MUNI
MED

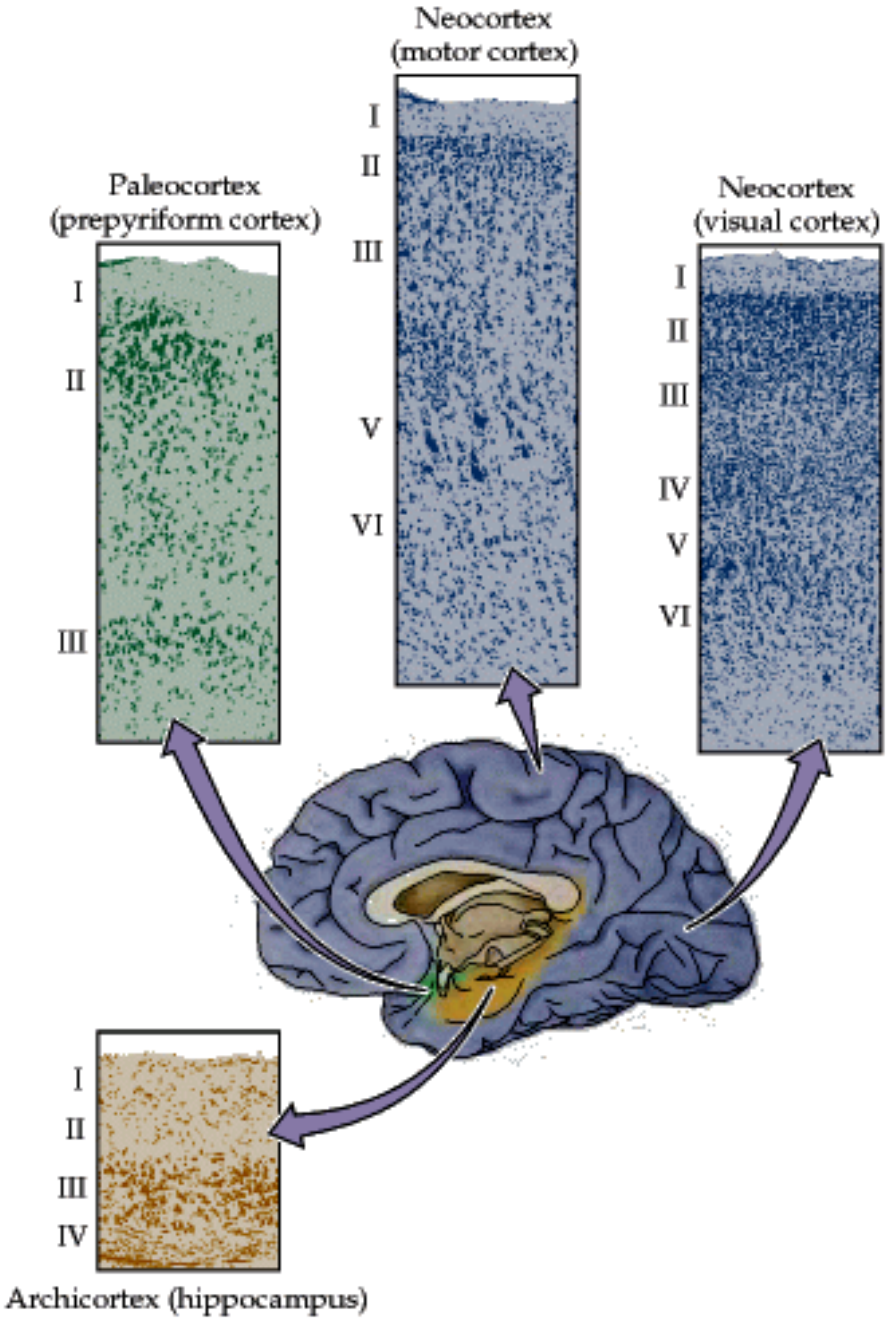
MUNI
MED

# 15

# Neocortex I

# Cerebral cortex

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

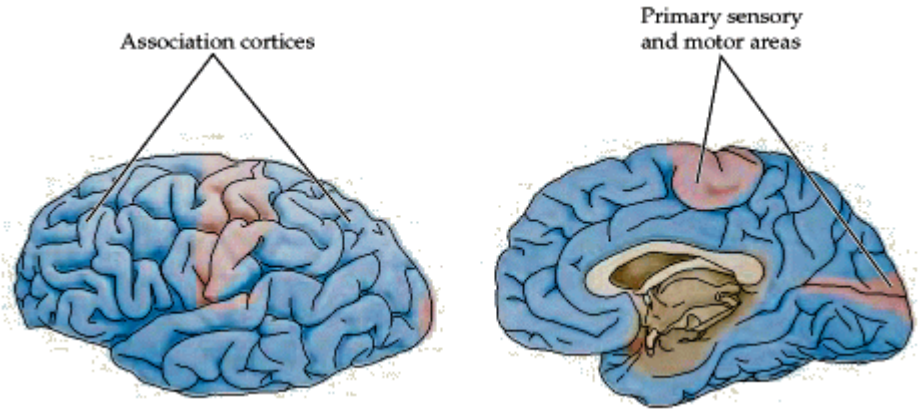



http://www.slideshare.net/drpsdeb/presentations



MUNI MED

