

M U N I

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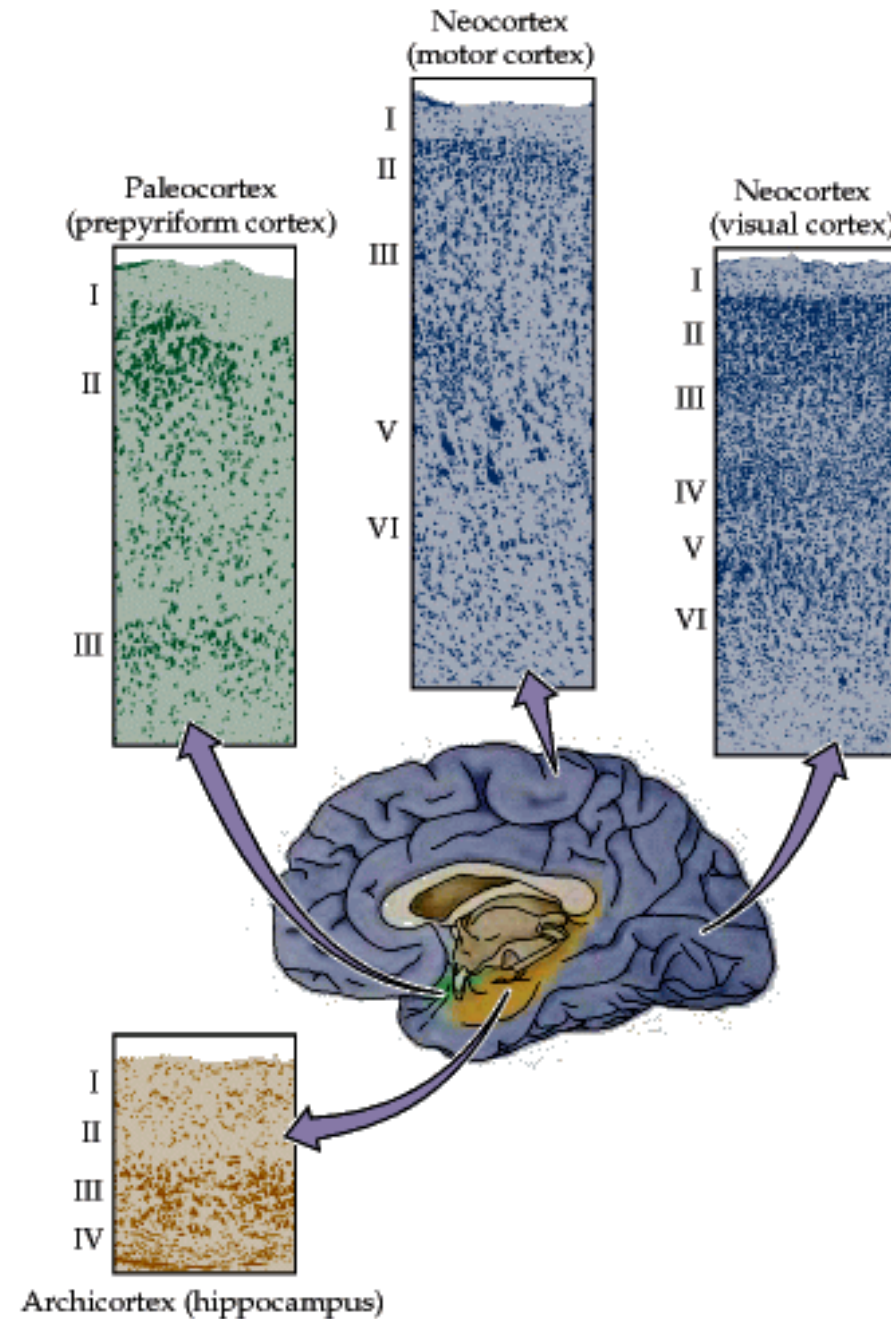
**M U N I**  
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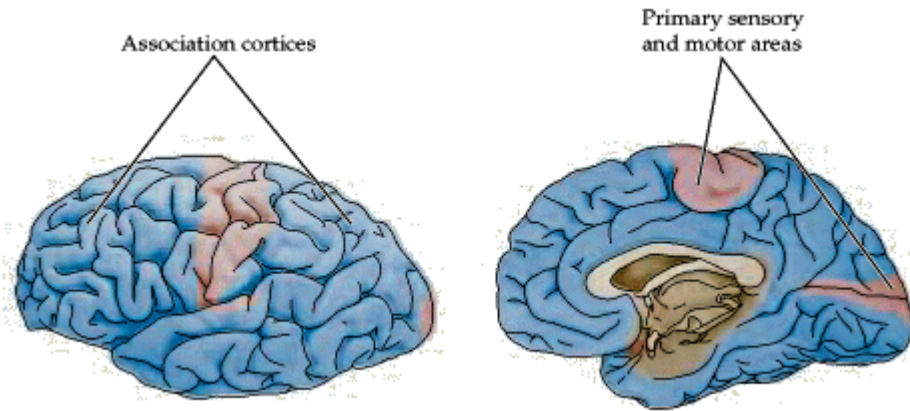
**Neocortex I**

# Cerebral cortex

- Paleocortex (1%)
  - 3 layers
  - rhinencephalon
- Archicortex (4%)
  - 3-4 layers
  - hippocampus
- Neocortex
  - 6 layers



# Neocortex

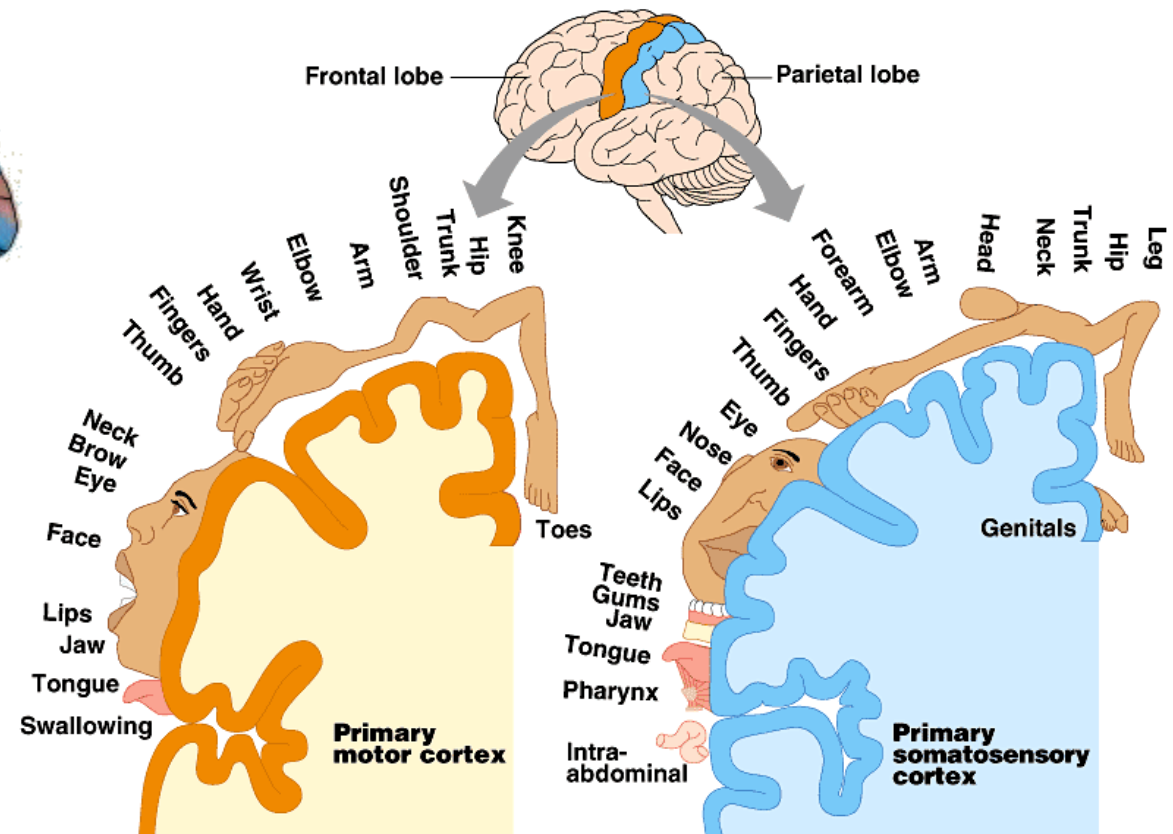


## Primary areas

- ✓ Somatotopic organization

## Association areas

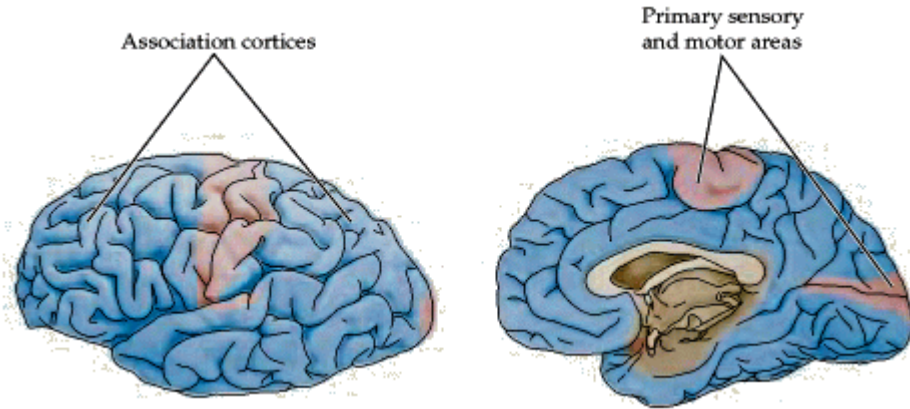
- ✓ No somatotopic organization
- ✓ Unimodal
- ✓ Polymodal



