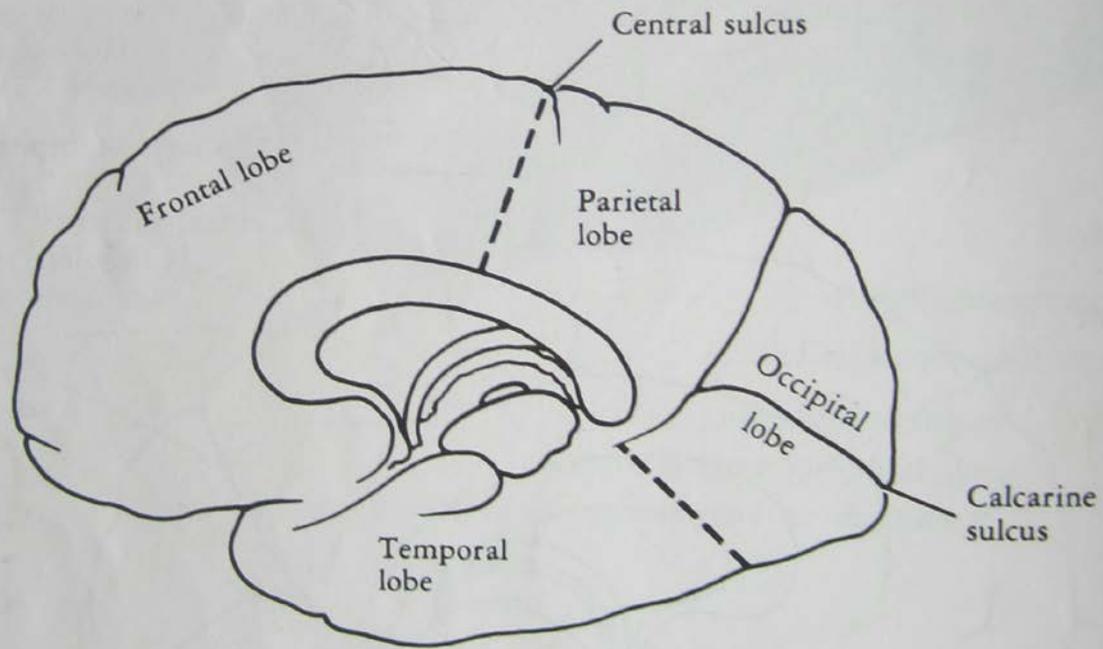
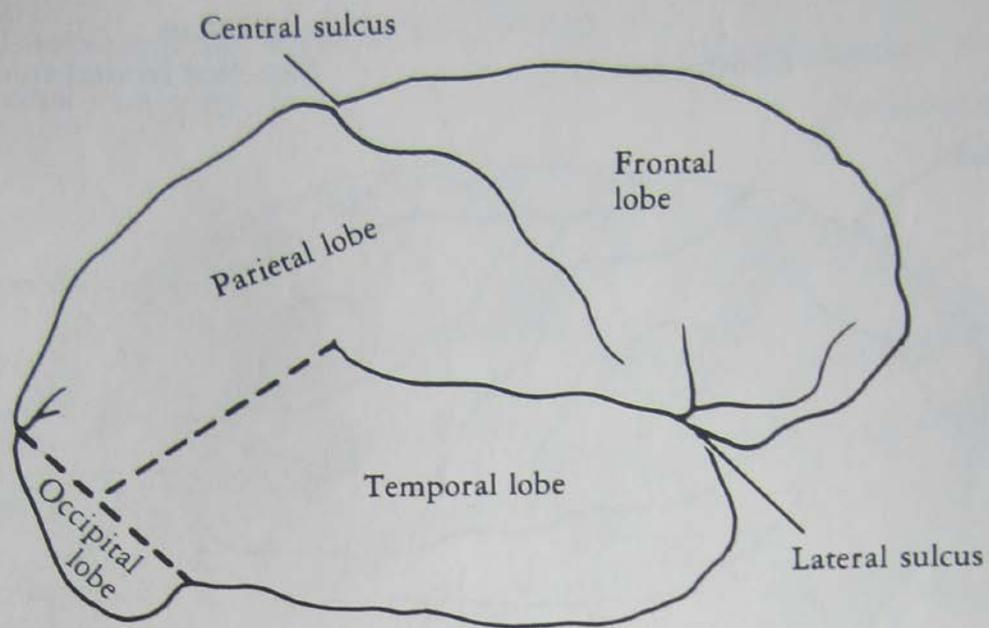


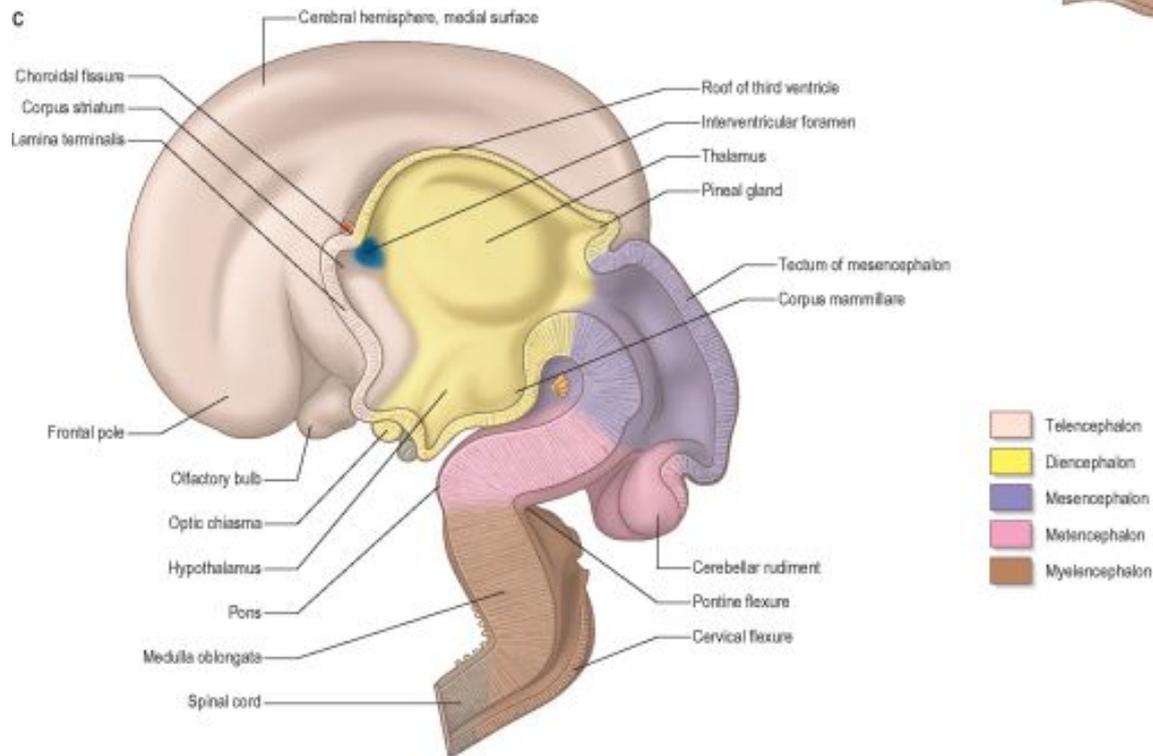
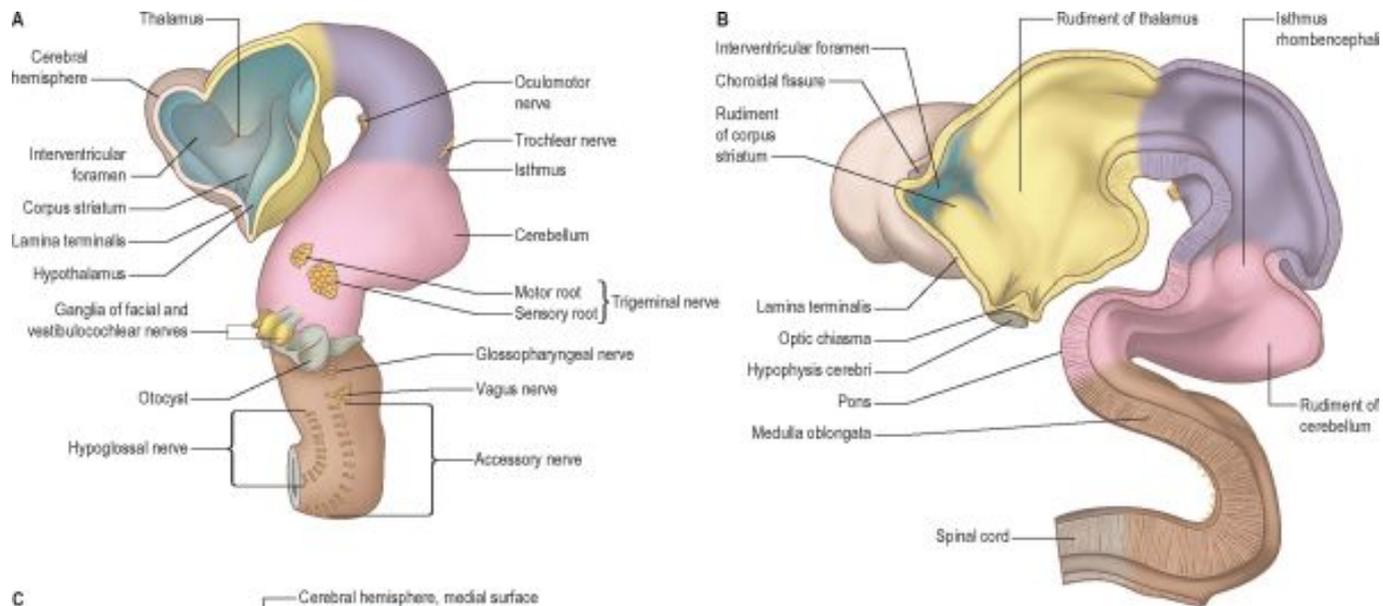
Frontal Lobes

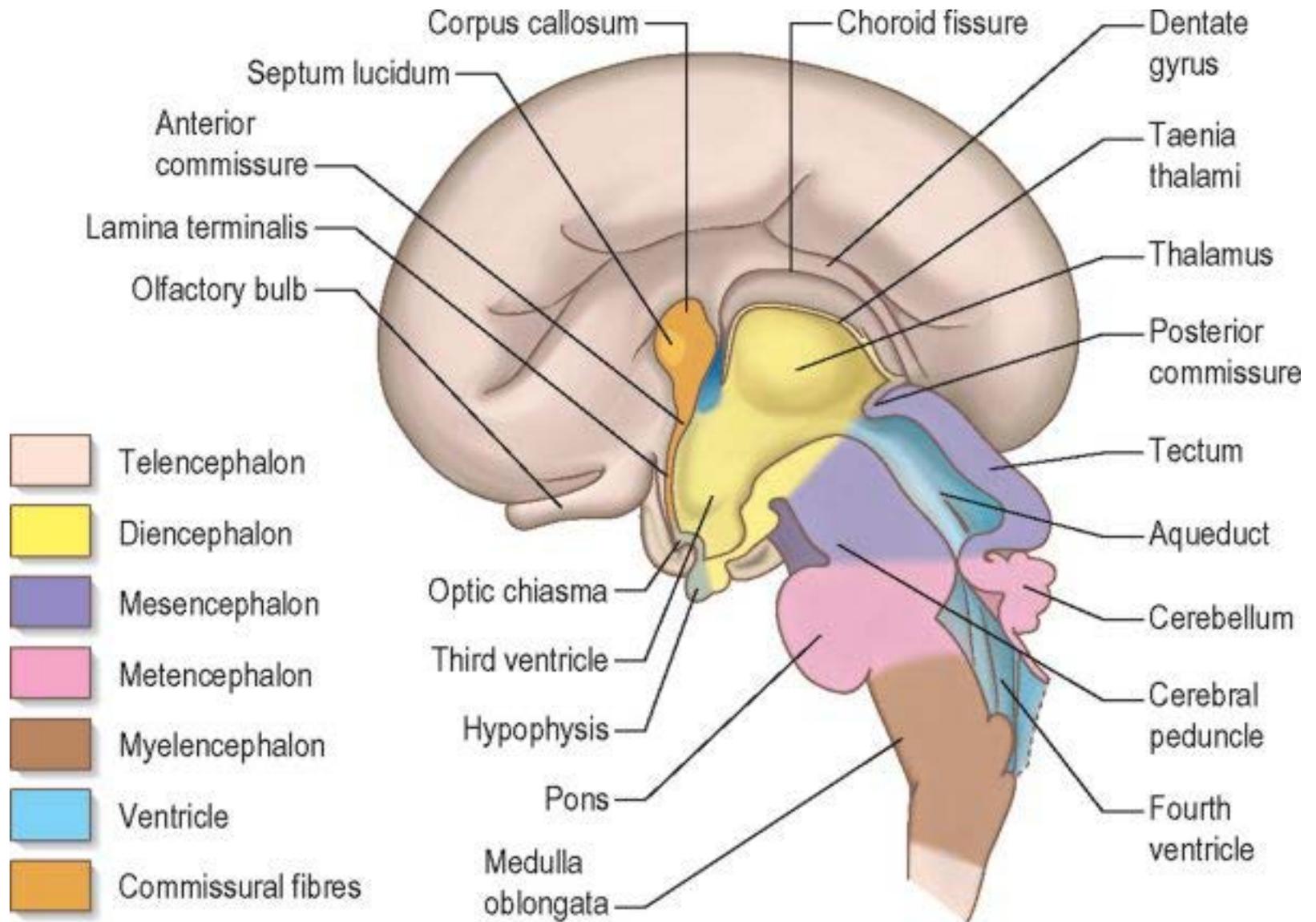
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Malay Dave



