CENTRAL NERVOUS SYSTEM

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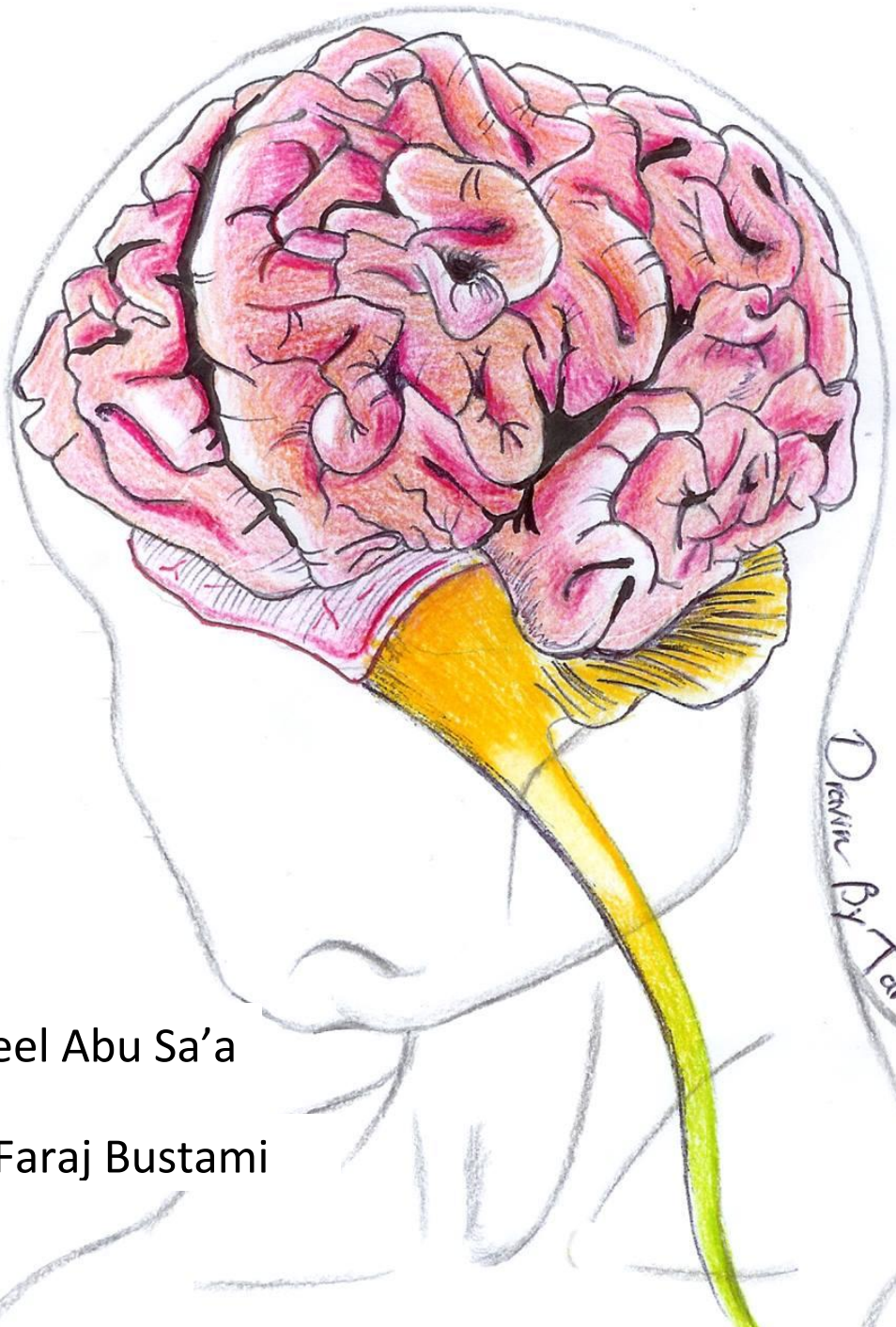

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Aphasia

Speech basically involves the understanding of spoken and printed words (the 1st aspect) besides the ability to express ideas in speech and writing (the 2nd aspect).

