented in the highest areas. Movements of the toes are on the medial surface of the hemisphere in the paracentral lobule.
 - Movements of the anal and vesical sphincters are located in paracentral lobule.

So, function of the primary motor area is to carry out the individual movements of different parts of the body.

To assist in this function, it receives afferent fibers from **premotor area, sensory cortex, the thalamus, the cerebellum, and the basal ganglia.**

Motor Homunculus



Premotor area (area 6)

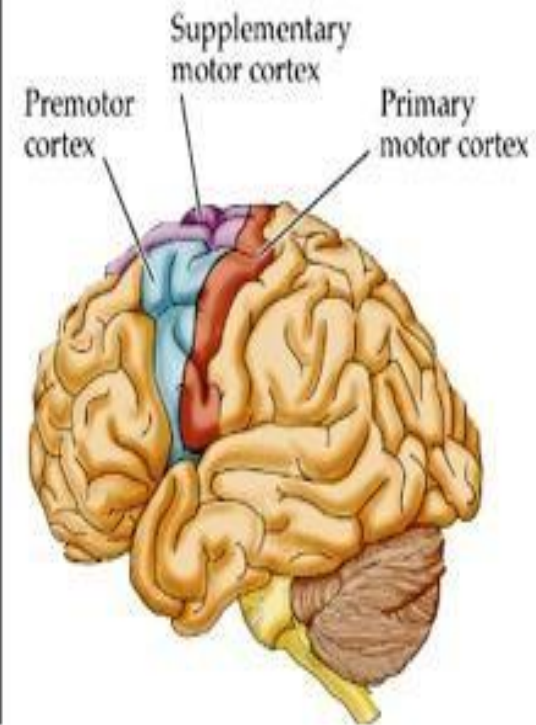
- Occupies the anterior part of the precentral gyrus and the posterior parts of the superior, middle, and inferior frontal gyri.
- Electrical stimulation produces muscular movements similar to those given by stimulation of the primary motor area but **stronger stimulation is necessary to produce the same degree of movement.**

-
- The premotor area receives inputs from the sensory cortex, the thalamus, and the basal ganglia.
 - Function is to **store programs of motor activity** that result from past experience. So it programs the activity of primary motor area.
 - It is particularly involved in controlling coarse postural movements by communicating with basal ganglia.

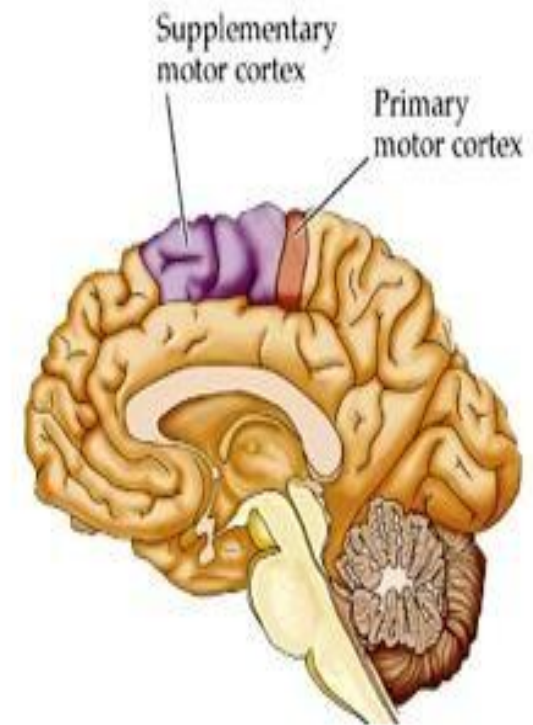
Supplementary Motor Area

- Situated in the medial frontal gyrus on the medial surface of the hemisphere and anterior to the paracentral lobule.
- Stimulation of this area results in **movements of the contralateral limbs**, but a stronger stimulus is necessary than when the primary motor area is stimulated.
- Removal of the supplementary motor area produces no permanent loss of movement.

(A) Lateral view



(B) Medial view



Frontal eye field

- Extends forward from the facial area of the precentral gyrus into the middle frontal gyrus (parts of Brodmann areas 6, 8, and 9).
- Electrical stimulation of this region causes **conjugate movements of the eyes**, especially toward the **opposite side**.
- It is considered to control voluntary scanning movements of the eye and is independent of visual stimuli.