Origins

- Man v/s Apes
- 16 weeks of gestation
- Prosencephalon
 - Telencephalon & Diencephalon
- Telencephalon – Frontal Lobes, 50% Of Total Volume
- Neuronal Migration – Glial networks
- Genetically determined
- Neocortex
 - 6 layers of cellularity / columnar arrangement





A



21 weeks

B



24 weeks

C



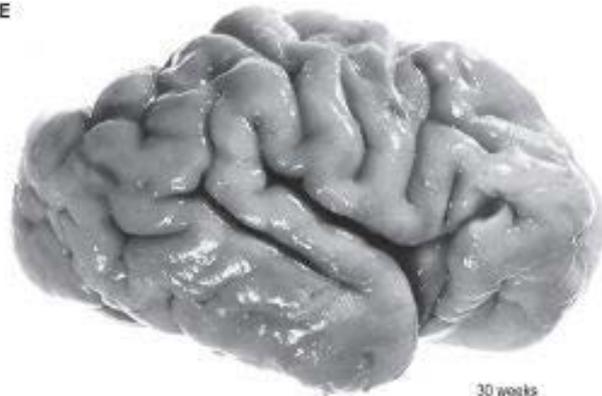
26 weeks

D



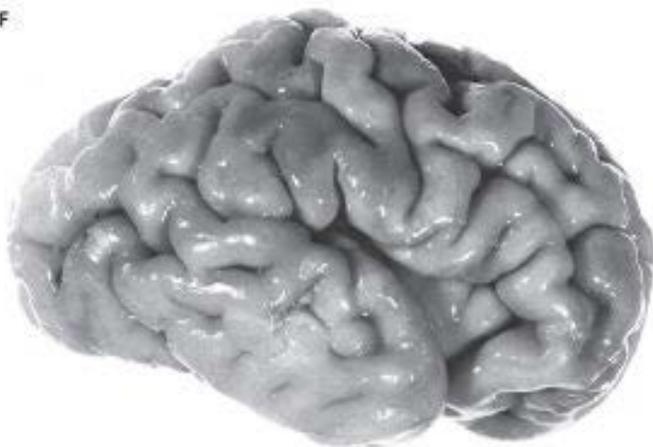
28 weeks

E



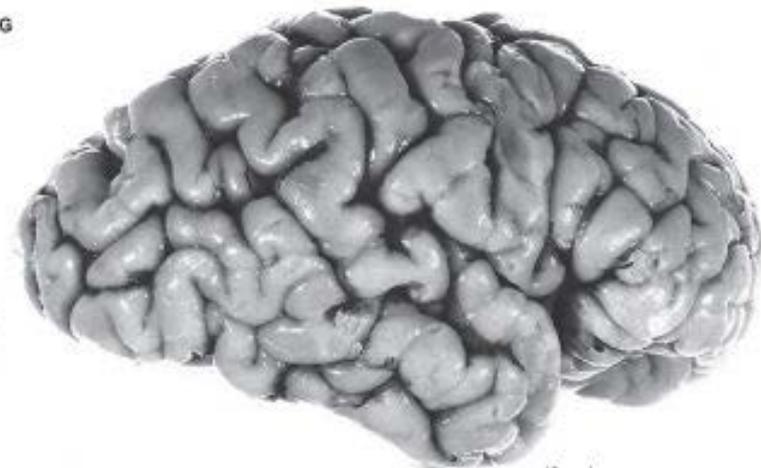
30 weeks

F

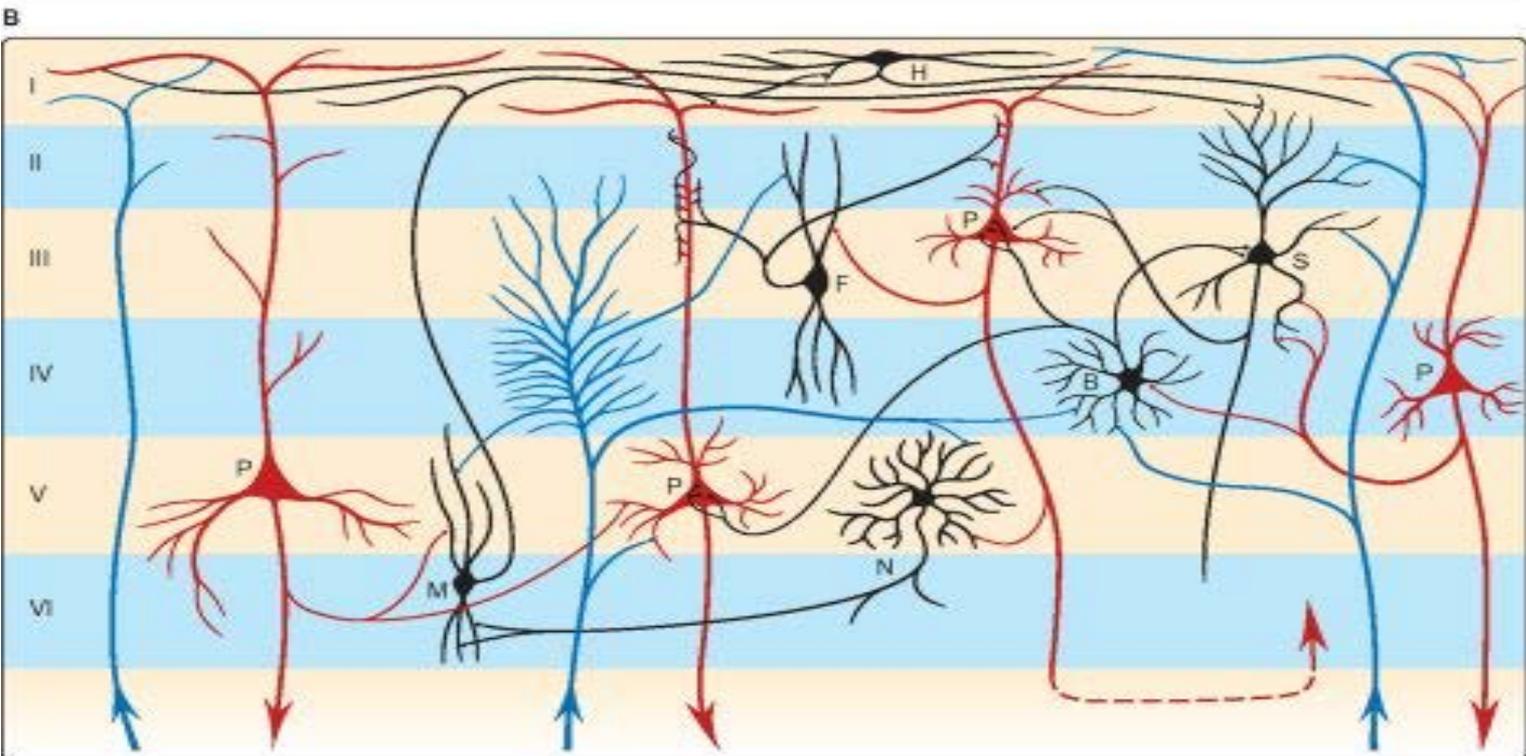
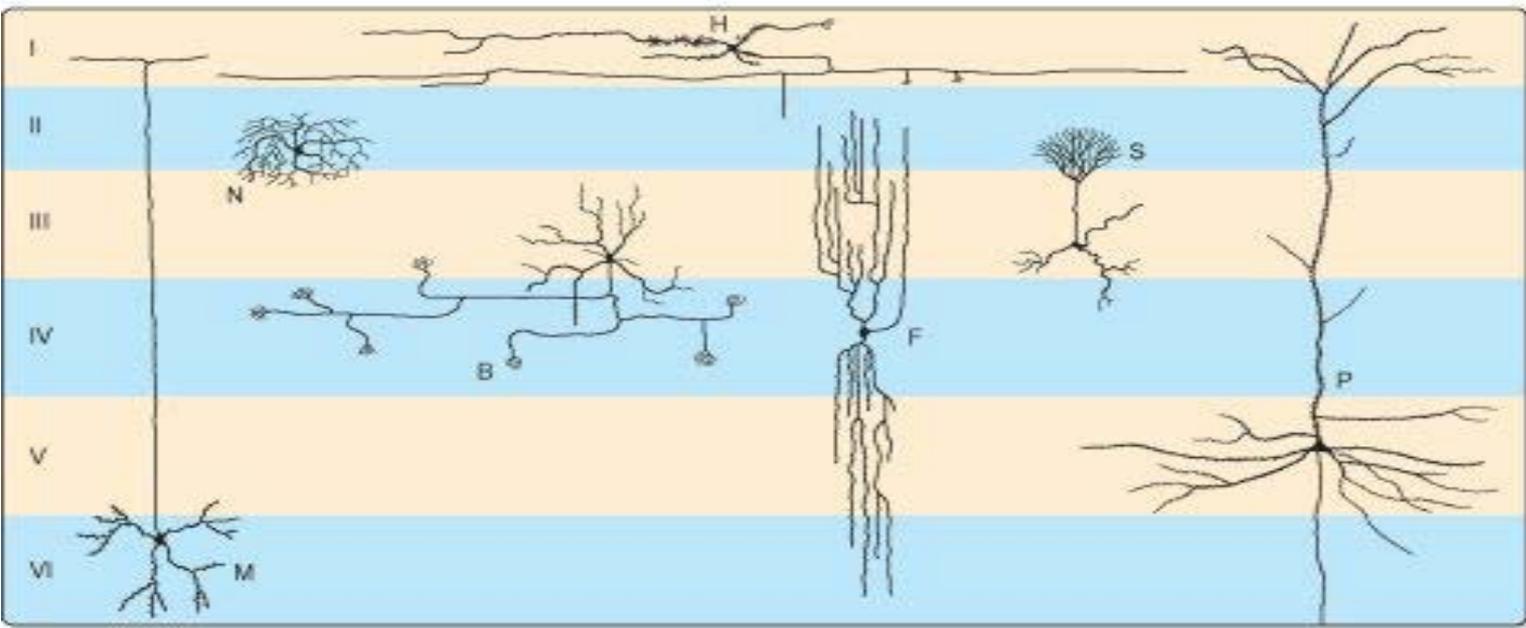


