



Cerebral cortex

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Learning outcomes:

• At the end of the lecture, you will be able to:

1. Explain the functions of the parieto-occipito-temporal association area.
2. Explain the functions of the prefrontal association area.
3. Define language and explain the functions of cortical areas involved in language comprehension and expression.
4. Define aphasia and explain its causes and types.

Functional areas of cerebral cortex



□ Cerebral cortex could be divided into:

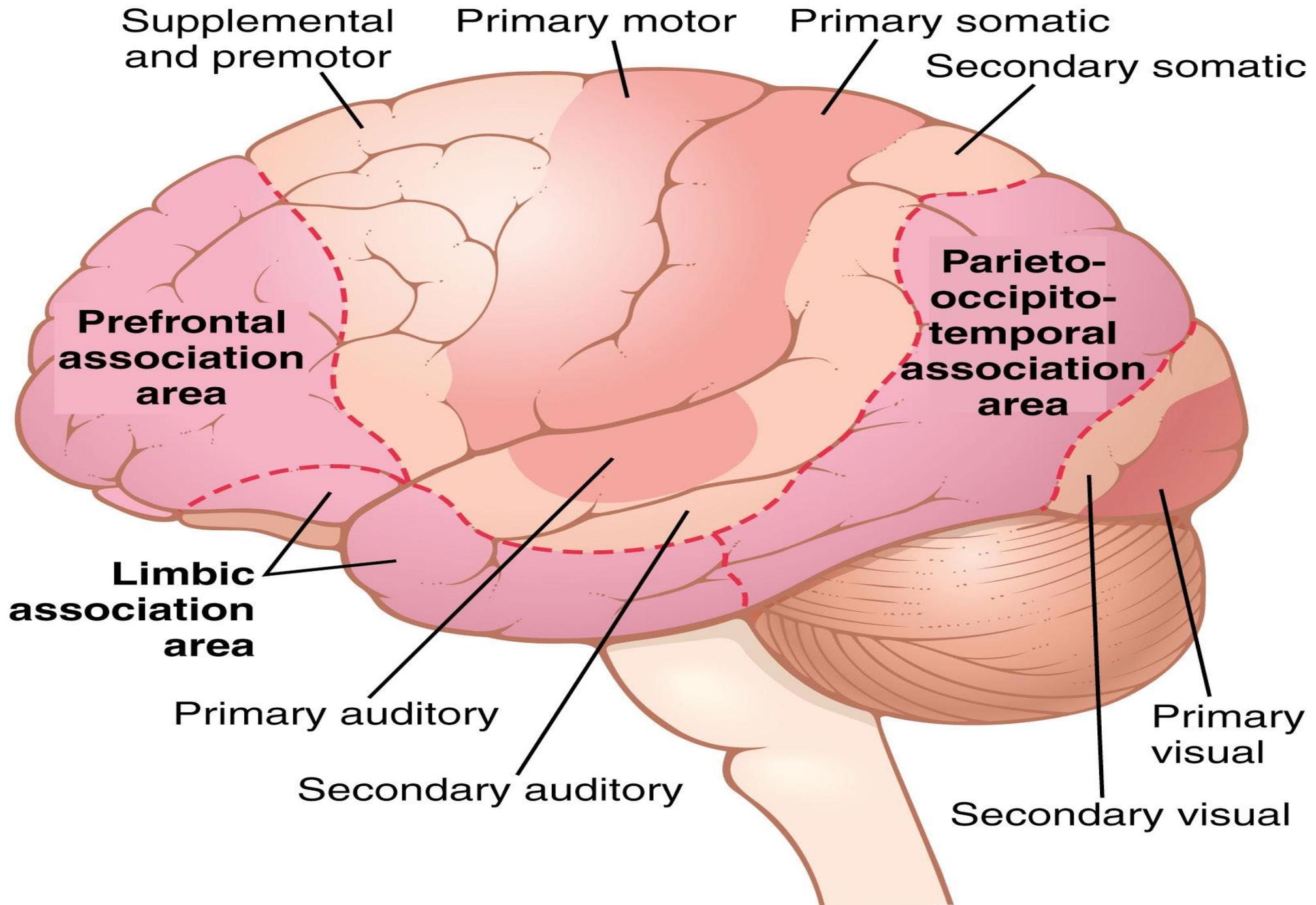
- Motor areas.
- Sensory areas.
- Limbic areas.
- Association areas.