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# Neocortex

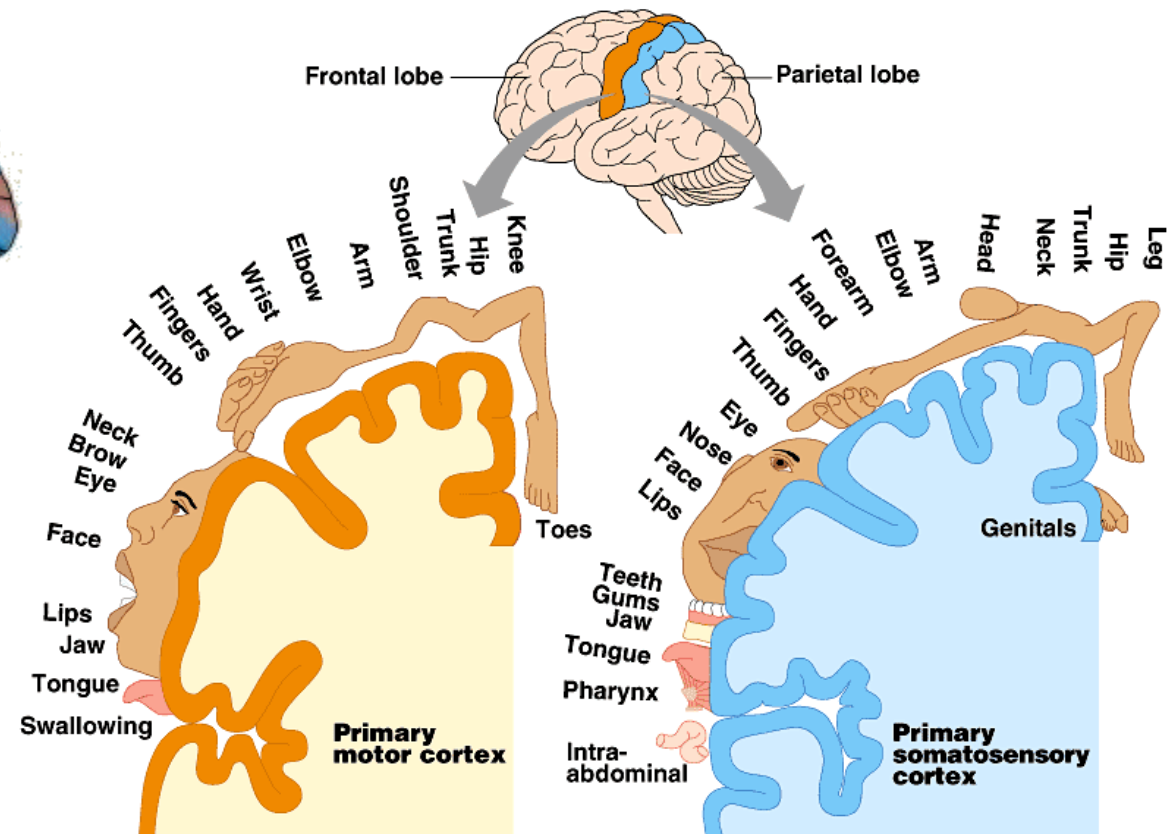


## Primary areas

- ✓ Somatotopic organization

## Association areas

- ✓ No somatotopic organization
- ✓ Unimodal
- ✓ Polymodal
- ✓ Association areas are thought to be the anatomical substrates of the highest brain functions—conscious thought, perception, and goal-directed action

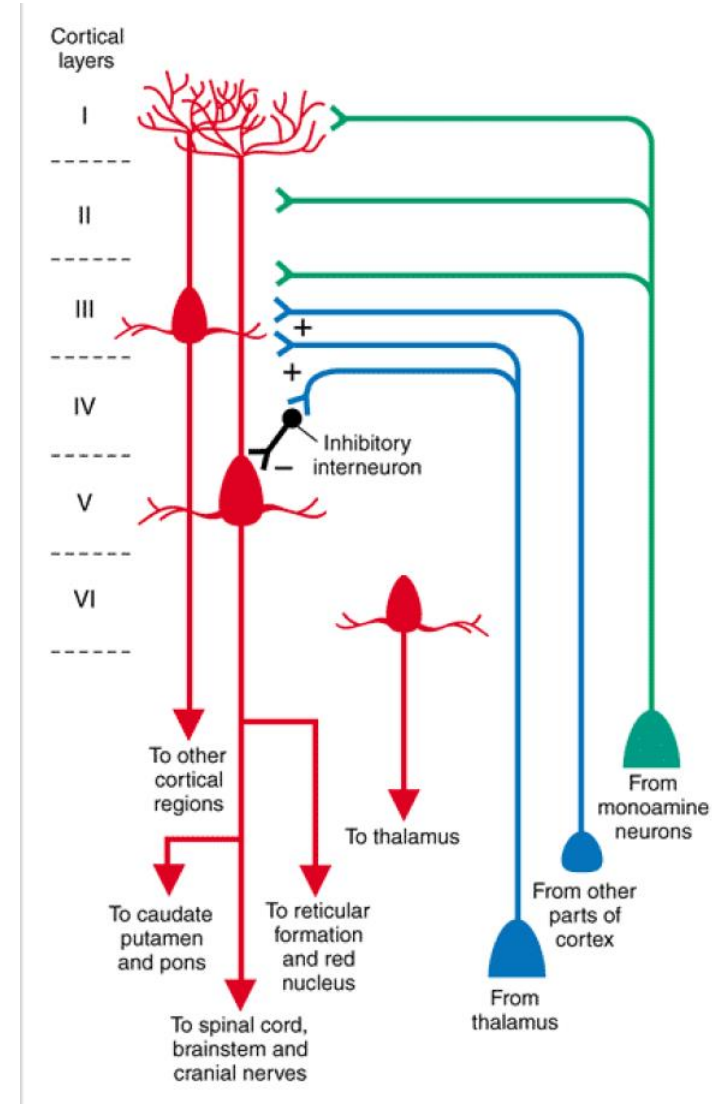


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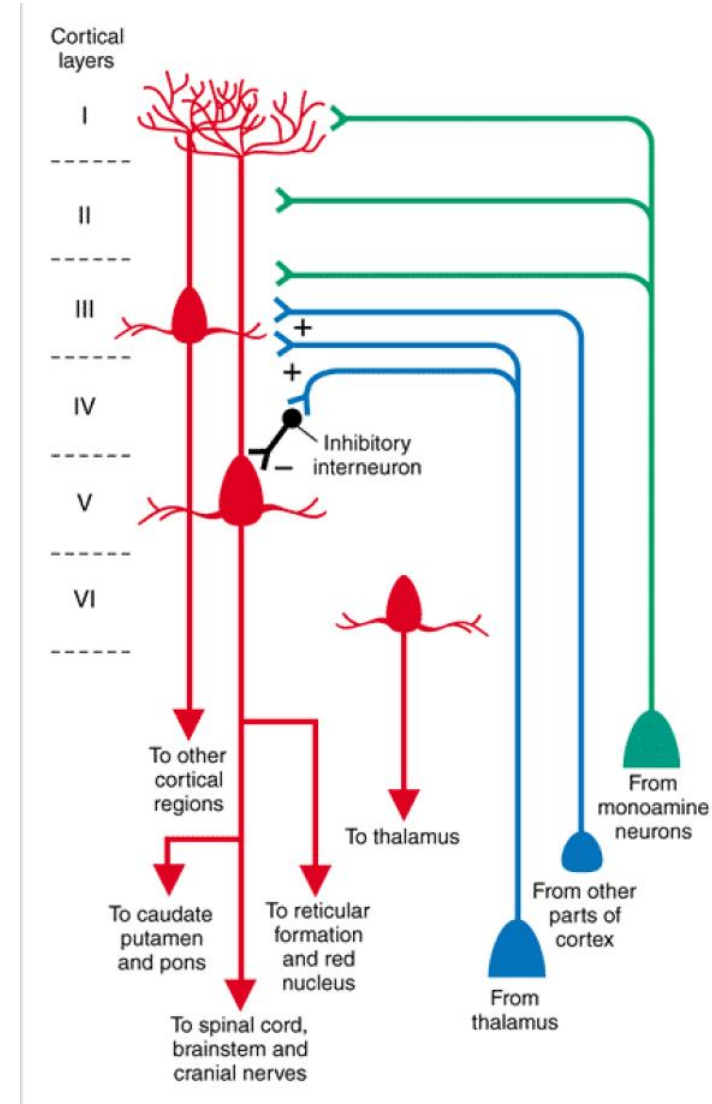
# Organization of neocortex

- Specific inputs/outputs to/from each layer
- Vertical and horizontal connections in each layer
- Each layer usually contains cells with similar functions



# Organization of neocortex

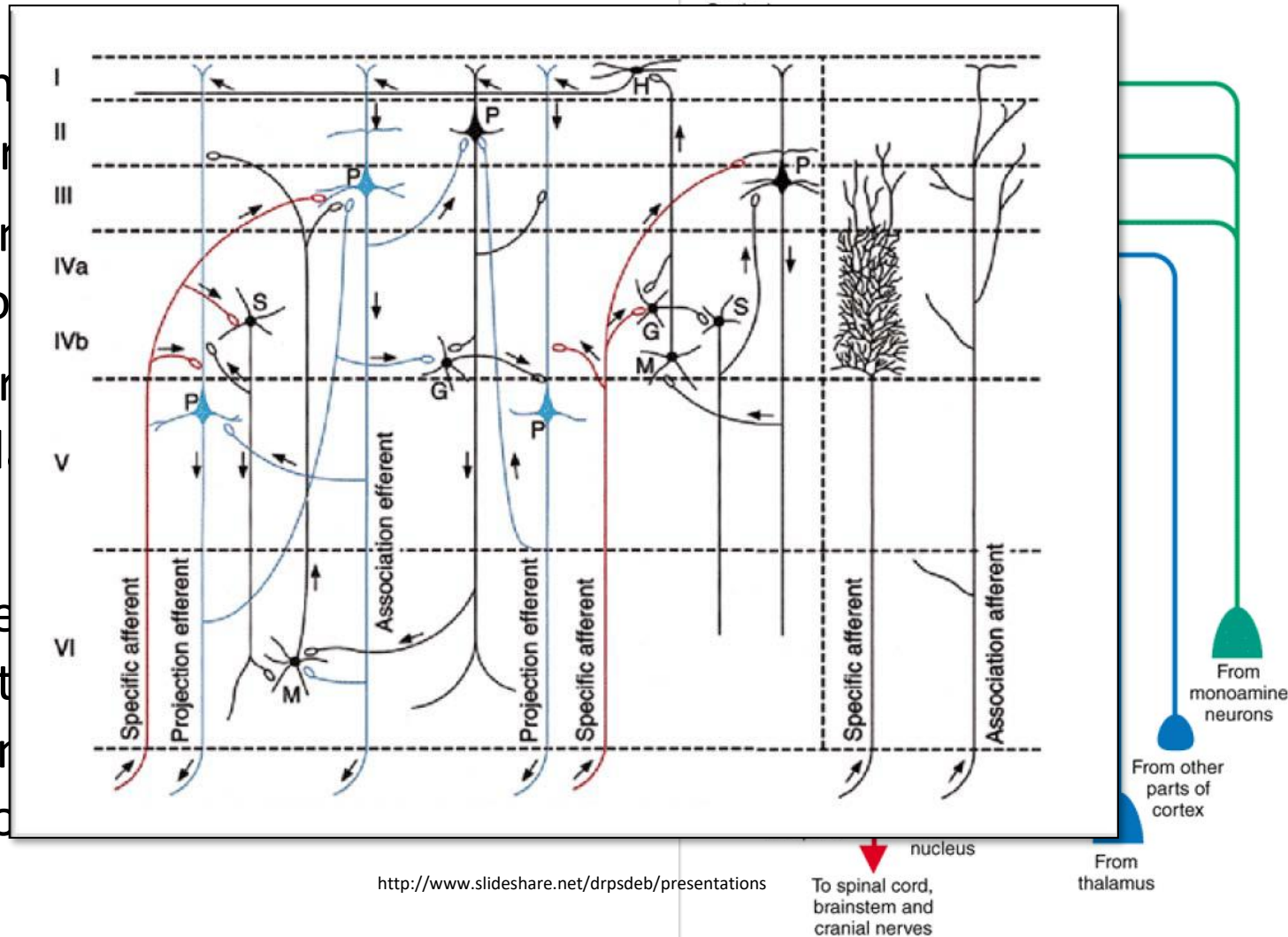
- Specific inputs/outputs to/from each layer
- Vertical and horizontal connections in each layer
- Each layer usually contains cells with similar functions
- Local differences in cytoarchitecture were used by Brodmann for construction of the map of brain areas





# Organization of neocortex

- Specific input to each layer
- Vertical association connections
- Each layer with similar cytoarchitecture
- Local differences in cytoarchitecture (Brodman's map of the map of the cortex)