34 weeks

G



40 weeks

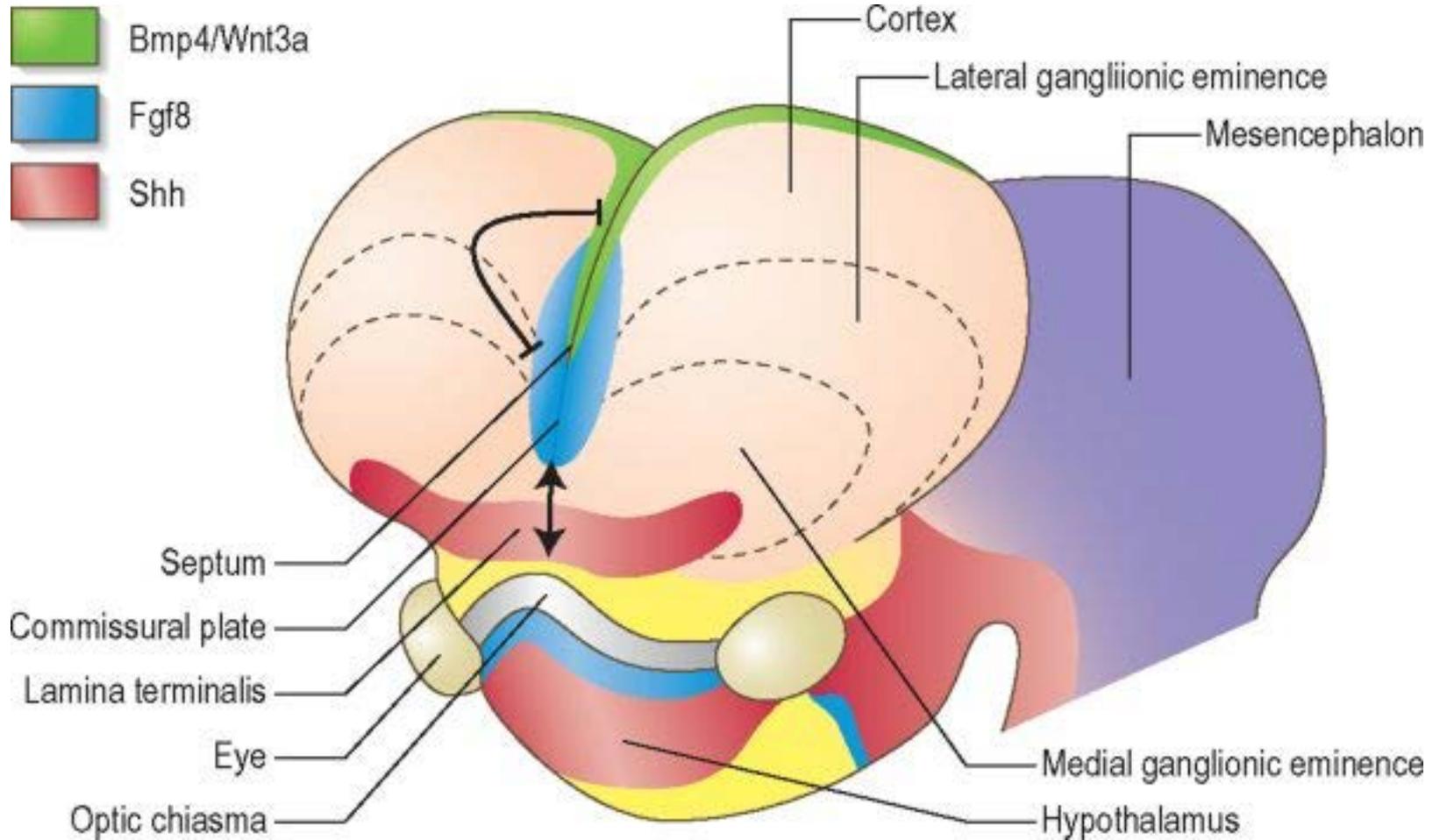


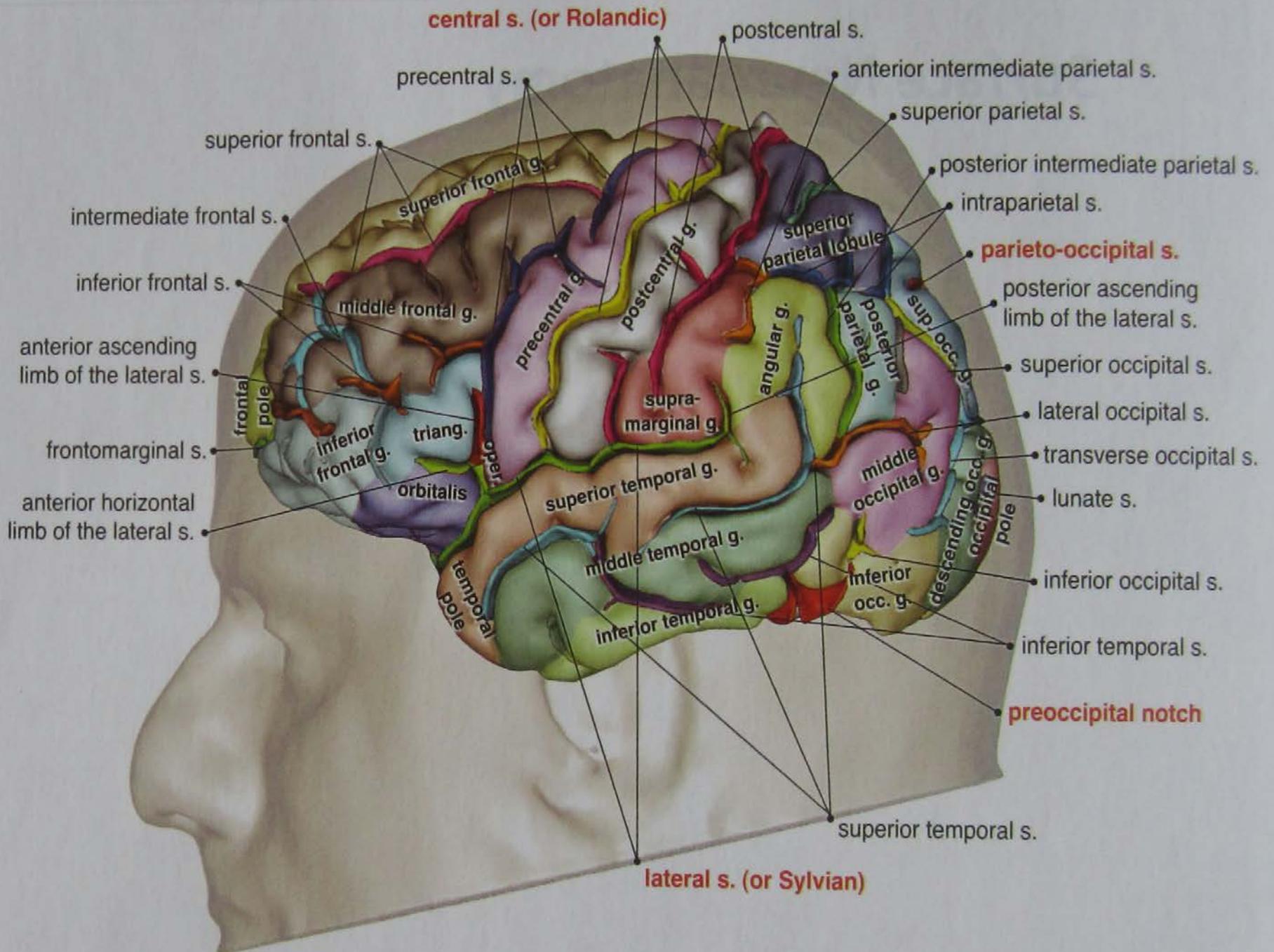
— Afferent fibres
— Efferent neurones
— Neurones limited to cortex

Neurone types:

- B Basket
- F Fusiform
- H Horizontal
- M Martinotti
- N Neurogliaform
- P Pyramidal
- S Stellate

Genetic Control Of Development





central s. (or Rolandic)

postcentral s.

precentral s.

anterior intermediate parietal s.

superior frontal s.

superior parietal s.

intermediate frontal s.

superior frontal g.

posterior intermediate parietal s.

inferior frontal s.

middle frontal g.

precentral g.

postcentral g.

superior parietal lobule

intraparietal s.

parieto-occipital s.

anterior ascending limb of the lateral s.

frontal pole

inferior frontal g.

orbital

triang.

operc.

supra-marginal g.

angular g.

posterior parietal g.

sup. occ. g.

posterior ascending limb of the lateral s.

superior occipital s.

frontomarginal s.

lateral occipital s.

anterior horizontal limb of the lateral s.

superior temporal g.

middle occipital g.

transverse occipital s.

lunate s.

temporal pole

middle temporal g.

inferior temporal g.

inferior occ. g.

descending occipital g.

occipital pole

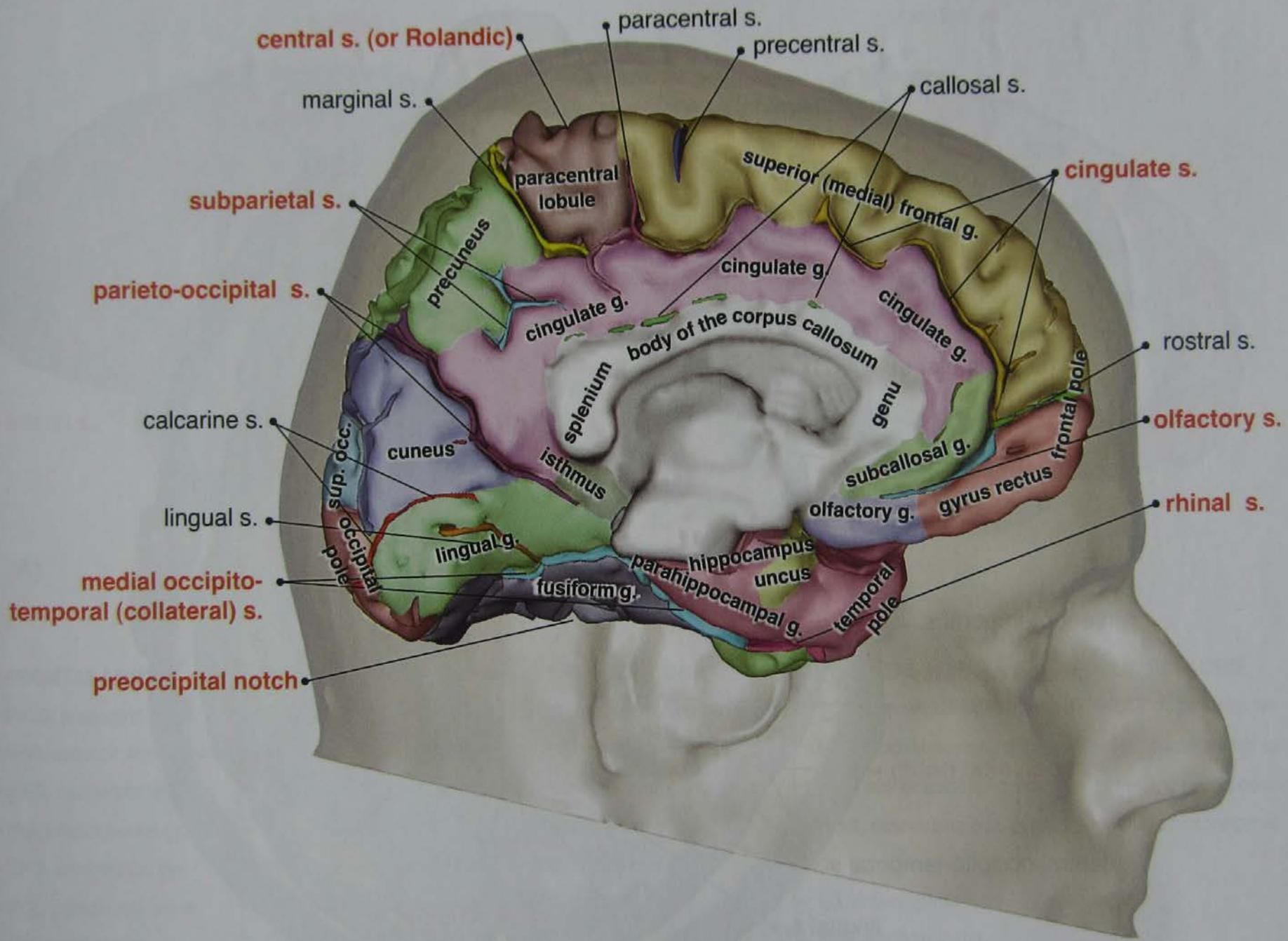
inferior occipital s.

