

# Neuroanatomy

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**Lecture 3 (14)**

*Corrected by:* Batool B.

If you have any comments, notes, corrections please don't hesitate to contact me



# Morphological Classification of Cortical Areas

There were Different mapping attempts of the brain that tried to number different areas on the cerebral cortex to distinguish them:

- ❖ based on cytoarchitectonic studies
- ❖ Campbell (1905) ----- about 20 areas
- ❖ **Brodmann (1909) ----- 47 areas** (the doctor said 52 areas)
  - The most popular
- ❖ Vogt and Vogt (1919) - over 200 areas
- ❖ von Economo (1929) -- 109 areas

# Functional Localization of Cerebral Cortex

Broadmann states that the brain areas are functionally divided into three categories:

## 1. Sensory areas (mostly in the parietal lobe)

primary sensory area (post central gyrus)

secondary sensory area

## 2. Motor areas (most of them are in the frontal lobe)

primary motor area 4 (precentral gyrus)

secondary (pre) motor area 6

supplementary motor area (SMA)

## 3. Association areas

Can be found in the parietal, occipital and temporal cortex, prefrontal (frontal) cortex

**Functions:** - thinking and learning  
- judgment, foresight

# Motor Areas

primary Motor Area (MI) area 4

Premotor Area (PM) area 6

Supplementary Motor Area (SMA)

Frontal Eye Field area 8

Broca's area of speech area 44,45

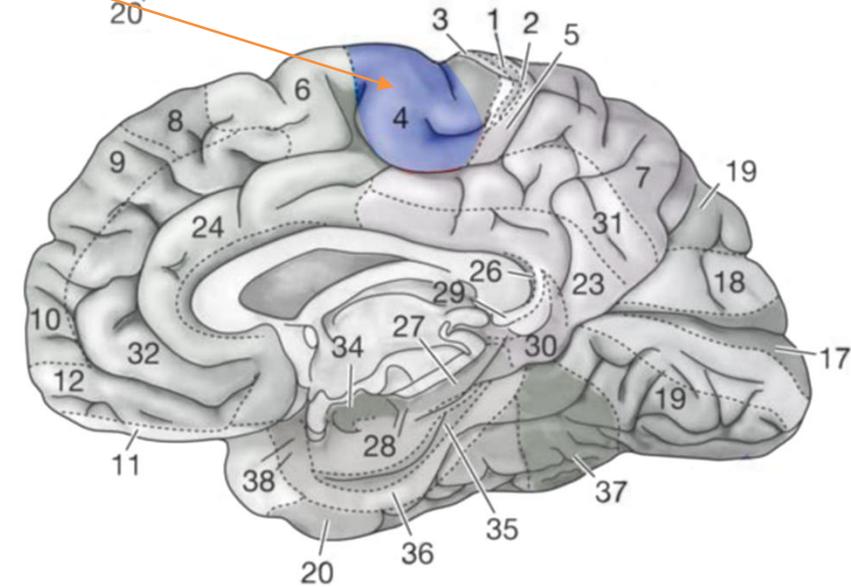
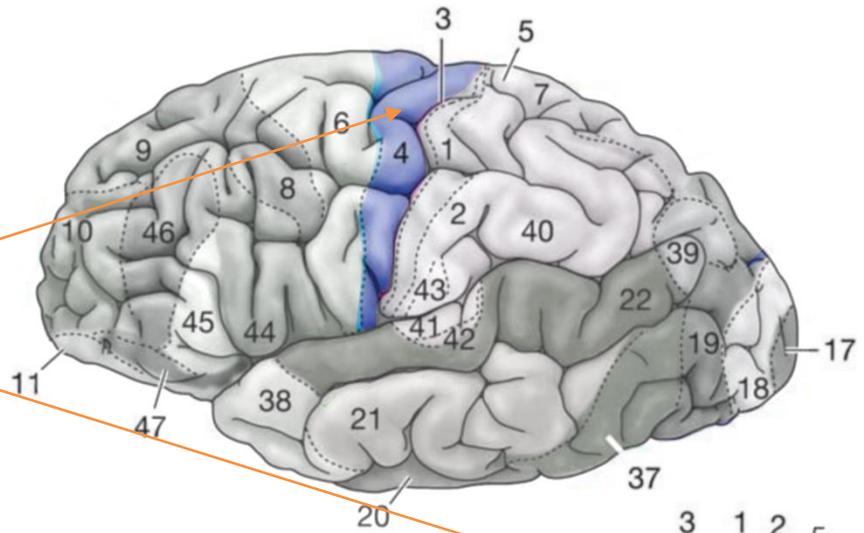
# Primary Motor Area (MI /area 4)

Primary means: it's the centre that sends the commands

**Location:** precentral gyrus of the **lateral surface**  
& anterior part of paracentral lobule (**medial surface**)

**Function:** **contralateral** voluntary control of fine specific movement mainly in the extremities.

- ⇒ **How?** We mentioned that the 5<sup>th</sup> layer of the cerebral cortex contains **giant pyramidal cell of Betz** which send fibers that form the pyramidal tracts, those pyramidal tracts -that control specific movement as we learned previously- mainly originate in the fifth layer **of this area**.
- ⇒ **however**, (40%) of the pyramidal fibers originate from the **premotor area (6)** and some originate from SMA, **parietal sensory area** & thalamus.



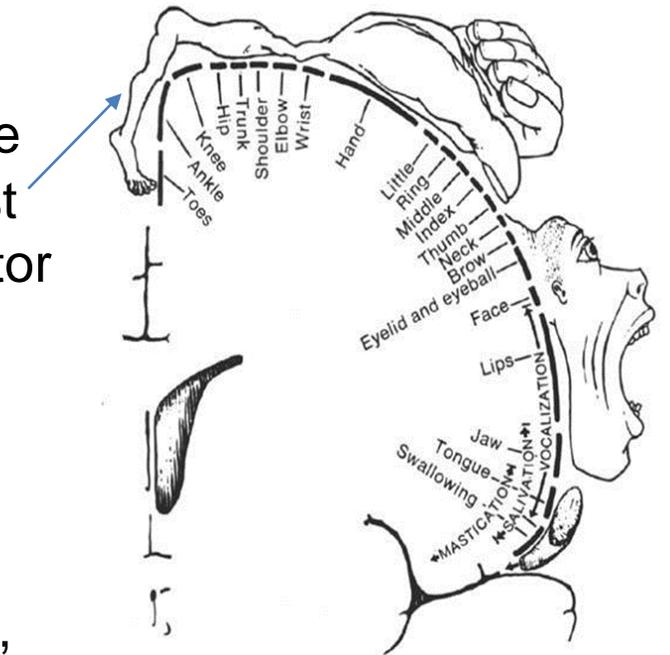
# Primary Motor Area (MI /area 4)

**localization:** the **motor Homunculus** is represented upside down with the face most inferior laterally and the lower limb and **perianal sphincters** most superior and curving medially and it is proportional to the degree of fine motor activity of the part.

**lesion:** **Upper Motor Neuron (UMN) syndrome**

Shows as: **spasticity & contra lateral hemiplegia or hemiparesis.**

- ➡ Which means the patient can't move their limbs on the contralateral side, or can move them but very weakly because the extent of the lesion isn't very complete.
- ➡ But as doctors; by knowing the representation, we can identify where the site of lesion is exactly and thus predict which muscles will be affected
- 💡 **Think:** if the MRI showed a lesion affecting the anterior part of the left paracentral lobule, what part would you expect to be paralysed/weak? Do you expect to see incontinence?



**Interesting side information:**

Cerebral cortex damage is caused by 4 Ts:

- Toxin
- Trauma
- Thrombus
- Tumor

Incontinence means: the patient can't control their excretory sphincters.

# Premotor Area (PM)/ area 6 (Extrapyramidal center)

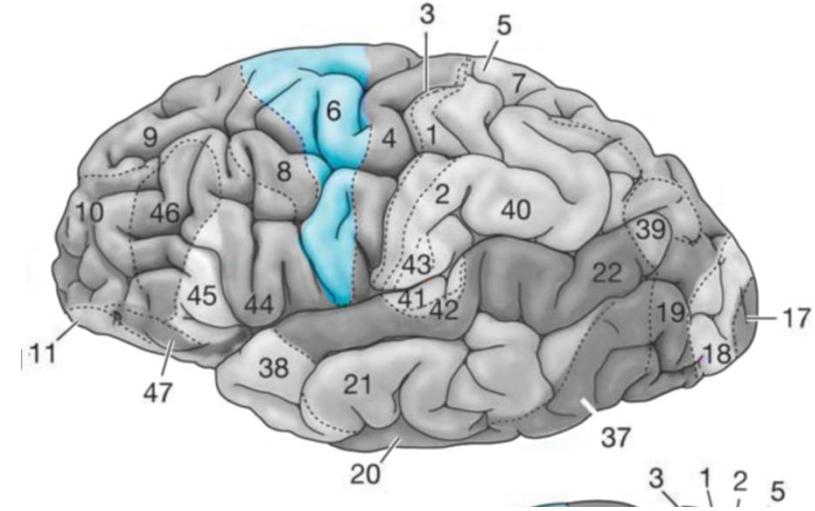
**location:** an inverted triangle (broad above, narrow below) in front of area 4

**Function:** It is the control centre of the **extrapyramidal tracts**

- Storing motor programs
- **Involuntary** coordination of coarse movement of mainly the trunk, shoulders and hip muscles. (we don't think of every muscle when we intend on making a move because it's programmed in here how every muscle will move)
- Sends inhibitory impulse to the muscle tone (loss of this function by a lesion results in spasticity)
- Send inputs to M4
- Remember we said it contributes in the formation of the pyramidal tract

**Receives afferents from:** thalamus ,from cerebellum, basal ganglia

**Lesion:** **motor apraxia** (there's no paralysis, but there's failure of coordination of different muscles to produce movement), **spasticity and loss of postural stability.**