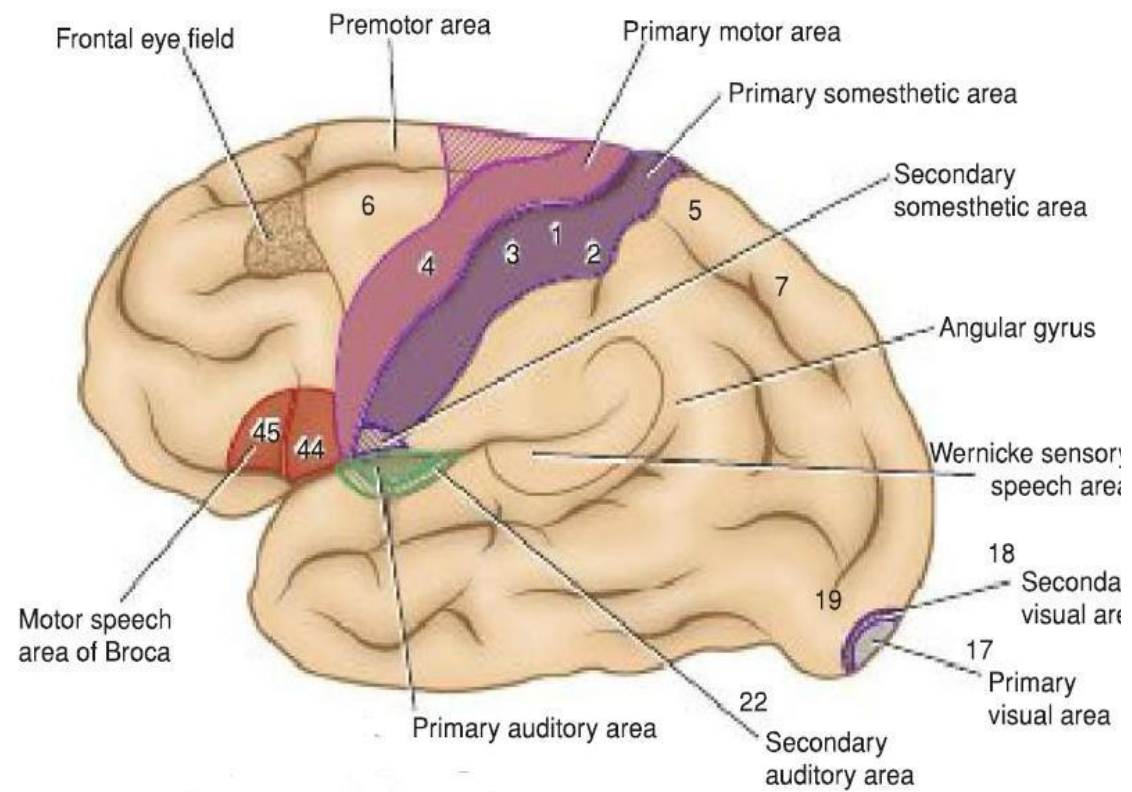
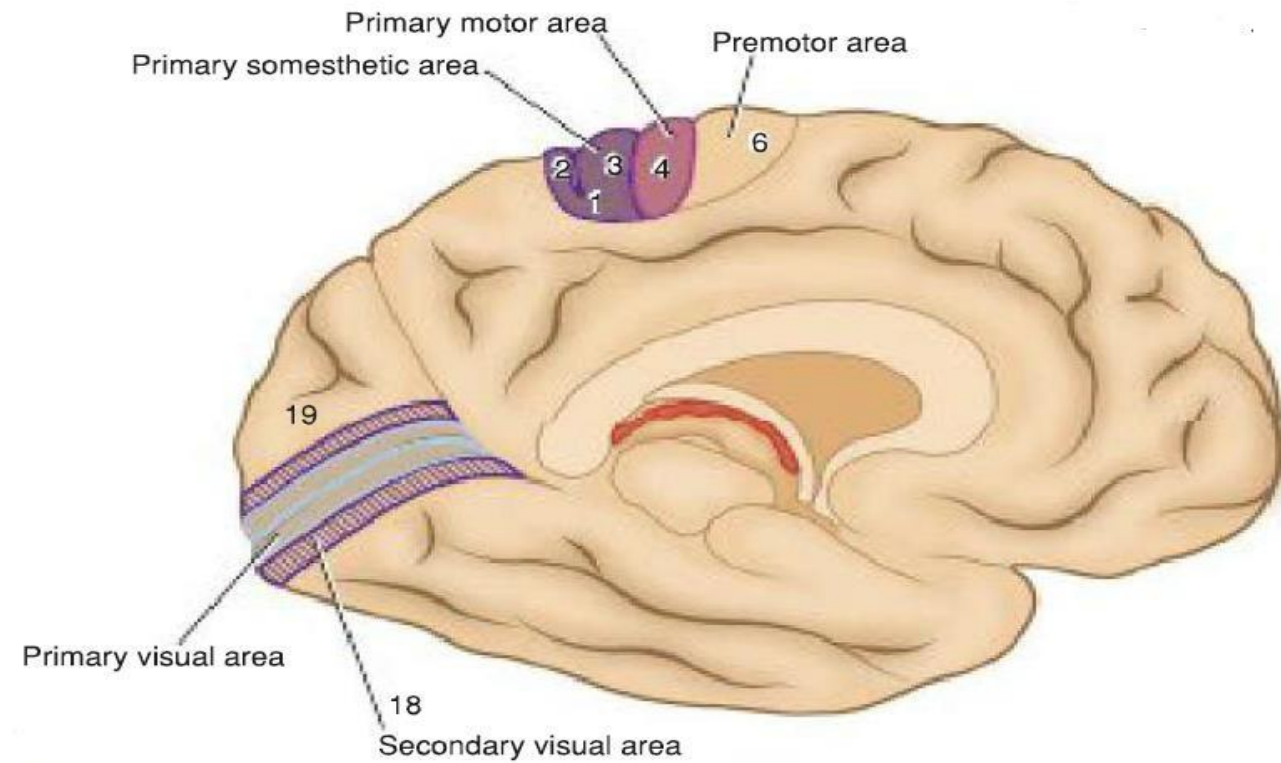
Prefrontal cortex

- Lies anterior to the precentral area.
- Includes the greater parts of the superior, middle, and inferior frontal gyri; the orbital gyri; most of the medial frontal gyrus; and the anterior half of the cingulate gyrus (Brodmann areas 9, 10, 11, and 12).
- It is concerned with the makeup of the individual's personality and plays a role as a regulator of the person's depth of feeling. It also exerts its influence in determining initiative and judgment.



Broca's area

- Located in the inferior frontal gyrus between the anterior and ascending rami and the ascending and posterior rami of the lateral sulcus (Brodmann areas 44 and 45).
- Of importance in the dominant hemisphere (the left in 98% of people).
- Ablation in the dominant hemisphere will result in paralysis of speech. Ablation in the non-dominant hemisphere has no effect on speech.
- Brings about the formation of words by its connections with the adjacent primary motor areas; the muscles of the larynx, mouth, tongue, soft palate, and the respiratory muscles are appropriately stimulated.