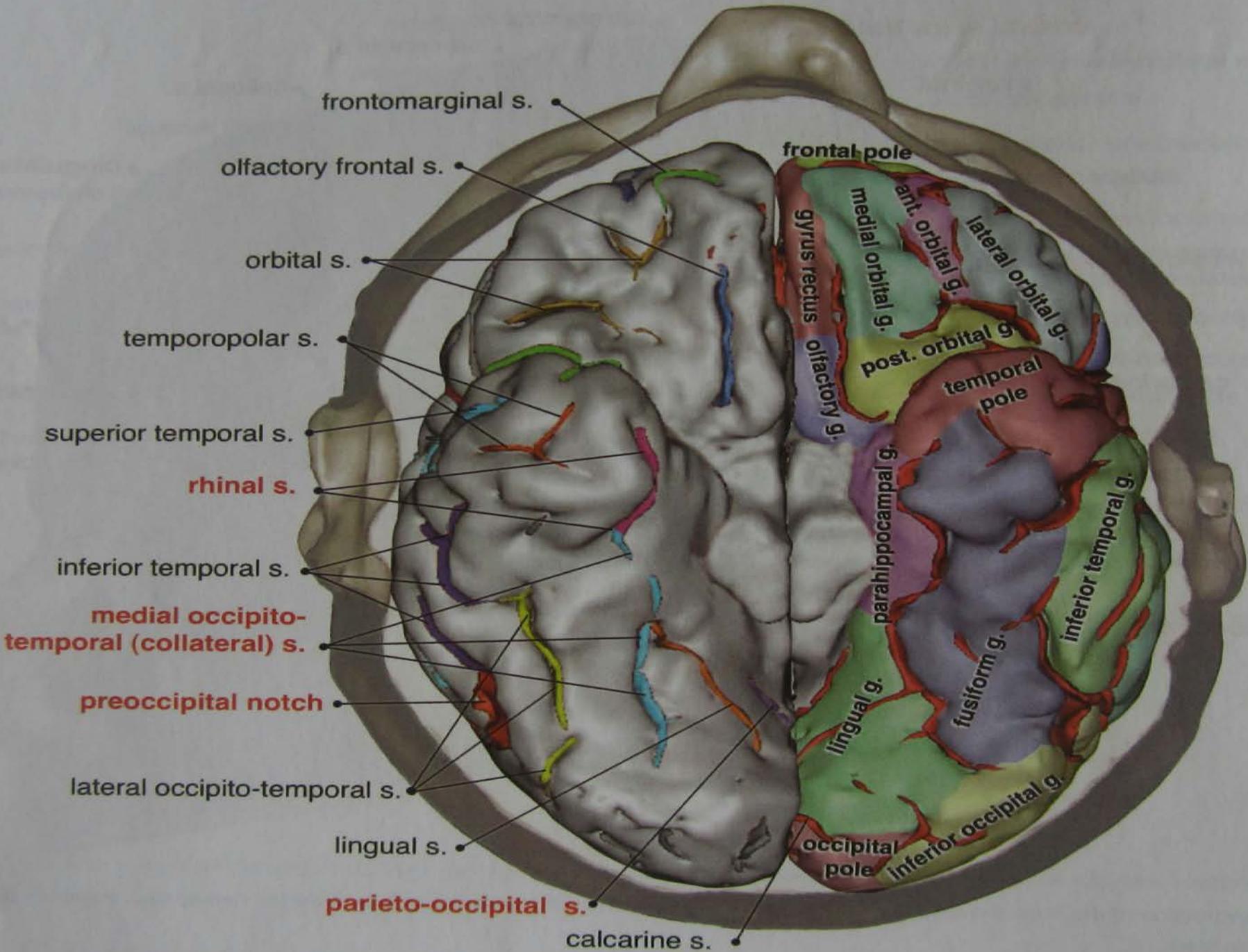
inferior temporal s.

preoccipital notch

lateral s. (or Sylvian)

superior temporal s.





Major Areas

Area 4: Primary Motor Area – Corticospinal Projection
Fibres

Area 6: Premotor Cortex (Lateral), Supplementary
Motor Area (Medial)

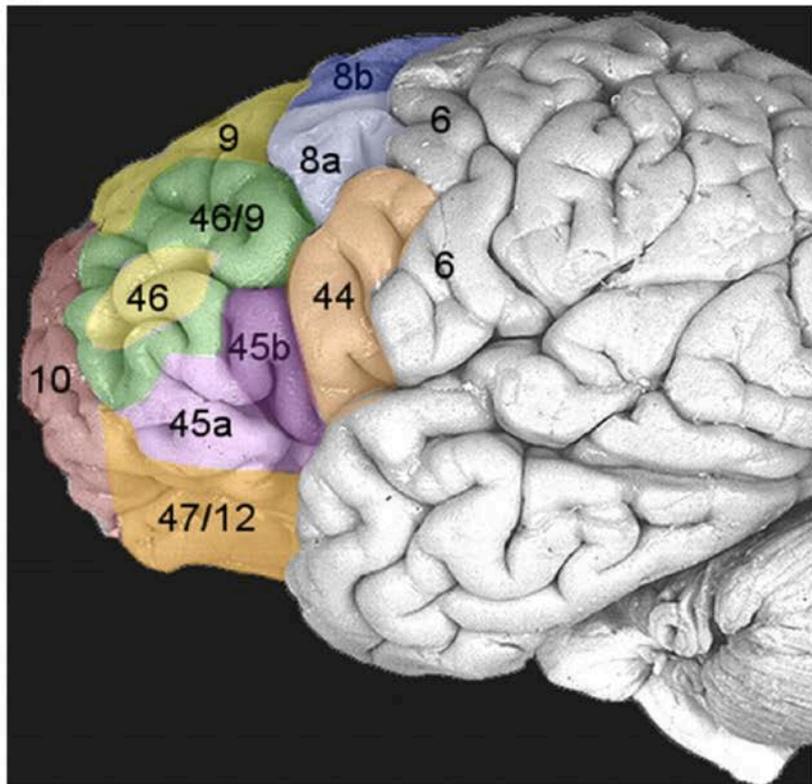
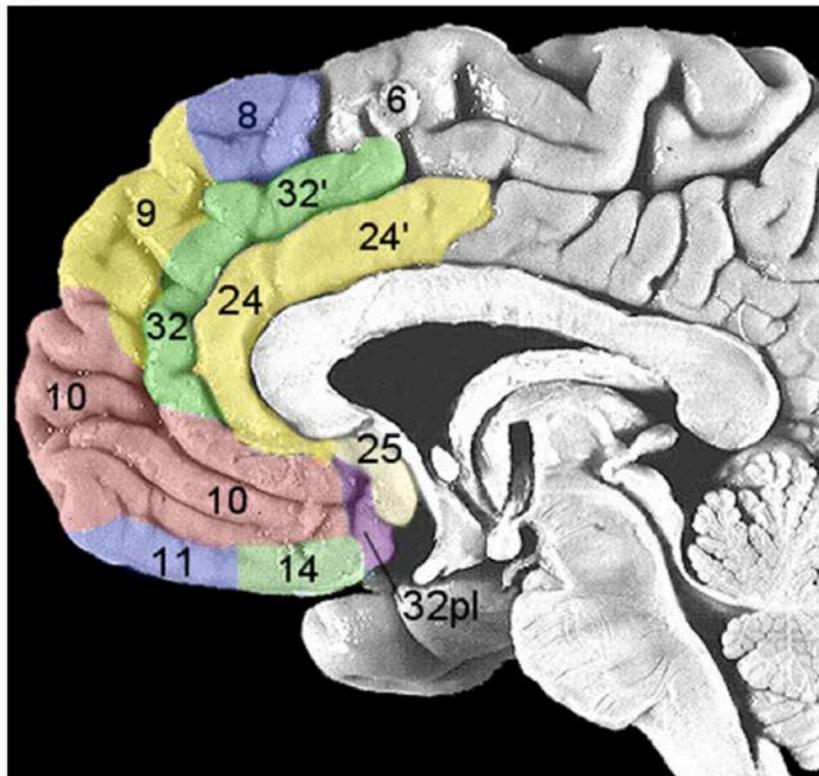
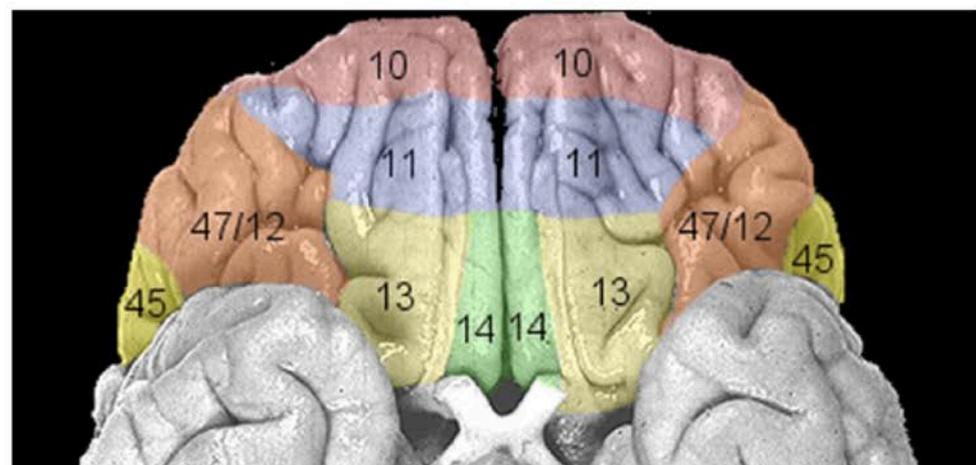
Areas 44, 45: Broca's Area

Areas 8, 9, 10, 46: DLPFC

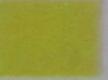
Area 47: VLPFC

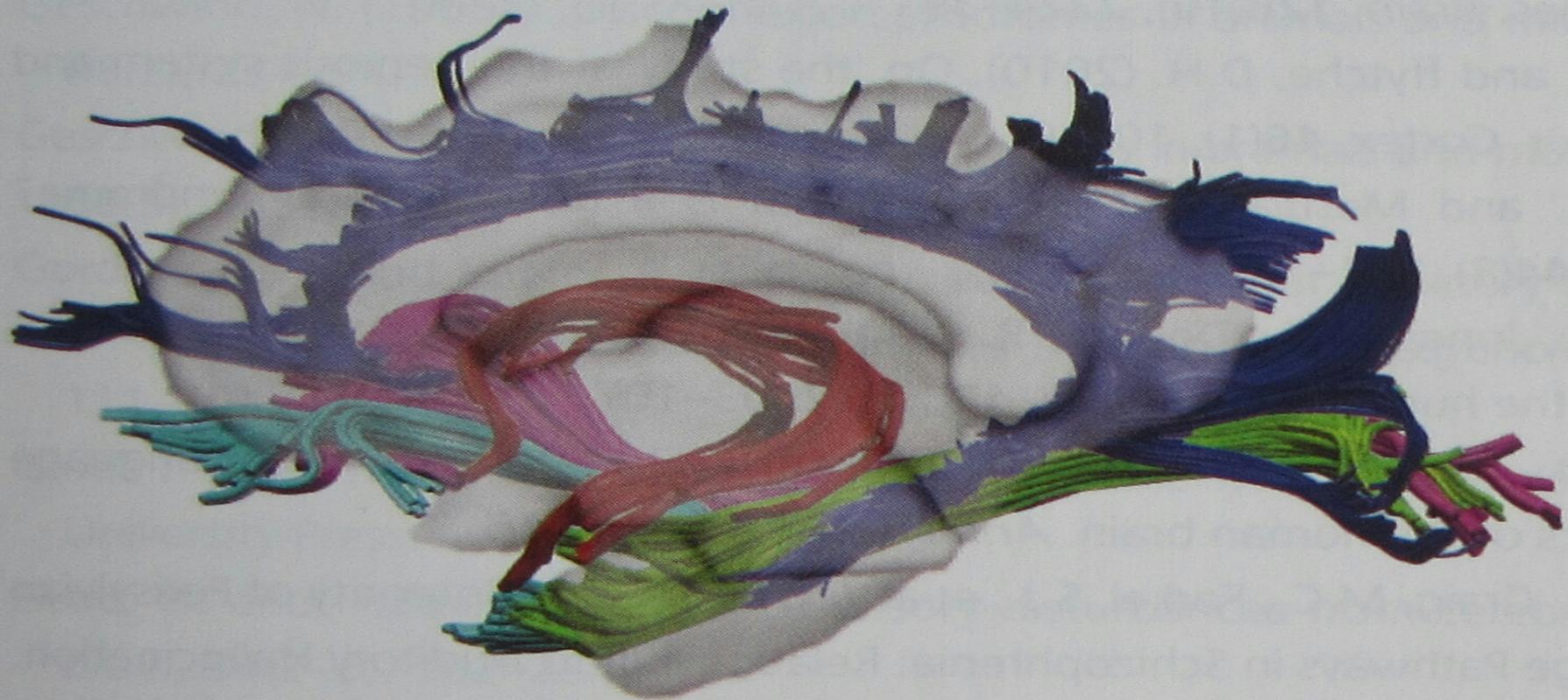
Areas 11, 47: OFPFC

Areas 6, 8, 9: Frontal Eyefields

A**B****C**



- | | | | | | |
|---|-------------------|---|-----------------|---|-----------------|
|  | AS/SLF III |  | Uncinate |  | Cingulum |
|  | LS |  | IFOF |  | SLF I |
|  | SLF II | | | | |