# Supplementary Motor Area (SMA)

## Extrapyramidal centre

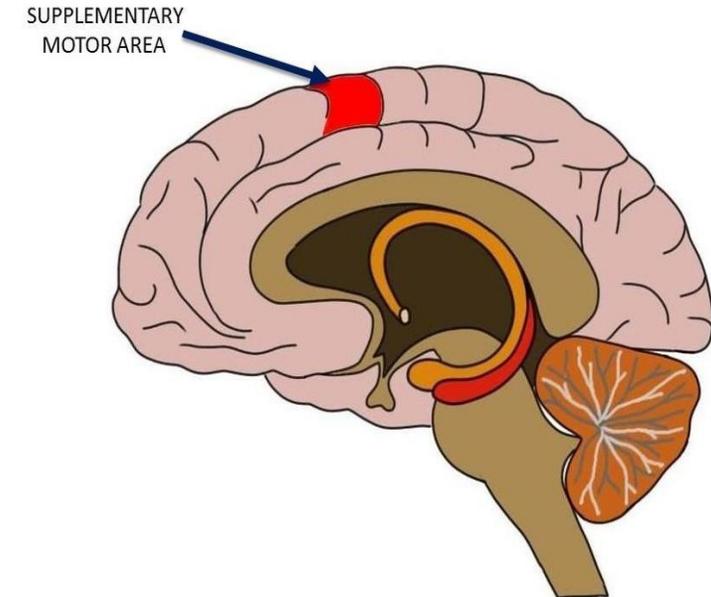
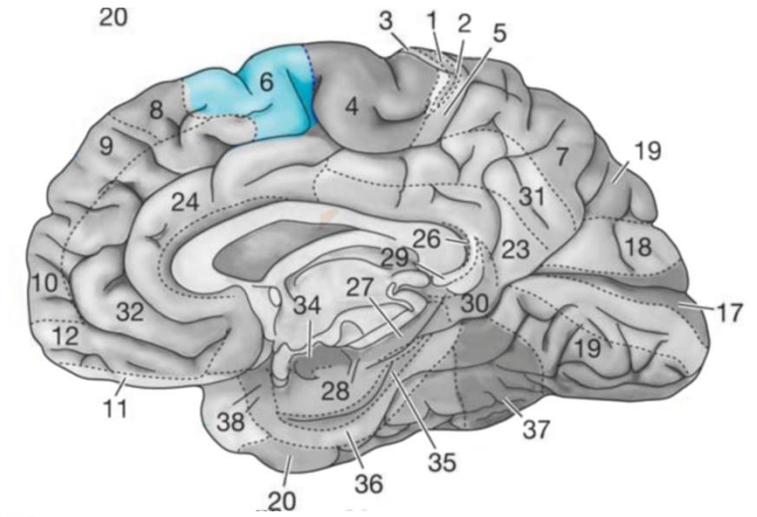
**Site:** mostly on the medial frontal gyrus anterior to paracentral lobule.

**Function:** it's supplementary to the premotor area that's why their functions are very related

- Postural stabilization of the body
- The coordination of both sides of the body.
- **The control of sequences of movements.**

**Afferents received:** from thalamus, basal ganglia & different parts of the cerebral cortex

**Lesion:** not definite, because the existence of the premotor area makes up for any lesion in this area.



# Frontal Eye Field (area 8)

**Site:** in front of the premotor area

**mainly in the middle frontal gyrus**

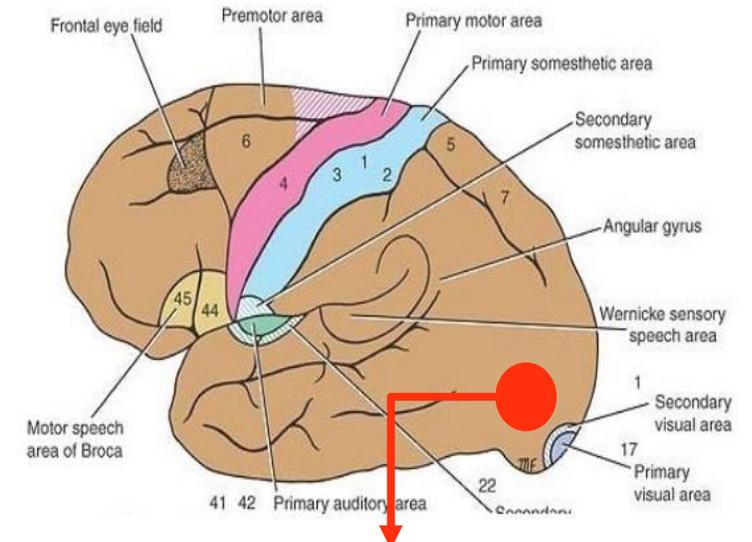
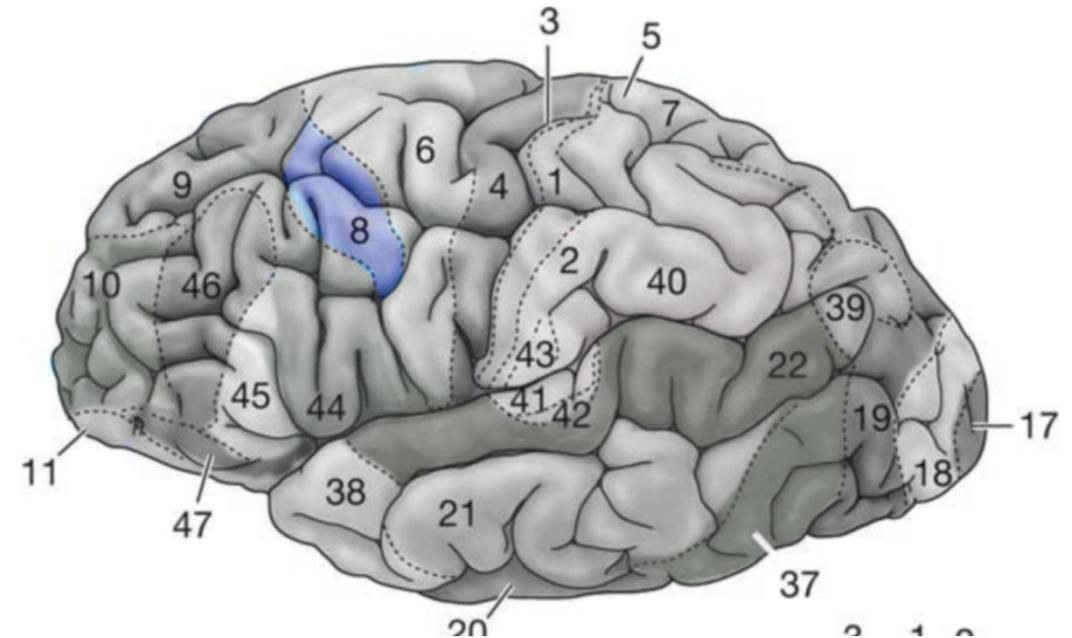
Connected to the visual area in occipital lobe through association fibers

**Function:** voluntary tracking movement (conjugate movement) to the opposite side

➔ **Explanation:** the left frontal eye field area will control BOTH EYES to move to the RIGHT side, while the right frontal eye field area will control the movement of BOTH EYES to the LEFT side.

**Lesion:** deviation of both eyes to same side of lesion

➔ **Explanation:** if a patient has a lesion affecting the right FEF, and I tell them to track a pencil moving to the left side, their eyes -instead of following the pencil to the left- will deviate to the right side, because the area of the side needed isn't functional.



**Visual area (occipital eye field area):**  
has the same function but involuntarily

# Motor (Broca's) area of speech (area 44, 45)

**Site:** inferior frontal gyrus

It's located mainly on the **left hemisphere** (left dominant hemisphere)

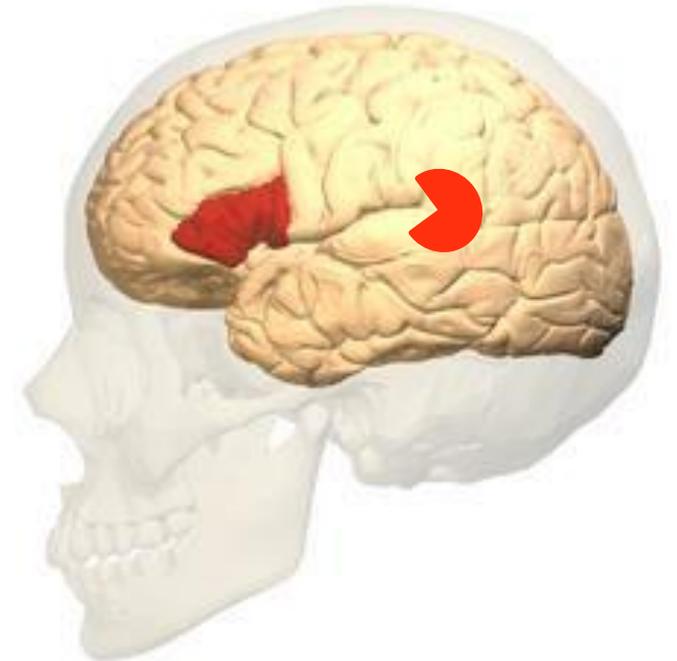
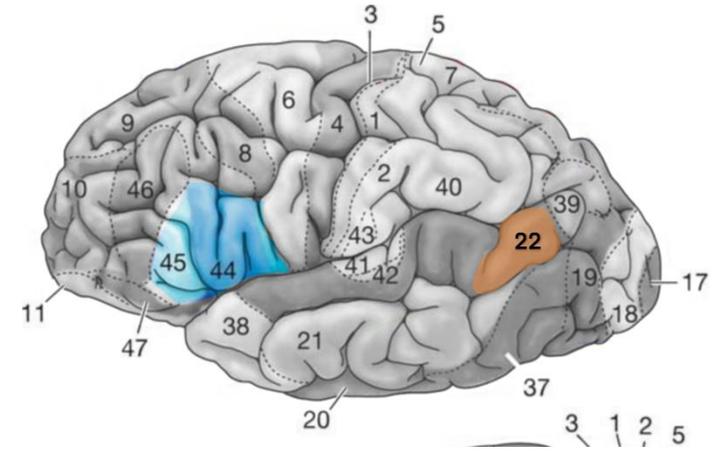
- 95% of the population are already left hemisphere dominant
- It's also on the left hemisphere in a good percentage of people with a right dominant hemisphere.