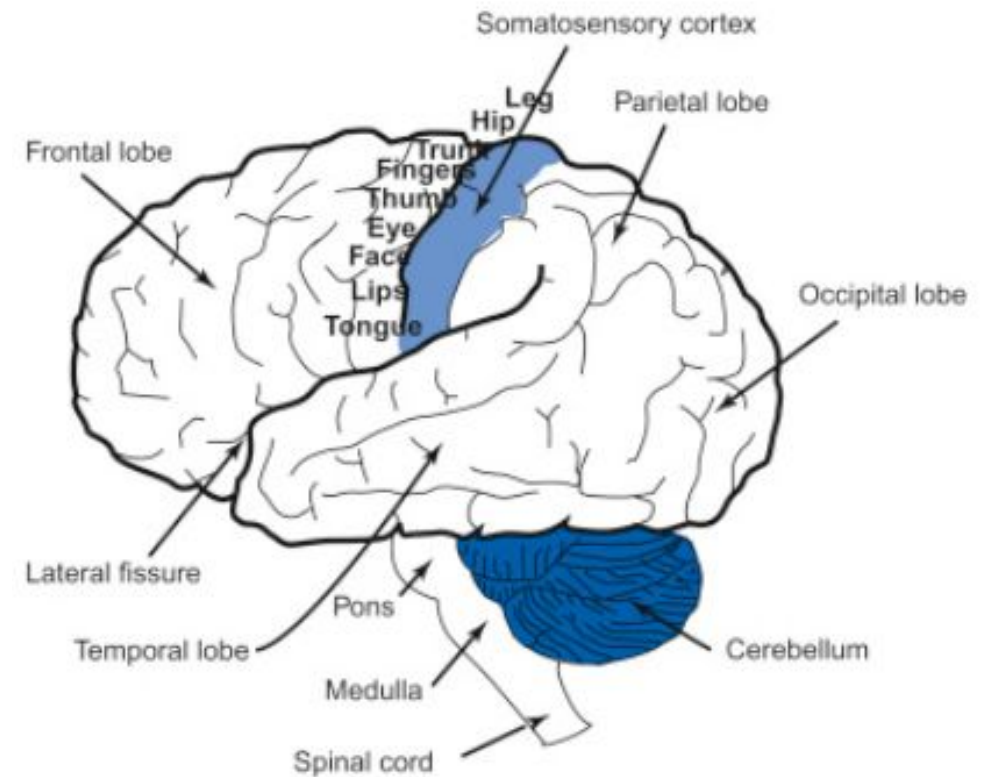


Parietal lobe

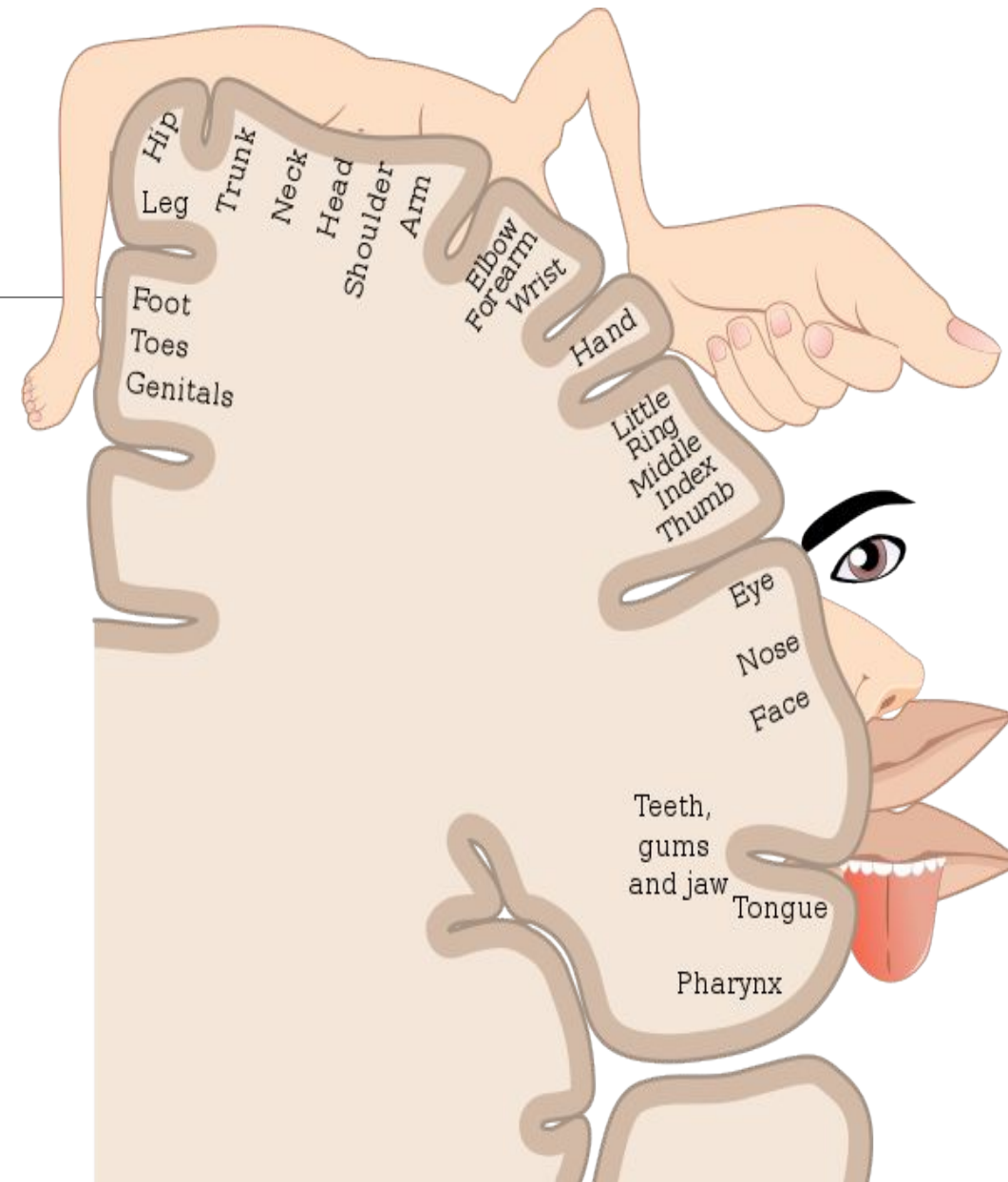
- The parietal lobe is involved in somatic sensations such as touch, pain, pressure, temperature, vibration, etc.
- Plays a key role in processing and analyzing somatosensory information to provide meaning and understanding to the stimulus.
- Functional areas of the parietal lobe:
 - 1- Primary Somatosensory Cortex S1
 - 2- Secondary somatosensory Cortex S2
 - 3- Somesthetic Association Area

Primary somatosensory cortex

- It is located in the postcentral gyrus on the lateral surface of the hemisphere and the posterior part of the paracentral lobule on the medial surface (Brodmann areas 3, 1, and 2).
- The primary somesthetic areas of the cerebral cortex receive projection fibers from the ventral posterior lateral and ventral posterior medial nuclei of the thalamus.



- opposite half of the body is represented as **inverted**.
- Pharyngeal region, tongue, and jaws are represented in the most inferior part of the postcentral gyrus, followed by the face, fingers, hand, arm, trunk, and thigh.
- Leg and foot areas are found on the medial surface of the hemisphere in the posterior part of the paracentral lobule. Anal and genital regions are also found in this latter area.

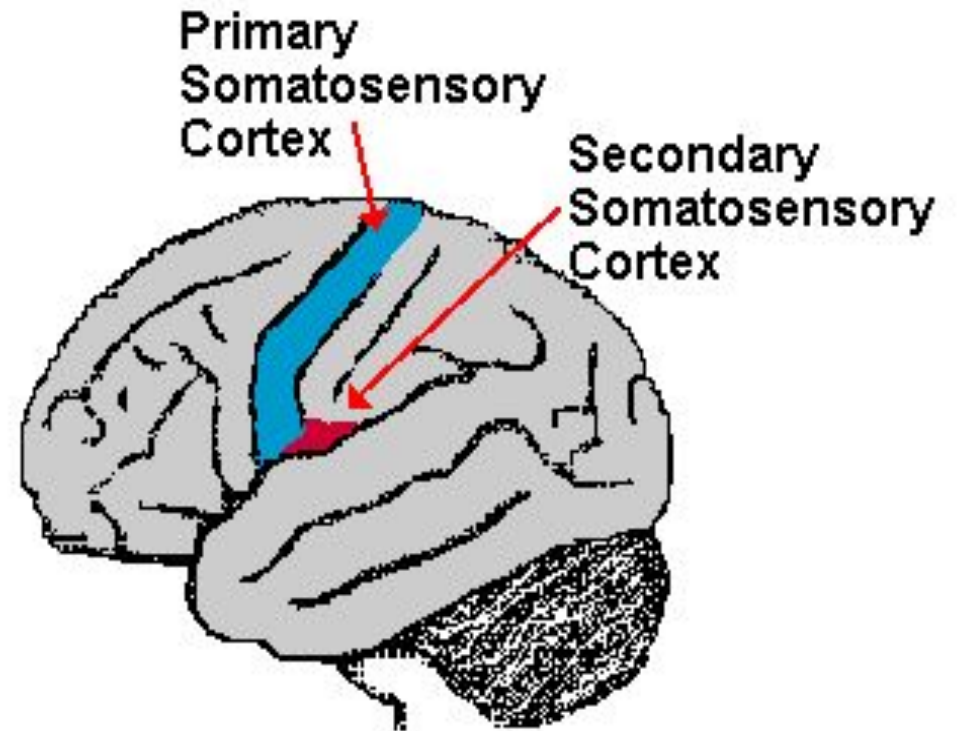


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- The apportioning of the cortex for a particular part of the body is related to its functional importance rather than to its size (**size is directly proportional to the number of sensory receptors present in that part of the body**).
 - Most sensations reach the cortex from the contralateral side of the body, **some from the oral region go to the same side, and those from the pharynx, larynx, and perineum go to both sides.**