# Neocortex




**Primary areas**

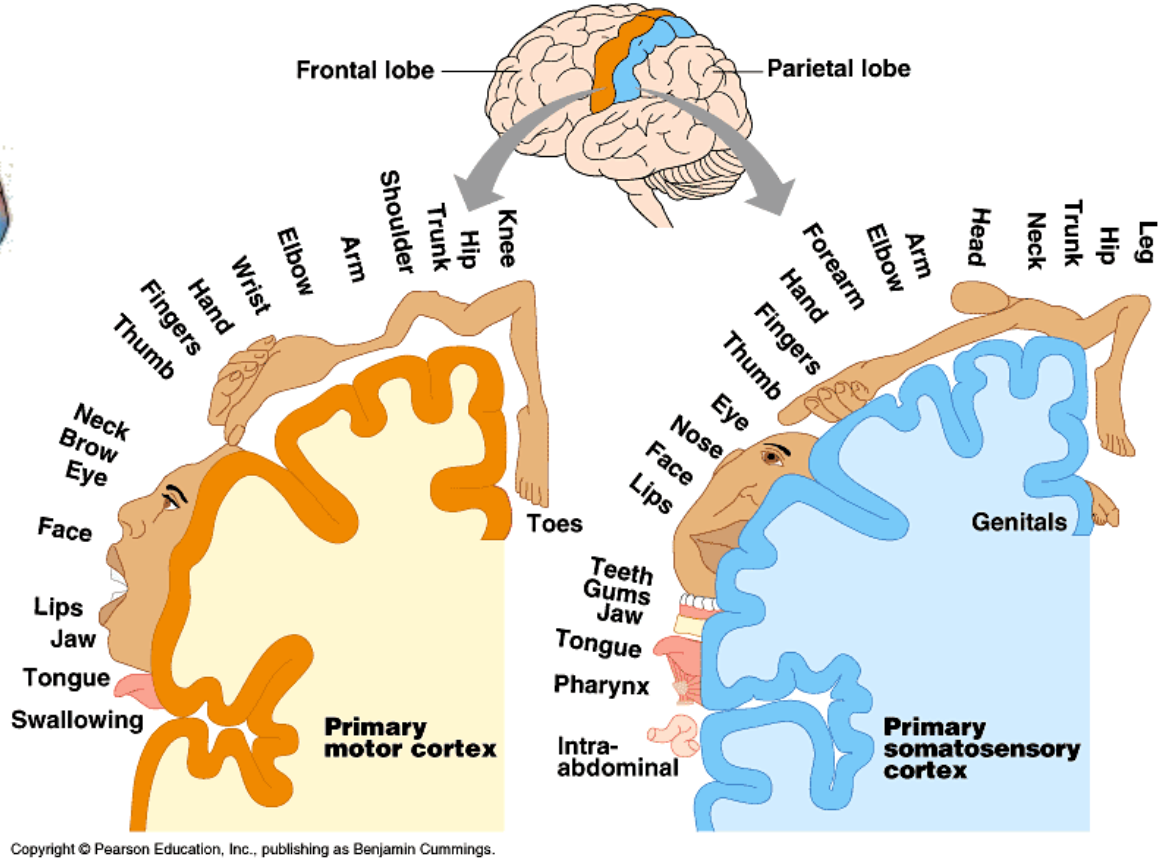
✓Somathotopic organization

**Association areas**

✓No somathotopic organization

✓Unimodal

✓Polymodal

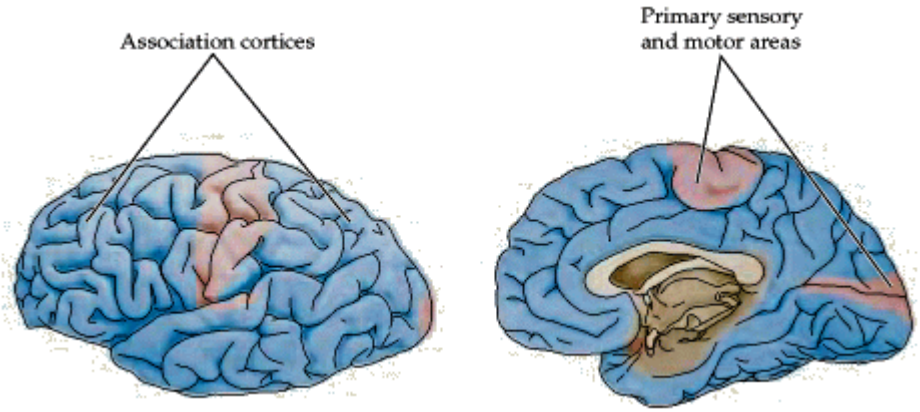



http://www.emunix.emich.edu



MUNI MED

# Neocortex




**Primary areas**

✓Somathotopic organization