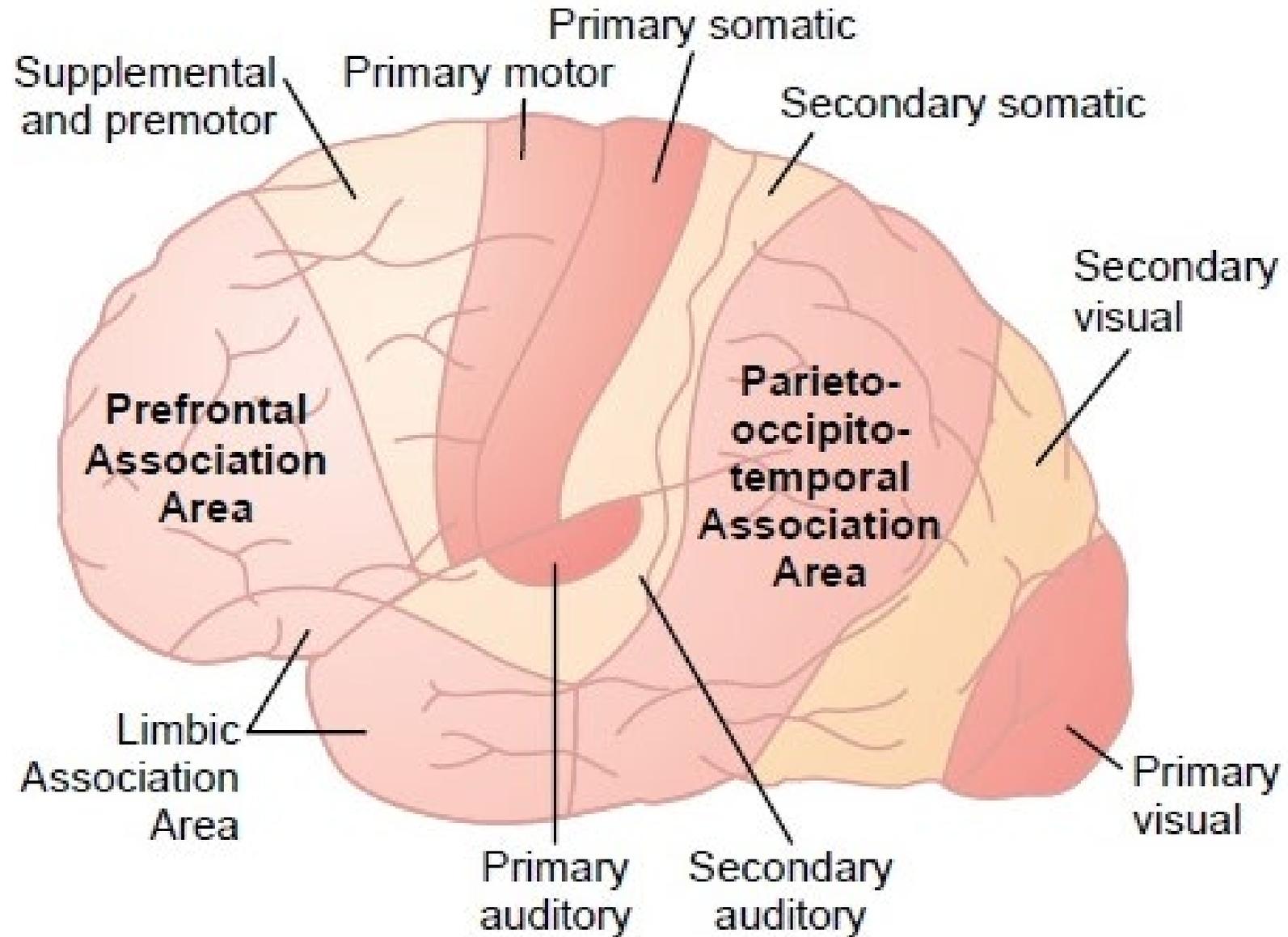


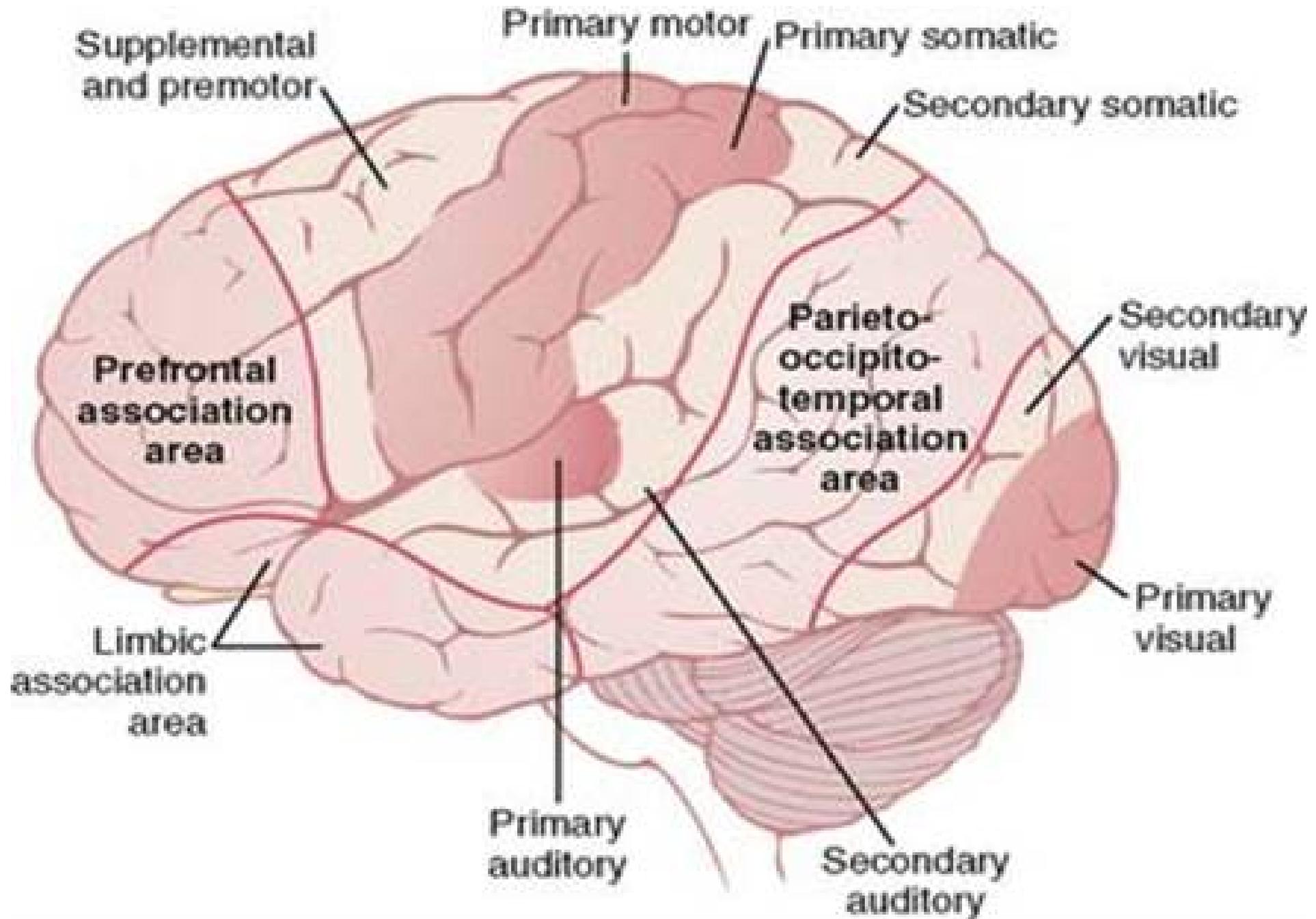
Cortical association areas

- They receive, analyze, and integrate signals from many regions of cerebral cortex and subcortical centers. The most important association areas are:

- 1) Parieto-occipito-temporal area.
- 2) Prefrontal association area.







Parieto-occipito-temporal association area

➤ Site: located in the cortical region between different sensory areas of parietal, occipital and temporal lobes.

➤ Functions: It contains many functional areas as:

1- Area for analysis of body position.