**Function:** coordination of muscles of larynx, mouth, tongue and palate to produce fluid speech.

Connected to **wernicke's area (39)** through arcuate fasciculus

**responsible for understanding of written and spoken words,**

**Note:** it's numbered 22 everywhere I searched, but the doctor said it was (39). However, both these areas have functions related to speech and words comprehension, and they work together.



# Motor (Broca's) area of speech (area 44, 45)

**Lesion:** Non fluent aphasia (motor aphasia)

It means inability to produce speech, aphasia is associated with upper motor neuron lesions

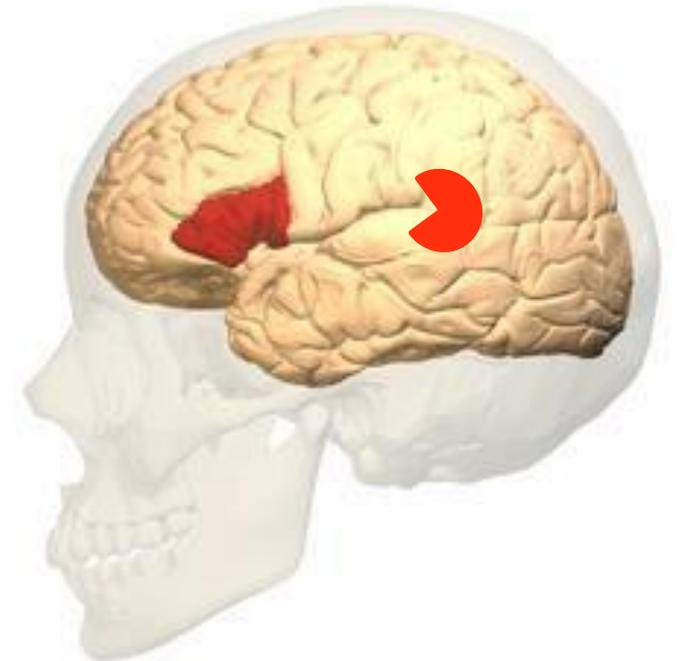
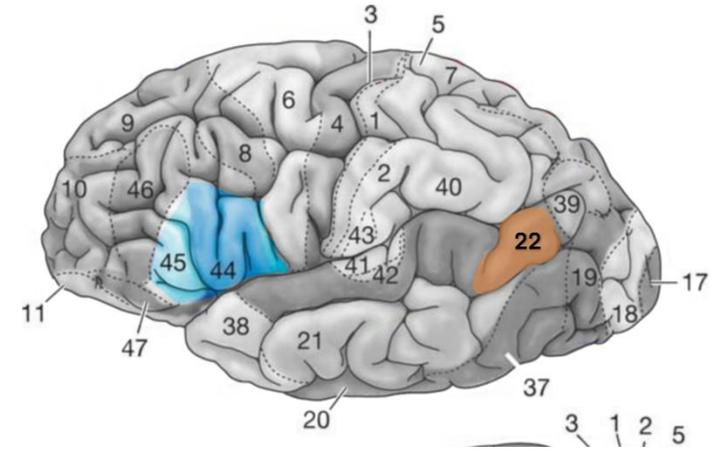
**In Motor (non fluent) aphasia, the lesion that affects Broca's area,** the patient is unable to coordinate muscles that produce speech (كلامه منقطع :non fluent: no sentences), this person is aware of this problem making matters worse for him, you can see an example here:

<https://youtu.be/JWC-cVQmEmY>

**VERY interesting Extra:**

**In fluent aphasia, lesion affecting area 39:** it's sensory aphasia, the patient is unable to understand written or spoken words, and is unaware of their problem.

<https://youtu.be/3oef68YabD0>



# Sensory areas

## Primary sensory area (3,1,2)

Primary means: it's the centre that receives sensations

**Site:** post central gyrus

Extends on the paracentral lobule shows Representation of the body like the motor area.

**Function:**

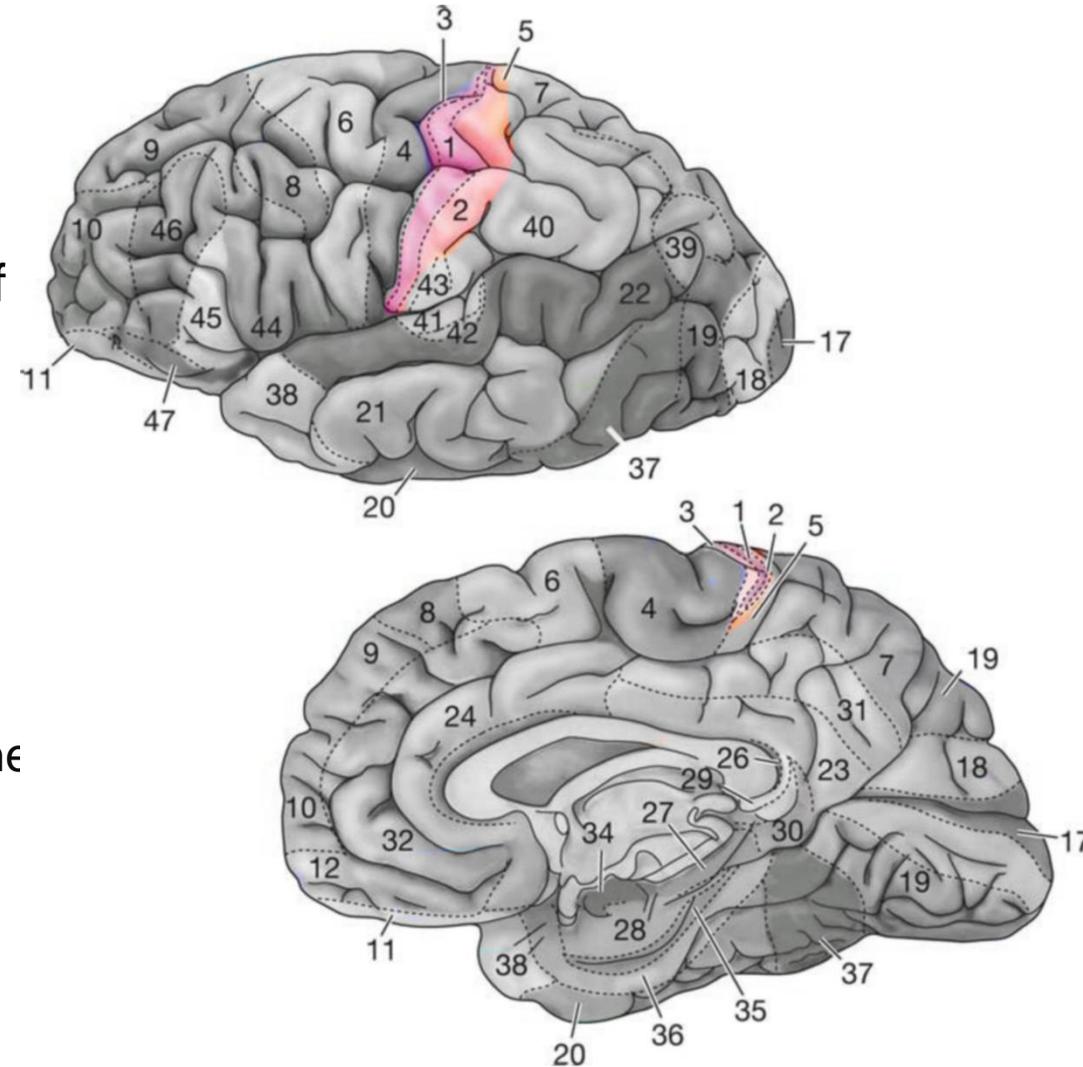
- localization and discrimination of different sensations.
- **Gives 20% of pyramidal tract**

**Lesion:** contralateral hemianesthesia

⇒ **Explanation:** the patient cannot feel or localize sensations on the opposite side

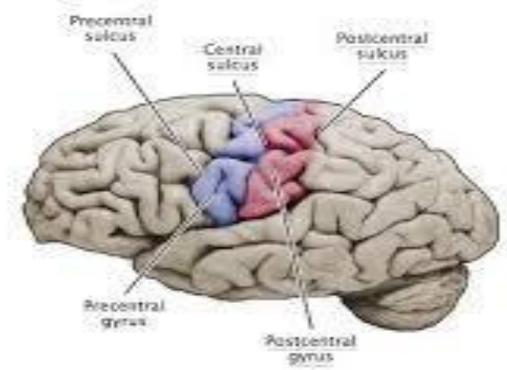
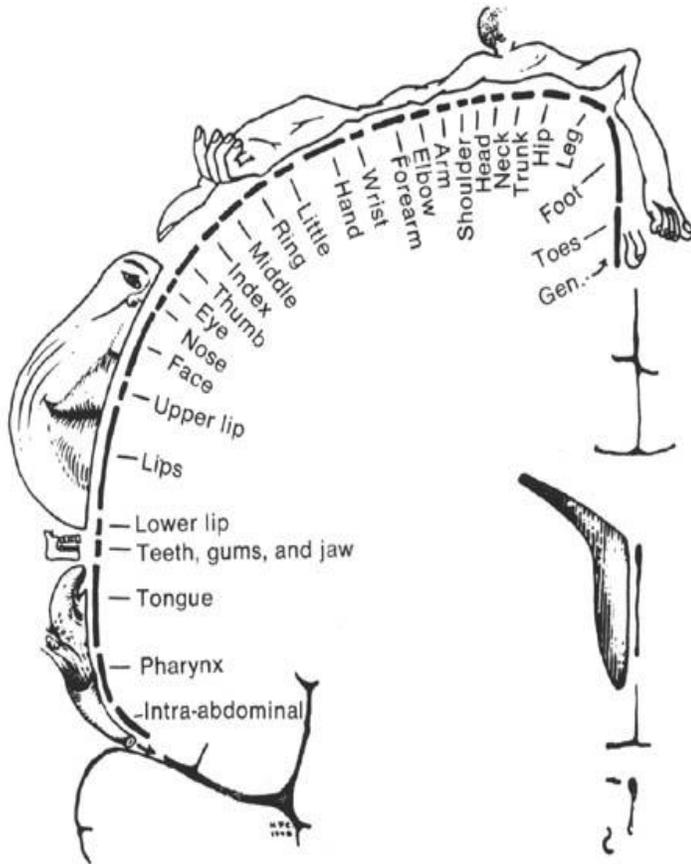
**Secondary sensory area** Lowermost part of postcentral gyrus (depth of lateral sulcus)