-
- The anterior part of the postcentral gyrus situated in the central sulcus receives a large number of afferent fibers from **muscle spindles, tendon organs, and joint receptors**.
 - This sensory information is analyzed in the sensory cortex, then passed forward beneath the central sulcus to the **primary motor cortex**, where it greatly influences the control of skeletal muscle activity.

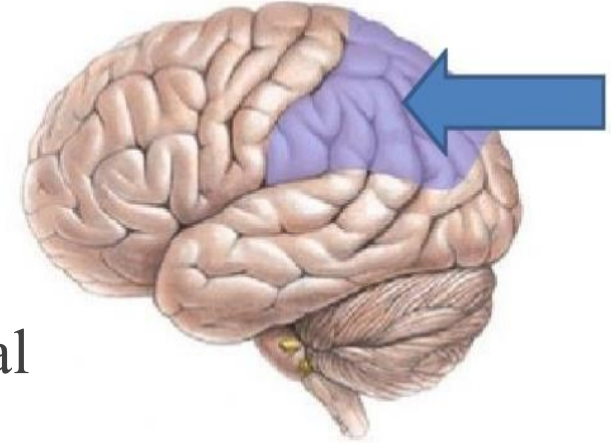
Secondary Somatosensory area

- It is located in the superior lip of the posterior limb of the lateral sulcus.
- The secondary sensory area is much smaller and less important than the primary sensory area.
- The face area lies most anterior, and the leg area is posterior. The body is bilaterally represented with the contralateral side dominant. Detailed connections in this area are unknown.



-
- Many sensory impulses come from the primary area, and many signals are transmitted from the brainstem.
 - The functional significance of this area is not understood. It has been shown that the neurons respond particularly to transient cutaneous stimuli, such as brush strokes or tapping of the skin.

Somesthetic association area



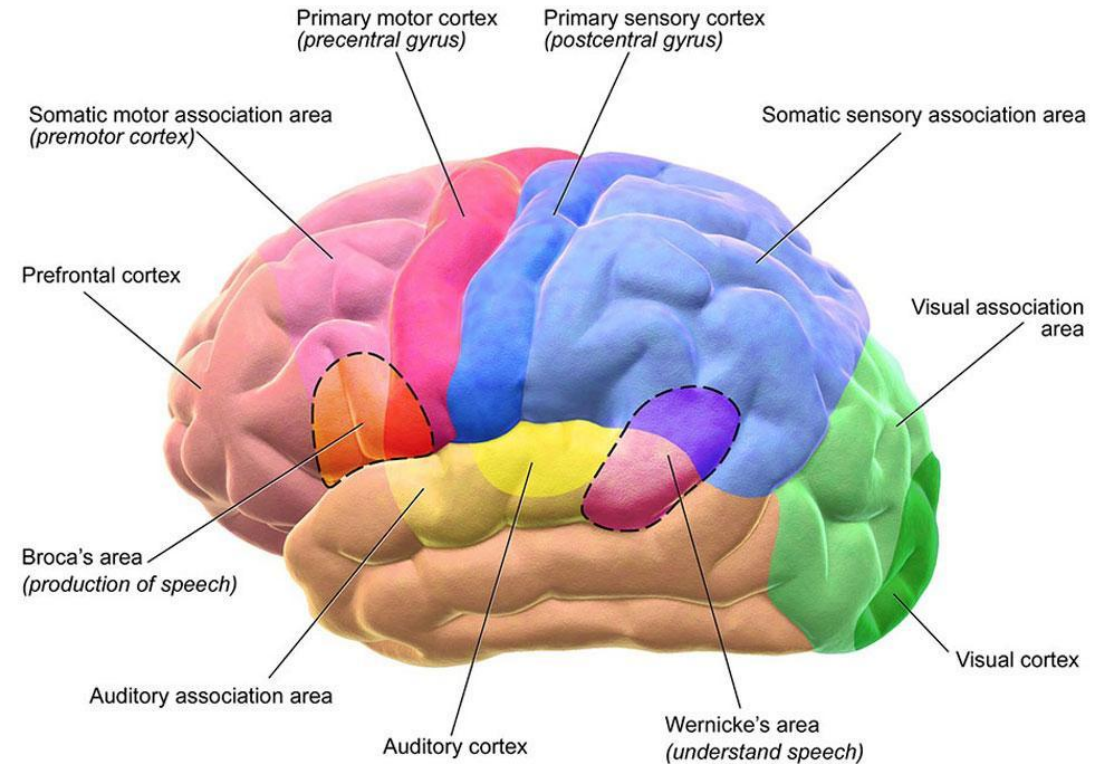
- Occupies the superior parietal lobule extending onto the medial surface of the hemisphere (Brodmann areas 5 and 7).
- Has many connections with other sensory areas of the cortex, and its main function is probably to **receive and integrate different sensory modalities**.
- For example, it enables one to recognize objects placed in the hand without the help of vision. In other words, it not only receives information concerning the size and shape of an object but also relates this to past sensory experiences; thus, the information may be interpreted, and recognition may occur.