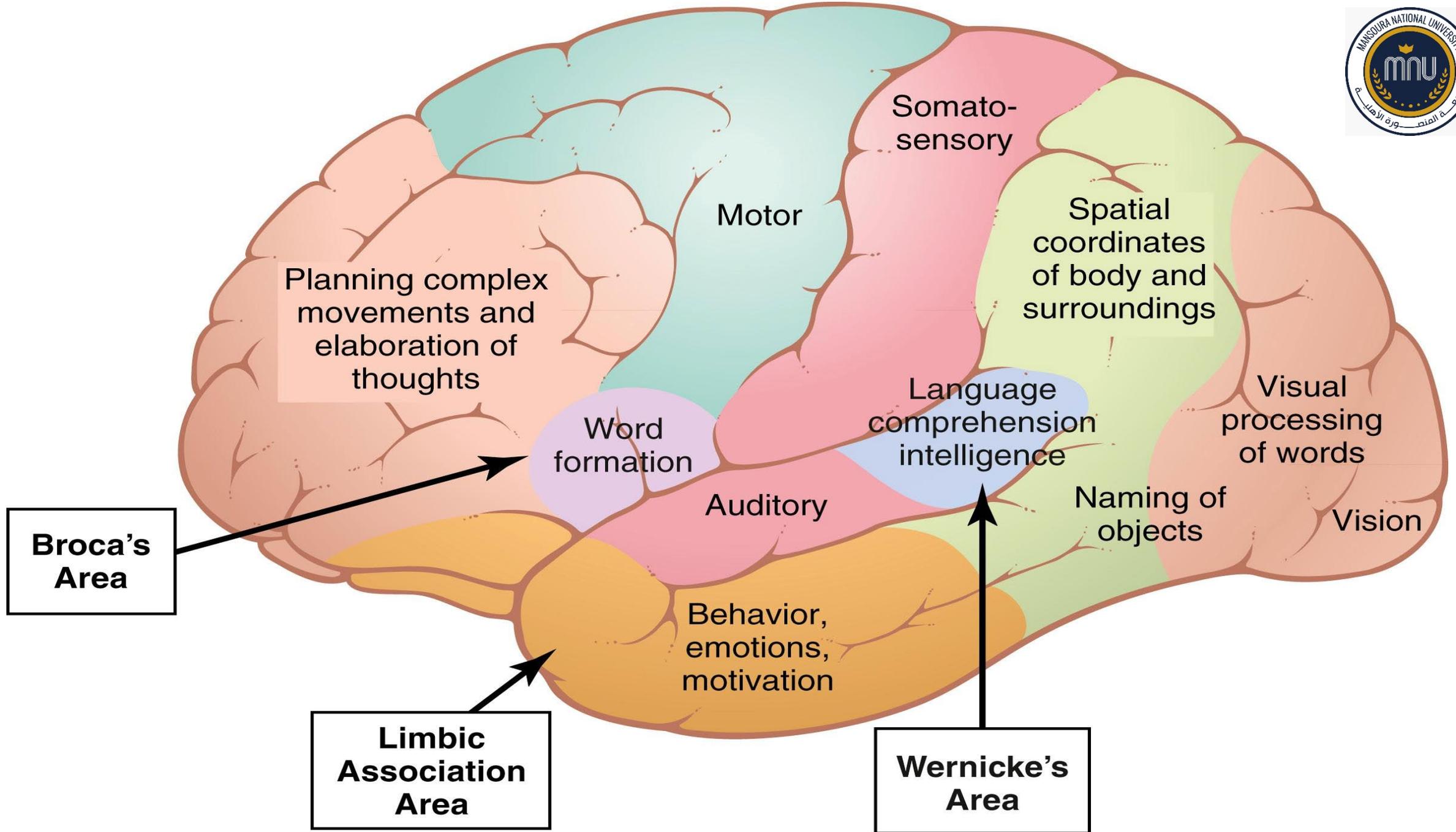
2- Reading area.