**Sensory association area (5,7)** behind the primary



# Primary sensory area 3,1,2 (general sensations)

It has the same organization of representation as the motor area (the face is on the inferior lateral side, and the lower limb is superior curving medially) but the representation of each part isn't the same, it's now proportional to **the number of receptors in that part**, You can see that the size of the hands, lips and tongue is large because they have a high density of receptors



## Other **Primary** Sensory Areas

Visual Area (vision) (17) Auditory

Area (Hearing) (41,42)

Vestibular Area (Equilibrium)

Gustatory Area (Taste) (insula)

Olfactory Area (Smell) (

# Visual Cortex

## V I ----- area 17

**Site:** around the calcarine sulcus lips (notice 17)  
(between the cuneus above and lingual below)

→ receives visual radiations from LGB

**Function:** perception of the opposite visual field

**Lesion:** **contralateral homonymous hemianopia with macular sparing**  
(because the macula lutea has 2 blood supplies)

## V II ----- 18, 19 (visual association area)

**Site:** remainder of cuneus and lingual gyri (notice 18 and 19)

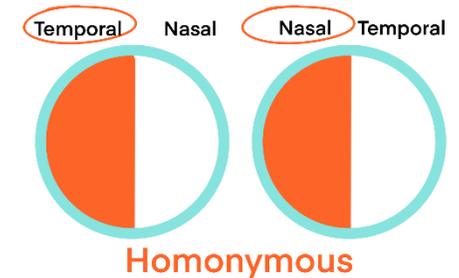
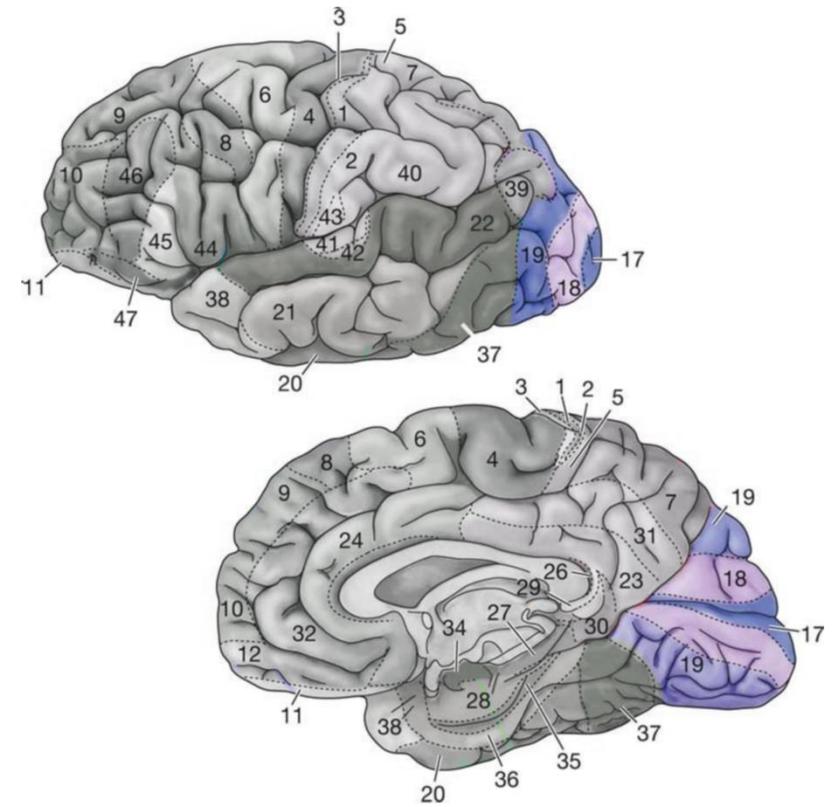
**function:** Interpretation of visual stimulus (perceived by area 17)  
with past experience

**lesion:** **visual agnosia and colour blindness (can't interpret visual stimuli)**

## Occipital eye field area

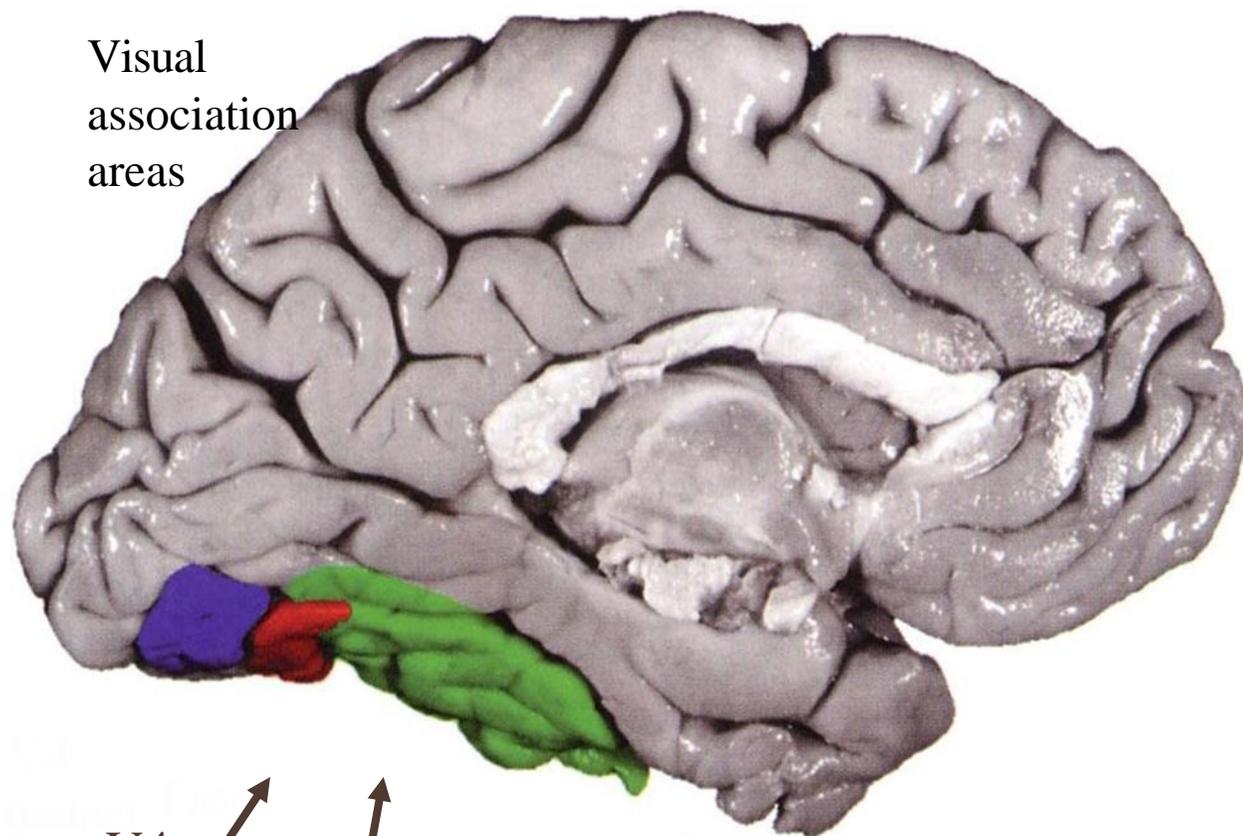
**Site:** Occupies the rest of the occipital lobe

**Function:** reflex conjugate movement of both eyes to opposite side (involuntary)



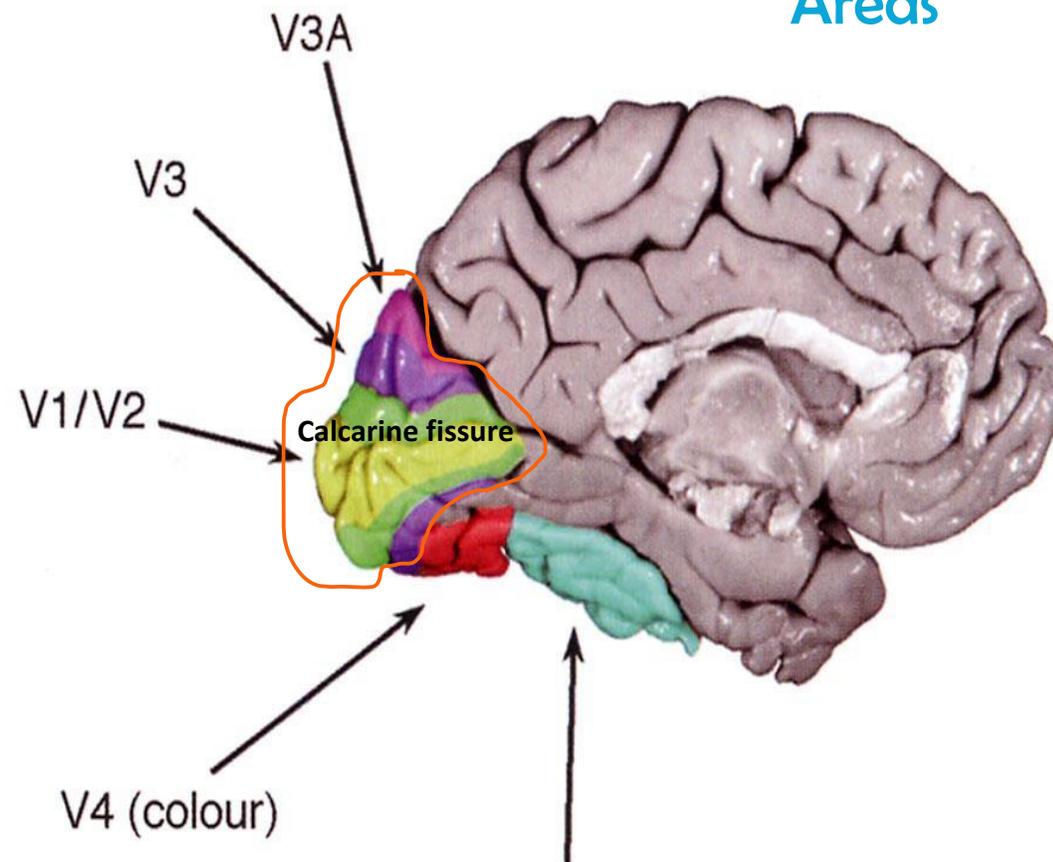
**Agnosia:** association areas' lesions, it means inability to interpret stimuli