Cingulum



Uncinate



IFOF

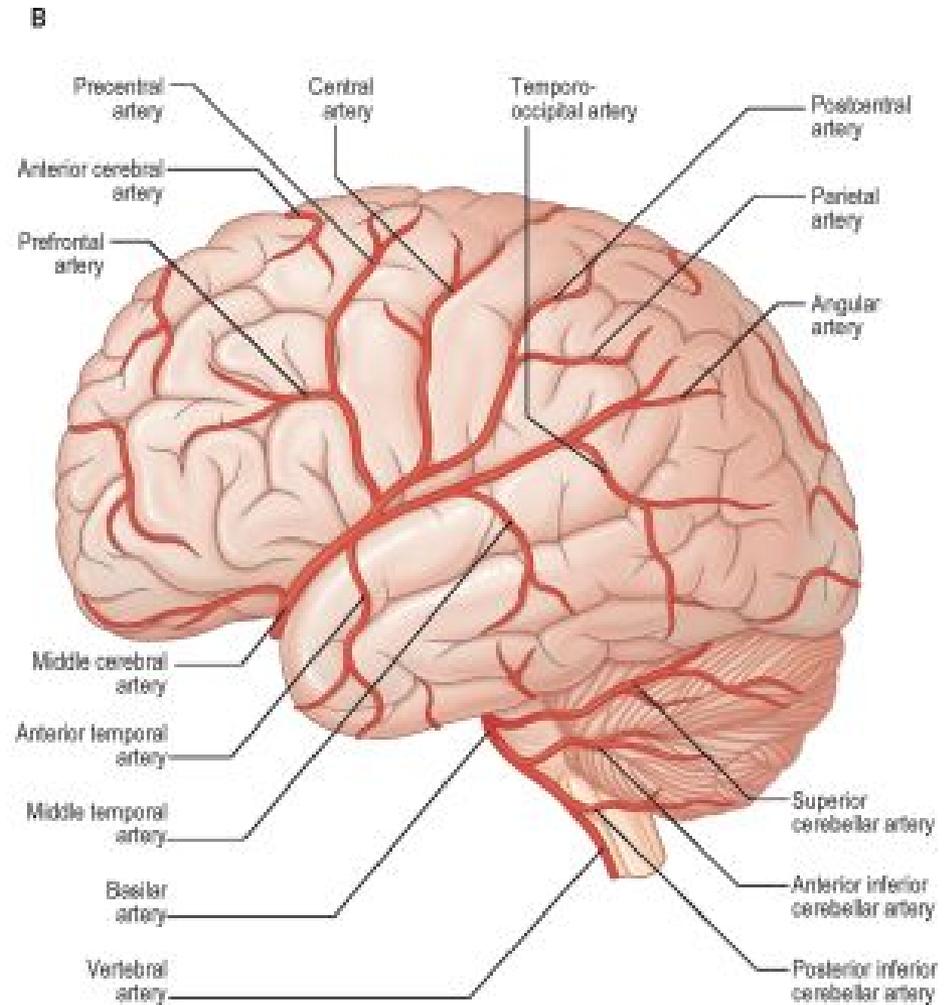
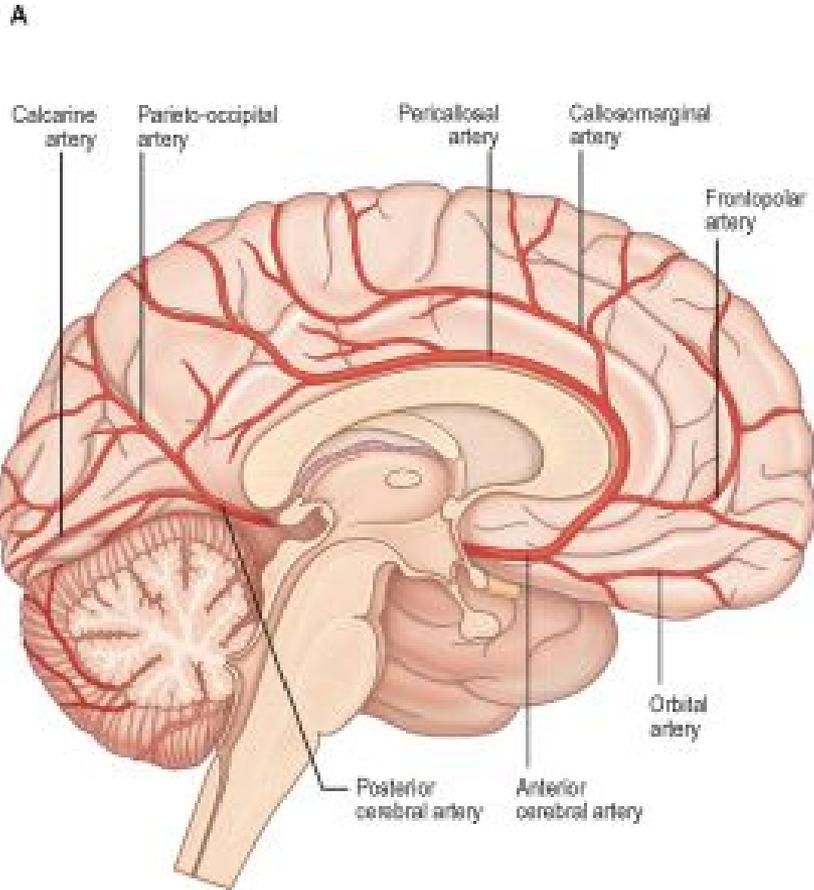


Fx

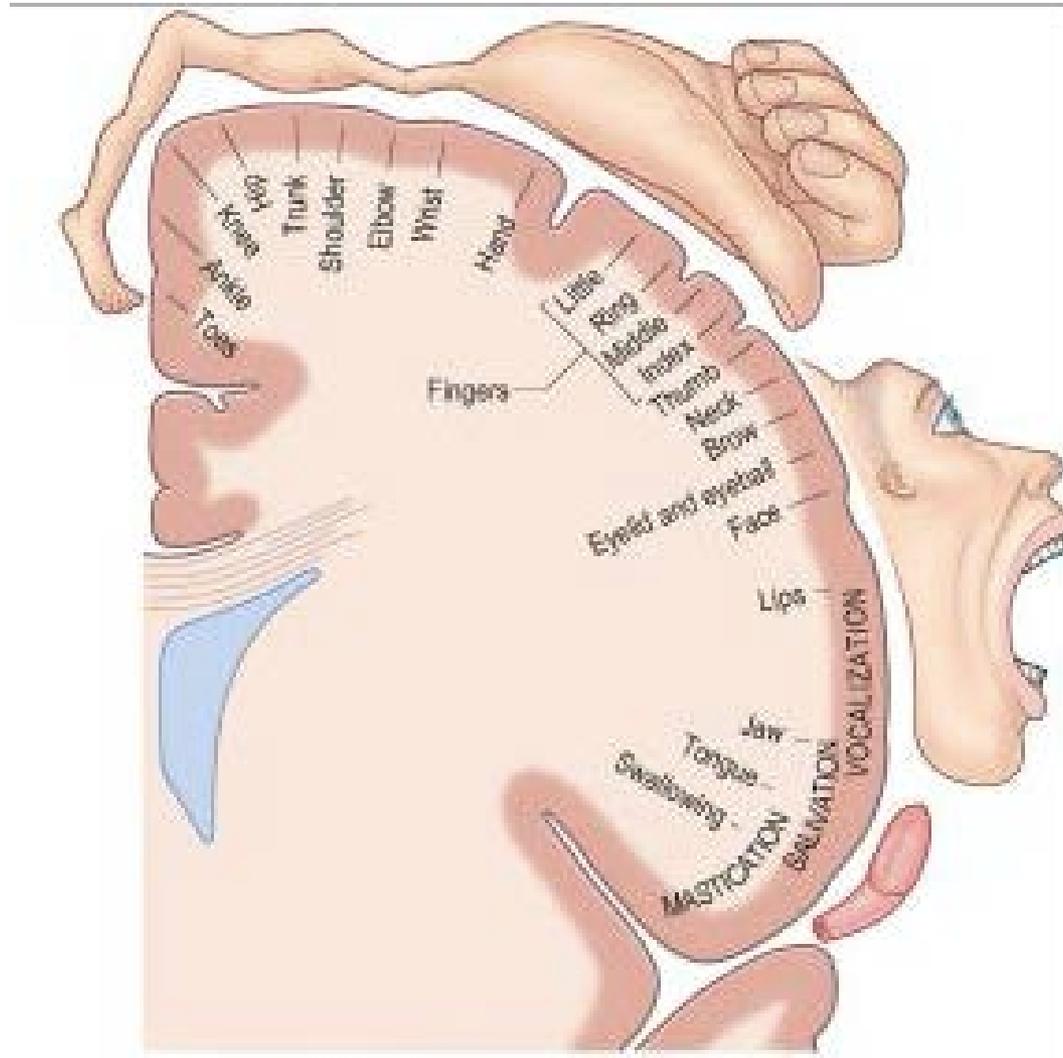


ILF

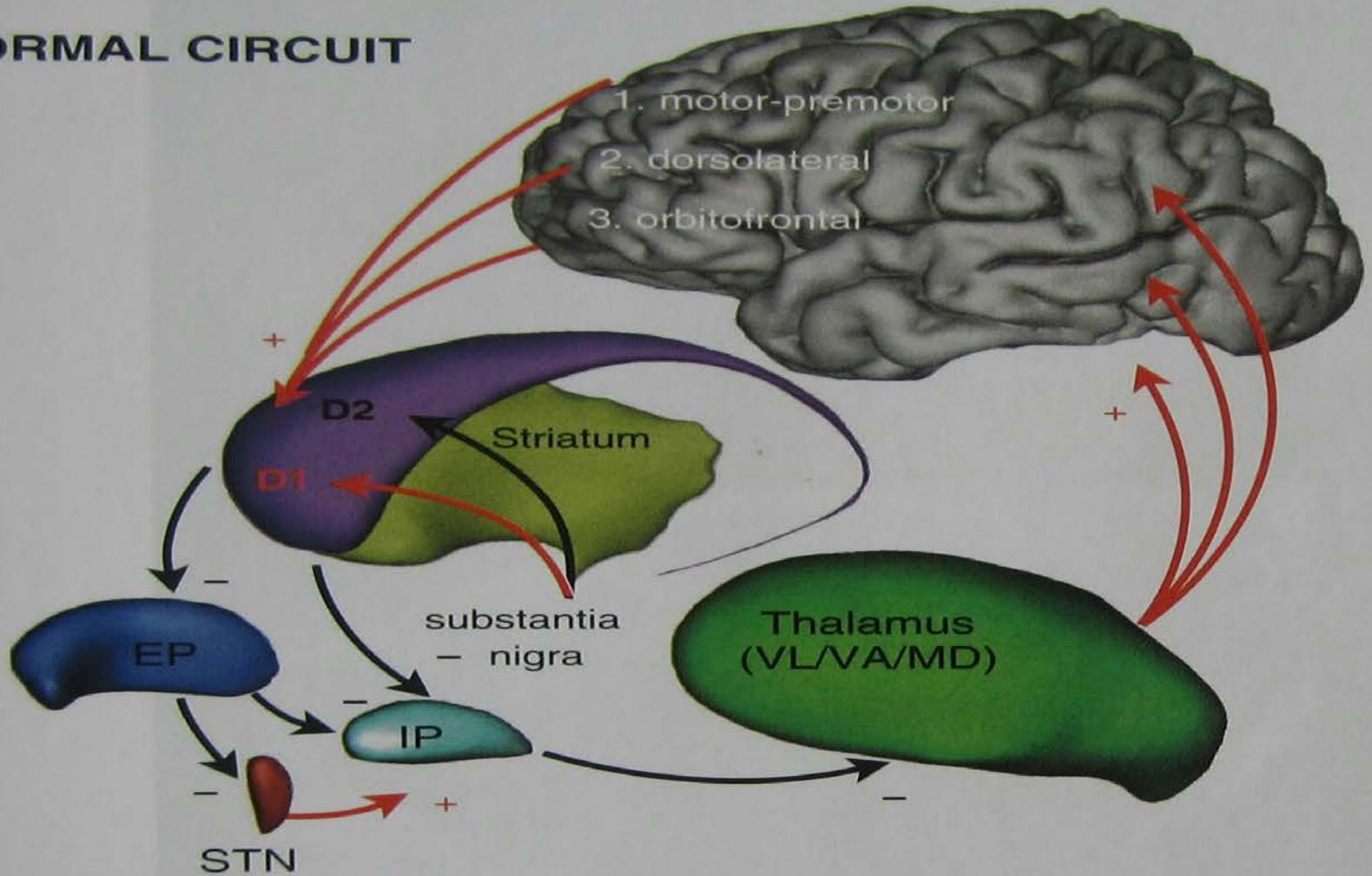
Blood Supply



Motor Homunculus



NORMAL CIRCUIT



STN, subthalamic nucleus

EP, external pallidum

IP, internal pallidum

D1-D2 dopamine receptors type 1 and 2

← excitatory projections

← inhibitory projections

←... projections primarily affected

The 5 Frontal - Subcortical Circuits

- Motor circuit originating in the motor cortex and pre-motor cortex – PD, Huntington's Disease
- Oculomotor unit originating in the frontal eye fields
- Dorsolateral prefrontal circuit, which underpins executive functions
- Anterior cingulate circuit which underpins motivation
- Orbitofrontal circuit which underpins impulse control and social behavior – Involves NA (295, OCD, SUD)

Direct Loop

Increased Thalamic Activation (+ Feedback)

Indirect Loop

Reduces Thalamic Activation (- Feedback)

Dopaminergic Regulation (VTA)

The Motor Syndrome

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Sachin Baliga

Case 1

A 52 year old man, known case of diabetes and hypertension was brought in an unconscious state to the casualty. On examination, his right upper and lower limbs were hypertonic and Babinski's sign was present.