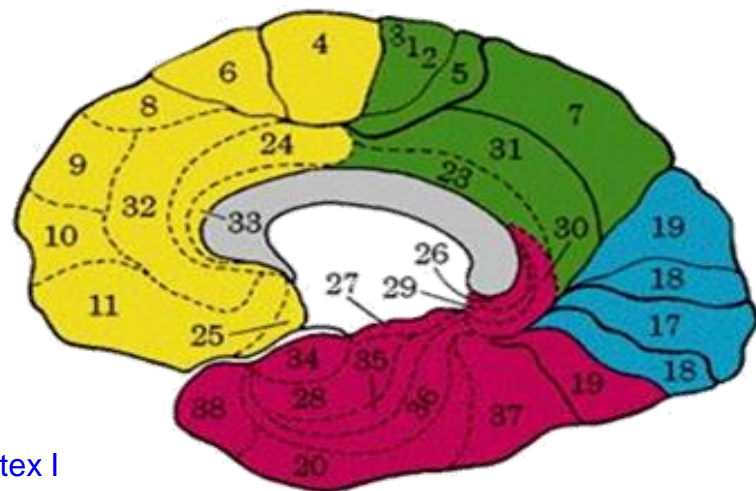
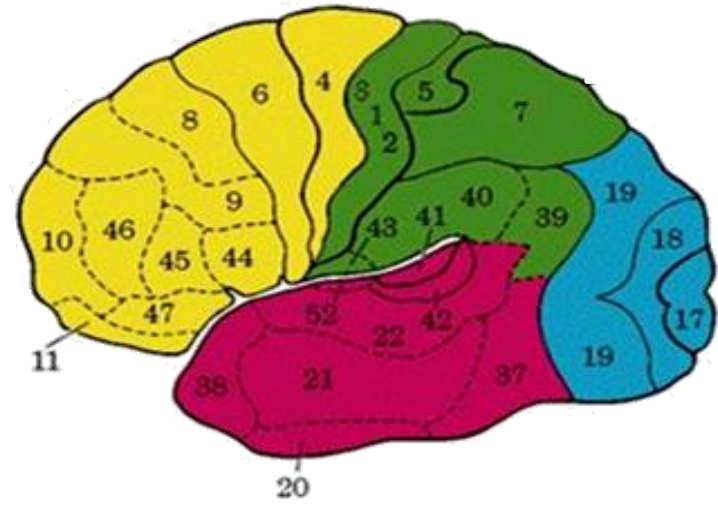
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To spinal cord,  
brainstem and  
cranial nerves

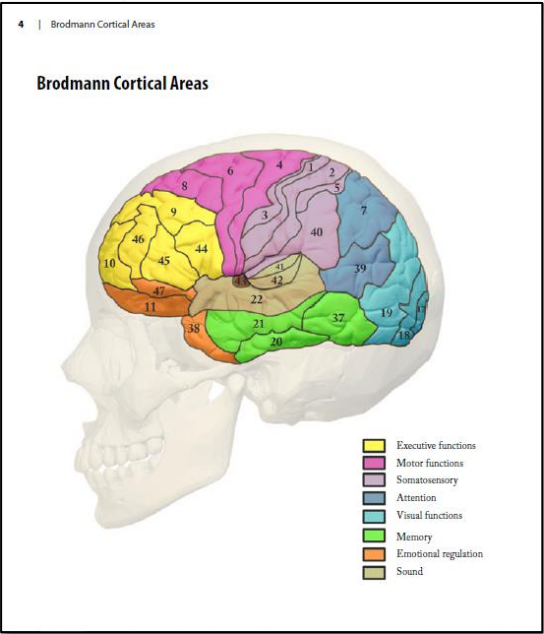
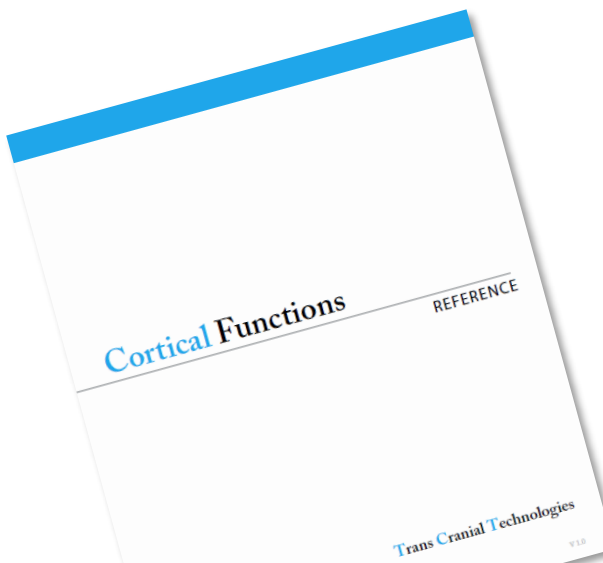
From thalamus



# Brodman areas

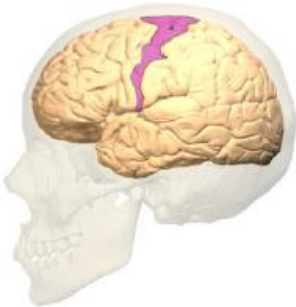


Brodman's #	NAME	FUNCTION
17	Occipital Lobe	Visual Projection Cortex
18		Visual Association Cortex
19	Posterior Parietal Lobe	Visual Association Cortex
37	Temporo-parietal-occipital area	General Sensory Association Cortex
39	Angular Gyrus	Word Recognition
40	Supramarginal Lobe	Somatosensory Association Cortex
1,2,3	Postcentral Gyrus	Somatosensory Projection Cortex
5, 7	Superior Parietal Lobule	General Sensory Association Cortex
41, 42	Middle 1/3 of Superior Temporal Cortex	Auditory Projection Cortex
22	Superior Temporal Gyrus	Auditory Association Cortex
21, 20, 38	Inferior Temporal Cortex	General Sensory Association Cortex
4	Precentral Gyrus	Primary Motor Cortex
1,2,3	Postcentral Gyrus	Somatosensory Projection Cortex
6,8,9	Premotor Cortex	Motor Association Cortex
41, 42	Middle 1/3 of Superior Temporal Cortex	Auditory Projection Cortex
44,45,46	Broca's Area	Motor Association Cortex - Specific to speech
10	Prefrontal Cortex	General Motor Association Cortex
11	Orbital Gyri	General Motor Association Cortex



### Area 4 – Primary Motor Cortex

The human primary motor cortex is located on the anterior wall of the central sulcus. It also extends anteriorly out of the sulcus partly onto the precentral gyrus. Anteriorly, the primary motor cortex is bordered by a set of areas that lie on the precentral gyrus.



**Clinical significance**  
Lesions of the precentral gyrus result in paralysis of the contralateral side of the body (facial palsy, arm-/leg monoparesis, hemiparesis).

**Notes**  
According to functional neuroimaging techniques area 4 participates in three different groups of functions: Motor, somatosensory, and "others" ("verbal encoding during a non-semantic process", "attention to action", and "motor memory for visual landmarks").

Motor function is the traditional function, and occasionally it has been reported that the primary motor cortex reacts to sensory stimulation. Nonetheless, in these cases the primary motor activation is found in addition to a more extensive pattern of activation, obviously including sensory areas; that is, area 4 may some times be included in a brain circuitry supporting sensory perception; area 4 activation may reflect in those cases the implicit representation of a potential movement.

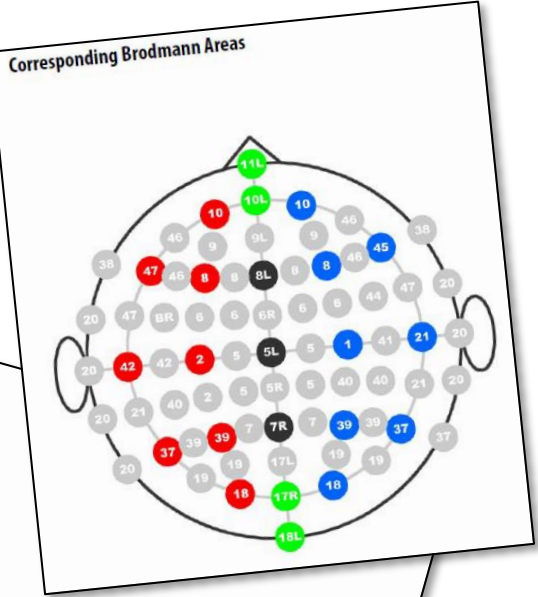
This implicit representation of movements can also account for "attention to action" and "motor memory".

The participation in "verbal encoding during a non-semantic process" is probably tangential, considering that it becomes activated (in addition to frontal and

temporal networks) only during "successful encoding", suggesting a certain role in the attentional process (increased muscle tone).

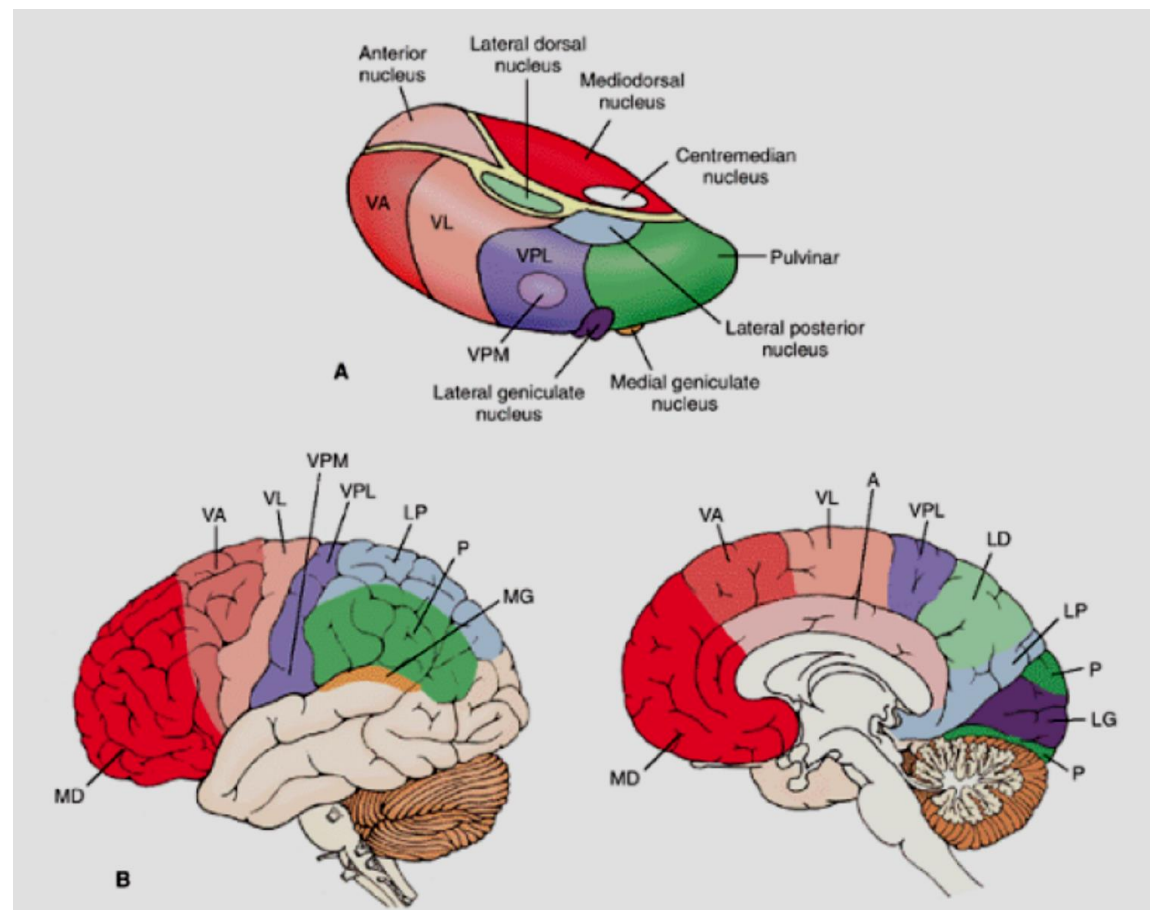
### Associated Functions

- Motor**
- Contralateral finger, hand, and wrist movements (Dorsal)
  - Contralateral lip, tongue, face, and mouth movement (Lateral)
  - Swallowing / laryngeal movement
  - Contralateral lower limb (knee, ankle, foot, toe) movement (Mesial)
  - Motor imagery
  - Learning motor sequences
  - Volitional breathing control
  - Control of rhythmic motor tasks (i.e. bicycling)
  - Inhibition of blinking / voluntary blinking
  - Horizontal saccadic eye movements
- Somatosensory**
- Kinesthetic perception of limb movements
  - Vibrotactile frequency discrimination
  - Finger proprioception
  - Thermal hyperalgesia (contralateral)
  - Response to touch/observed touch (Left)
- Other**
- Verbal encoding during a non-semantic process (Right)
  - Attention to action (posterior)
  - Topographic memory (motor memory) for visual landmarks