Occipital lobe

Functional areas in occipital lobe:

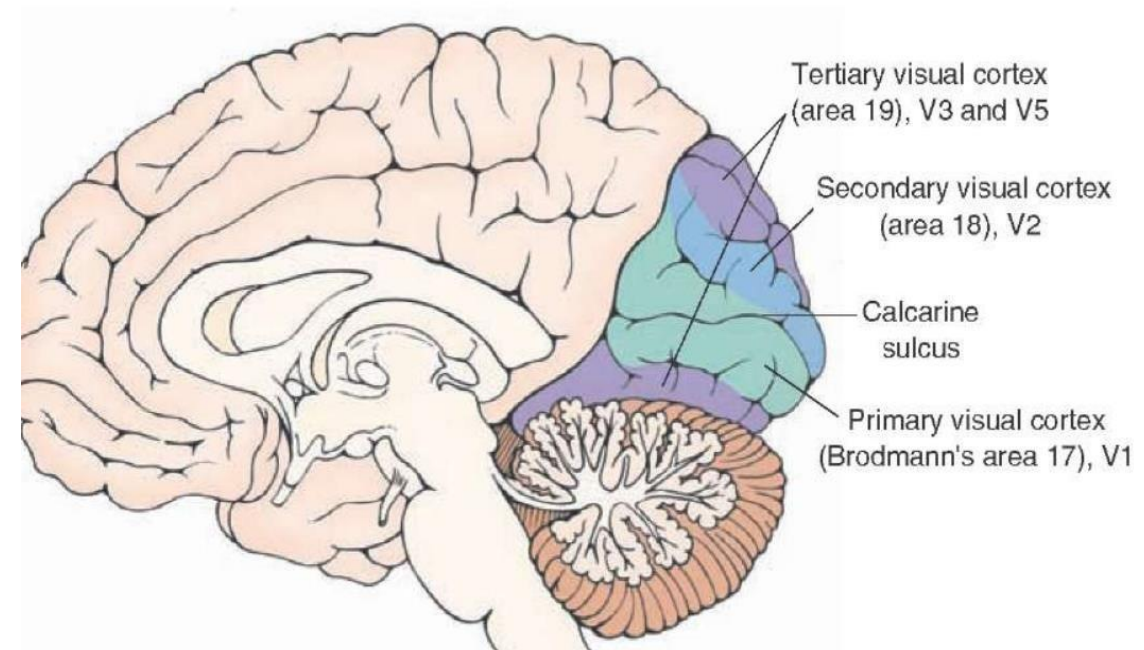
1- Primary Visual Cortex

2- Visual Association Cortex

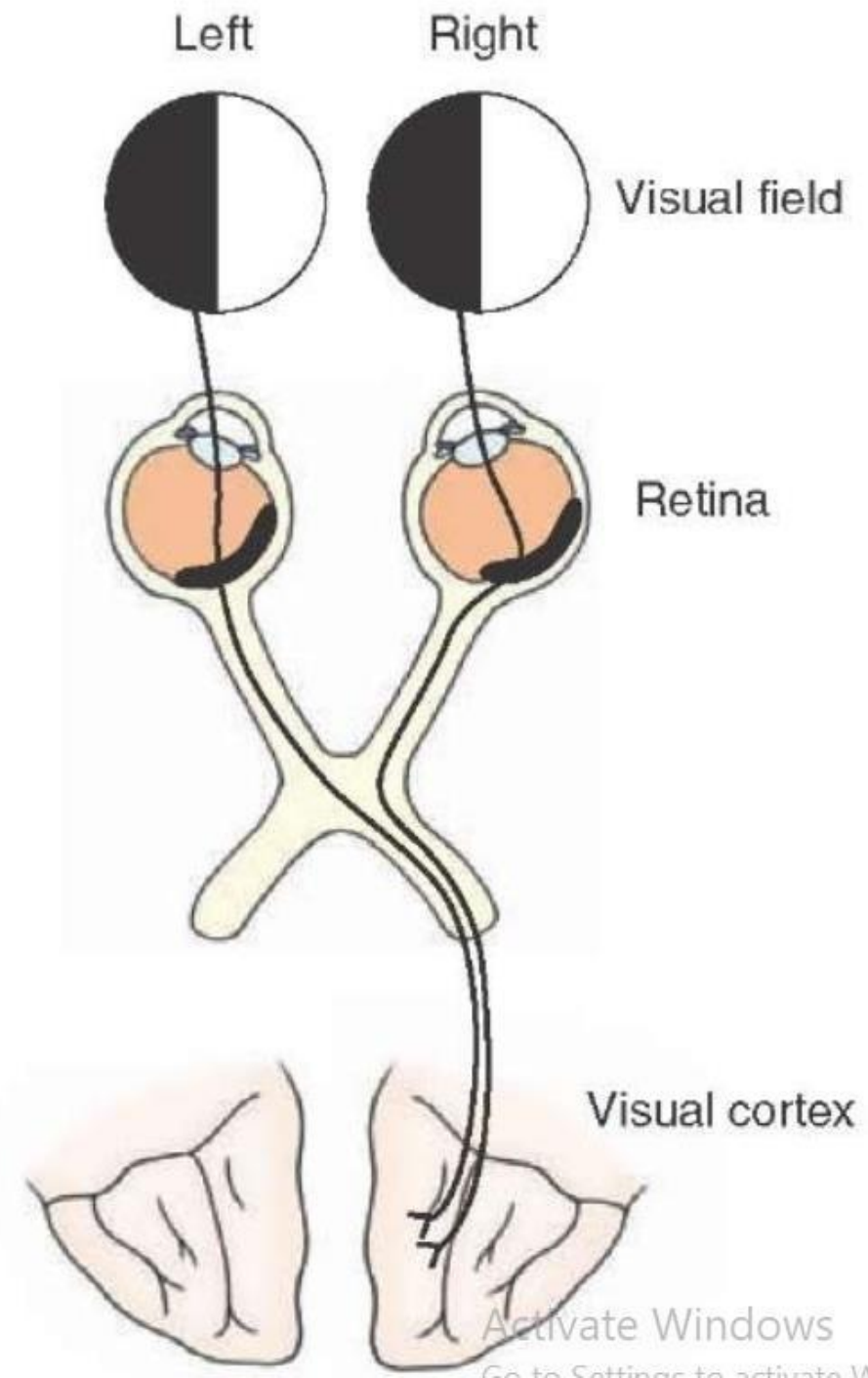


Primary visual area

- **Primary visual area** (Brodmann area 17) is situated in the walls of the posterior part of the calcarine sulcus and occasionally extends around the occipital pole onto the lateral surface of the hemisphere.