Aphasias are abnormalities in language functions that are NOT due to defects of vision or hearing, or to motor paralysis. Meaning that muscles of the larynx, tongue, and lips are intact (not paralyzed). Hearing and vision are normal as well.

** So either the individual is unable to speak OR their words cannot be understood.

Note: Aphasia must be differentiated from dysarthria, which is characterized by disturbances in speech secondary to cerebellar diseases where the coordination between muscles of speech is lost. However, in aphasia, there is NO paralysis or loss of coordination between speech muscles.

Aphasias are always caused by lesions in the categorical (dominant) hemisphere.

In 95% of people, the **left** hemisphere contains the centers for language and comprehension irrespective of handedness. That's why it is called the Dominant Hemisphere.

On the other hand, the right hemisphere is involved in the recognition of faces and music, interpretation of mathematical problems, and many other functions.

In cases of Monoplegia, where the lesion is most probably found in areas 4&6 of the cerebral cortex, the speech area (area 44, 45), AKA **The Broca's Motor Speech Area**, might be affected as well. This area is located in the Left inferior frontal gyrus posteriorly.

Important Note: if the monoplegia is on the right side, this means that the lesion involves the **left** hemisphere and will consequently affect the speech area that lies in front of areas 4 and 6.

Which parts of the brain are involved in the speech mechanism?

1. **Primary Auditory Area** (area 41, 42), which is found on the superior surface of superior temporal gyrus deep to the lateral fissure.
2. **Association Auditory Area** (area 22), which is found on the outer surface of superior temporal gyrus.
3. **Wernicke's area**: allows you to perceive what you hear. It is thought to be the association auditory cortex itself; however, others suggested that it is actually the posterior part of association auditory cortex. Once the Wernicke's area receives an impulse (music for e.g.), it sends signals through an association bundle known as *Arcuate Fasciculus.*
4. **Arcuate Bundle,** which connects the Wernicke's area to the Broca's area (association fibers).
5. **Broca's Area** (area 44, 45). It is the motor speech area which is located in the left inferior frontal gyrus posteriorly

Note: Wernicke's area is the sensory speech area and is found in the parietal lobe, whereas Broca's area is the motor speech area and is found in the frontal lobe. They are connected together via the Arcuate Fasciculus.

6. **Motor and Premotor Cortex.**
7. **Corticobulbar Tract.**
8. **Nucleus Ambiguus, hypoglossal nucleus, and other cranial nuclei that supply speech muscles.**
9. **Speech muscles.**
10. **Primary visual Area (area 17)**
11. **Association Visual Area (area 18,19)**
12. **Angular gyrus, (**area 39), which is found in the inferior parietal lobule and lies posterior to the end of the Superior temporal sulcus.

** Areas 1-9 mediate the spoken language (communication) pathway.

** Areas 10-12 mediate the written language (reading) pathway.

How do we understand spoken words? / Communication Pathway:
Impulses from both ears (more from the contralateral one mainly) **>> primary auditory area** >> **Association Auditory Area** >> **Wernicke's area** >> **Motor Speech Area** (inf. Frontal gyrus posteriorly) >> **Premotor and motor cortex (Areas 4&6)** the face region >> sending corticobulbar fibers to the **nucleus ambiguus** >> **muscles of the larynx and pharynx** (speech muscles) as well as to the **hypoglossal nucleus**. Once impulses reach these muscles, they contract so we can speak.

How do we understand printed words?/ Reading Pathway
Impulses form both eyes run to the **primary visual cortex (area 17)** >>**Association visual Area (area 18, 19)**, which sends signals to the infratemporal gyrus (the major visual association area) >> **Angular gyrus (area 39)**, which is found in the inferior parietal lobule posterior to the end of the superior temporal sulcus. Once information reaches this area, it sends signals to the Wernicke's area.
Conclusion: the Wernicke's area (sensory speech area) is involved in both hearing (spoken language) and reading (written language) pathways, allowing you to perceive spoken or printed words.

❖ Types of aphasia:

** The two types result from vascular injuries involving the **Middle Cerebral Artery**, and they may coexist (Global Aphasia). Early intervention prevents the progression of simple aphasia to global aphasia.