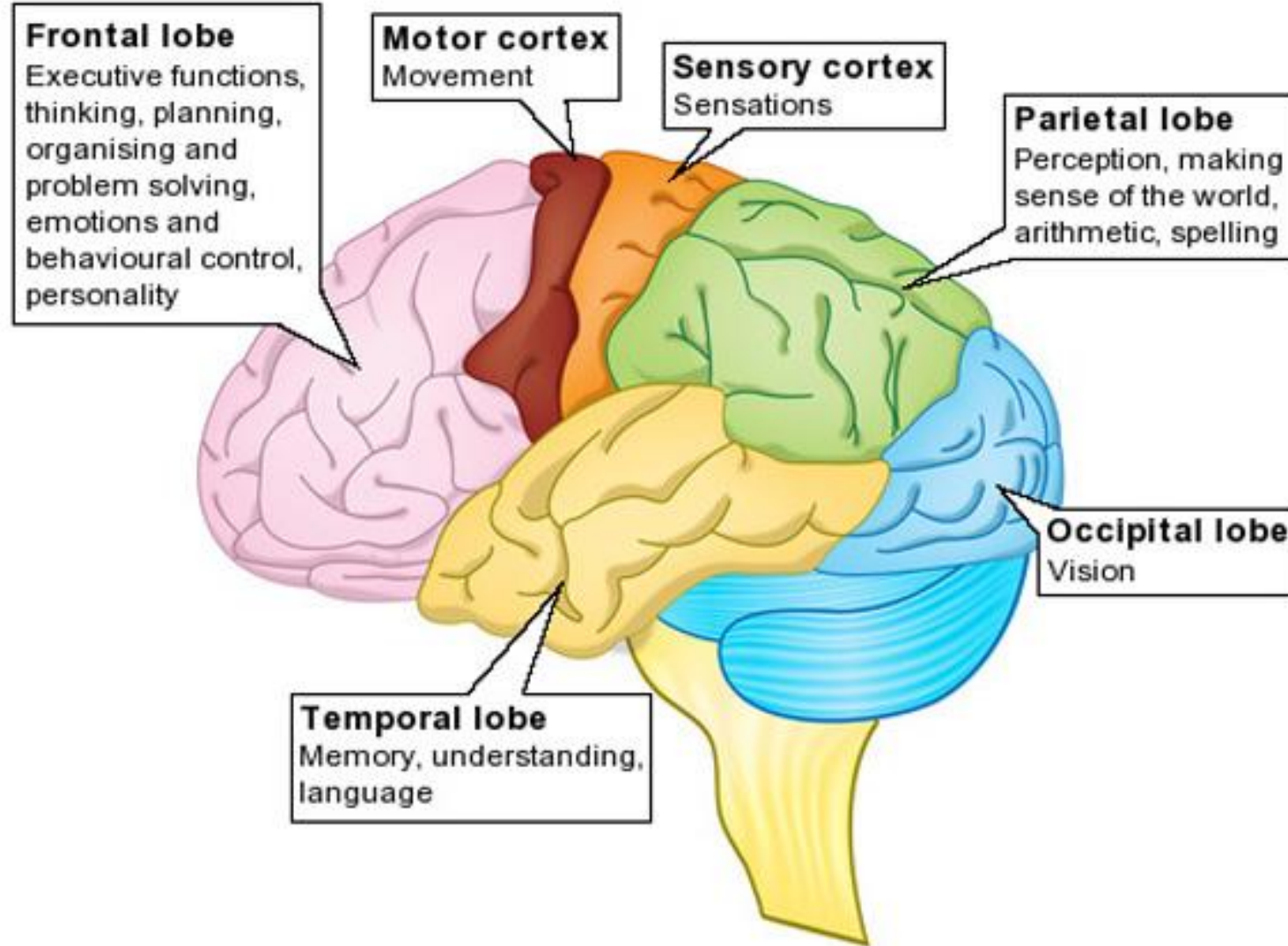
# Cerebral cortex and thalamus

- Close cooperation between cerebral cortex and thalamus
- Bilateral connections
- Almost all sensory information reaching cerebral cortex is gated by thalamus
- Exception - olfaction



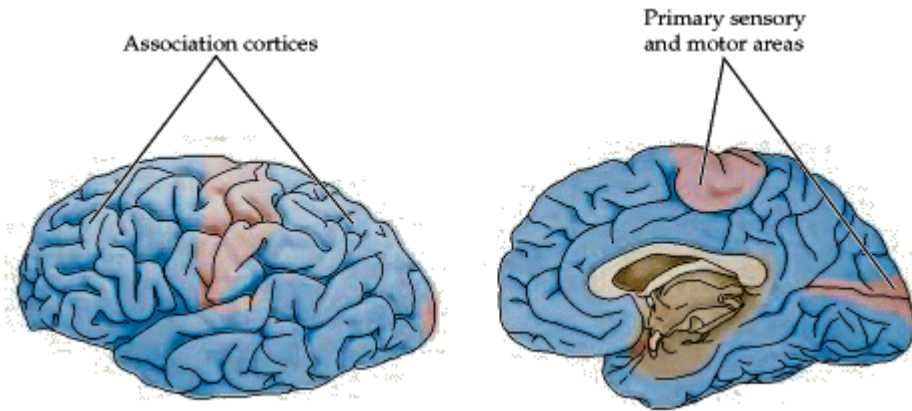
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# Cortical functions