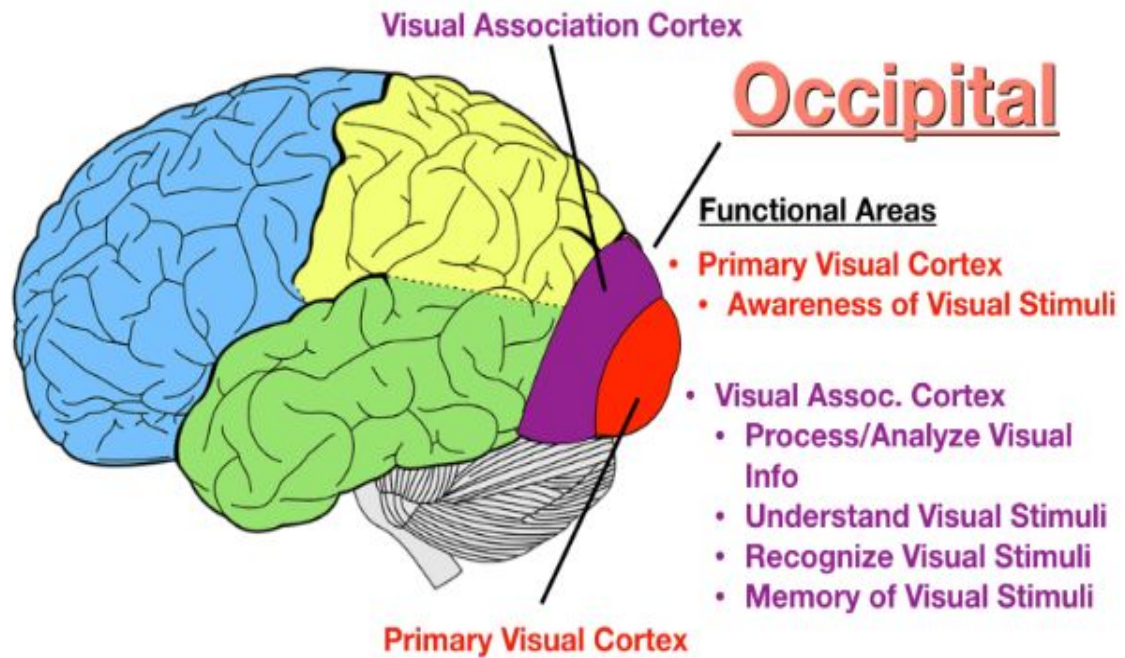
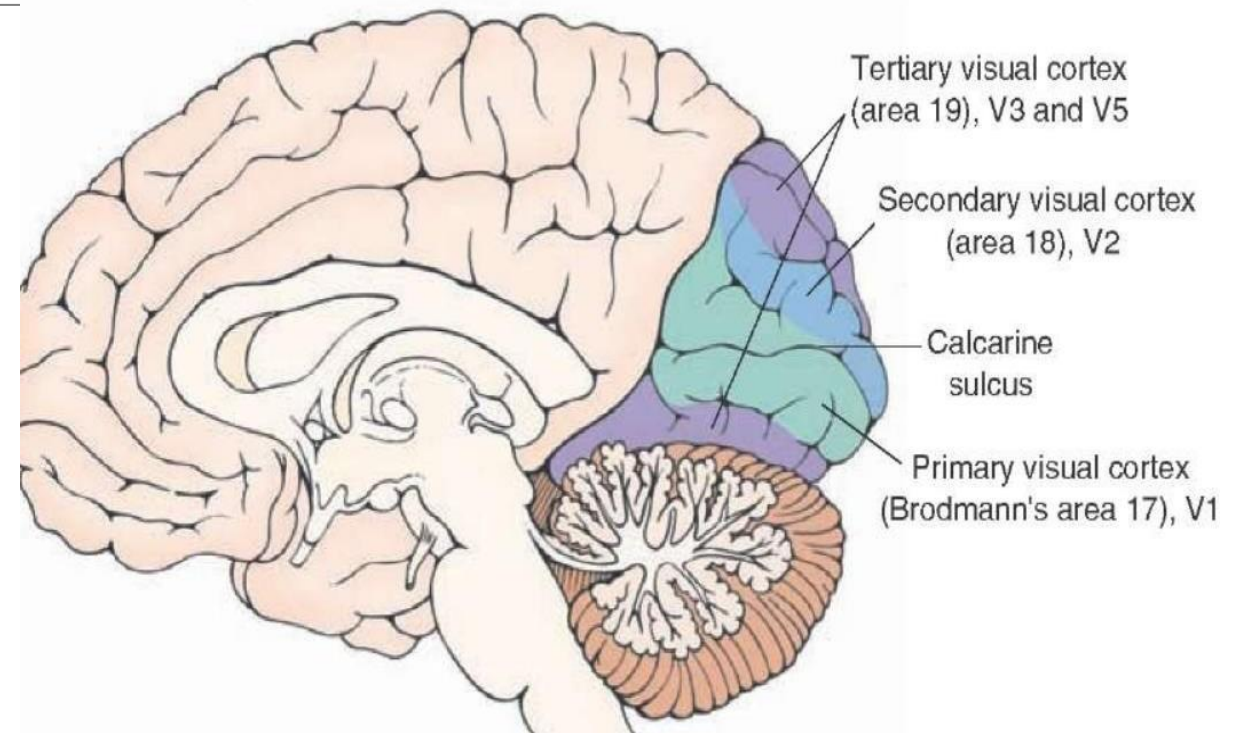
- Visual cortex receives afferent fibers from lateral geniculate body. Fibers first pass forward in the white matter of the temporal lobe and then turn back to the primary visual cortex in the occipital lobe. It receives fibers from **the temporal half of the ipsilateral retina and the nasal half of the contralateral retina.**
- So, right half of the vision field is represented in the visual cortex of the left cerebral hemisphere and vice versa.



-
- Superior retinal quadrants (inferior field of vision) pass to the superior wall of the calcarine sulcus, while the inferior retinal quadrants (superior field of vision) pass to the inferior wall of the calcarine sulcus.
 - Macula lutea, which is the central area of the retina and the area for most perfect vision, is **represented on the cortex in the posterior part of area 17**. It accounts for 1/3 of the visual cortex.
 - Visual impulses from the peripheral parts of the retina terminate in concentric circles anterior to the occipital pole in the anterior part of area 17.

Secondary Visual area

- Brodmann areas 18 and 19.
- Surrounds the primary visual area on the medial and lateral surfaces of the hemisphere.
- It receives afferent fibers from area 17 and other cortical areas as well as from the thalamus.
- Function is to relate the visual information received by the primary visual area to past visual experiences, thus enabling the individual to recognize and appreciate what he or she is seeing.