1. **Motor (non-fluent) Aphasia:** Due to a lesion in the Broca's Motor Speech Area (for e.g. occlusion of the artery supplying this area).
Patients understand every single word you say but are unable to express themselves by speech, i.e. they understand what they want to say but have

difficulty expressing themselves meaningfully through speech. That's why the first thing he is going to suffer from is severe depression.

** Both Borca's area and the upper limb region of (area 4) are the supplied by middle cerebral artery, so any obstruction of middle cerebral artery will affect both of them. That's why patients with motor aphasia usually have difficulty in writing as well.

CLINICAL CASE:
A patient was talking fluently and now he talks poorly and slowly, where is the lesion? In frontal lobe (inferior frontal gyrus) area 44, 45.

2. **Sensory/receptive (fluent) Aphasia:** Due to a lesion in the Wernicke's area which results in a total failure to comprehend spoken or written words. Usually patients are unaware of their defect; they are unaware of how they are speaking and do not realize their speech may lack meaning (fast speech with irrelevant phrases).
Wernicke's area is responsible for UNDERSTANDING spoken or written words, so it will receive its input from:
1. Association auditory area
2. Angular gyrus (area 39)→to understand what you read.

Output of Wernicke's area:
1. Broca's area (through arcuate fasciculus)
2. Hand skill area in premotor area (area 6): responsible for writing.

- When you are asked a question; if you want to answer by talking → the signal will go from Wernicke's area to Broca's area to muscles of speech. But if you want to answer by writing → the signal will go from Wernicke's area to the hand skills area.

❖ Although patient with sensory aphasia is fluent but he still has a problem in using nouns :

1. Circumlocution: instead of saying "I use a knife" he will say "I use the thing that you cut with" الدوران حول المعنى

2. Verbal paraphrasia: instead of saying "I use a knife" the patient will say "I use a fork" because the knife and fork are kind of related.
3. Phonemic paraphrasia: Instead of saying "knife and fork" he will say "bife and dork".

**people might think this patient is mentally retarded but he is not, he just has a lesion in his Wernicke's area.

❖ Angular gyrus (Area 39):

- It's important to understand what you READ and is found at the end of superior temporal sulcus.

- The LEFT angular gyrus is important for visual to auditory conversion (In order to understand what you read you need to convert visual input to auditory signals) whether you're reading in silence or reading aloud.

- INPUT:

1. Visual association area
2. Angular gyrus of the **opposite side**.

- OUTPUT: to Wernicke's area → Broca → motor areas → corticobulbar.

- Lesion in left angular gyrus will result in: Alexia or dyslexia; the patient cannot understand what he reads since there is no conversion from visual to auditory (he reads the words but doesn't understand them).

❖ ALEXIA:

Can be congenital (developmental) or acquired defect in the left angular gyrus; if it's congenital the patient will have difficulty to learn reading.

- Which functional areas of the cortex are required to read aloud?

  Optic nerve → optic chiasma → thalamus → optic radiation → primary visual area → association visual area [from association area on the right goes to association area in the left (the dominant hemisphere)] → left angular gyrus (to convert visual to auditory) → Wernicke's area (to understand the converted signals) → Broca → area 4 → corticobulbar → muscles of speech.

- Two causes of alexia:
  1) Lesion in the left angular gyrus (congenital OR acquired).
  2) Cutting part of corpus callosum (preventing the signal from going from right to left dominant hemisphere).

- Left Posterior parietal disease (Gerstman syndrome, angular gyrus syndrome):

  - If a lesion affected the left angular gyrus and a broad area around it; the patient will develop symptoms of alexia due to the lesion in left angular gyrus and the other symptoms reflecting the lesion of the surrounding area.

  - These additional symptoms include:

    1. Agraphia: inability to write.
    2. Acalculia: inability to do simple sums (2+2=4)
    3. Difficulty in distinguishing right from left
    4. Finger agnosia: inability to tell how many fingers are held up by the examiner.