# Visual Areas



V4 (color) Face recognition

Perceive Facial Expression



Face and object recognition areas

**Around the sulcus** → primary visual  
**The rest** → association (face recognition and color recognition functions)

# Auditory Areas

**All primary auditory area** ----- areas 41, 42

**Site:** middle of the Superior Temporal Gyrus

**Function:** perception, analysis of pitch, intensity of sound

**Lesion:** **hearing defect** - reduction of hearing acuity on both ears mainly on opposite side.

→ Hearing is the only sensation that perceives stimuli from both ears, each ear is represented on both right and left cerebral cortex, so no hearing loss happens, rather just a decrease in hearing acuity on the opposite side, because there's still some representation on the opposite cortex

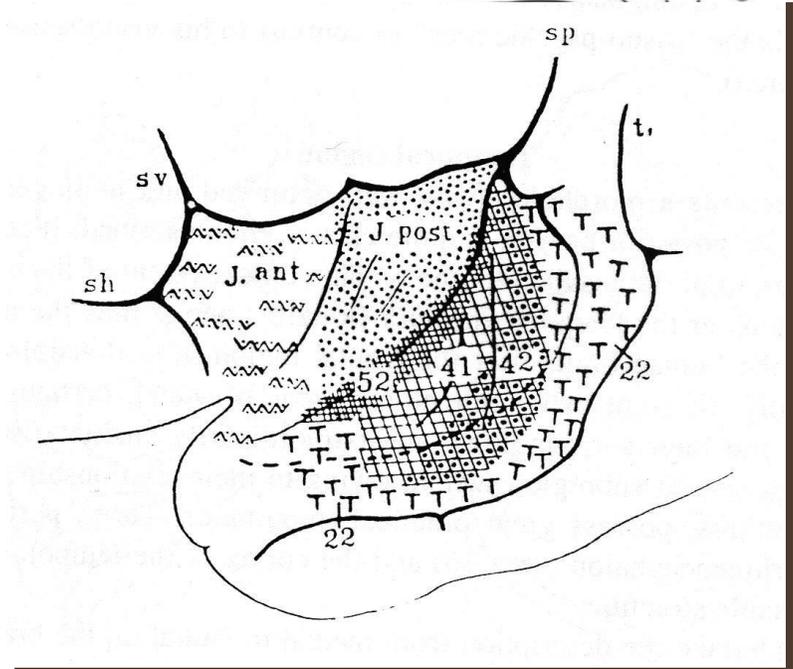
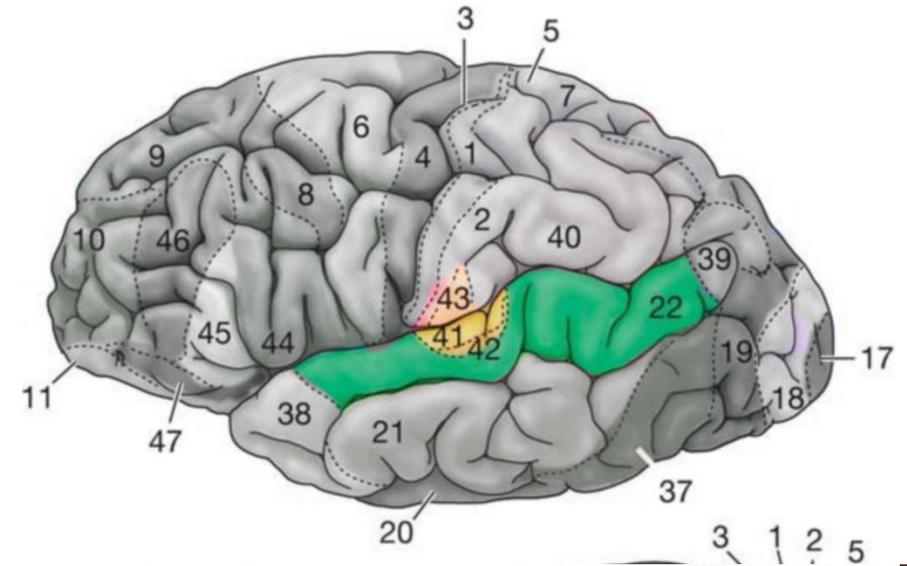
**All auditory association area** ----- area 22

**Site:** back of superior temporal gyrus along with Wernicke's area

**Function:** interpretation of auditory stimulus

**Lesion:** **auditory agnosia (inability to interpret sounds)**

**Rest of temporal lobe** ----- memory





# Association Areas

1 **Language Areas** ----- 22, 39, 40, 44, 45 they associate hearing and speaking

2 **Posterior Parietal Association Area (5,7)**

body image → knowing an object by feeling it

Lesion: **Asterognosis**

3 **Temporal Association Area (22)** / in the rest of the temporal lobe

Function: functions mainly in memory

Lesion: **(acoustic or verbal agnosia)**

4 **Visual association area/ occipital lobe (19)**

Lesion: **visual agnosia**

Function: judgment, foresight, personality

5 **Prefrontal Association Area (9, 10, 11, 12)**

Site: greater part of frontal cortex

Function: in judgement and personality

Lesion: psychological and neurological **(Alzheimer) amyloid degeneration and schizophrenia (low dopamine)**

# Language Areas

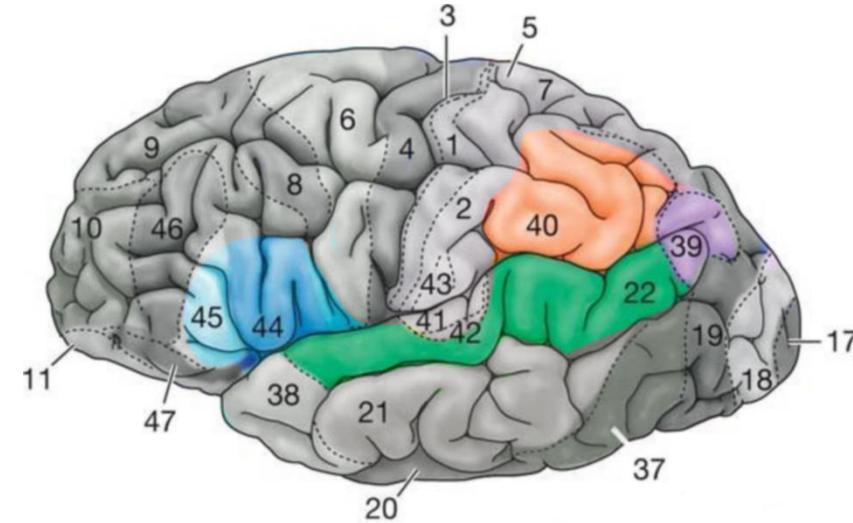
**Motor Language Area (Broca's area) --- 44, 45** (contains 3 gyri : orbital triangular, opercular)

**Lesion: Motor Aphasia (non-fluent aphasia)-** good comprehension, poor speech

**Sensory Language Area (Wernicke's area) ---- 22, 39, 40**

**Site: left dominant hemisphere of superior temporal gyrus**

- extending into posterior end of lateral sulcus into parietal lobe
- Connected to Broca's area by arcuate fasciculus
- Receives fibers from visual and auditory areas.



**Function:** understanding **written and spoken words** enables person to read and understand

Works in coordination with **angular gyrus (39)** and **supra marginal gyrus (40)**

→ A lesion in any of these gyri and areas will give neurological manifestations in language processing, in angular gyrus for example one wouldn't be able to describe words, in the supramarginal gyrus, the person wouldn't be able to describe or understand the words they read.

# Summary of disorders of Association Cortex

## ❖ Agnosia

Tactile agnosia (Asterognosis) site? ..... Visual agnosia  
? .....

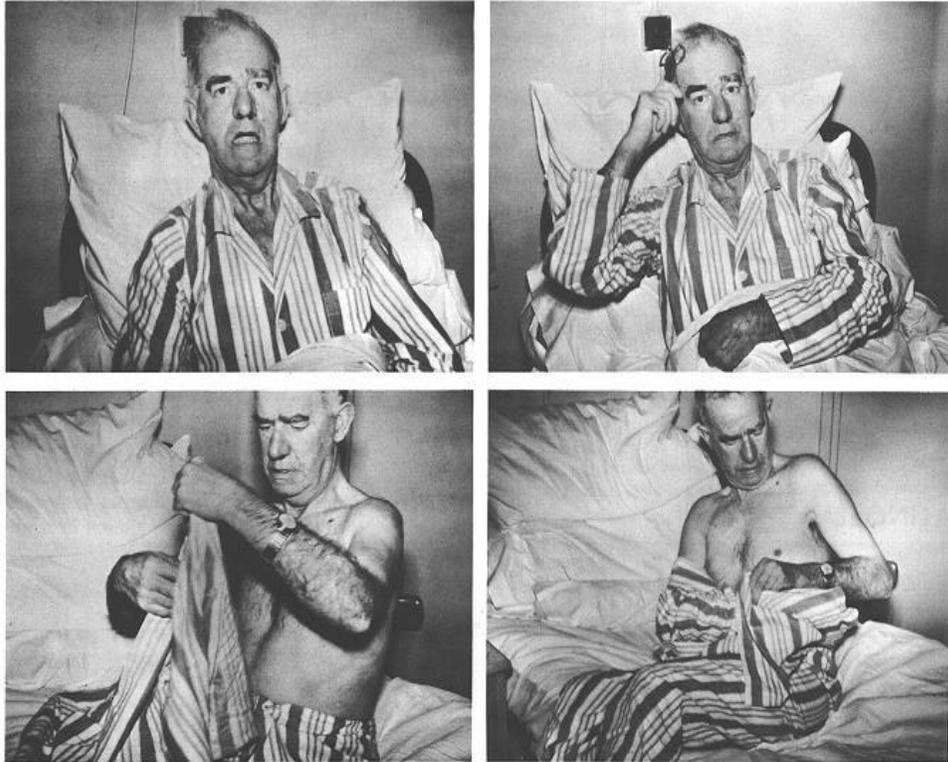
Auditory agnosia ?.....