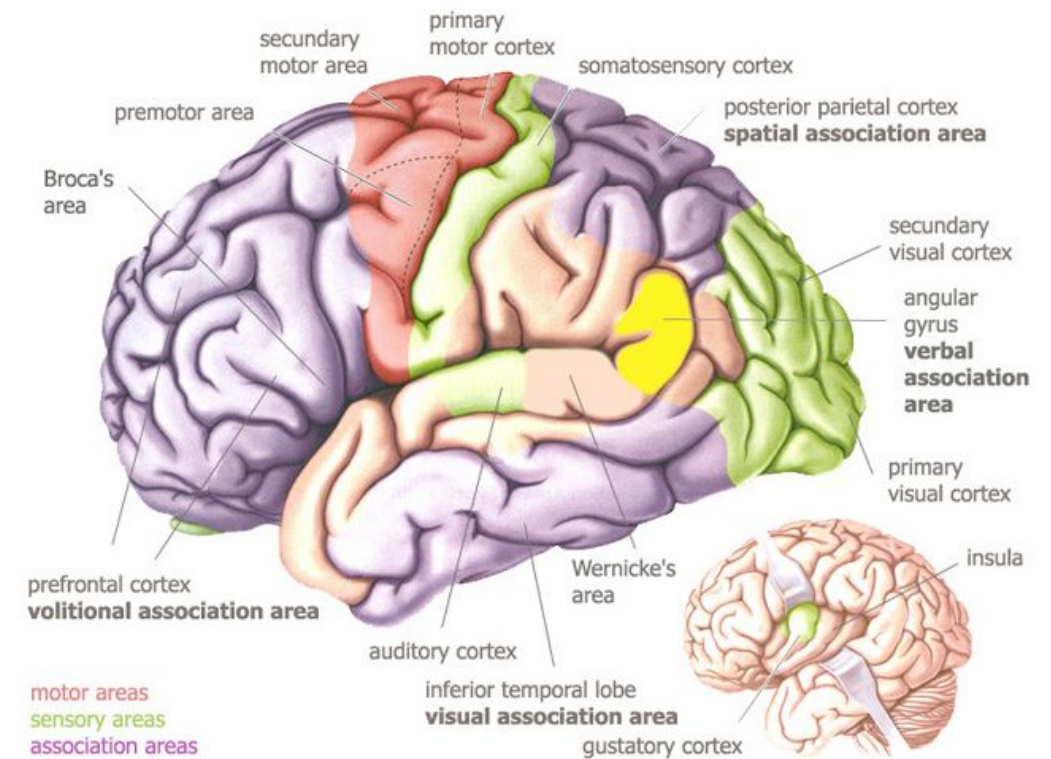


Occipital eye field

- Is thought to exist in the secondary visual area in humans.
- Stimulation produces conjugate deviation of the eyes, especially to the opposite side.
- The function of this eye field is reflex and associated with movements of the eye when it is following an object.
- In both hemispheres, is connected by nervous pathways and also are thought to be connected to the superior colliculus.
- By contrast, the frontal eye field controls voluntary scanning movements of the eye and is independent of visual stimuli.

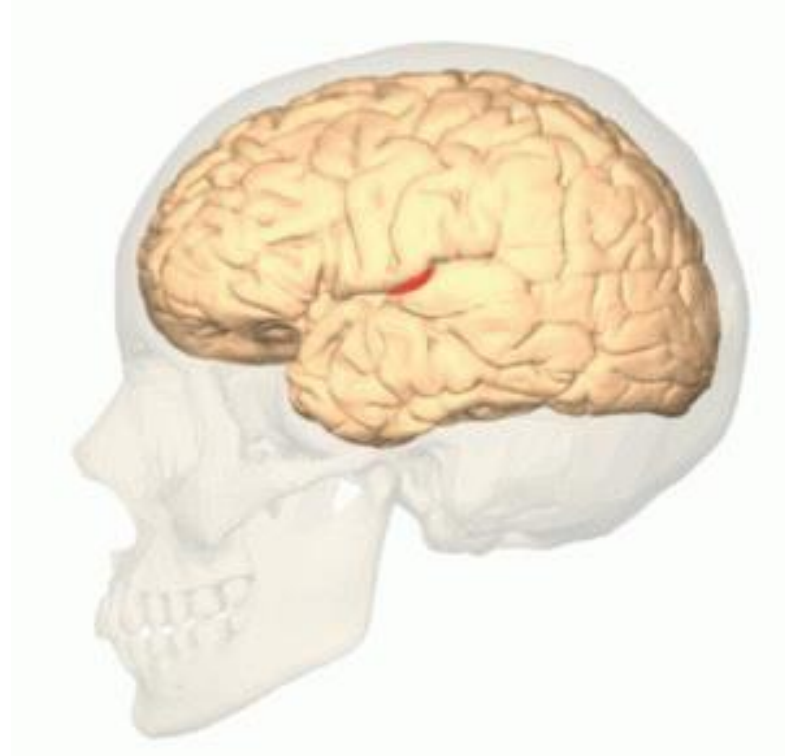
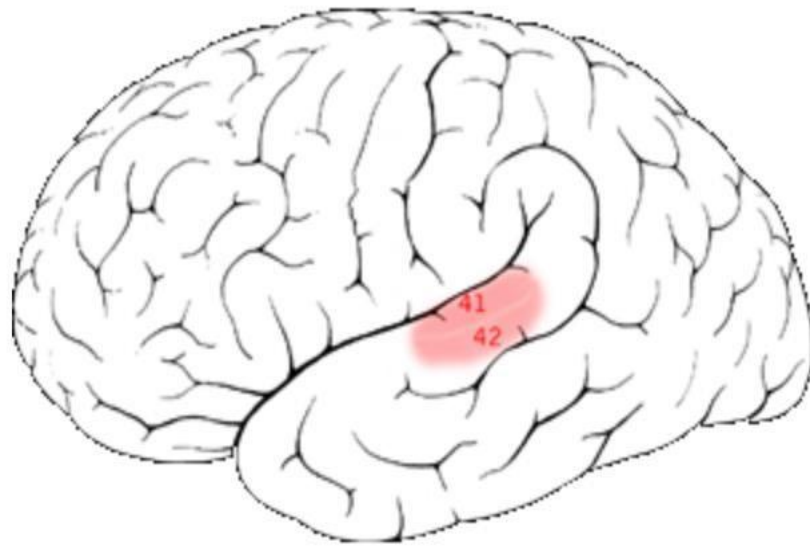
Temporal lobe

- 1- Primary Auditory Cortex
- 2- Auditory Association Cortex
- 3- Wernicke's Area (sensory speech area)



Primary auditory area

- **The primary auditory area** (Brodmann areas 41 and 42) includes the gyrus of Heschl.
- It is situated in the inferior wall of the lateral sulcus.
- Projection fibers to the auditory area arise principally in the medial geniculate body and form the auditory radiation of the internal capsule.
- The **anterior part** of the primary auditory area is concerned with the **reception of sounds of low frequency**, and the **posterior** part of the area is concerned with **the sounds of high frequency**.
- A **unilateral** lesion of the auditory area produces **partial deafness in both ears**, the greater loss being in the contralateral ear.