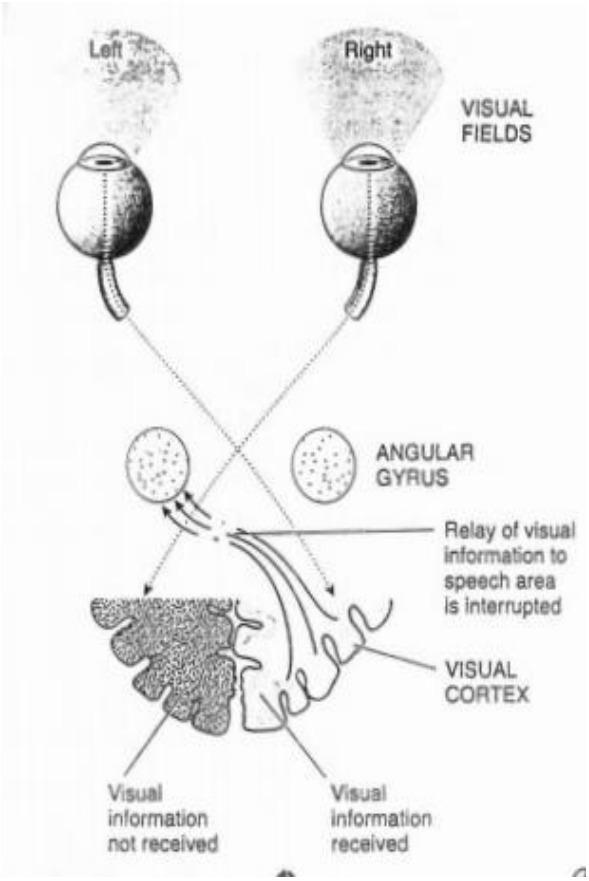
  - Patients with angular gyrus syndrome may be thought to have Alzheimer's disease, but when doing MRI we'll find that the lesion is in left angular gyrus and not in the hippocampus as in Alzheimer's.

- Acquired alexia:
  It's most commonly due to stroke and it is of two types:

  1. Pure alexia (without agraphia): can't understand what he reads, can write but doesn't understand what he writes (**pure word blindness**)

  In pure alexia, lesions are in wo regions:

  A) **Left primary visual cortex**: the left primary visual cortex receives input from the right half of visual field transmit it to the left visual association and left angular gyrus, but in this case the road is t between the left visual cortex and left angular gyrus. So the patient cannot understand what he reads from the right half of visual field.



  B) **Splenium of corpus callosum**: Input from the left half of visual field will go to the right visual cortex then through splenium of corpus callosum it will go to left angular gyrus. If the splenium of corpus callosum is damaged, the patient cannot understand what he reads from the left half of visual field as the way between the right visual cortex and left angular gyrus is cut.

  - Note that the splenium can be intact and the lesion could be in the occipito-temporal region that connects both al cortexes with the left angular gyrus (the anterior part of both visual cortexes).

2. Alexia and agraphia (parietal alexia):

The lesion is in the left angular gyrus itself. It involves alexia and inability to write, the patient can't understand what he reads and he also can't write. While in pure alexia he was able to write but unable to understand what he writes.

- Conductive aphasia:

- Lesion in the white matter deep to the cortex of supramarginal area (area 40) which is found at the end of lateral fissure. The lesion affects the area where the **arcuate fasciculus** passes; so there is cut in the way between Wernicke's area and Broca's area.

- Symptoms of conductive aphasia:

1) Wernicke's like aphasia (but this patient can comprehend)

2) The most important symptom that the patient cannot repeat what you say. When you say something for him to repeat (primary auditory → association auditory → Wernicke's **here the way is cut so can't reach the broca**

- A Patient with conductive aphasia can understand a little bit more than sensory aphasia patients.

- Conductive aphasia is usually accompanied by fascial apraxia.

- Apraxia:

- Inability to perform a task in the presence of normal motor power (no paralysis), he can hear, see, understand normally but he just can't understand the command.

- In other words: it's the inability to carry out any movement on command in the presence of normal cerebration.

