

PHYSIOLOGY

☒ Sheet

☐ Slide

☐ Handout

Number

20

Subject

Cerebral Cortex; Intellectual Functions of the
Brain; Learning and Memory 'Part 1'

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☺ Read the following:-

- This sheet was written according to section 1!
- This sheet is beyond being easy!
- In this sheet we aim to :
 - Describe intellectual functions of the cerebral cortical areas (Mainly Language)
 - Outline the dominant and non-dominant hemispheres
 - Delineate language areas of speech
- In this sheet we will depend a lot on the slides as the doctor did so through the entire lecture. And there are about 14 slides.
- .. Let's start ...

♣ **Slide #1** 'Physiologic Anatomy of Cerebral Cortex'

• **Each area of the cortex is connected to a specific part of the thalamus.**

- As we know by now, the thalamus receives from so many areas around the body, and each area in the thalamus projects to on specific area upon to the cerebral cortex.

- Examples to clarify what we said :

> Sensory sensation is sent to the VPL& VPM in the thalamus, then to the post-central gyrus in the cortex.

> Motor orders from Cerebellum and Basal Ganglia is sent to the VA& VL in the thalamus, then to the pre-central gyrus in the cortex(Motor area).

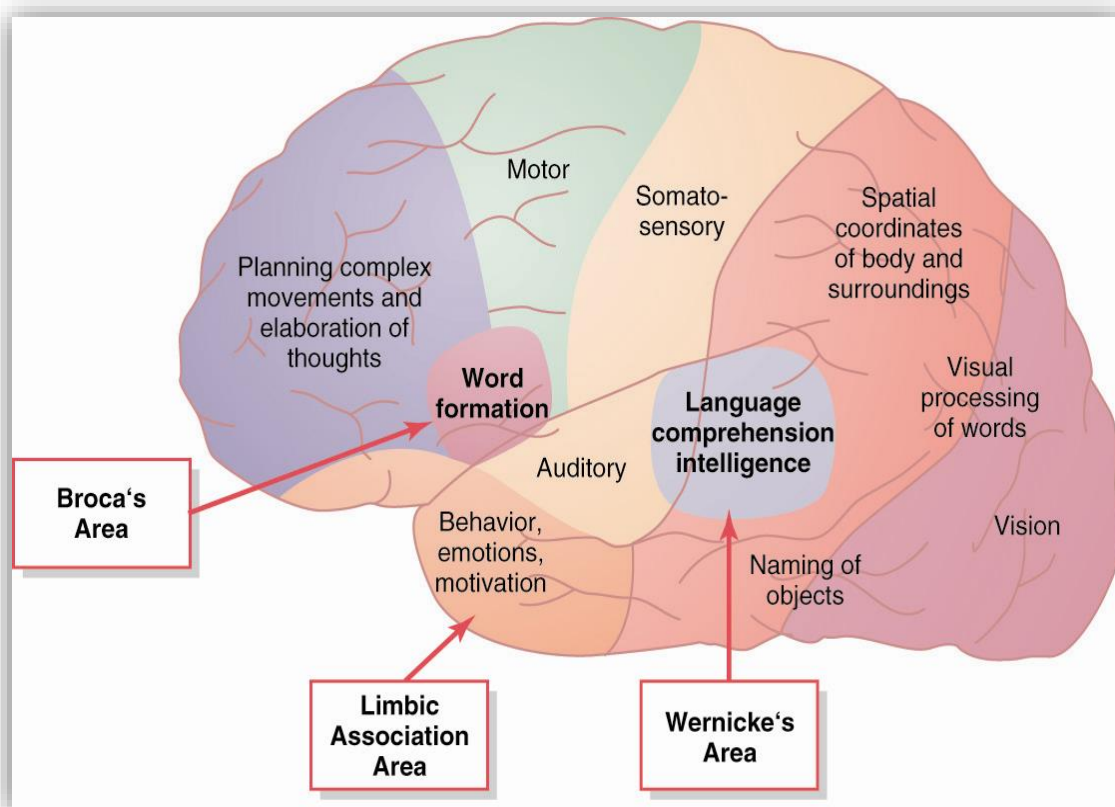
> Visual sensation is sent to the Lateral Geniculate in the thalamus, then to the Occipital lobe of the cerebral cortex.

> Auditory sensation is sent to the Medial Geniculate in the thalamus, then to the Temporal lobe of the cerebral cortex.

> Taste sensation is sent to the VPM in the thalamus, then to post-central gyrus in the cerebral cortex.