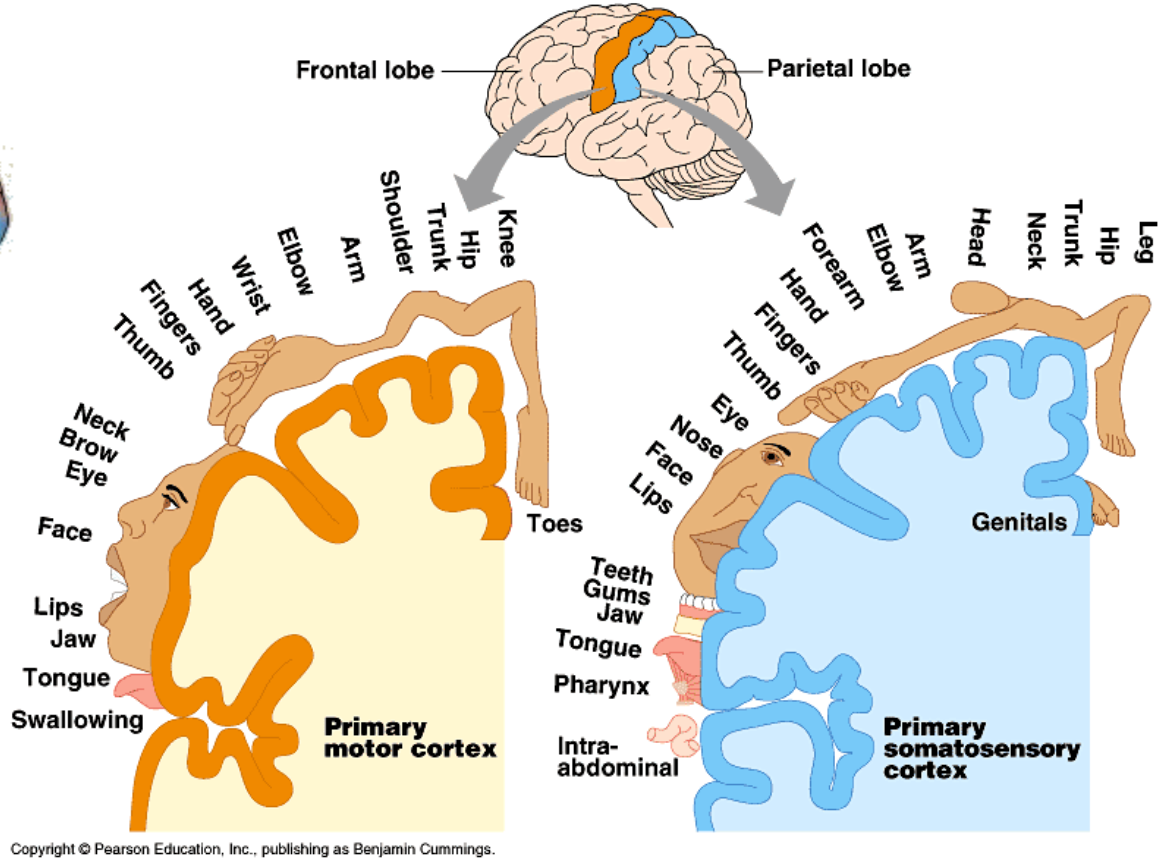
**Association areas**

✓No somathotopic organization

✓Unimodal

✓Polymodal

✓Association areas are thought to be the anatomical substrates of the highest brain functions—conscious thought, perception, and goal-directed action