-Two Types of fascial apraxia can accompany conductive aphasia:

1. Cut of the way between visual association and premotor area → to lower end of area 4. He can't respond to gestures but can respond to verbal commands.
2. Cut of the way between auditory association and premotor area, he can perform tasks given with gestures but not with verbal commands.

- Upper limb apraxia (hand apraxia): if you ask the patient to put a picture on the wall he can't because premotor area is damaged.

- Fascial apraxia or upper limb apraxia may occur in association of motor aphasia if the lesion is large enough to affect the premotor cortex.

○ Global aphasia:

- Extensive lesion by occlusion of main trunk of middle cerebral artery or the internal carotid artery affecting both areas; Broca's area anteriorly and posteriorly Wernicke's area.

- The patient cannot comprehend (due to the lesion in wrenick's area) or speak (due to the lesion in broca's area). He also has marked hemiparesis (due to the lesion in motor areas).

- If a patient has sudden onset of simple fluent aphasia without hemiparesis he most probably has sensory aphasia due to an **embolus** occluding posterior branch of middle cerebral artery or common carotid artery coming from the heart. We should give this patient anticoagulants before it becomes GLOBAL APHASIA (the worst type of aphasia).

- ## The importance of defining aphasia:

  - If the patient has fluent, non-fluent, receptive aphasia … etc we can identify that the lesion in the left cerebral cortex.

  - Also a patient coming with hand weakness and beginning of aphasia → lesion in the left cerebral cortex and not in the nerves of brachial plexus.

- ## Prognosis of aphasia:

  - The best prognosis → traumatic aphasia (aphasia after trauma of the head, the patient will recover).

  - The worst prognosis → global aphasia.

  1. Patients with global aphasia have poor prognosis and almost never recover completely.
  2. Patients with anomic and conduction aphasias have good prognosis and complete recovery occurs frequently.
  3. Broca's and Wernicke's aphasia patients have an intermediate prognosis and show wide range of outcome.

- ## Examination of aphasia:

  1. Listen to speech output: is it fluent or non-fluent?

     - If fluent the lesion is posterior, if non-fluent it usually is anterior.

  2. Can the patient read and write with no errors? if so → aphasia is NOT present.

  3. Is there hemiparesis? If so → the lesion is anterior involving motor area.

  4. In fluent aphasia check whether the patient can (repeat, comprehend, name):

     a. In Wernicke's (sensory) aphasia; he can't comprehend or repeat (in order to repeat he has to comprehend) but he names poorly.

b. Conduction aphasia: cannot repeat but can comprehend and name poorly.
c. Anomic aphasia (believed to be a lesion in left angular gyrus): can both comprehend and repeat, but has trouble with naming.

- Callosal syndrome:

- Note: Previously physicians were surgically cutting corpus callosum as a treatment of grand mal epilepsy to prevent the electrical focus to be transmitted from right hemisphere to left and vice versa. So if there is electrical focus in the right cerebral cortex the electricity will cause spasms in the left side of the body only, instead of affecting both sides, but this procedure is not done anymore.

- Callosal syndrome nowadays is only due to **ischemia** (the blood supply for corpus callosum is anterior cerebral artery).

- Only left hemisphere can communicate through speech or writing.

- Cut of corpus callosum (the splenium for example) will result in:

1. Left Hemialexia: the patient is unable to read material presented to the left visual field while in the right visual field he can read and write.

   - Explanation: input from left visual field → right visual cortex → **splenium of corpus callosum** → left angular gyrus. While the right visual field goes to left visual cortex and directly to left angular gyrus (no need for corpus callosum).

2. Unilateral (left) tactile anomia:Cannot identify and describe what is put in the left hand with closed eyes. When he closes his eyes, I put a key in his left hand he can't describe it.

   - Explanation: sensation from left hand to right somatic sensory cortex to association sensory cortex (he sensed the key) but the signal can't be

transmitted to the left hemisphere (left angular gyrus) due to damaged corpus callosum so he can't describe it. If you put the key in this his right hand, it will go to left somatosensory cortex, there is no need for corpus callosum he can speak and describe the key.

Good Luck!