- **When thalamic connection is lost cortical function stops.**
 - We will get a closer look on this next lecture when we talk about the Reticular Formation(RF)& Sleep.
 - For now keep in mind that the Reticular Activating System(RAS) is found in the brain stem, and upon its stimulation; it sends impulses to all areas of the cortex to awaken it!
 - Also, keep in mind that the thalamus is considered as a part of the RAS; as it receives the impulses from the RF and sends it up to the cortex to awaken it.
- **All sensory pathways pass through the thalamus with the exception of some olfactory signals.**
 - By now, you must know that not all the olfactory signals pass directly to the cortex as thought before! As some of the olfactory passes to the thalamus(Dorso-medial part of the thalamus) then to the cortex! Just like some olfactory passes directly to the cortex!

♣ Slide #2 'Physiologic Anatomy of Cerebral Cortex'



- This figure is just a review for the physiological anatomy of the cerebral cortex (central sulcus, primary motor, primary sensory, the representation of the body, the density of the receptors, ...) which we covered a lot in previous lectures. The doctor also mentioned the Frontal Eye Field for the voluntary eye movement(Area 8).

- What matters for us here is some secondary areas; Association areas! We know that a lot of the frontal lobe is actually association areas; like area 6 (the pre-motor cortex& the supplementary area) which is for designing programs for movement, Area 44& 45 which is the Broca's area for word formation& programming for speech!

- If you pay attention to the location of Broca's area, you can tell that it is very close to the area that controls the movement of the muscles of the larynx, vocal cords& the tongue.

- The pre-frontal cortex is also one of the association areas found in the frontal lobe which its function was discovered accidentally. And now, it is well-known that it is linked to the thoughts, social behavior, judgment& complex mathematical equations. Damage to this area causes disinhibition for the behavior that the person adapts(goes away from the social norms that are accepted).

Lobotomy is one surgical procedure that is used in the treatment of cases such as severe schizophrenia which targets this area.

- Just inferior to the pre-frontal cortex and anterior in the **Temporal lobe**; we find the Limbic Association Area which is part of the limbic system as a whole. It is concerned with motivation, emotion& memory.

♣ Slide #3 & #4 & #5 & #6 'Functional organization of the cerebral cortex'