On checking his eyes, it was found that turned towards the left side on turning his head to the right. However, they continued to look to the left even after turning his head to the left.

- 1. Which circuits are involved in this case?**
- 2. What other tests would you like to do?**
- 3. What other features will you look for?**

Motor Syndrome

Primary Motor Cortex

- Contralateral Limbs & Face
- Apraxia of Left Arm & Face (Arcuate Fasciculus – Anterior Segment)
- Gaze abnormalities – Frontal Eyefields
- Anarchic Hand Syndrome – Medial Frontal Lobe & its Callosal / Intralobar Connections)
- Jacksonian March

Primary Motor Cortex

Bedside Tests

1. Motor strength of hand grip
2. Motor speed as in finger tapping
3. Detailed CNS examination

The Premotor Cortex

Bedside Tests

1. Sensorimotor abilities are tested by asking the patient touch each finger to the thumb in succession as rapidly as possible. Watch for speed and dexterity.
2. Apraxia can be tested by asking the patient to "blow a kiss" and to demonstrate the use of a shovel.

The Frontal Eye Fields

Bedside Tests

1. Ask the patient to follow the movement of a finger from left to right and up and down.
2. Ask the patient to look from left to right, up and down (with no finger to follow).

Cognitive Functions Of The Frontal Lobe

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VIDYA GIRI SHANKAR

A 53 year old professor received a severe head injury while rock climbing. While ascending, his companion's ice axe fell from his belt and struck the professor's head causing a depressed fracture of the frontal bone. After convalescing from his accident, the professor returned to his work. Soon it became evident that the professor's social behavior had changed dramatically. Previously a smartly dressed man, now had an unkempt appearance. His lectures, although amusing, had lost direction.

He failed to organize and plan his day and the organization of the department rapidly deteriorated. Finally, he was removed from the office after being found one morning urinating into the trash can of the classroom.

- 1. What is the circuit involved in this case?**
- 2. What are the other features to look for?**
- 3. How do we assess this region at the bedside?**

Circuits

- Information regarding **external environment** via long hemispheric white matter tracts connecting DLPFC to **posterior sensory association cortex**
- Information regarding **emotional state** from **limbic system** via short association fibres from the adjacent cingulate and orbital cortex
- Information regarding **internal milieu** from projections from the **hypothalamus**

Cognitive Syndrome

DLPFC

- Memory Deficit
- Altered Serial Motor Sequencing
- Poor Response Inhibition
- Impaired Cognitive Estimation
- Impaired Abstract Thinking
- Impaired Executive Functioning
(Planning, Rule Learning, Focusing, Hierarchical Organization, Switching, Monitoring)

Cognitive Syndrome (Contd)

- Motor Perseveration

Lateralization

Right Inferior Frontal Gyrus

- Meaning, Emotions through Speech Intonation, Stress, Rhythm & Gestures (Anterior Affective Prosodia)
- Unilateral Neglect

Left Inferior Frontal Lesions

- Broca's Aphasia

Dorsolateral Prefrontal Cortex

Bedside Tests

1. Is the patient able to make an appointment and arrive on time?
2. Is the patient able to give a coherent account of current problems and the reason for the interview? Is there evidence of thought disorder?
3. Digit span, days of the week or months of the year backwards. Here the patient has to retain the task and simultaneously manipulate information.

4. **Controlled Oral Word Association Test (COWAT)**

The patient is asked to produce as many words as possible, in one minute, starting with F, then A, then S.

Proper nouns and previously used words with a different suffix are prohibited.

Other categorical fluency tests include naming animals, fruits and vegetables.

For a formal result, it is necessary to test under strict conditions, using norms. However, valuable information may be obtained without formal testing. Generally, a normal individual will be able to provide more than ten items for each of these categories, while a patient with significant deficits will usually score less than eight. The performance of the task will also provide valuable information. Common errors include perseveration (repeating words which have already been given either during the task at hand or an earlier task). There may also be inappropriate or profane utterances.

5. Alternating Hand Sequences

These can be devised by the examiner. One example is that one hand is placed palm upwards and the other is placed palm downwards, and the patient is then asked to reverse these positions as rapidly as possible.

Another example is that the backs of the hands are both placed downwards, but one hand is clenched and the other is open, then the patient is asked to close the open hand and open the closed hand, and keep reversing the posture of the hands as rapidly as possible.

A final example is that the patient taps twice with one fist and once with the other, then after the rhythm is established, the patient is asked to change over the number of beats (the fist which first tapped twice now taps only once).

Patients with frontal lobe deficits usually perform poorly on these tests, often being unable to follow the relatively simple instructions.

Psychological testing

- **Wisconsin Card Sorting Test (WCST)**

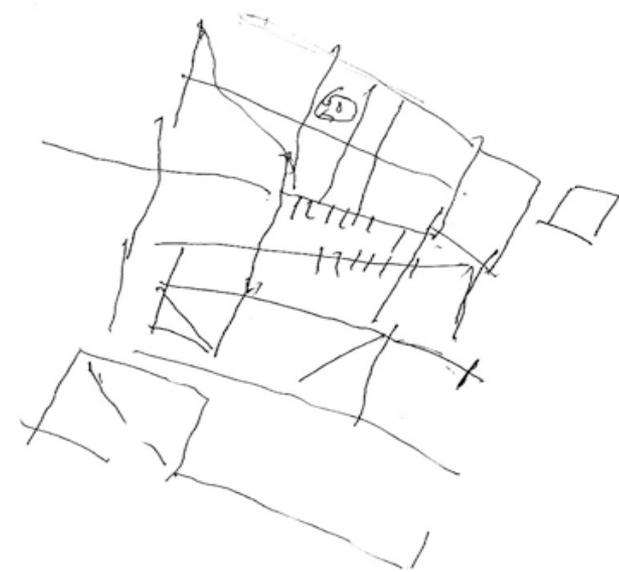
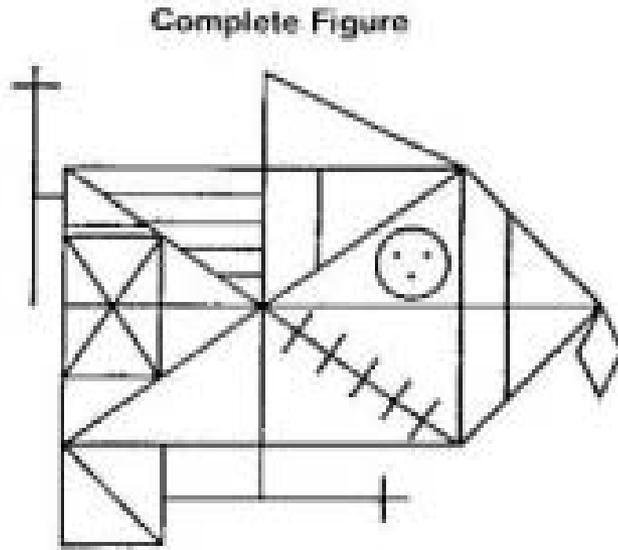
There is a difficulty in altering set in response to changing contingencies ie they maybe unable to change the set when necessary exhibiting Perseveration.

- **California Verbal Learning Test**

This is to assess the learning strategy of the patient. Does the patient semantically cluster words which is observed in normal individuals.

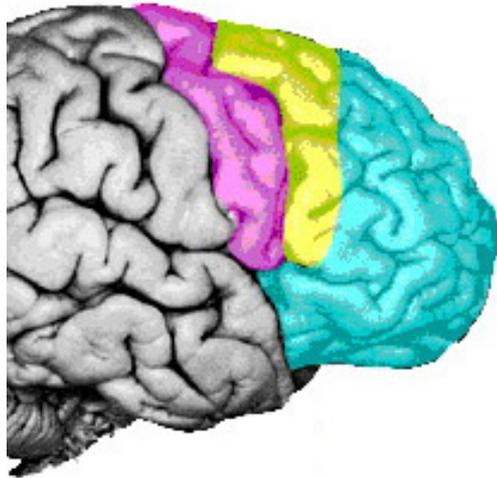
Learn a list of 16 words - 4 groups of 4 related words (eg. fruits, tools)

- Rey - Osterrieth Figure or Taylor Figure

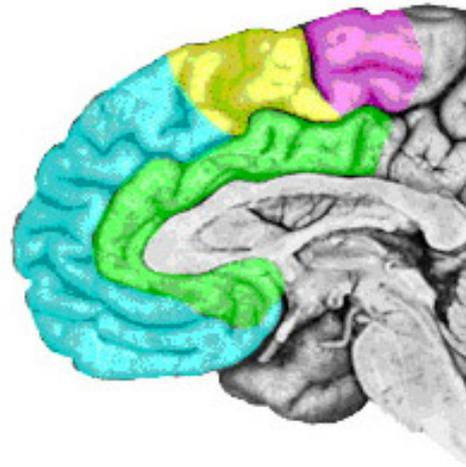


Abulic
&
Behavioural Syndromes

Pragya Sharma



-  Motor
-  Premotor
-  Prefrontal
-  Limbic



Case 3

- 40 years old with h/o head injury in RTA – 8 months back was brought by family members with c/o not speaking, decreased interest in daily activities, indifference and inability to move.
- On examination, power of the limbs – 5/5.
- ROR –reported impoverished thinking.
- **What is the circuit involved in this case?**
- **What are the other features to look for?**
- **How do we assess this region at the bedside?**

Abulic Syndrome

Medial PFC, Anterior Cingulate Cortex (Cognitive Symptoms)

- Apathy
- Affective Blunting
- Decreased Engagement With Usual Activities
- Lack Of Curiosity & Interest In Learning
- Impoverished Generative Thinking
- Reduced Ability To Sustain Effort
- Limb Akinesia, Mutism (Posterior MPFC)

Anterior Cingulate Cortex

No bedside or neuropsychological tests

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Case 4

- 25 years old man, had an accident with a crow bar piercing his left cheek and coming out of the head just behind his hairline. When the patient was brought to hospital, he was conscious and able to recount his colleagues names.
- However, after recovering from the injury his family members noticed that, he was no more the same man. He had become very irritable and aggressive.
- **What is the circuit involved in this case?**
- **What are the other features to look for?**
- **How do we assess this region at the bedside?**

Behavioural Syndrome

OFC

Personality Changes

- Disinhibition, Social Inappropriateness, Sexual Preoccupation

Automatic Motor Behaviour

- Imitation, Grasping, Utilization

Neuropsychiatric Changes

- Lack Of Empathy, Impulsivity, Distractibility, Emotional Lability, Depression, Mania & Hypomania

Infrequent Cognitive Symptoms

Disorders Of The OF – Amygdala Division

- Kliver – Bucy Syndrome

Emotional Placidity, Hyperorality, Hypermetamorphosis, Altered Dietary Preferences, Increased Sexual Activity, Visual Agnosia

- Temporolimbic Epilepsy
- Personality Changes

Orbitofrontal Cortex

Bedside Tests

1. Does the patient dress or behave in a way which suggests lack of concern with the feelings of others or without concern to accepted social customs.
2. Test sense of smell - coffee, cloves etc.

3. Go / No-Go Test

The patient is asked to make a response to one signal (the Go signal) and not to respond to another signal (the no-go signal). The most basic is to ask the patient to tap their knee when the examiner says, "Go" and to make no response when the examiner says, "Stop".

The task may be made more demanding by reversing the customary meaning of signals. An example is to ask the patient to tap the knee when the examiner says "Stop" and not to tap when the examiner says "Go" .

4. The Stroop Test

This is a neuropsychological test which examines the ability of the patient to inhibit responses. Patients are asked to state the color in which words are printed rather than the words themselves, e.g., truck may be printed in blue, house may be printed in red.

This task is made difficult by presenting the name of colors printed in different colored ink. The task is to state the color of the ink, not to read the word. This is not as easy as it sounds. Try it now. Do it quickly, to increase the pressure.

Frontal Release Reflexes

- The primitive reflexes are present in normal babies. As the CNS matures, frontal lobe cells develop and begin to inhibit. These may reappear with brain damage or disease - they may also reappear with normal aging. Their significance is greater when they appear unilaterally and in young individuals (Ross, 1985).

Grasp

- The hand is stroked across the palm toward the thumb by the examiners fingers or the handle of the patella hammer. When the reflex is present the fingers grasp or the thumb strongly adducts. The patient may be unable to release the grip. Presence suggests contralateral frontal lobe disease.

Sucking (pout, snout, rooting)

- The sucking reflex is elicited by stroking the lips of the patient with a finger or a spatula from side to middle and back again. The pouting reflex is elicited by the examiner placing the index finger of the patient's closed lips and tapping the finger with a patella hammer. Sucking or pouting movements of the lips suggest frontal lobe damage or bilateral lesions above the mid-pons.