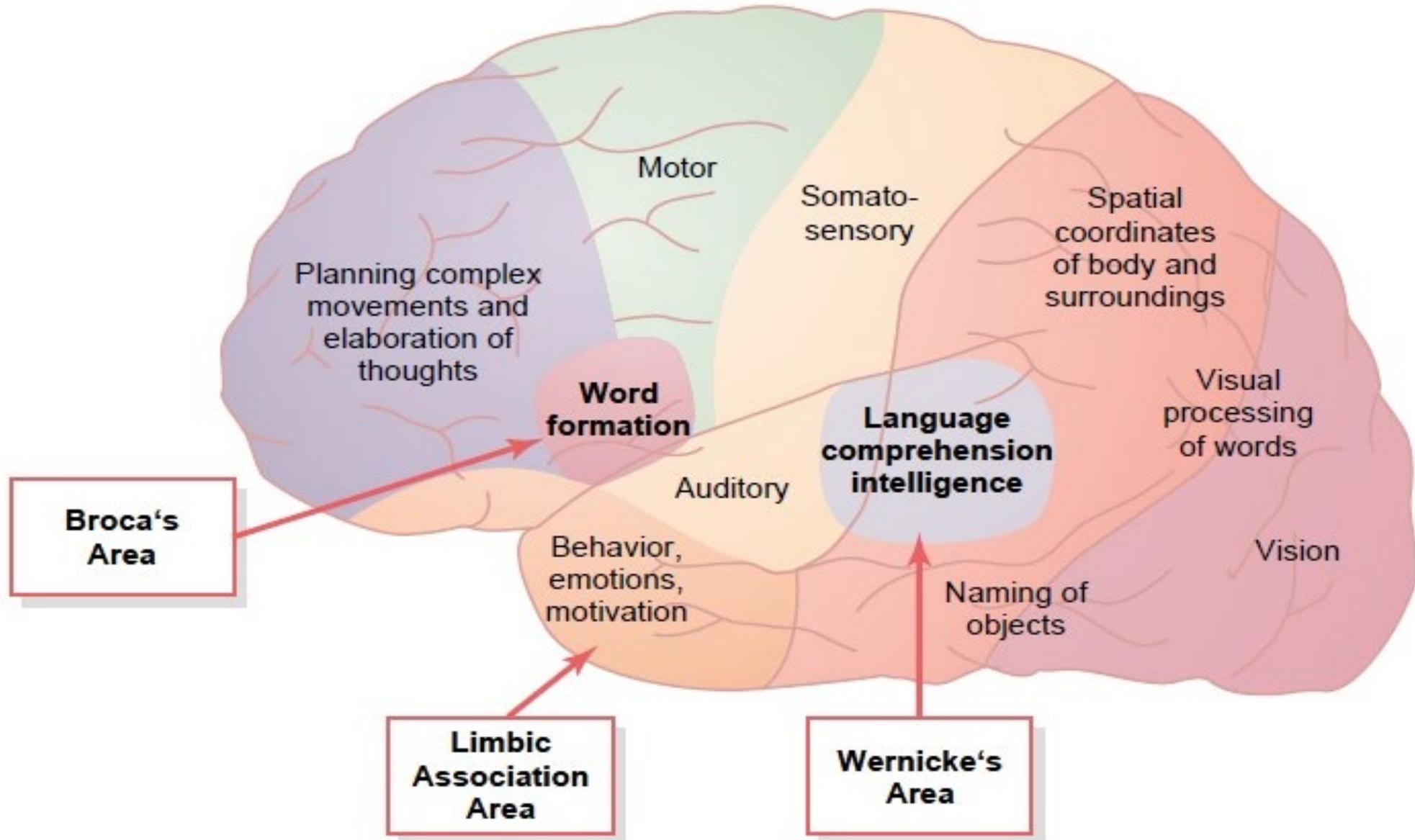
3-Area for naming of objects.