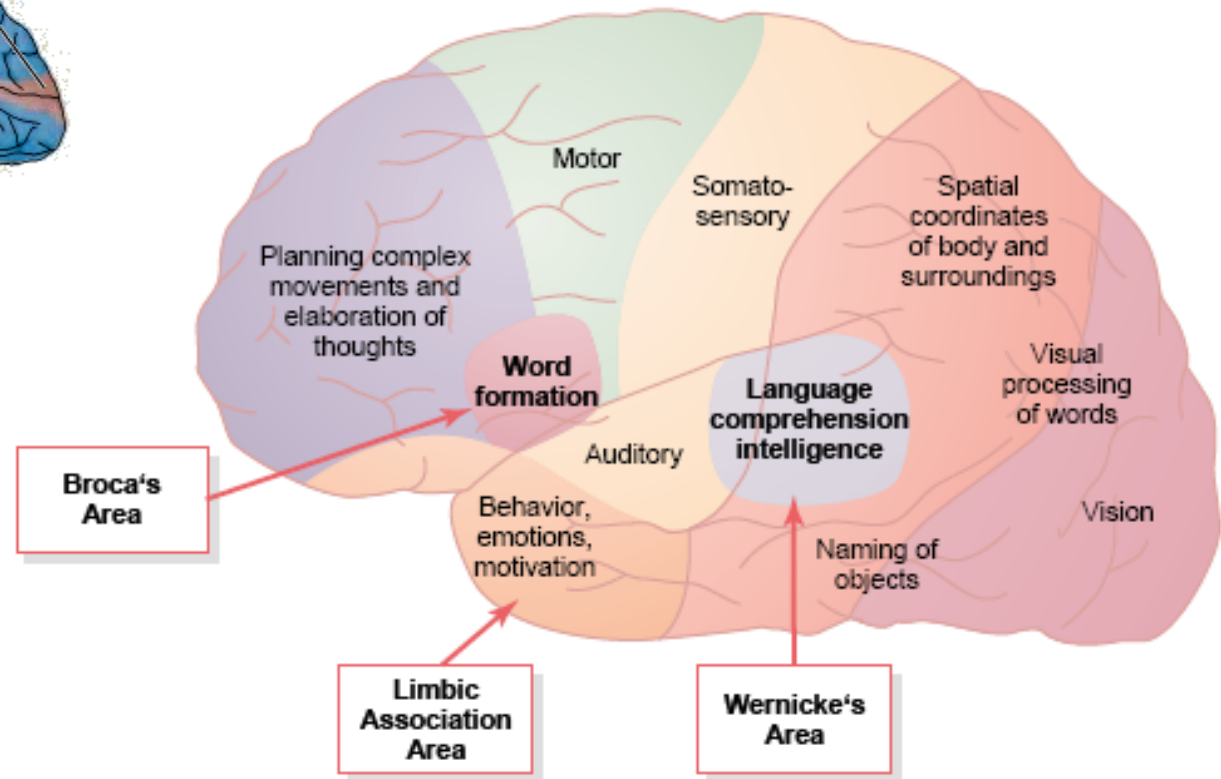




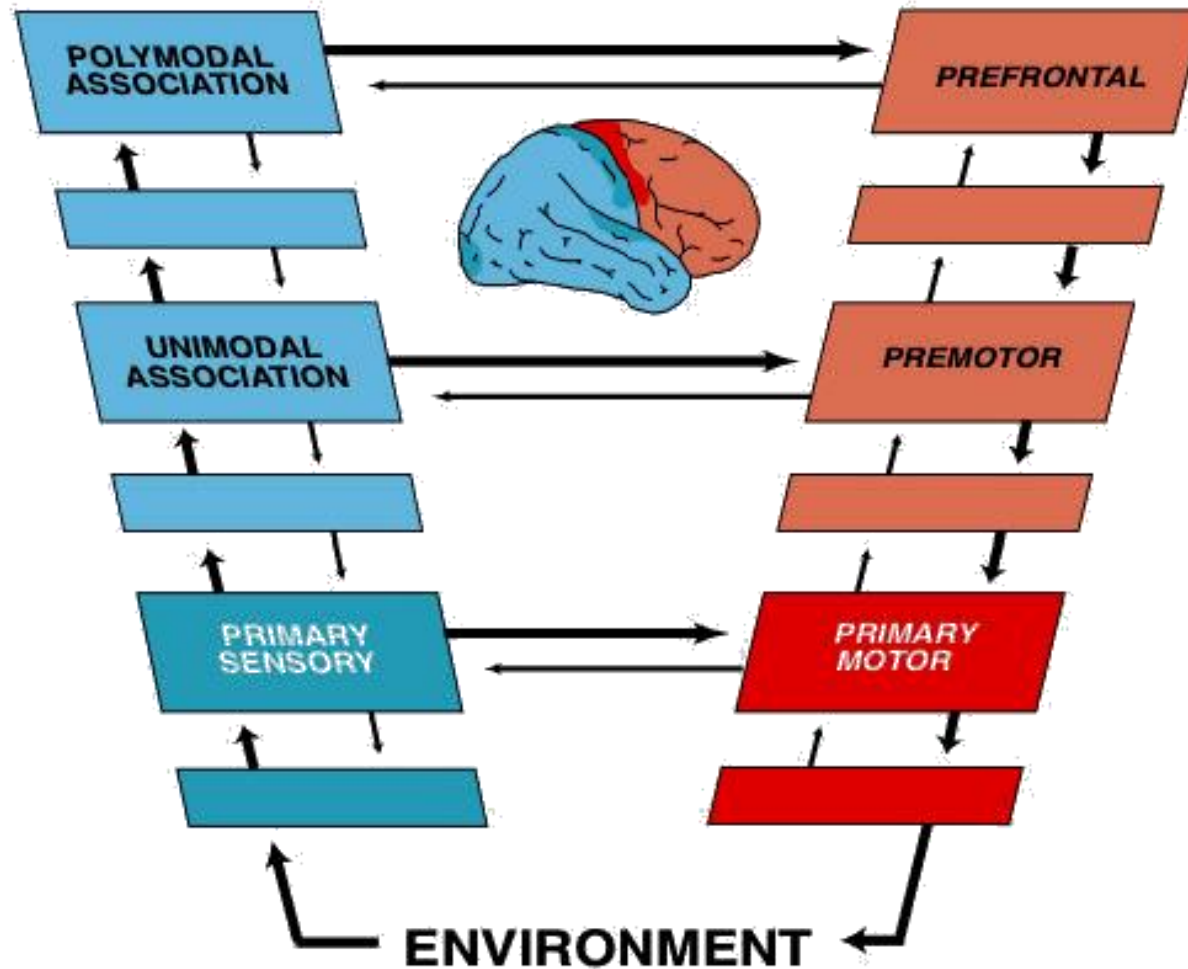
# Association areas



- Neither receptive
- Nor effector
- Integrative function
- Limbic
- Parieto-occipito-temporal
- Frontal

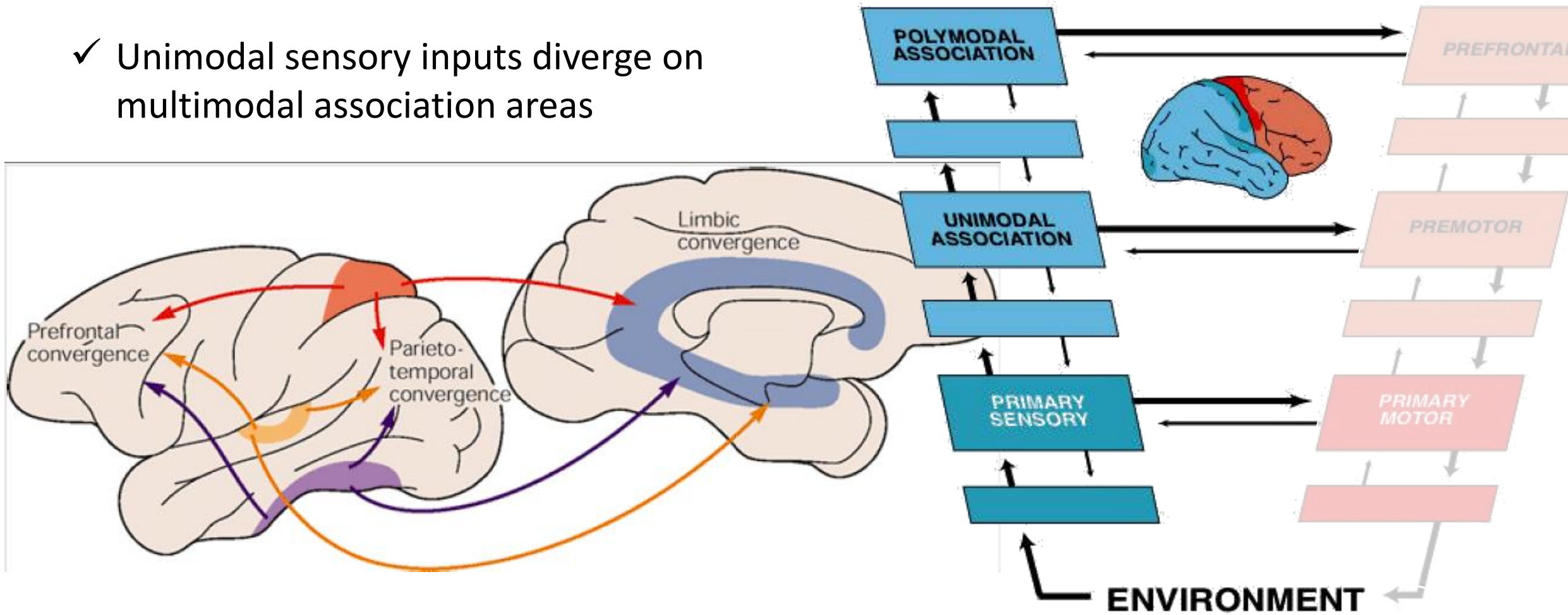


# Signal processing algorithm



# Aferentation

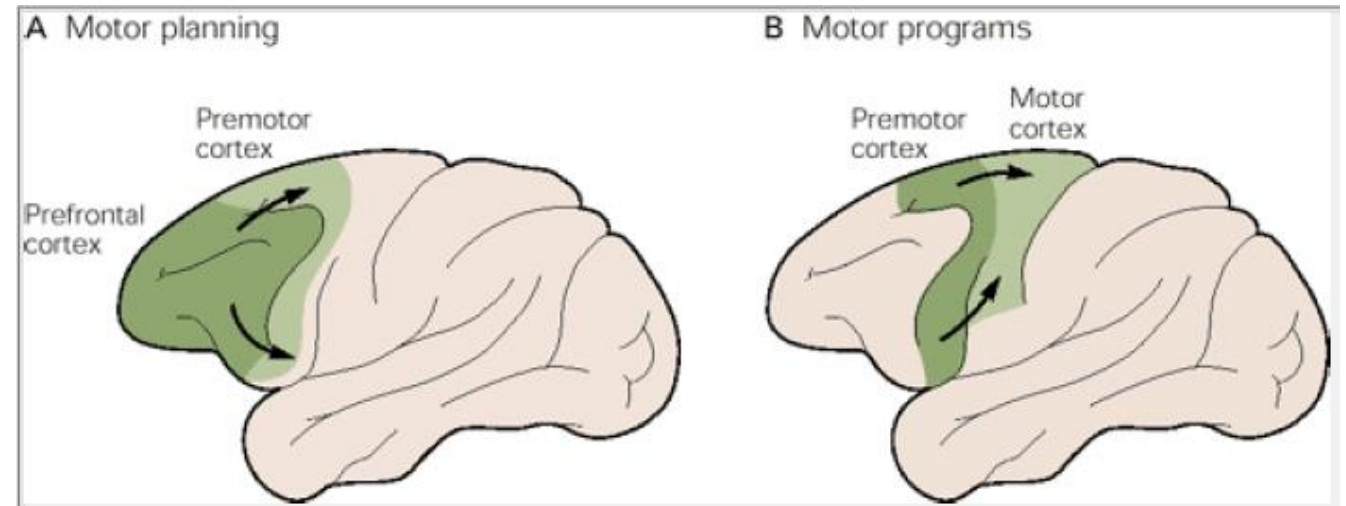
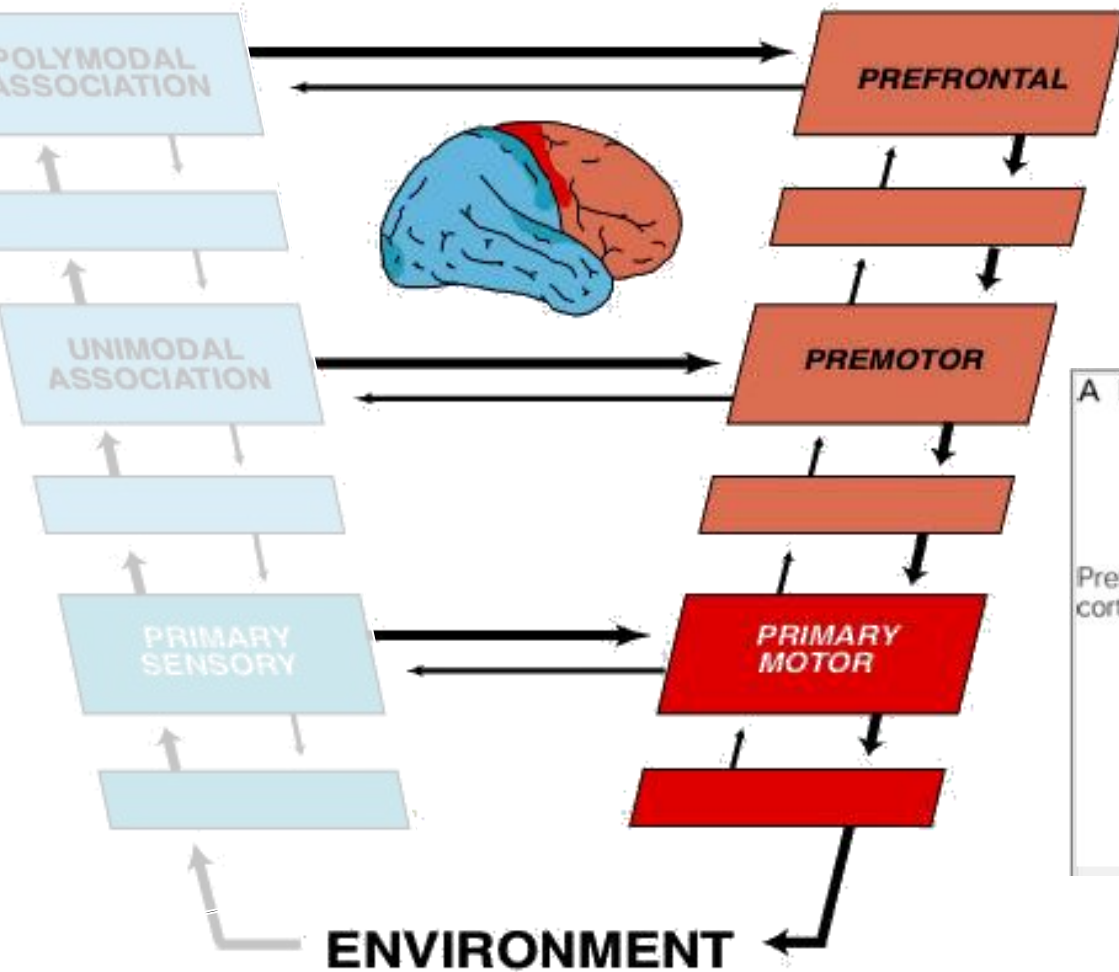
- ✓ Unimodal sensory inputs diverge on multimodal association areas