## ❖ Apraxia (posterior parietal damage and or premotor area 6), CC

## ❖ Aphasia (types)

- 1- Wernicke's (sensory or receptive) aphasia
- 2- Broca's (Motor) aphasia (expressive)
- 1+2 global aphasia
- 3- Conduction aphasia

# Apraxia



The inability to execute a voluntary motor movement despite being able to demonstrate normal muscle function. Lesion is mainly due to injury of posterior parietal area or the split brain syndrome due to corpus callosum injury.

# More about aphasia.....Read only

## (Fluent aphasia)

**Receptive Aphasia** - area 22 defect in comprehension, good spontaneous speech (inability to understand spoken, written)

**Anomic Aphasia** - word finding difficulty

**Jargon aphasia** - fluent, but unintelligible not understood **Global aphasia:** both Broca's and Wernicke's.

## Superior Longitudinal Fasciculus lesion:

Conduction Aphasia

good comprehension, good spontaneous speech poor repetition, poor response

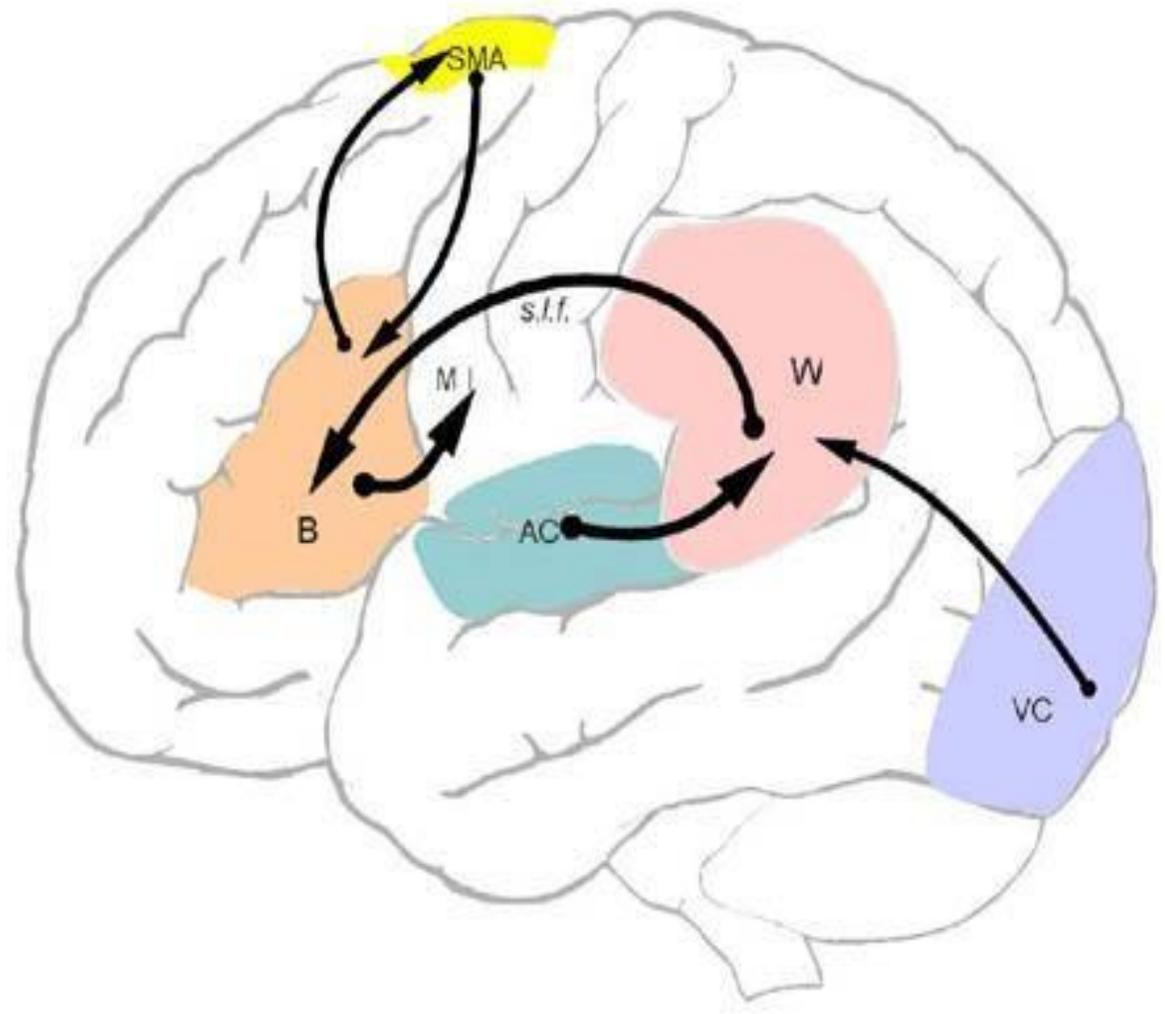
## Angular gyrus (39)

**Site:** around posterior end of superior temporal gyrus

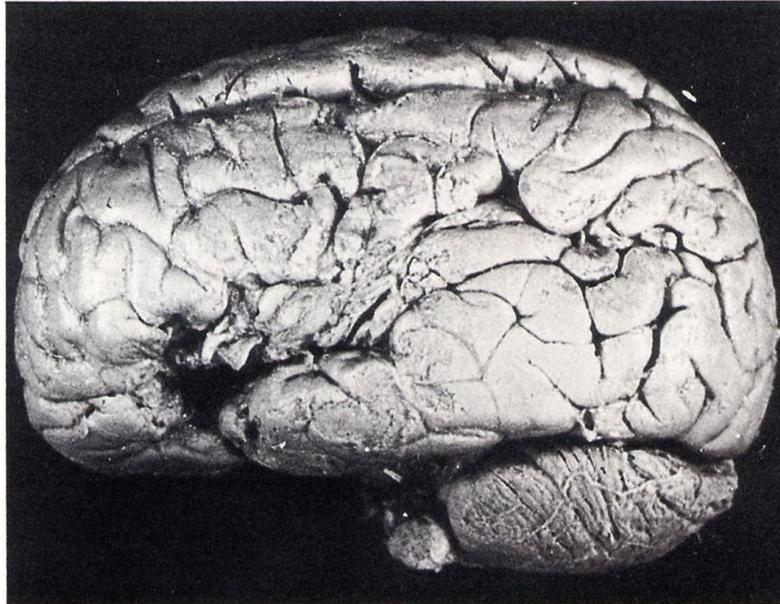
**Lesion: Agraphia** : inability to write or identify drawn objects

**Alexia:** inability to read

**Acalculia:** inability to solve small calculations

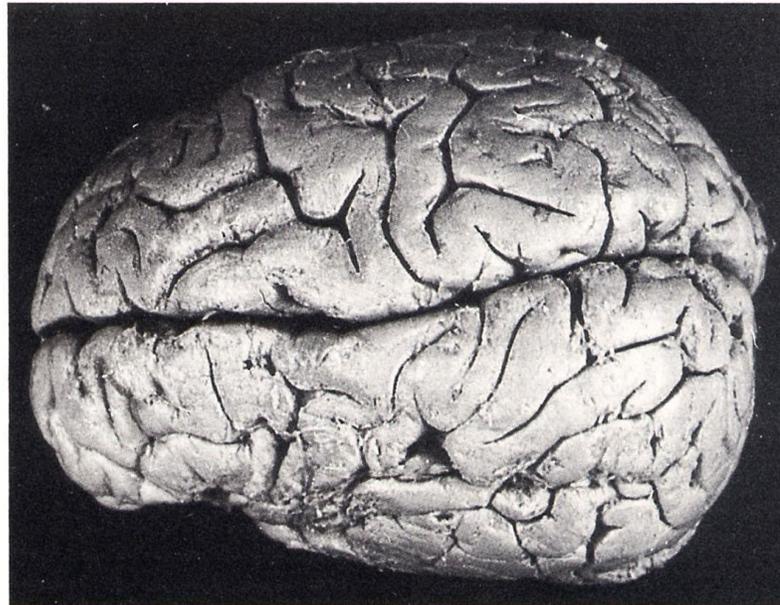


# Language Areas



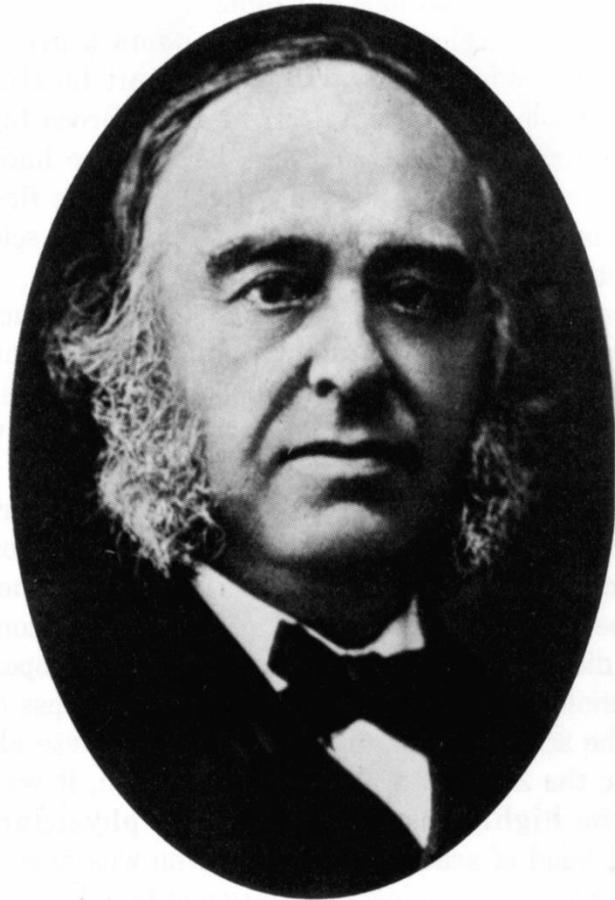
## Broca's Area

Pars triangularis and  
pars opercularis of the  
inferior frontal gyrus of  
dominant hemisphere



Photograph of the brain of  
Broca's patient.  
Atrophy of the area

To appreciate the scientists...