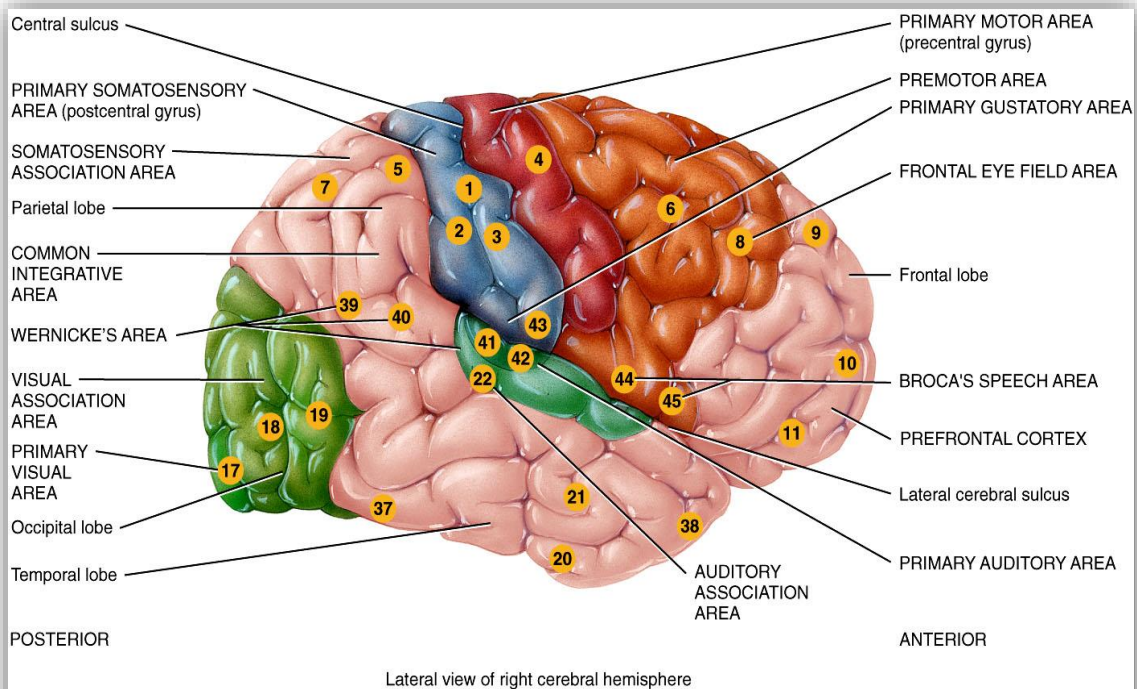
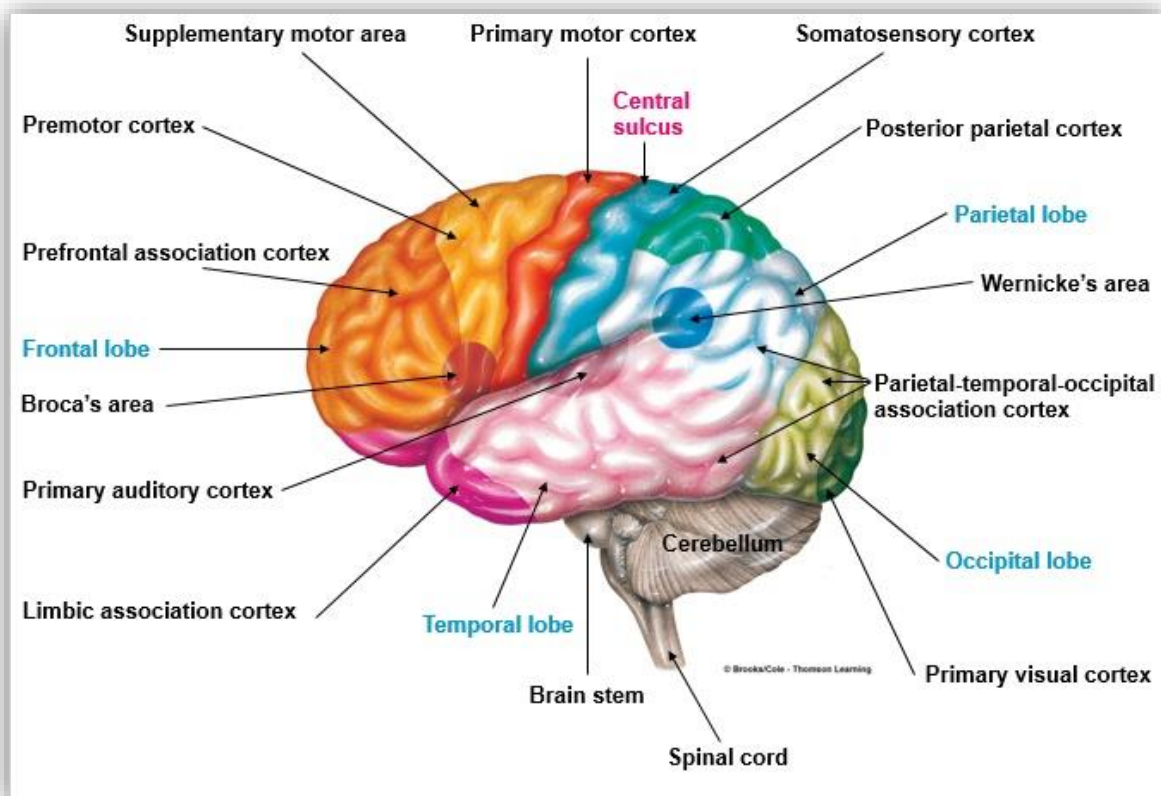


Figure 14.15 Tortora - PAP 12/e
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- Brodmann's classification is just to look at for this lecture, do not memorize it !

- The Association sensory cortex is where we get the spatial coordination for our body, it gets the information from the primary sensory area. A damage to this connection would cause Amorphosynthesis; where the patient is unaware of somatic sensation from one side of the body(loss of the spatial coordination for one side of the body).

- The visual association area is where we explain what we see. A lesion in that area would cause word blindness/ dyslexia/ visual aphasia!

- The temporal association area is where we explain what we hear. A lesion in that area would cause word deafness/ auditory aphasia!

- Inferiorly and medially in the cortex, we can find a specialized area for identifying the faces, a lesion in this area can lead to prosopagnosia/ face blindness; in which the patient fails to recognize the faces around him/her.

- An area for the integration of the visual, auditory& sensory input is the parieto-occipito-temporal area; known as the Wernicke's area(named upon the German scientist who first described it). It can be found in the most posterior part of the temporal lobe. Also, this area is known as the Speech comprehension area; where we can integrate what is seen, heard& sensed then we formulate an idea/thought about it, then we send this idea to an association area in order to put a program to express it. Like sending it to the Broca's area in order to form the words needed. This area is linked to the dominant hemisphere.