Palmar-mental

- The palm is scratched firmly with a key or the handle of the patella hammer, from the fingers, toward the wrist. The positive response is a flicker in the skin on the ipsilateral side of the point of the chin. Presence suggests contralateral frontal lobe damage, however, the true value of the reflex is yet to be clearly determined.

Glabella Tap

- The patient is asked to close the eyes and the examiner repeatedly taps (finger tip or patella hammer) the supraorbital ridge. In the normal individual the orbicularis oris contracts in response to the first two or three taps and then ceases. In pathological conditions the orbicularis oris continues to contract with every tap. This reflex is used in the diagnosis of Parkinson's disease, but it may also occur with frontal damage of other etiologies.

Psychiatric Disorders

Antisocial Behaviours

- Altered Interaction b/w OFC & Amygdala

295

- ACC a/w Hallucinations
- Myelination, Glial Structure, Migrational Issues

Depression

- Subgenual Cingulate Cortex Activation

Bipolar Disorders

- Subgenual Abnormalities
- Glial Issues (Number & Density)
- Neuronal Density (Also in BA9)
- Myelination

OCRD

- Medial OFC, Anterior Dorsal Cingulate & Striatal Network
- Increased Functional Connectivity

ASD

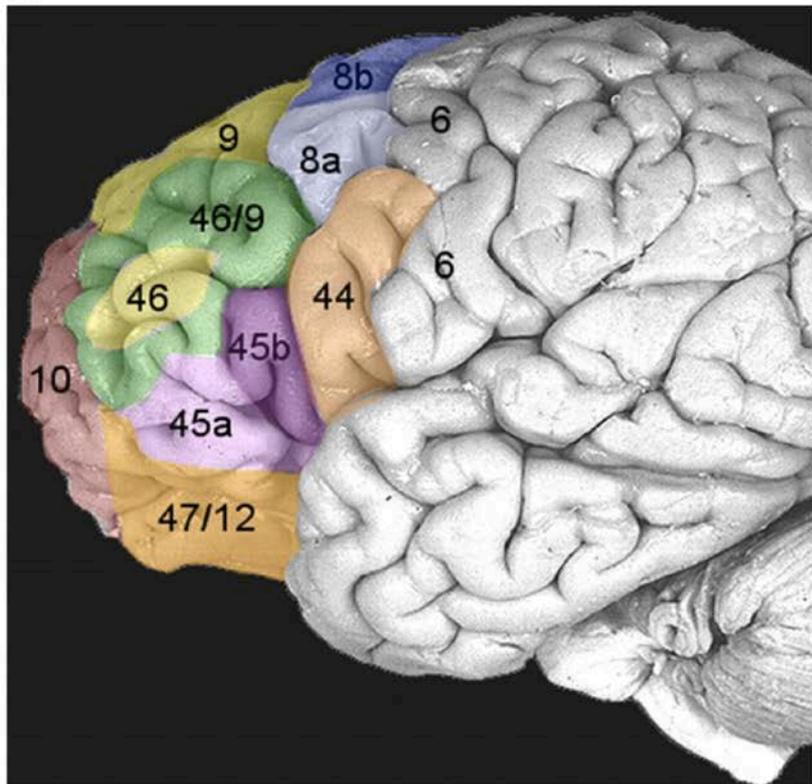
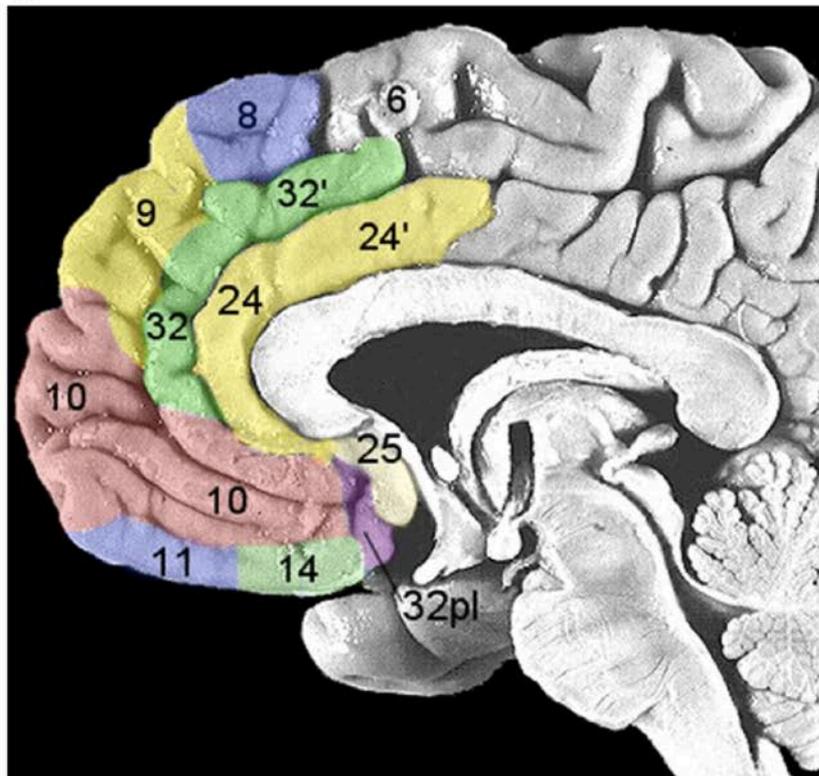
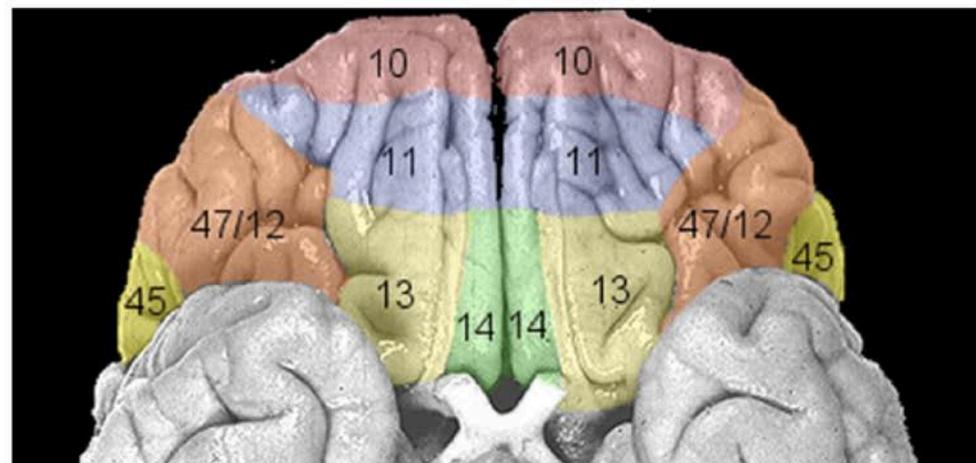
- Reduced Neuronal Size, Dense Packing in Entorhinal Cortex
- Uncinate Fasciculus
- Dorsal Cingulate Cortex

Thank You

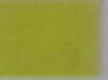
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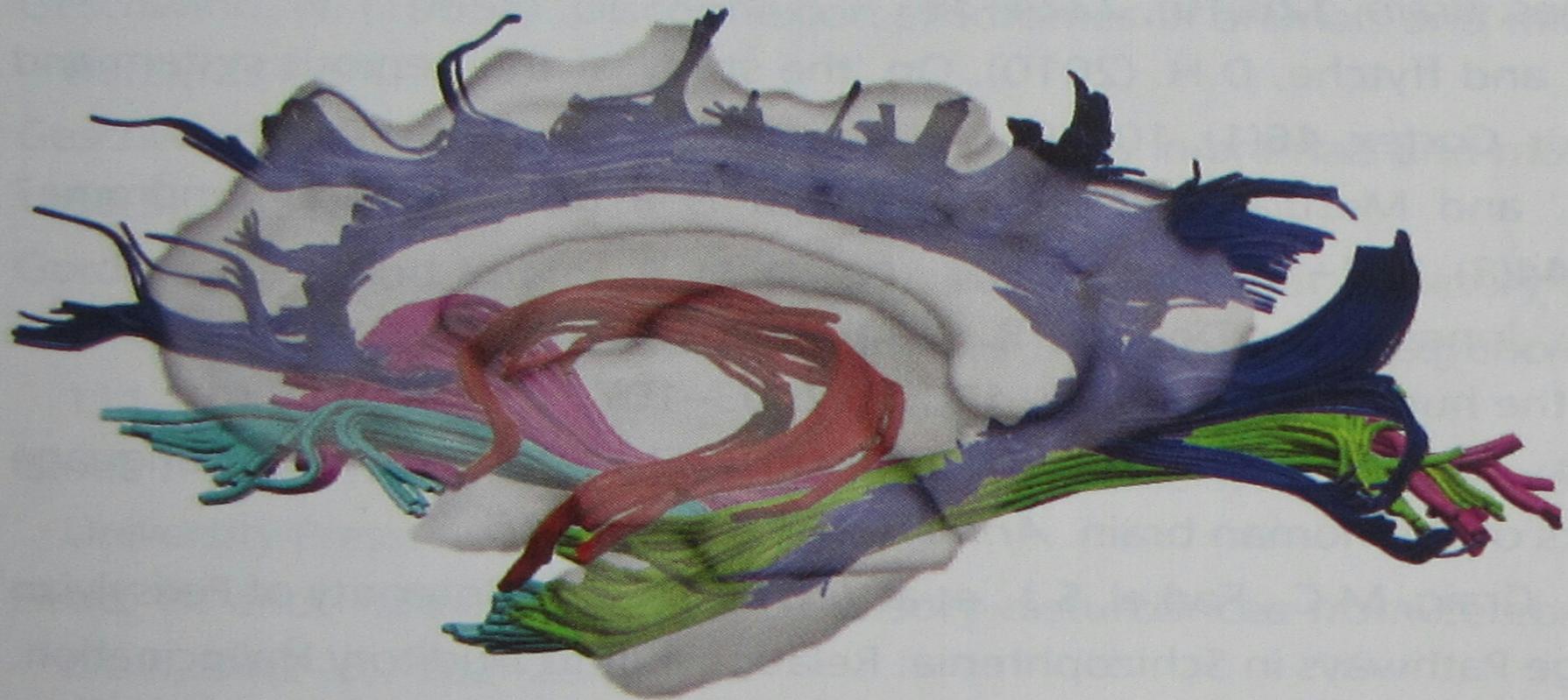
Major Functional Areas

- Area 4: Primary Motor Area – Corticospinal Projection Fibres
- Area 6:
Premotor Cortex (Lateral) – programming
Supplementary Motor Area or MsII (Medial) – complex movements
- Areas 44, 45: Broca's Area
- Areas 6, 8, 9: Frontal Eyefield
- Areas 8, 9, 10, 46: DLPFC – cognition
- Area 47: VLPFC – affect and emotions
- Areas 11, 47: OFPFC - behaviour