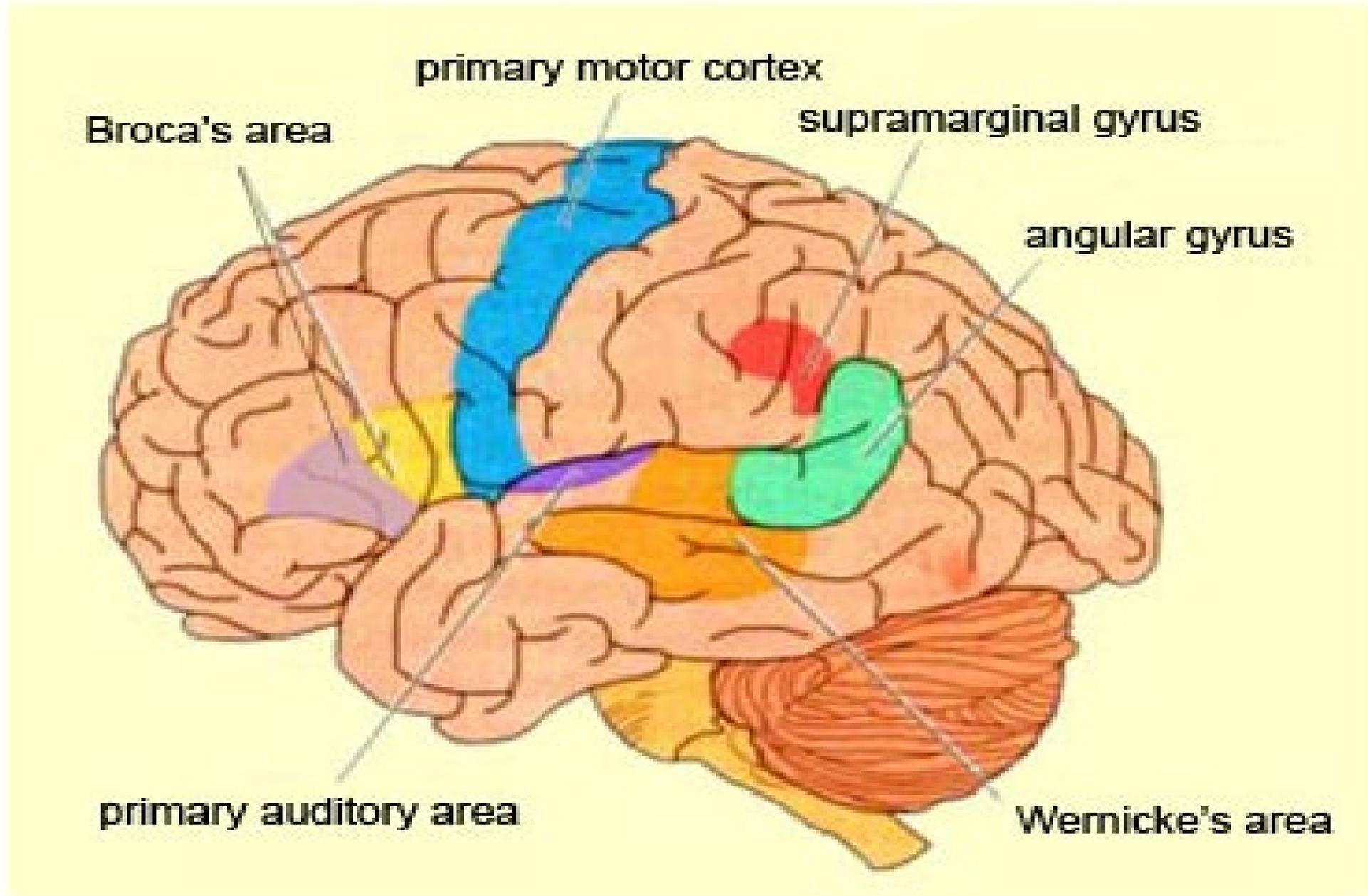
4- Area for recognition of faces.