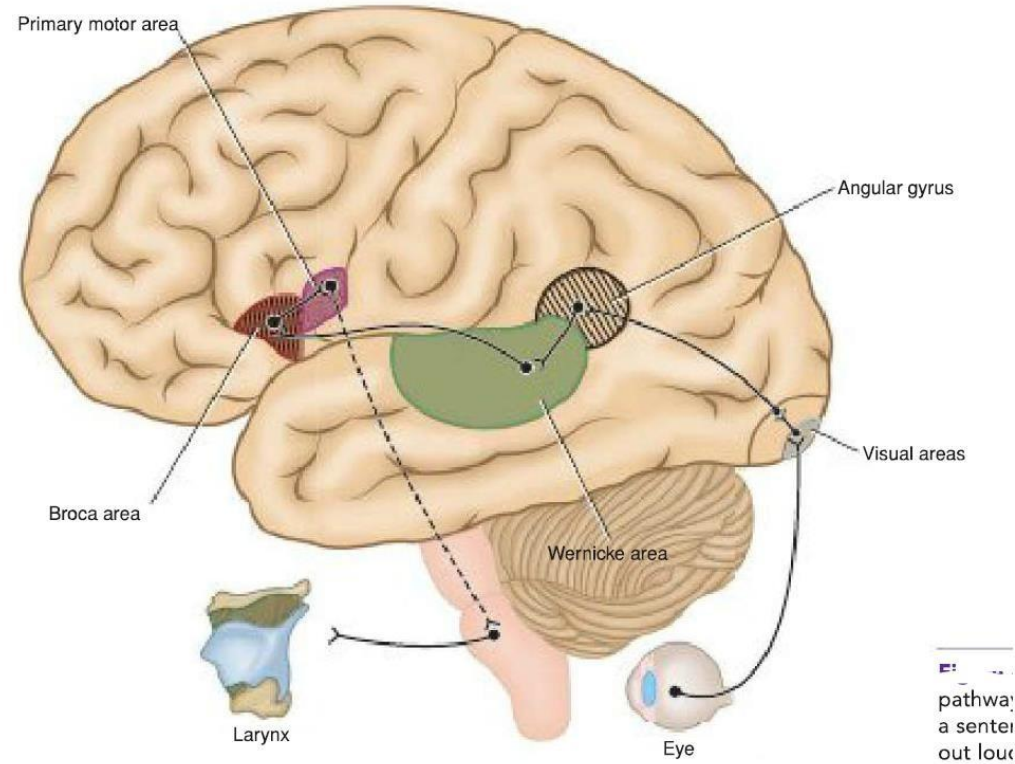


Secondary auditory area

- Also called the auditory association cortex.
- Is situated posterior to the primary auditory area in the lateral sulcus and in the superior temporal gyrus (Brodmann area 22).
- It receives impulses from the primary auditory area and from the thalamus.
- It is thought to be necessary for the interpretation of sounds and for the association of the auditory input with other sensory information.

Wernicke's area

- Sensory speech area.
- Localized in the left dominant hemisphere, mainly in the superior temporal gyrus, with extensions around the posterior end of the lateral sulcus into the parietal region.
- Connected to the Broca area by a bundle of nerve fibers called the arcuate fasciculus. it receives fibers from the visual cortex in the occipital lobe and the auditory cortex in the superior temporal gyrus.
- Permits understanding of written and spoken language and enables a person to read a sentence, understand it, and say it out loud.
- It's a very important area because it is where somatic, visual, and auditory association areas all come together.



Other cortical areas

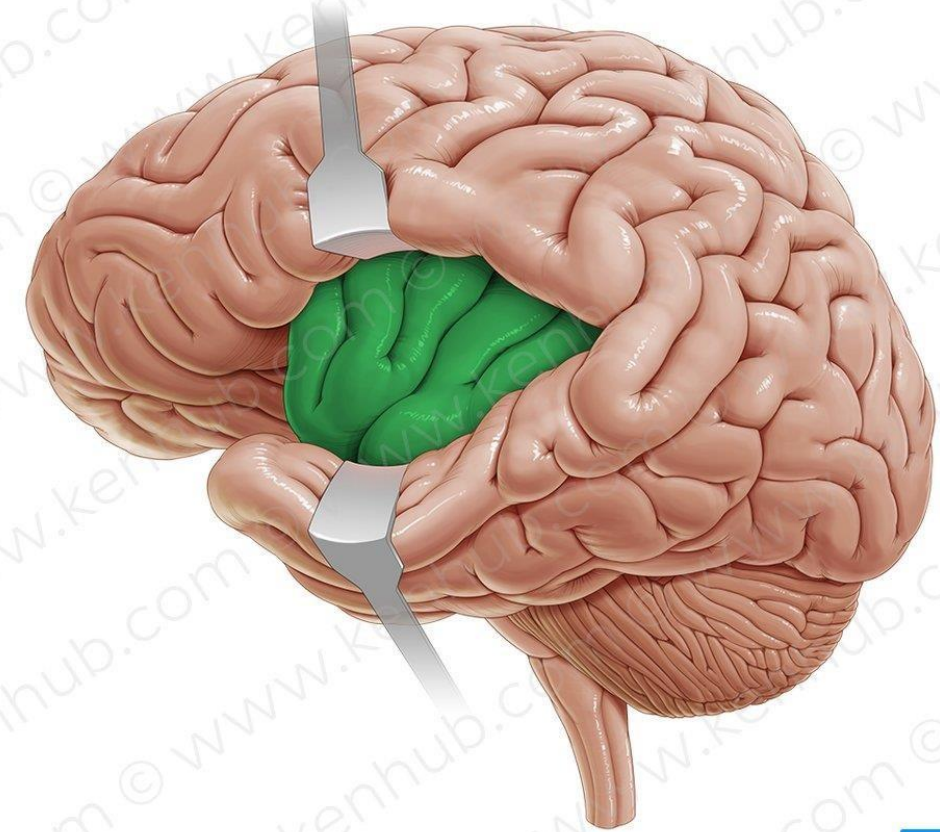
- **Taste area:**
 - Is at the lower end of the postcentral gyrus in the superior wall of the lateral sulcus and in the adjoining area of the insula (Brodmann area 43).
 - Ascending fibers from the nucleus solitarius ascend to the ventral posteromedial nucleus of the thalamus where they synapse on neurons that send fibers to the cortex.

- **Vestibular area:**

- Is near the part of the postcentral gyrus concerned with sensations of the face, opposite the auditory area in the superior temporal gyrus.
- Together with the vestibular part of the inner ear are concerned with appreciation of the positions and movements of the head in space.
- Through its nerve connections, the movements of the eyes and the muscles of the trunk and limbs are influenced in the maintenance of posture.

- **Insula:**

- Area of the cortex that is buried within the lateral sulcus and forms its floor.
- It can be examined only when the lips of the lateral sulcus are separated widely.
- Its fiber connections are incompletely known.
- It is thought to be important for planning or coordinating the articulatory movements necessary for speech.



Cerebral Dominance

- Anatomically, the two cerebral hemispheres show that the cortical gyri and fissures are almost identical.
- Nervous pathways projecting to the cortex do so largely contralaterally and equally to identical cortical areas.
- Cerebral commissures, especially the corpus callosum and the anterior commissure, provide a pathway for information that is received in one hemisphere to be transferred to the other.
- Still, certain nervous activity is predominantly performed by one of the two cerebral hemispheres. Those are handedness, perception of language, and speech are functional areas of behavior that are controlled by the dominant hemisphere in most individuals.

-
- By contrast, spatial perception, recognition of faces, and music are interpreted by the nondominant hemisphere.
 - More than 90% of the adult population is right-handed and, therefore, is left-hemisphere dominant.
 - About 96% of the adult population is left-hemisphere dominant for speech.

THANK YOU