A**B****C**

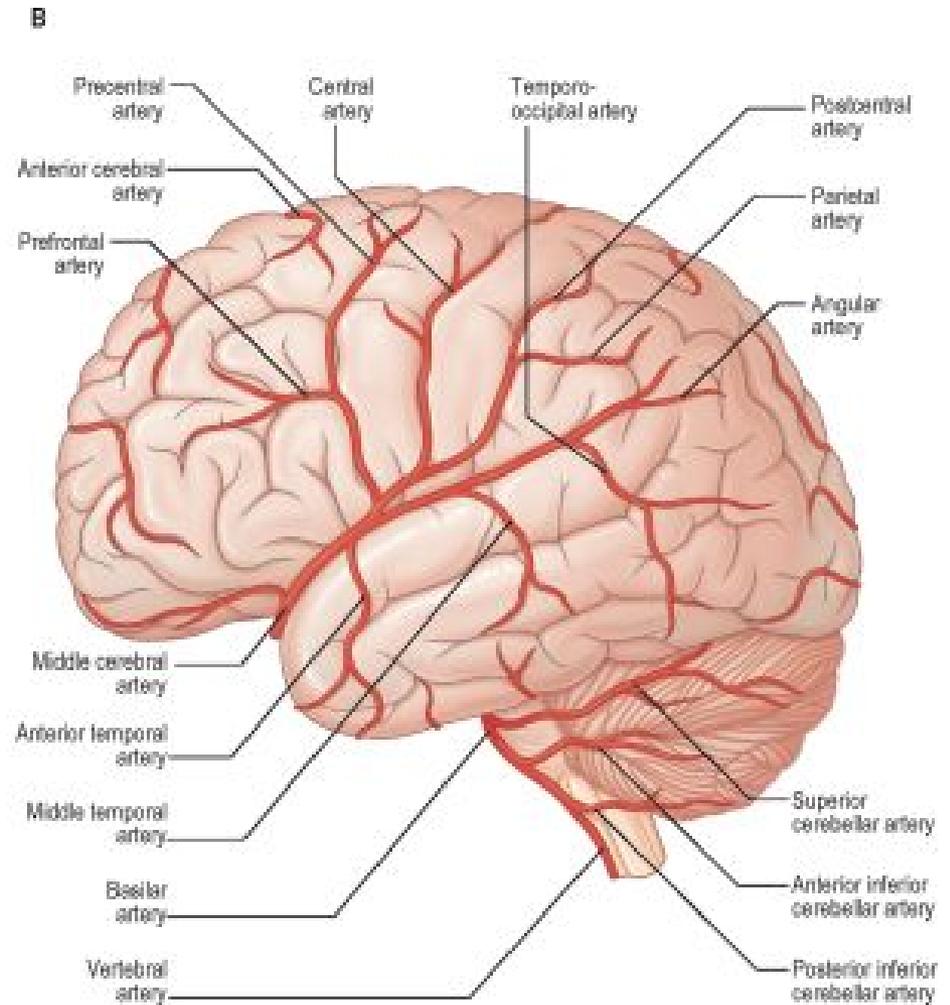
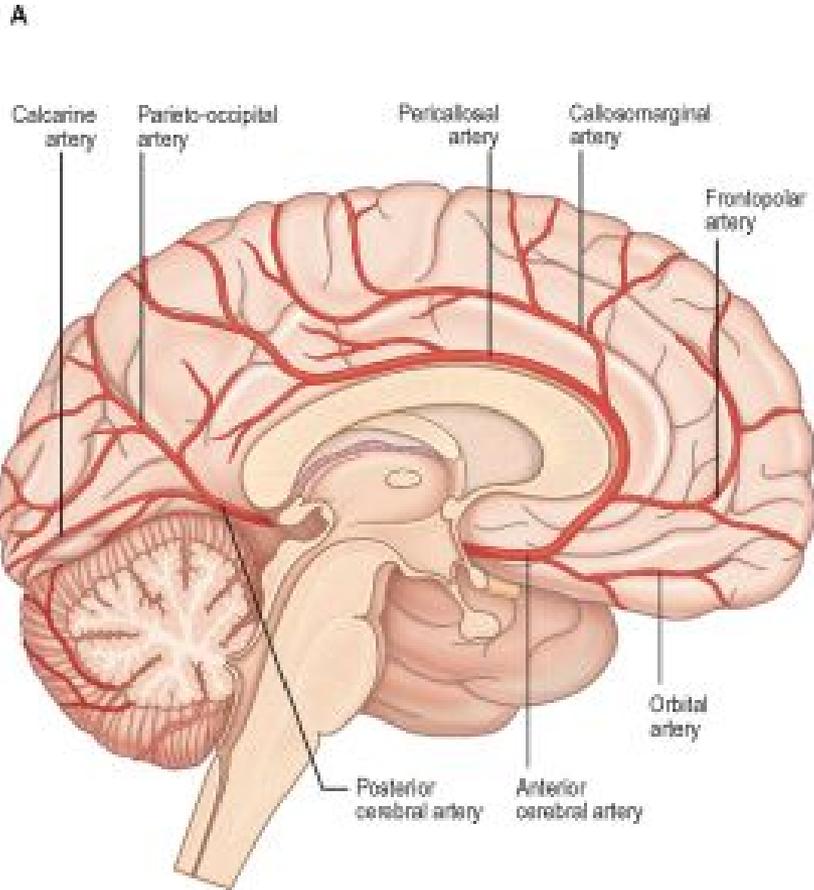


- | | | | | | |
|---|-------------------|---|-----------------|---|-----------------|
|  | AS/SLF III |  | Uncinate |  | Cingulum |
|  | LS |  | IFOF |  | SLF I |
|  | SLF II | | | | |

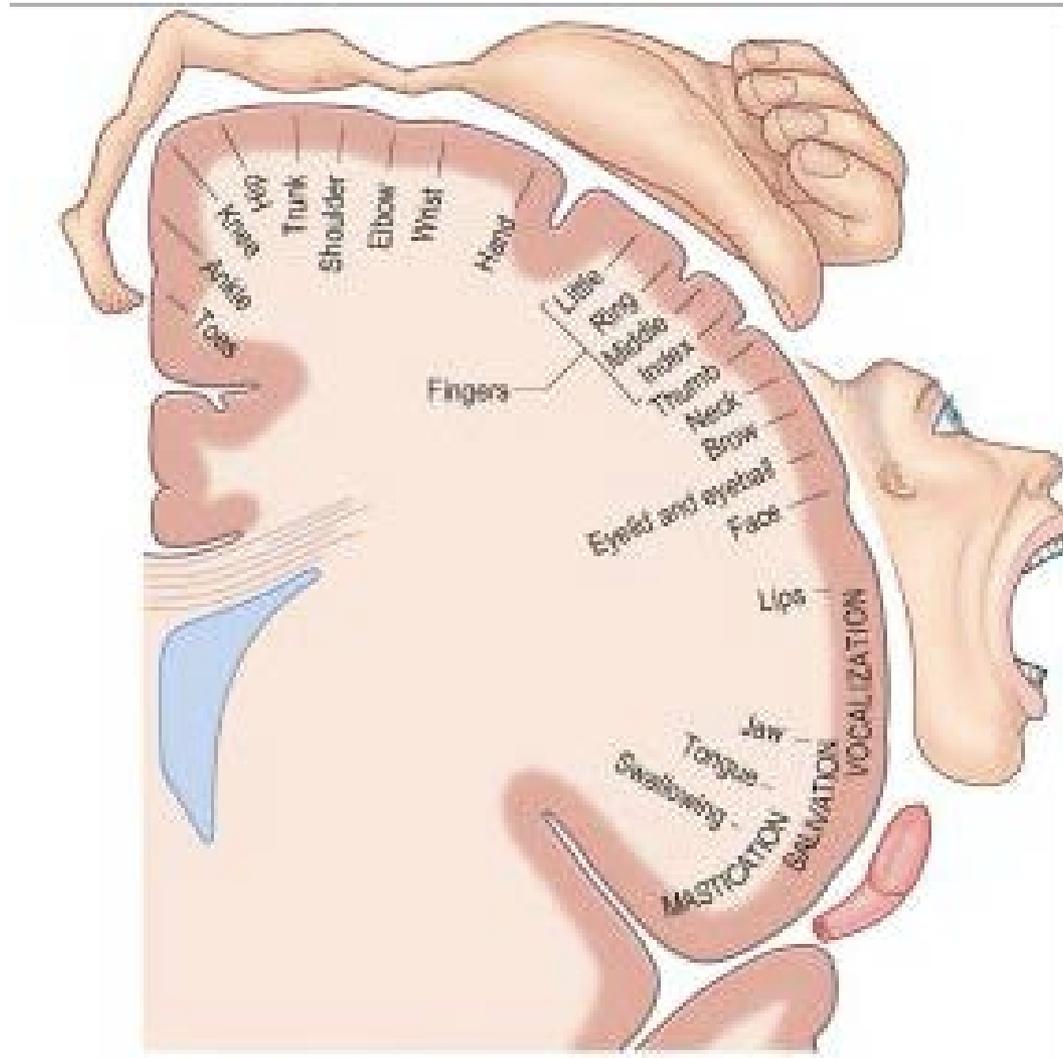


- | | | | | | |
|---|-----------------|--|-----------------|---|-------------|
|  | Cingulum |  | Uncinate |  | IFOF |
|  | Fx |  | ILF | | |

Blood Supply



Motor Homunculus



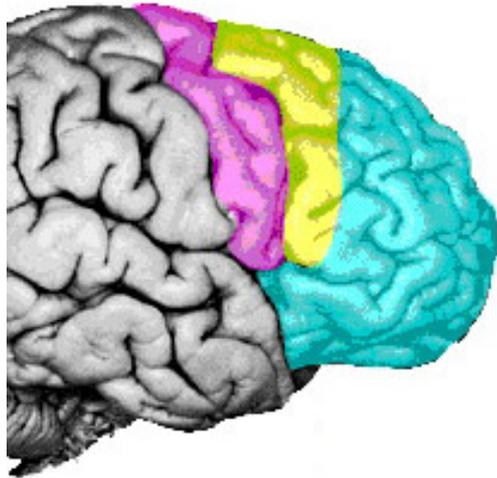
Motor Syndrome

Primary Motor Cortex

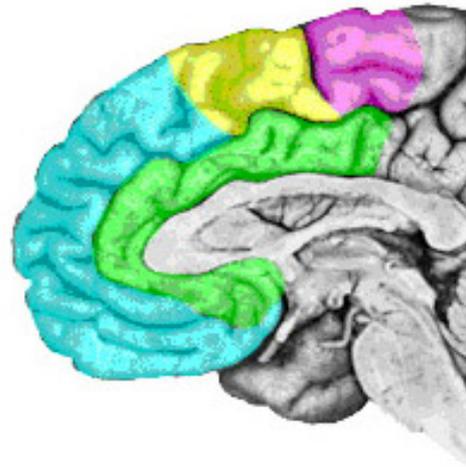
- Contralateral Limbs & Face
- Apraxia of Left Arm & Face (Arcuate Fasciculus – Anterior Segment)
- Gaze abnormalities – Frontal Eyefields
- Anarchic/ Alien Hand Syndrome – Medial Frontal Lobe & its Callosal / Intralobar Connections)
- Jacksonian March – epileptic activity along motor homunculus

Abulic
&
Behavioural Syndromes

Pragya Sharma



-  Motor
-  Premotor
-  Prefrontal
-  Limbic



Case 3

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- **What is the circuit involved in this case?**
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- **How do we assess this region at the bedside?**

Abulic Syndrome

Medial PFC, Anterior Cingulate Cortex (Cognitive Symptoms)

- Apathy
- Affective Blunting
- Decreased Engagement With Usual Activities
- Lack Of Curiosity & Interest In Learning
- Impoverished Generative Thinking
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Anterior Cingulate Cortex

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Neuropsychiatric Changes

- Lack Of Empathy, Impulsivity, Distractibility, Emotional Lability, Depression, Mania & Hypomania

Infrequent Cognitive Symptoms

Cognitive Syndrome

DLPFC (Brodmann areas 9,10 and 46)

- Memory Deficit (retrieval deficit and reduplicative paramnesia)
- Altered Serial Motor Sequencing
- Poor Response Inhibition
- Impaired Cognitive Estimation
- Impaired Abstract Thinking
- Impaired Executive Functioning
(Planning, Rule Learning, Focusing, Hierarchical Organization, Switching, Monitoring)

Cognitive Syndrome (Contd)

- Motor Perseveration
- Confabulation

Lateralization

Right Inferior Frontal Gyrus

- Meaning, Emotions through Speech Intonation, Stress, Rhythm & Gestures (Anterior Affective Prosodia)
- Unilateral Neglect

Left Inferior Frontal Lesions

- Broca's Aphasia and aphemias (loss of speech but retention of writing)

Dorsolateral Prefrontal Cortex

Bedside Tests

1. Is the patient able to make an appointment and arrive on time?
2. Is the patient able to give a coherent account of current problems and the reason for the interview? Is there evidence of thought disorder?
3. Digit span, days of the week or months of the year backwards. Here the patient has to retain the task and simultaneously manipulate information.

4. **Controlled Oral Word Association Test (COWAT)**

The patient is asked to produce as many words as possible, in one minute, starting with F, then A, then S. (normal- >15/min for each letter, abnormal <10/min)

Proper nouns and previously used words with a different suffix are prohibited.

Other categorical fluency tests include naming animals, fruits and vegetables. (normal- >18/min, abnormal- <12/min)

For a formal result, it is necessary to test under strict conditions, using norms. However, valuable information may be obtained without formal testing. Generally, a normal individual will be able to provide more than ten items for each of these categories, while a patient with significant deficits will usually score less than eight. The performance of the task will also provide valuable information. Common errors include perseveration (repeating words which have already been given either during the task at hand or an earlier task). There may also be inappropriate or profane utterances.

5. Alternating Hand Sequences

These can be devised by the examiner. One example is that one hand is placed palm upwards and the other is placed palm downwards, and the patient is then asked to reverse these positions as rapidly as possible.

Another example is that the backs of the hands are both placed downwards, but one hand is clenched and the other is open, then the patient is asked to close the open hand and open the closed hand, and keep reversing the posture of the hands as rapidly as possible.

A final example is that the patient taps twice with one fist and once with the other, then after the rhythm is established, the patient is asked to change over the number of beats (the fist which first tapped twice now taps only once).

Patients with frontal lobe deficits usually perform poorly on these tests, often being unable to follow the relatively simple instructions.

Primary Motor Cortex

Bedside Tests

1. Motor strength of hand grip
2. Motor speed as in finger tapping