5- Area for language comprehension = Wernicke 's area (General interpretative area).











1- Area for analysis of body position

- **Site:** Area between somatosensory area of parietal cortex and superior region of occipital cortex.

- **Function:**

It detects **body position** by interpretation of impulses from:

a) Visual receptors.

b) Proprioceptors.

2- Area for analysis of written words (Reading area)

- **Site:** Angular gyrus behind language comprehension area.
- **Function:** It recognizes meaning of perceived words during reading.
- **Lesion:** *word blindness (Dyslexia).*



3-Area for naming of objects



- **Site:** Inferolateral region of parieto-occipito-temporal area

- **Function:**

Associates *auditory input* with the *physical nature* of the object.

4- Area for recognition of faces

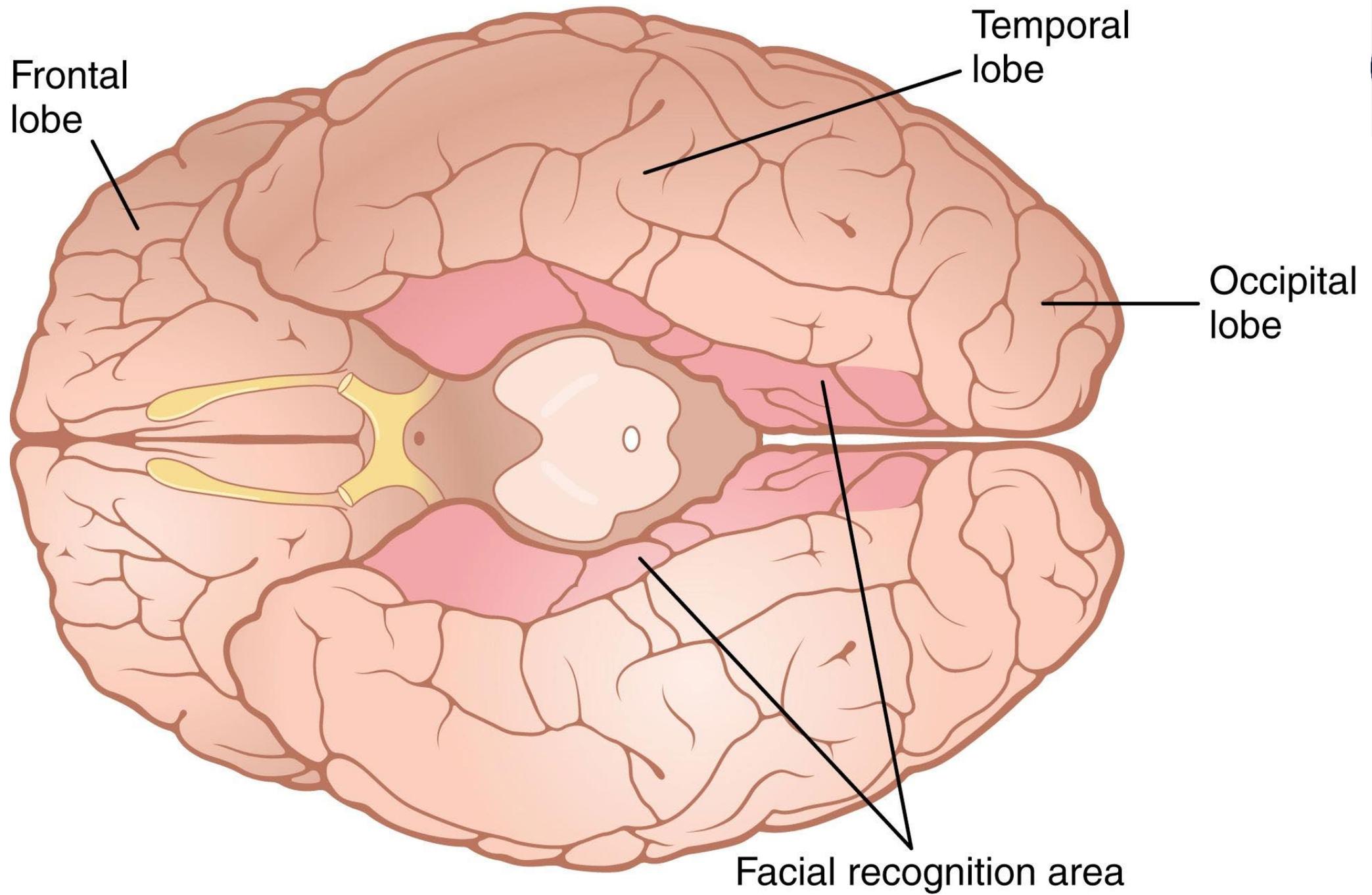


- **Site:** Medioventral surfaces of occipital and temporal lobes.

- **Function:**

It enables the person to *recognize familiar faces*.

- **Lesion:** → *prosopagnosia*



5- Area for language comprehension = Wernicke 's area (General interpretative area):



- **Site:** Posterior part of superior temporal gyrus

- **Function:**

- a) Higher levels of **language comprehension.**

- b) Understand **meanings** of spoken and written words

c) Formulation of thoughts and selection of *appropriate words* to express these thoughts in a *meaningful speech*.

d) Processing and recall of information stored in *memory*

Lesion: → deterioration of intellectual functions (language, thoughts) →

i) person is **unable to interpret** what is seen or heard

ii) person **can't express** himself **(Aphasia)**.

Prefrontal association area



- Site: occupies anterior portion of frontal cortex.

- Functions:

- 1) Planning of complex pattern of voluntary movement: It receives **pre-analyzed sensory information** from parieto-occipito-temporal area about the position of different parts of body in relation to the surroundings → **motor plan** → cortical motor areas for performance of desired movement.



2) Sustains mental concentration

3) Elaboration of thoughts

4) Adjust the personal behavior:

- It interprets the ongoing events and makes predictions about future behavior.
- It adjusts the behavior according to social and moral basis.

5) A working memory: i.e. ability of prefrontal cortex to:



- **Collect** many bits of information simultaneously.
- **Store** it in a readily accessible temporary memory.
- **Recall** these information when needed.



- **Damage: leads to:**

- **Inability to plan** complex motor actions in proper sequence.
- **Mental distraction.**
- **Inappropriate social behaviour.**

Neurological basis of language (Speech)



- **Def:** Language is highest mental function in humans, through which they can **express their thoughts** (communicate with each others) either by **spoken or written words.**
- Language is a **complex process** which requires integrity of whole cortex of **dominant cerebral hemisphere (left side in right-handed people and vice versa)** because it has both sensory and motor aspects.



- **Cortical areas involved in language:**

- I. Areas for language comprehension**

(Sensory aspect)

- II. Areas for language expression**

(motor aspect)

I. Areas for language comprehension (Sensory aspect)



- Wernick's area receives input about both spoken words and written words from auditory and visual association areas, a pathway important in reading comprehension.
- Wernick's area is responsible for formulating coherent (Meaningful) pattern of speech.