# Efferentation

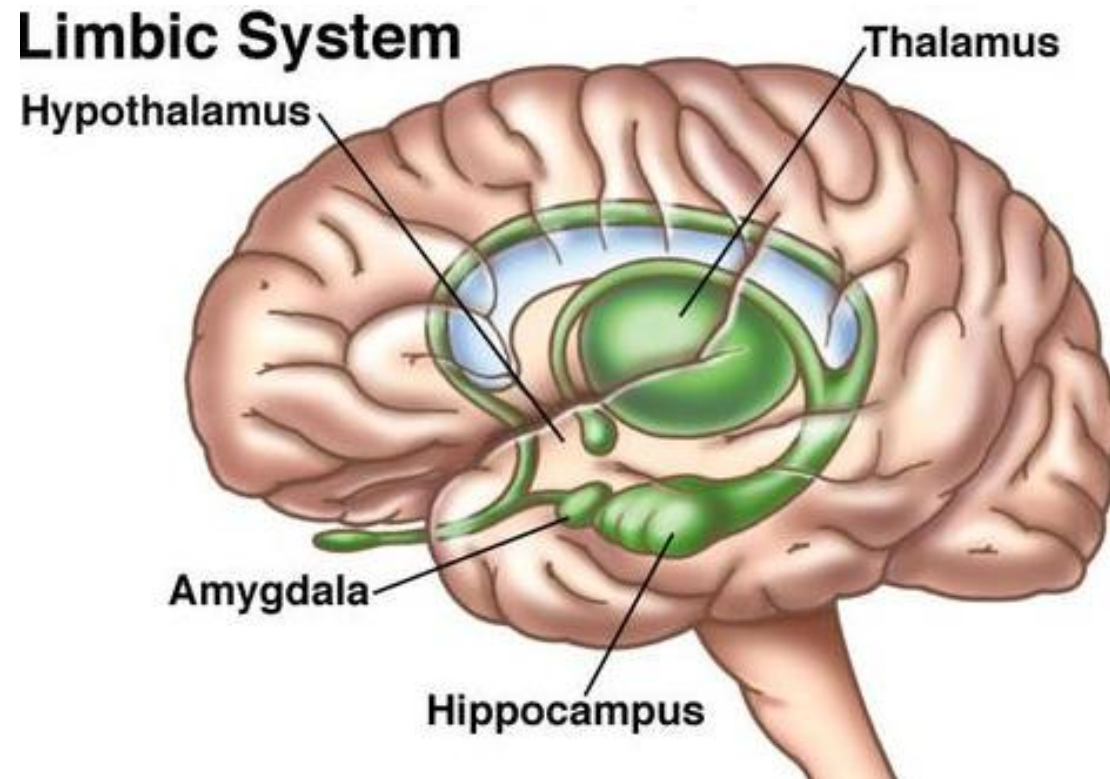
- ✓ The Sequence of Information processing Is Reversed in the Motor System



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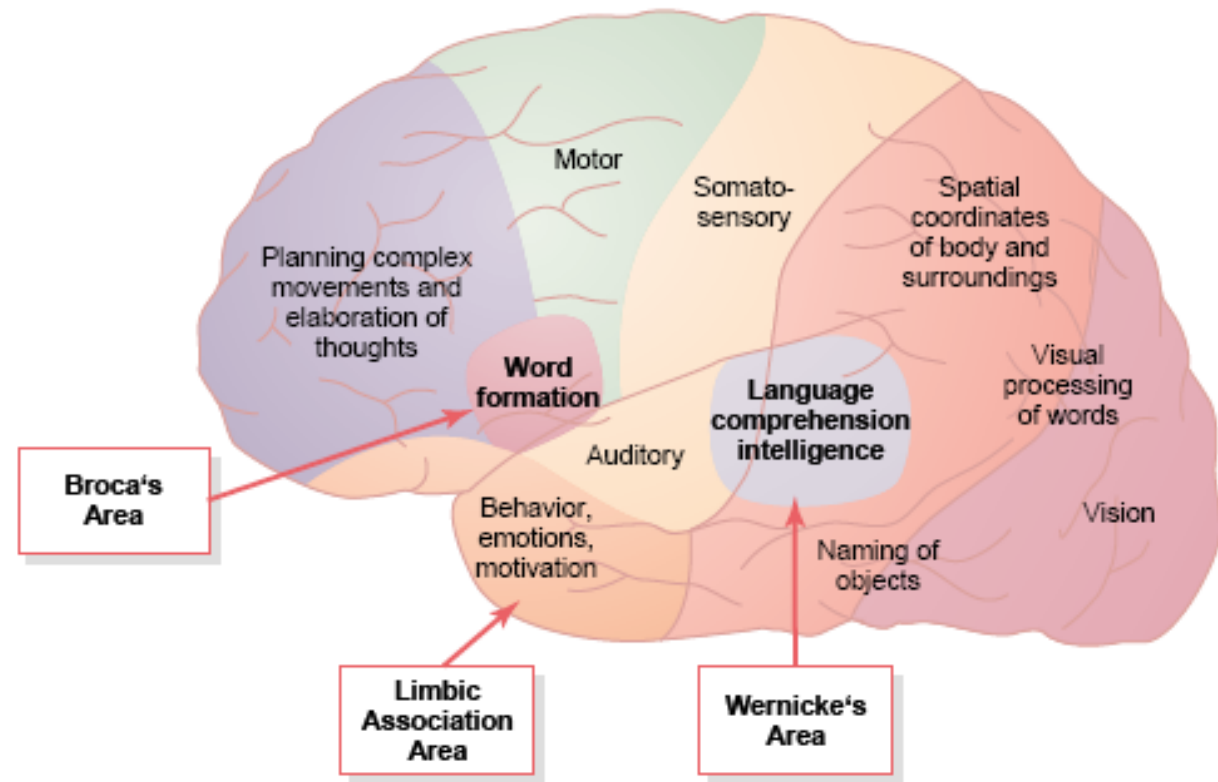
# Limbic association area

- Integration of information from inner and outer environment
- Hypothalamus
- Emotions
- Motivation
- Instinct behavior



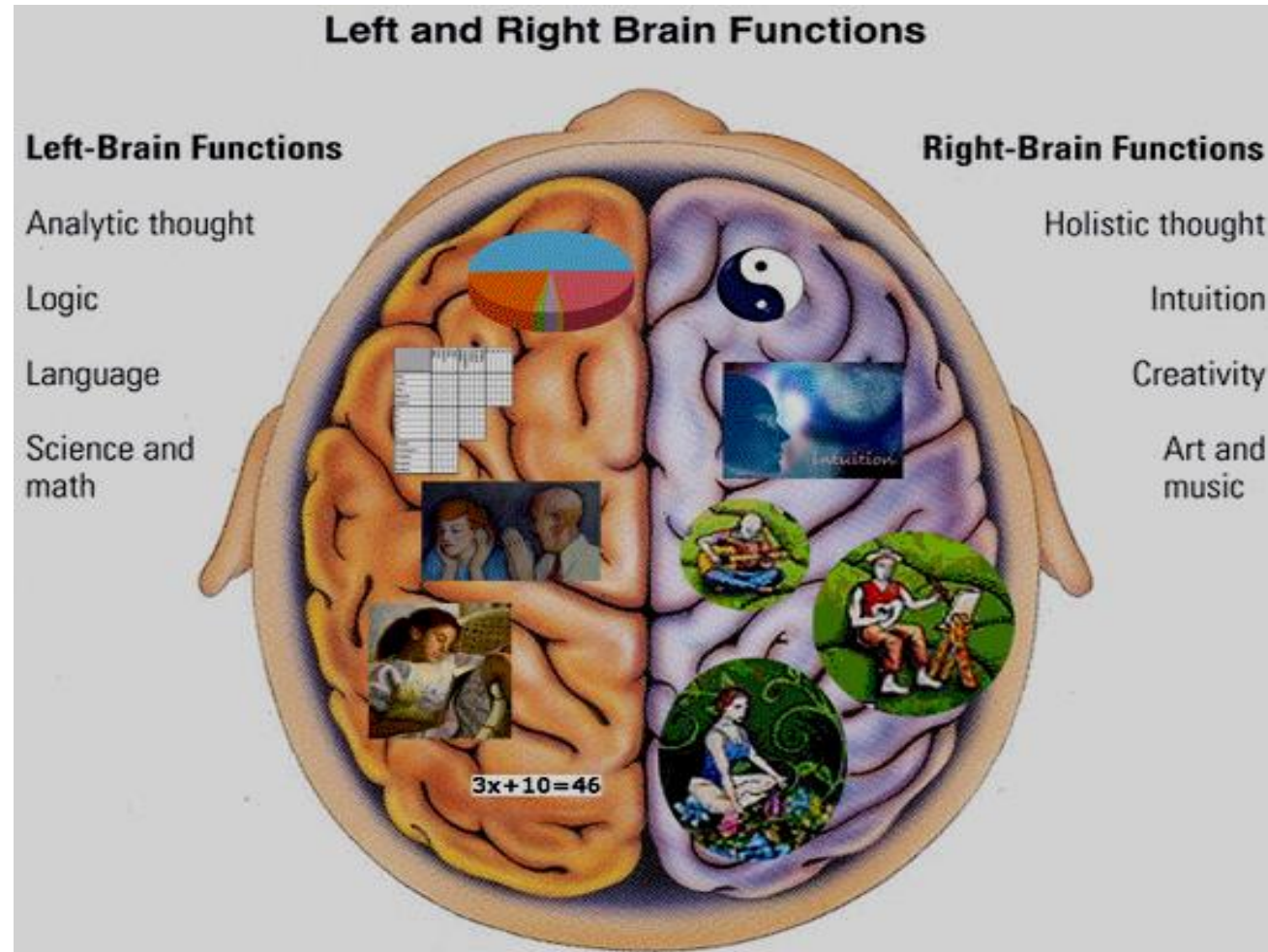
# Parieto-occipito-temporal association area

- Linkage and interpretation of information from several sensory modalities
- Visual – acoustic – sensory analysis
- Object recognition and categorization
- Language comprehension
- Attention