Paul Broca (1824-1880)



Carl Wernicke (1848-1905)

# Summary of The Main Functional Areas Of The Different Lobes Of The Brain

## The Frontal lobe:

- Contains motor area (4) which controls muscles of the opposite half of the body. Premotor area (6), Frontal eye field (8) & Broca's (motor) area for speech (44,45)

## The parietal lobe:

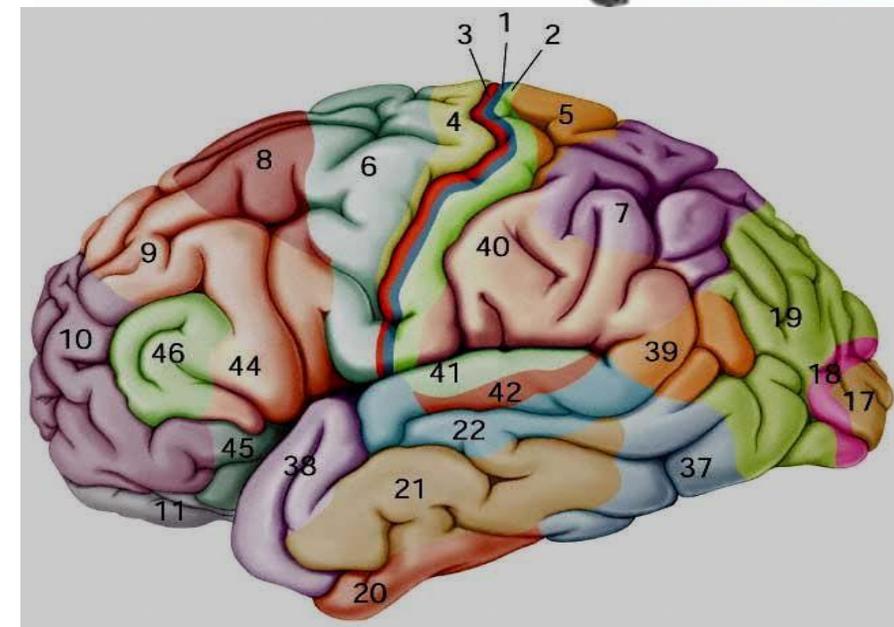
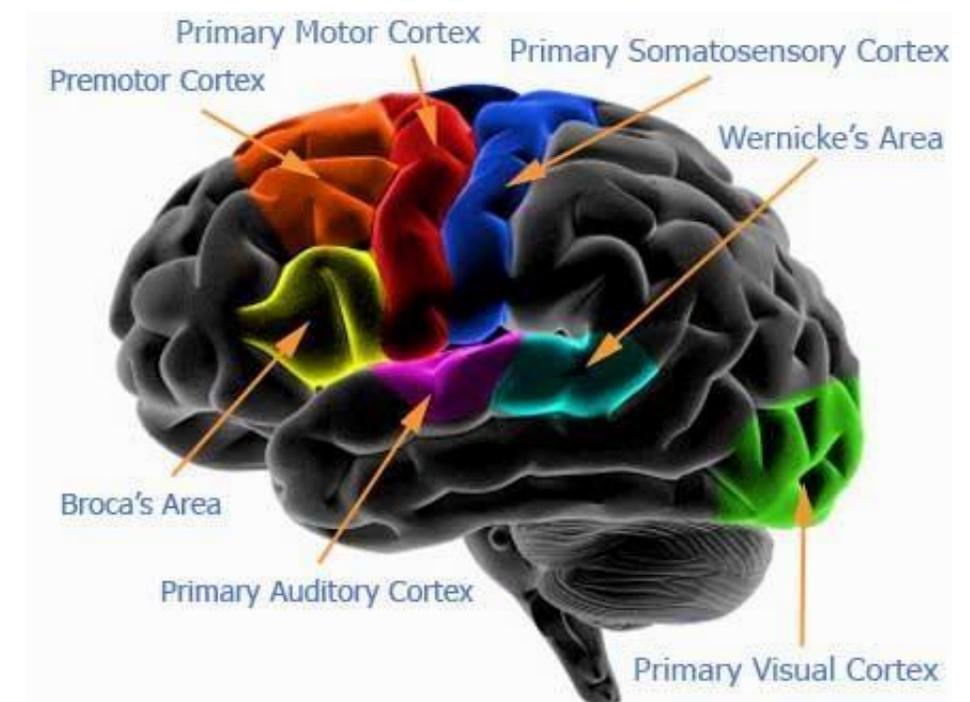
- Contains the sensory area (3,1,2) for the opposite half of the body.
- Wernicke's area (39,40,22)

## The temporal lobe:

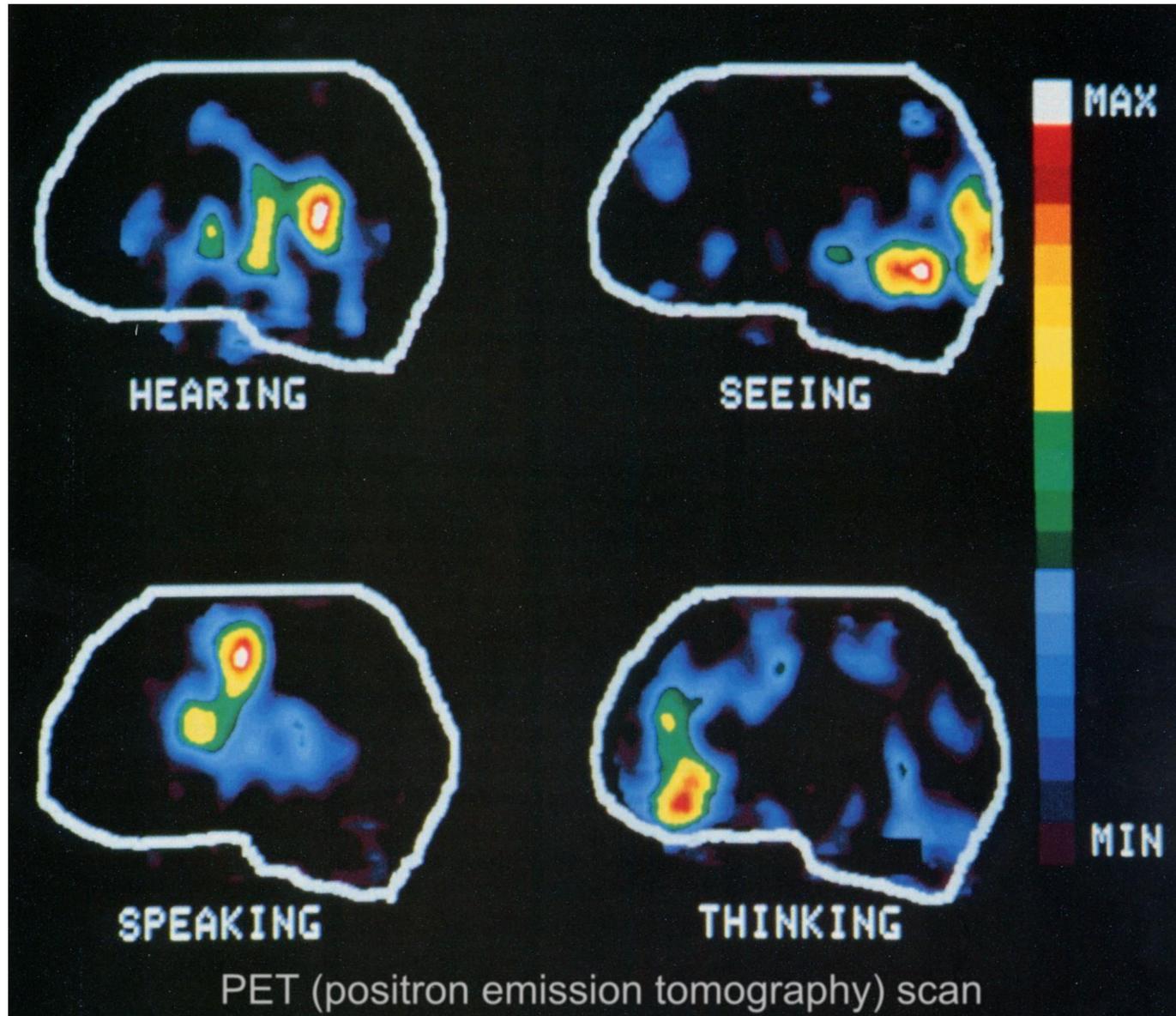
Contains hearing center (41,42,22).

## The occipital lobe:

Contains center for vision (17,18,19).