II. Areas for language expression (motor aspect)

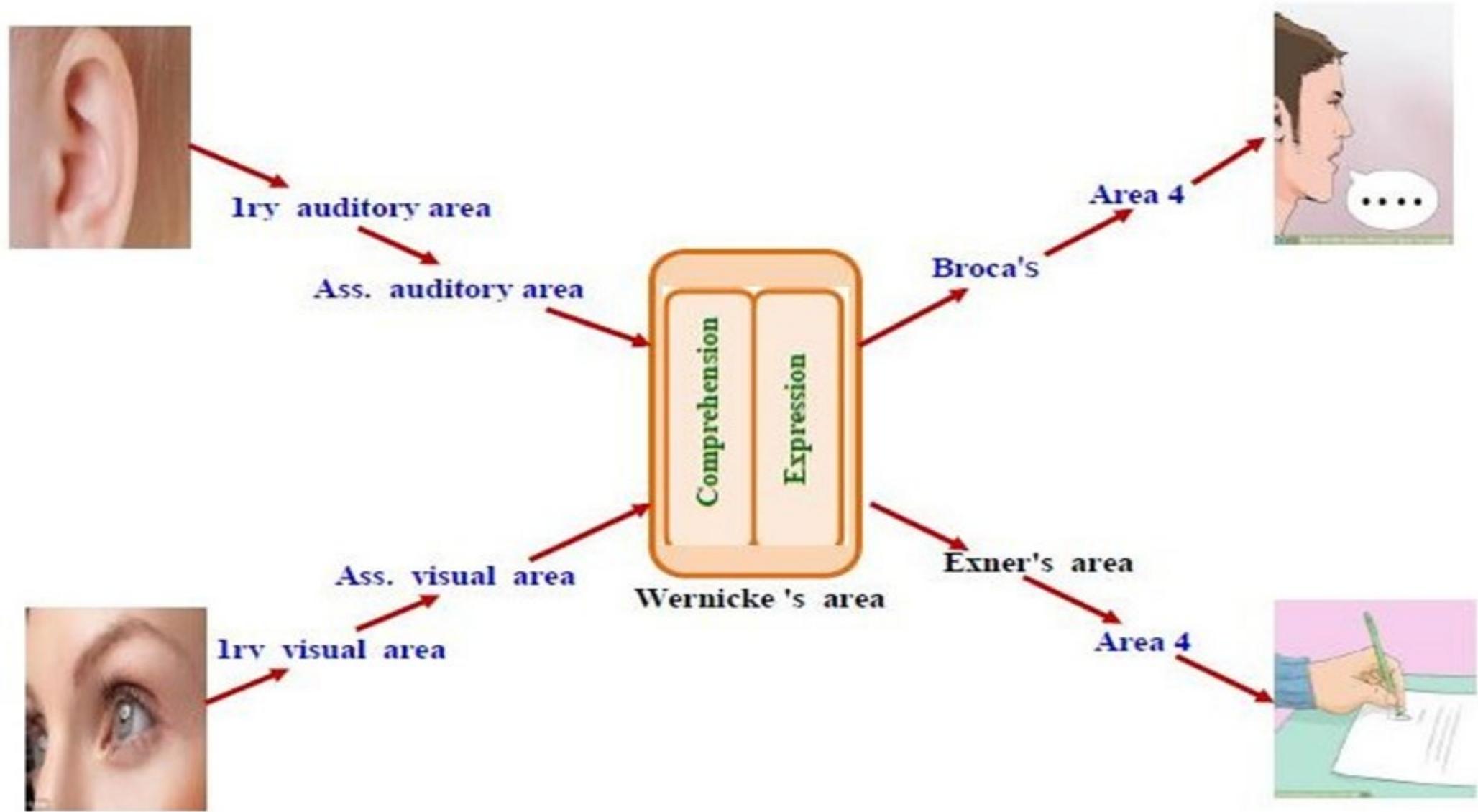
a) Broca's area:

- **Site:** Located in posterior part of inferior frontal gyrus in dominant hemisphere just in front of primary motor cortex which initiates contraction of laryngeal and mouth muscles.
- **Function:** Broca's area integrates language signals received from Wernicke's area → transmit it into detailed coordinated pattern of motor commands → specific area in primary motor cortex (area 4) → initiation and coordination of appropriate contraction of muscles of lips, tongue and lower jaw → vocal production of speech.



b) Exner's area:

- **Site:** Located in **frontal cortex in premotor cortex** immediately in front of region of primary motor cortex for hands and fingers.
- **Function:** When writing is needed, the language signals are transmitted from Wernick's area to **Exner's area** → **coordinates** the **skilled movements of hands and fingers** that are necessary for **writing**.



Aphasia

- **Def:** Aphasia is a speech abnormality resulting from damage of specific language areas in the dominant hemisphere, NOT due to defects in vision or hearing or paralysis of the speech muscles.
- **Causes:** vascular stroke affecting cerebral blood vessels supplying this region.

• Types:

I- Receptive (Sensory) aphasia

a) Auditory type:

➤ Site of lesion: Auditory association area
(area 22)

➤ Characteristics: Inability to understand
spoken words (**auditory agnosia**).

b) Visual type:

➤ ***Site of lesion:*** Visual association area
(area 18-19)

➤ ***Characteristics:*** Inability to
understand written words (**visual
agnosia**).

c) Wernicke's type:

➤ Site of lesion: Wernicke's area

➤ Characteristics:

i- Inability to understand both spoken and written words.

ii- Inability to formulate speech.

II- Expressive (Motor) aphasia

- Failure to articulate speech due to lesion at Broca's area (area 44-45)
- Failure of writing (agraphia) due to (lesion at Exner's area (area 46))

III- Global aphasia (both types)

- Site of lesion: association area & motor areas
- Characteristics: Failure to understand or express thoughts.



References

1. Costanzo, Linda S. "BRS Physiology (Board Review Series)." (2018).
2. Ganong, William F. "Review of medical physiology." (2020).
3. Hall, John E and Hall, Micheal E. "Guyton and Hall Textbook of medical physiology." (2021).