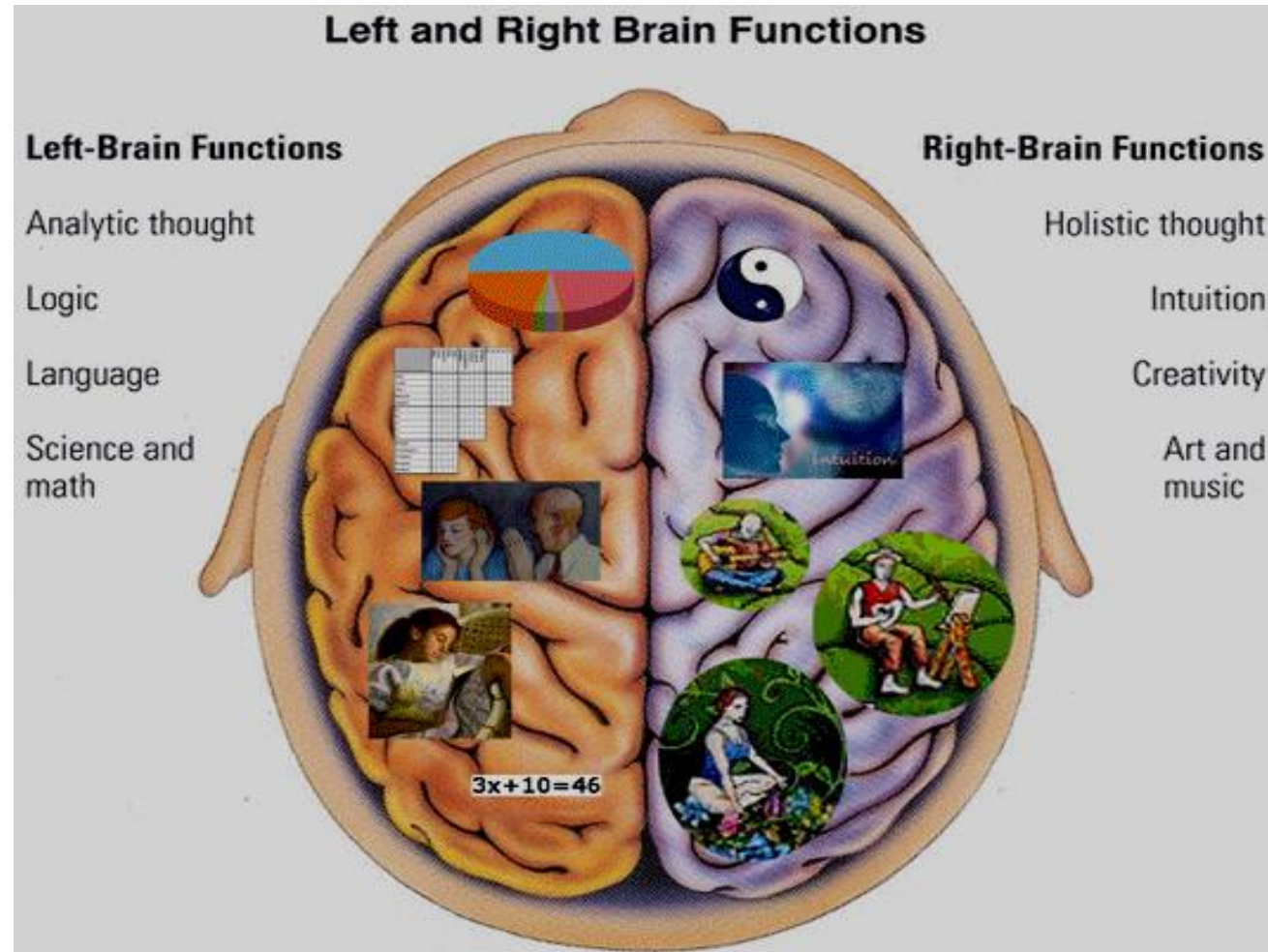
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# Lateralization of cerebral functions





# Lateralization of cerebral functions



Aphasia

Acalculia

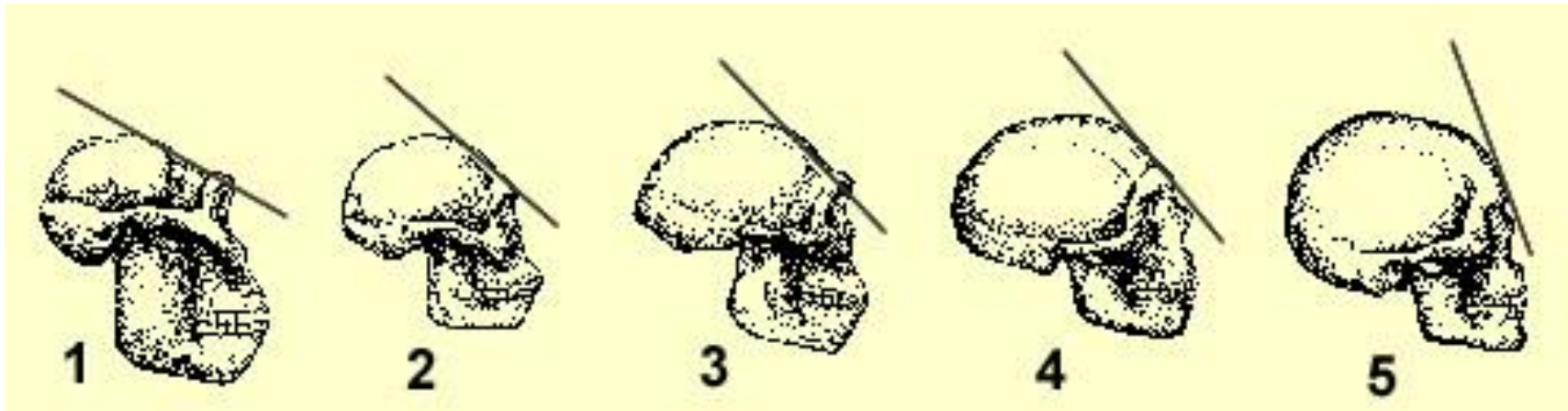
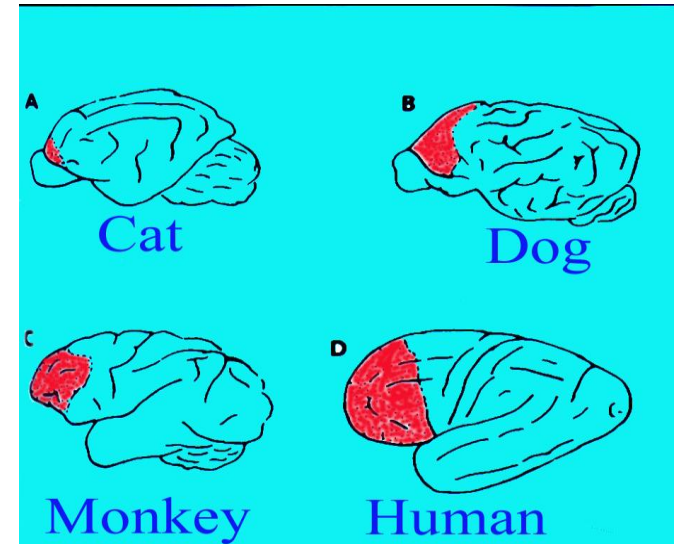
Tactile agnosia

Conceptual apraxia

Ideomotor apraxia

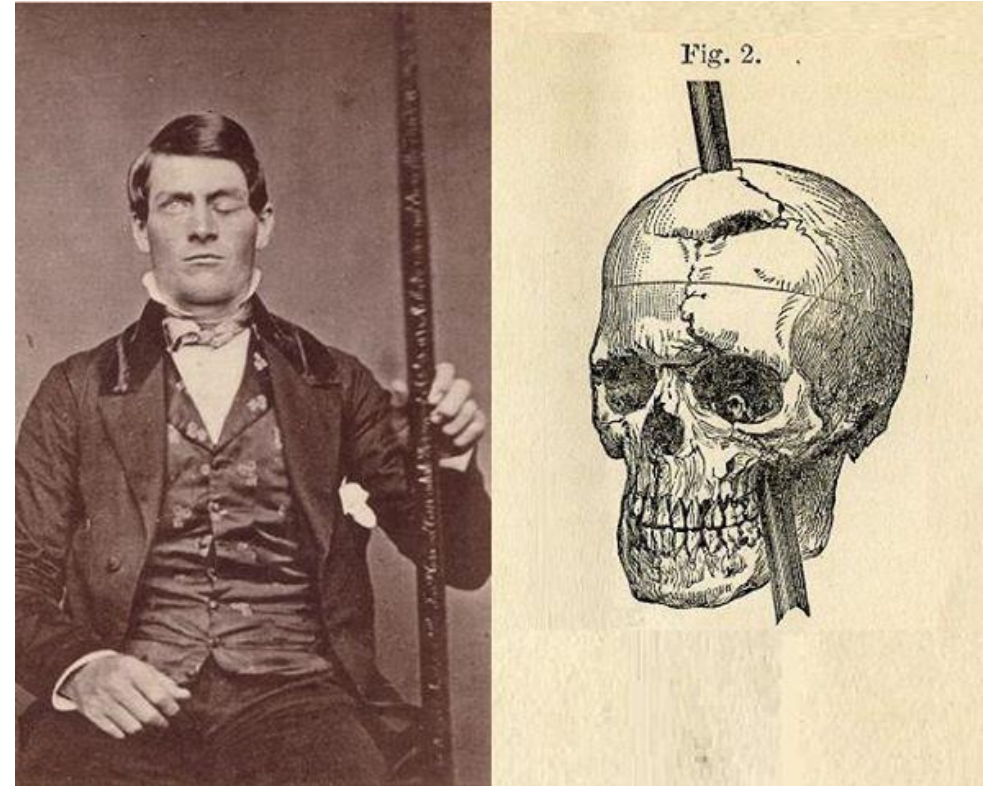
# Frontal association area

- Executive function
  - Motor / behavioral
  - Cognitive
- Mostly developed in human



# Phinease Gage (1823 – 1860)

- 1848 – work injury
- Before injury
  - Reliable
  - Friendly
  - Responsible
  - Polite