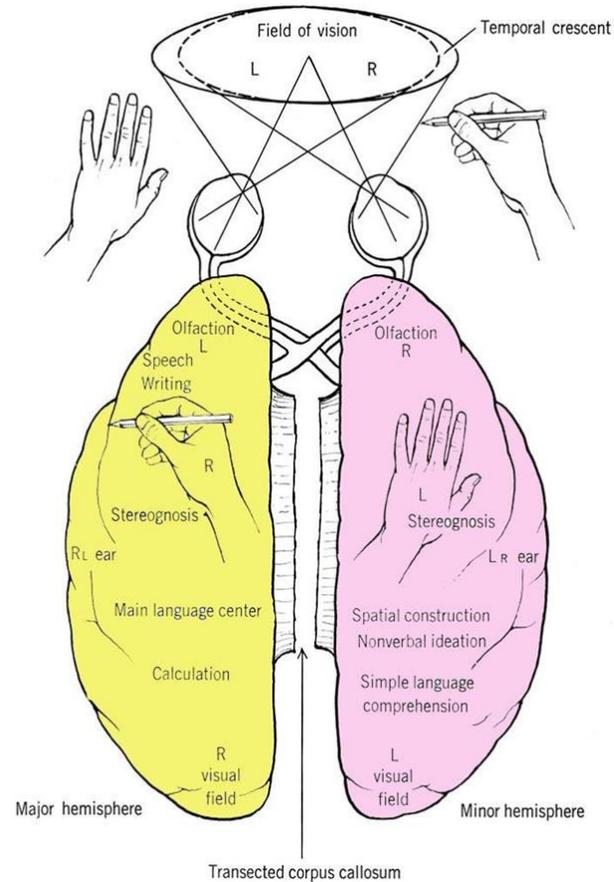
Here you can see the areas while they're active..



# Cerebral Dominance (Lateralization, Asymmetry)

## Dominant Hemisphere

Language  
speech, writing  
Calculation



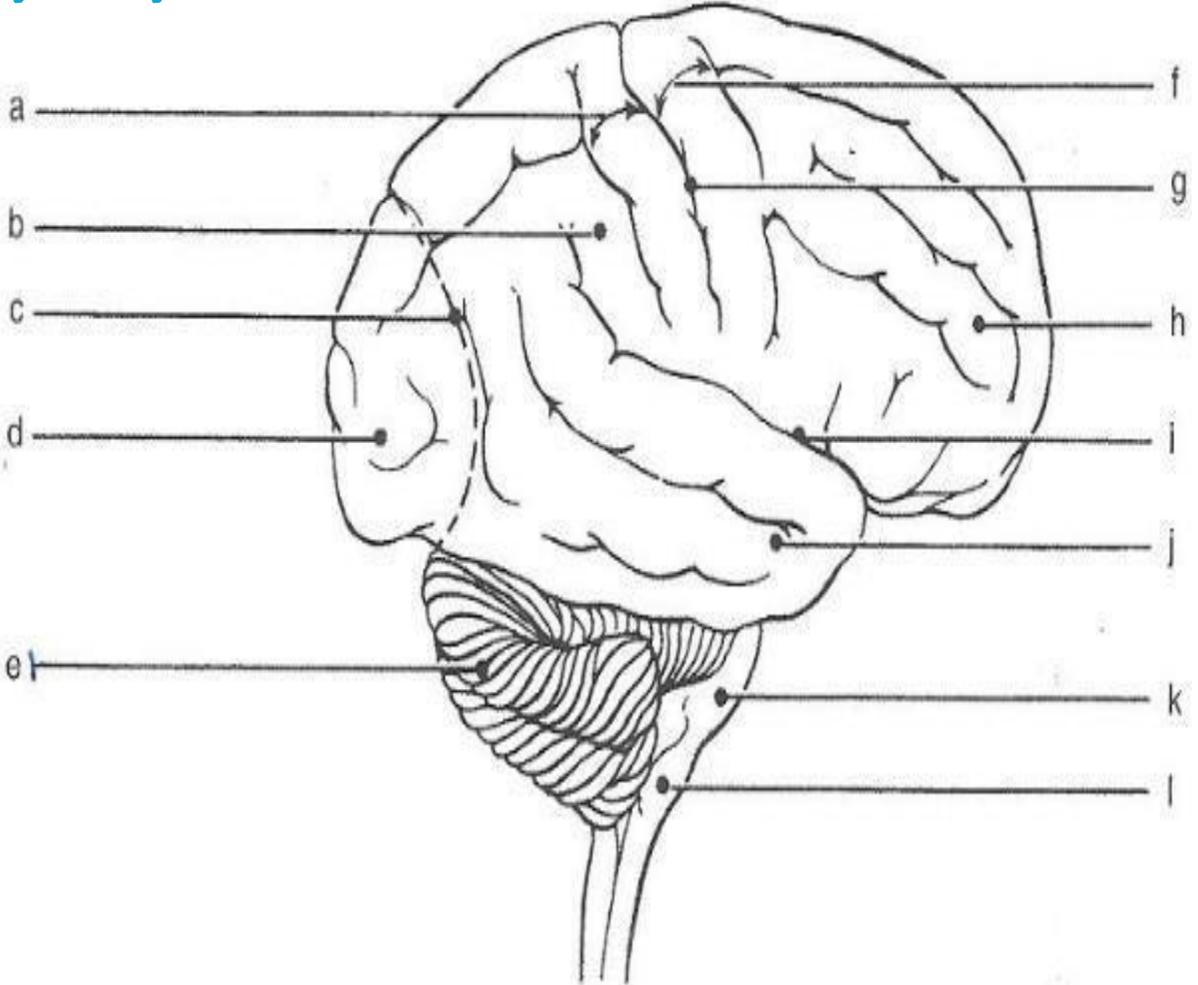
## Non-dominant Hemisphere

Spatial Perception (3D subject)  
Singing  
Playing musical instrument

## Now test yourself

Identify the orientation then the gyri and sulci

keep your eyes off the answers



- A- post central gyrus
- B- inferior parietal lobule
- C- imaginary line
- D- occipital lobe
- E- cerebellum
- F- precentral gyrus
- G- central sulcus
- H- inferior frontal gyrus
- I- posterior ramus (lateral fissure)
- J- middle temporal gyrus
- K- pons
- L- medulla oblongata

# Another test yourself :D

**Label Key:** Insert the correct brain term into the picture's label boxes.

...

## LOBE TERMS

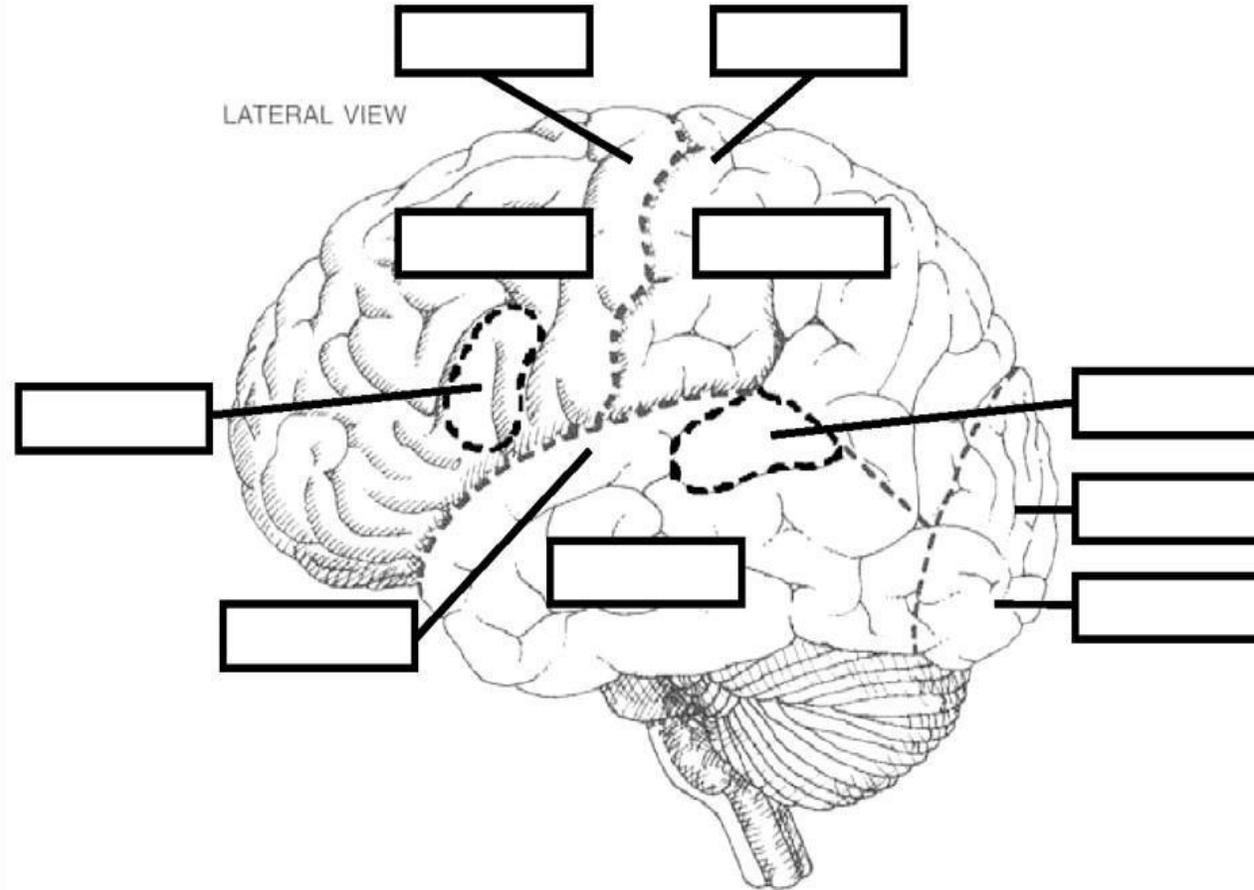
1. Occipital Lobe
2. Parietal Lobe
3. Temporal Lobe
4. Frontal Lobe

## SENSORY CORTEX TERMS

7. Visual Cortex
8. Auditory Cortex
9. Somatosensory Cortex
10. Motor Cortex

## SPECIAL FEATURE TERMS

5. Wernicke's Area
6. Broca's Area



Brain diagram adapted from Pinel, J. P. J. & Edwards, M. (2008, p.113). *A colorful introduction to the anatomy of the human brain: A brain and psychology coloring book*. Boston, Massachusetts: Pearson Education.

**THANK YOU**