- Arcuate fasciculus are the nerve fibers that connects the Wernicke's area to the Broca's area

♣ Slide #7 'Dominant and Non-Dominant Hemisphere'

- Wernicke's area more developed in one hemisphere, responsible for verbal symbolism and related intelligence. *Dominance is related to Language.*

- 95% of population has a left dominant hemisphere.

- Wernicke's area can be as much as 50% larger in the dominant hemisphere.

- Dominance is not related to handedness(which hand you use more frequently). 'Handedness is discussed later in this sheet'

When we say that the left hemisphere is the dominant; this means that the Wernicke's& Broca's areas are larger on the left.

- Why are they larger ? It is thought that these people are born with a larger left hemisphere, which means they have more tendency to use the Wernicke's& Broca's areas on the left making them larger than the ones on the right more further; putting the left hemisphere as the dominant one.

- Dominance is mostly due to genetics factor; just like Intelligence.

♣ Slide #8 'Dominant and Non-Dominant Hemisphere'

- Damage to dominant Wernicke's area leads to dementia

- Non-dominant side related to other forms of sensory intelligence (music, sensory feelings).

- A non-dominant hemisphere doesn't mean that it is not functioning. It means that it has another type of function like dealing with arts, music& body language.

♣ Slide #9

TABLE 14.3

Functional Differences Between the Two Cerebral Hemispheres

LEFT HEMISPHERE FUNCTIONS

Receives somatic sensory signals from and controls muscles on right side of body.

Reasoning.

Numerical and scientific skills.

Ability to use and understand sign language.

Spoken and written language.

RIGHT HEMISPHERE FUNCTIONS

Receives somatic sensory signals from and controls muscles on left side of body.

Musical and artistic awareness.

Space and pattern perception.

Recognition of faces and emotional content of facial expressions.

Generating emotional content of language.

Generating mental images to compare spatial relationships.

Identifying and discriminating among odors.

Table 14.03 Tortora - PAP 12/e
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- The clinical correlation for the dominance is that, if someone presents to you with right-sided hemiplegia; you expect to see aphasia too ! Why? Because the lesion is in the left hemisphere. But you wouldn't expect that in a person with left-sided hemiplegia.(Saying that this person has the left hemisphere as the dominant one of course!)

♣ Slide #10 'Language Areas'

- Located in a large area surrounding the left (or language-dominant) lateral sulcus.
- Major parts and functions.
 - Wernicke's area – involved in sounding out unfamiliar words – sensory aspect of speech– damage leads to sensory aphasia (Receptive aphasia)
 - Broca's area – speech preparation and production– motor aspect of speech – damage leads to motor aphasia (expressive aphasia)

- Both Wernicke's and Broca's area damage leads to global aphasia.
- Lateral prefrontal cortex – language comprehension and word analysis–
- Lateral and ventral temporal lobe – coordinate auditory and visual aspects of language.

♣ Slide #11 'Brain Organization and Handedness'

- Close to 90% of people are right-handed and close to 10% are left-handed and a small number are ambidextrous (use both hands).
- 95% of right-handers process speech primarily in the left hemisphere.
- left-handers: around 65% in left hemisphere, 15-20% in right hemisphere, 15-20% in both.
- More than 90% of people are born with the left hemisphere area that controls the movement of the right hand is bigger.
- They tend to use the right hand, this area grows and become dominant.
- Left or Right handed is not linked to dominance !
- Left or Right handed is due to a bigger area that controls the skilled-movement of the hand in one of the hemispheres (contralateral). If the area for the movement of the hand was bigger on the left and the person worked upon that tendency to use his right hand more frequently; he will be right handed. So is the other way around.
- Can it be converted ? YES, by practice& the younger the better and easier, because the brain will be more flexible to such change.

♣ Slide #12 'Brain Organization and Handedness'

- Left handed people have their right cerebral hemisphere area that controls the movement of the left hand bigger.
 - If they use the left hand then this area grow and become dominant.
 - They still can convert and the younger the more easier if they start to use their right hand instead and then they become right handed.
 - Same applies for using the legs.

♣ Slide #13 'Intellectual Functions of the Prefrontal Association Area'

- Responsible for calling forth stored information and using it to obtain a goal.
- Responsible for concerted thinking in a logical sequence.
 - damage causes an inability to keep track of simultaneous bits of information, easily distracted.
 - Also, damage causes social disinhibition on the behavior and personality changes!

♣ Slide #14 'Intellectual Functions of the Prefrontal Association Area'

- Elaboration of thought.
 - prognosticate(predict), plan, consider consequences of motor actions before they are performed.
 - correlate widely divergent information, control one's activities.
 - Personality trait and behavior that confines to values and manners of the culture.

.. End of this lecture .. The subject is yet to be continued .. ☺