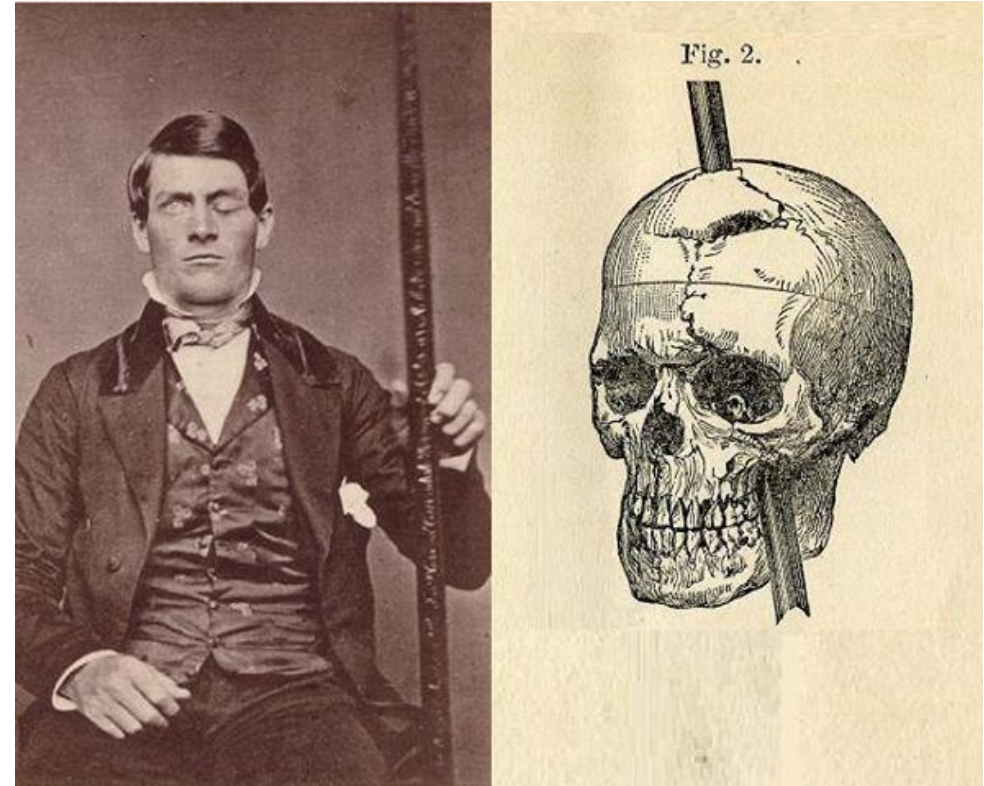


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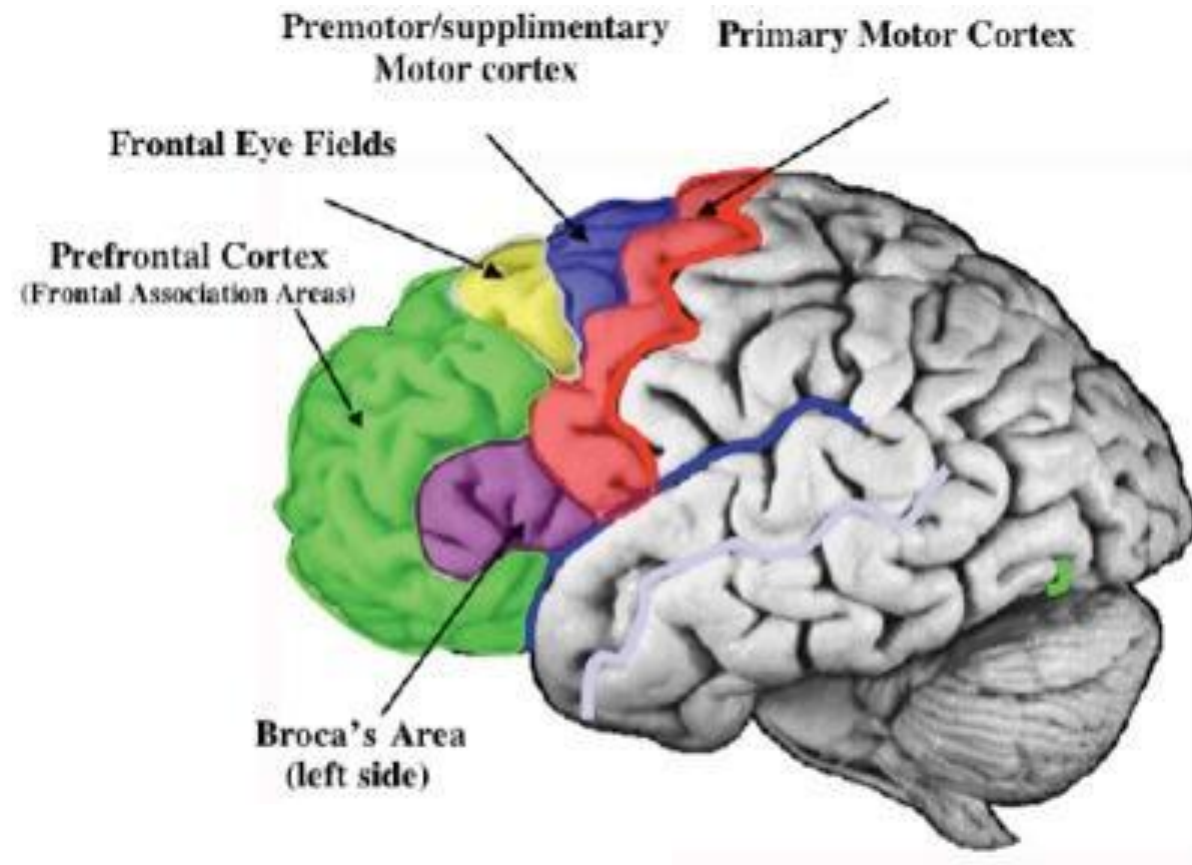
# Phineas Gage (1823 – 1860)

- 1848 – work injury
- Before injury
  - Reliable
  - Friendly
  - Responsible
  - Polite
- After injury
  - Unreliable
  - Hostile
  - Irresponsible
  - Rude
- 1860 – died from status epilepticus



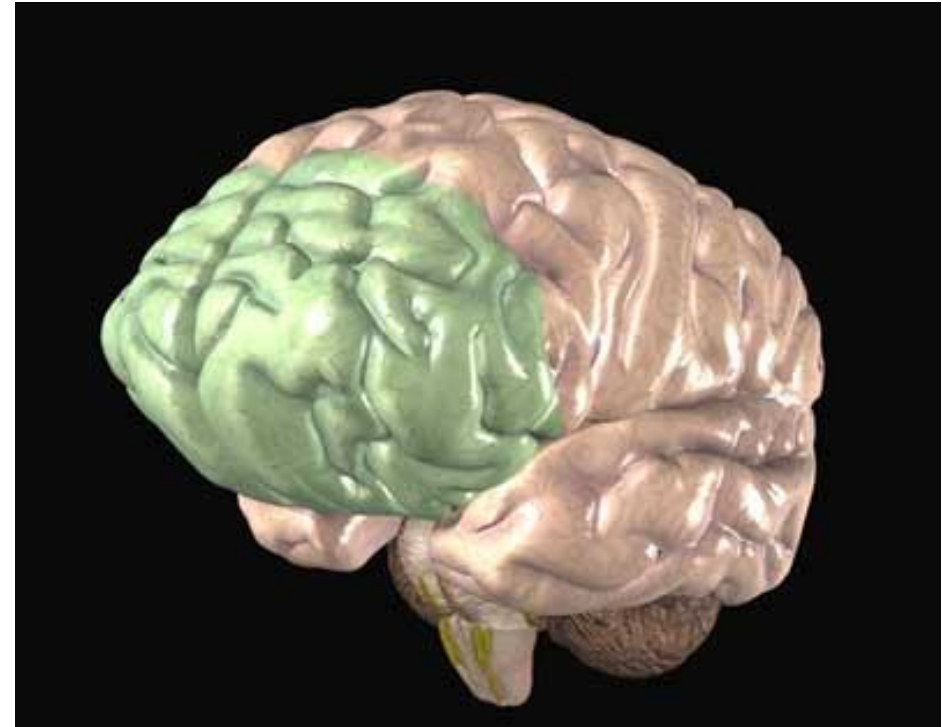
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# Frontal lobe



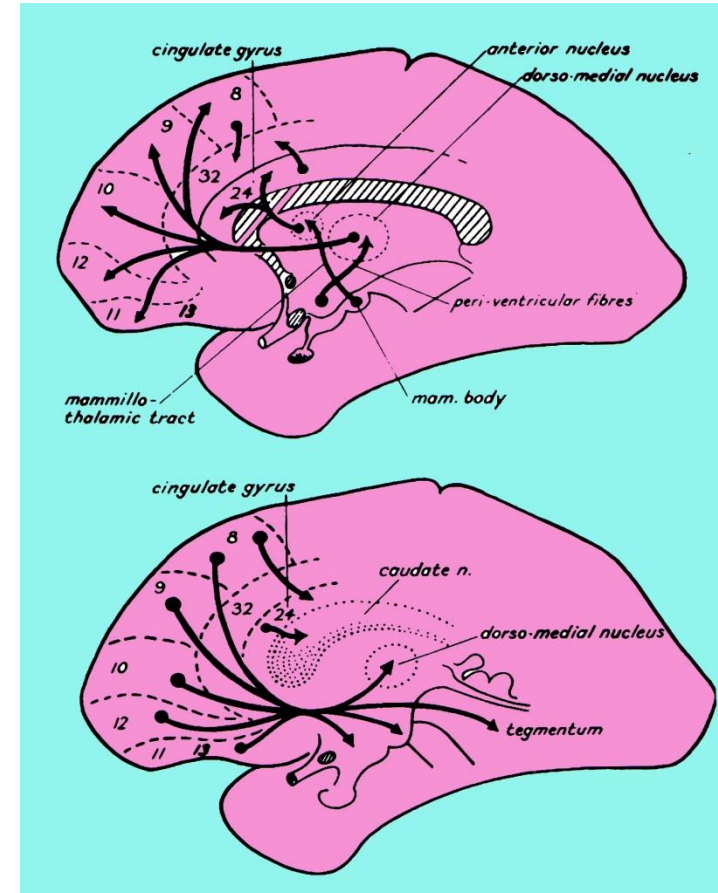
# Frontal association area

- ~ 1/3 of neocortex
- One of the evolutionary youngest cortical areas
- Late development in ontogeny
  - Differentiation during the 1st year of life
  - Mostly developed around the 6th year of life
  - ? End of maturation around the 20th year of life?



# Frontal association area

- Input from association cortex
  - P-O-T association area
  - Limbic association area
- Reciprocal connections:
  - prefrontal processing modulates perceptual processing
  - „Loops“
- Input to premotor areas



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# Functions of frontal association area

- Motor/non-motor planning/organization - strategy - anticipation

- Thinking – mental models processing

- Attention – „information filtering“

- Behavioral control
  - Facilitation of „wanted“
  - Inhibition of „unwanted“



<http://thenextweb.com/wp-content/blogs.dir/1/files/2015/03/jerry1.jpg>



<http://thenextweb.com/wp-content/blogs.dir/1/files/2015/03/jerry1.jpg>

# 1. Motor planning / organization

- Frontal association area
- Premotor area
- ✓ Close cooperation with motor cortex
- ✓ Planning and preparing of complex motor action (in cooperation with Basal ganglia)
- ✓ Close cooperation with P-O-T area which sends visual-acoustic-sensory-spatial information
- ✓ Voluntary motor control



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## 2. Thinking skills

- Organization
  - The ability to arrange information in a meaningful system
- Planning
  - The ability to create a strategy for reaching goals
- Time management
  - The ability to estimate time needed for reaching goals
- Working memory
  - The ability to hold information in awareness while performing a mental operation



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# 3. Attention

- Selective attention
  - The ability to filter information
- Sustained attention
  - The ability to actively attend to a task
- Divided attention
  - The ability to attend to two tasks at once
- Shifting attention
  - The ability to shift attention between two or more tasks



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# 4. Behavioral control

- Facilitation/ initiation of „wanted“ (re)action
- Inhibition of „unwanted“ (re)action
  - Anticipation
  - Self-regulation x procrastination
- Flexibility
  - The ability to revise plans when it is needed
- Goal-directed persistence
  - The ability to self-motivate
- Social brain
  - Mentalization
  - Empathy
    - Social behavior - frontal association area
    - Instinct behavior - limbic association area



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# Frontal lobe and mental arousal

- Right frontal lobe
  - Bilateral influence
  - Inhibition
- Left frontal lobe
  - Unilateral influence
  - Activation
- Left frontal lobe damage
  - Reduced spontaneous activity
  - Reduced self-control; impulsive instinct behavior



<http://www.anna-om-line.com/BRAIN-GRAPHICS-by-annaOMline.jpg>

# Frontal lobe functions

<b>Motor</b>	<b>Cognitive</b>	<b>Behavior</b>	<b>Arousal</b>
Voluntary movements	Memory	Personality	Attention
Language Expression	Problem solving	Social and sexual	
Eye movements	Judgment	Impulse control	
Initiation	Abstract thinking	Mood and affect	
Spontaneity			

## 85. The basic characterization of neocortical functions – primary vs. association areas, topographical overview of cortical functions

- Neocortex – majority of cerebral cortex - 95% (Paelo 1%, Archi 4%...)
- Basic overview of neocortical cytoarchitecture (6 layers, specific inputs/outputs to from each layer, both vertical and horizontal connections, local differences - Brodman)
- Definition and comparison of primary and association areas
  - Somatotopic vs. non-somatotopic
  - Unimodal and polymodal association areas
- Topographical overview of cortical functions (localization and function)
  - Primary areas (motor, somatosensory...)
  - Association (...Parietooccipital – „analytic“, frontal – „executive“, limbic – not a neocortex, but from functional point of view it is a regular and the most important association area – integration of information from inner and outer environment, neocortex is overridden by hypothalamus)
  - Lateralization of brain functions

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