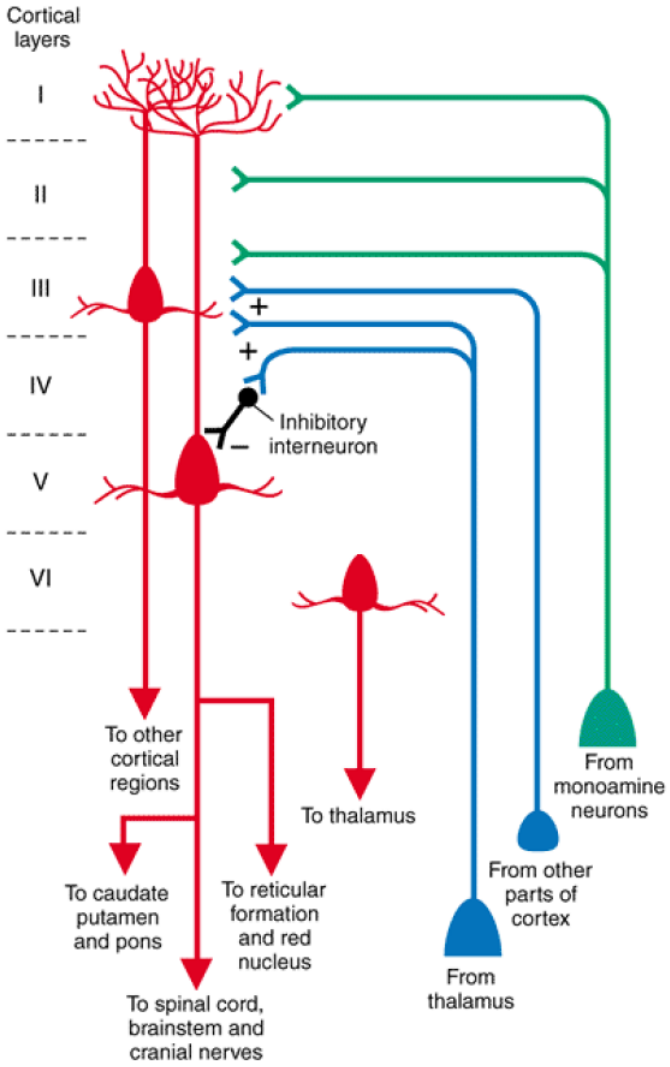

http://www.emunix.emich.edu



MUNI MED

# 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




http://www.slideshare.net/drpsdeb/presentations

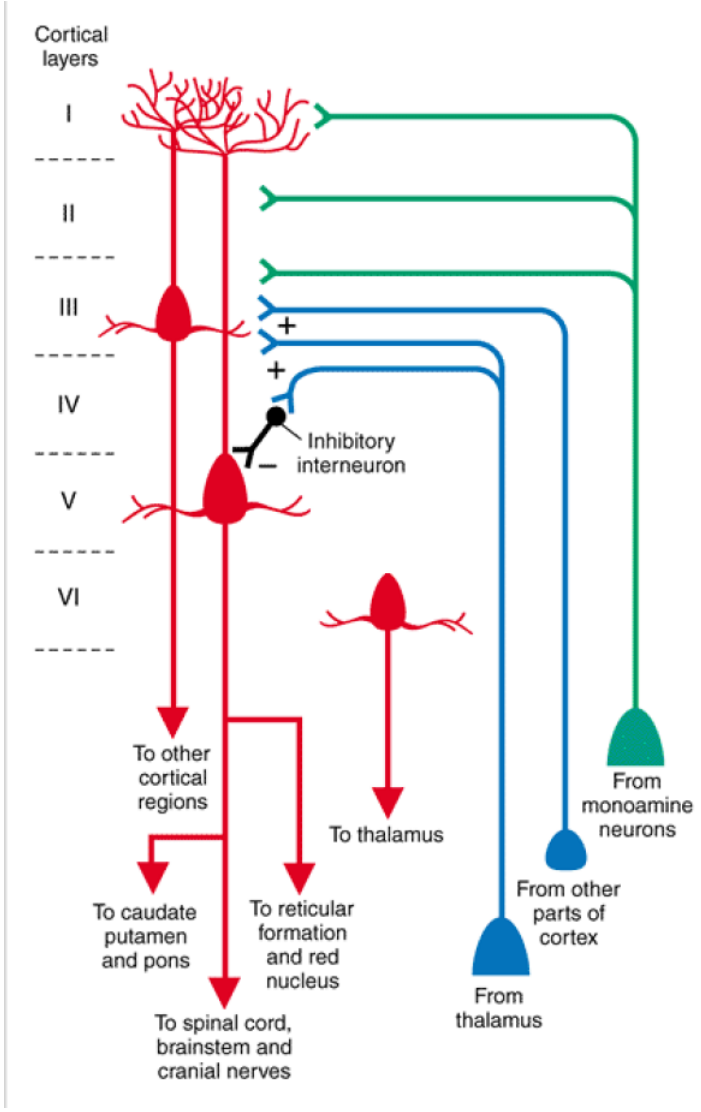


MUNI MED

# 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



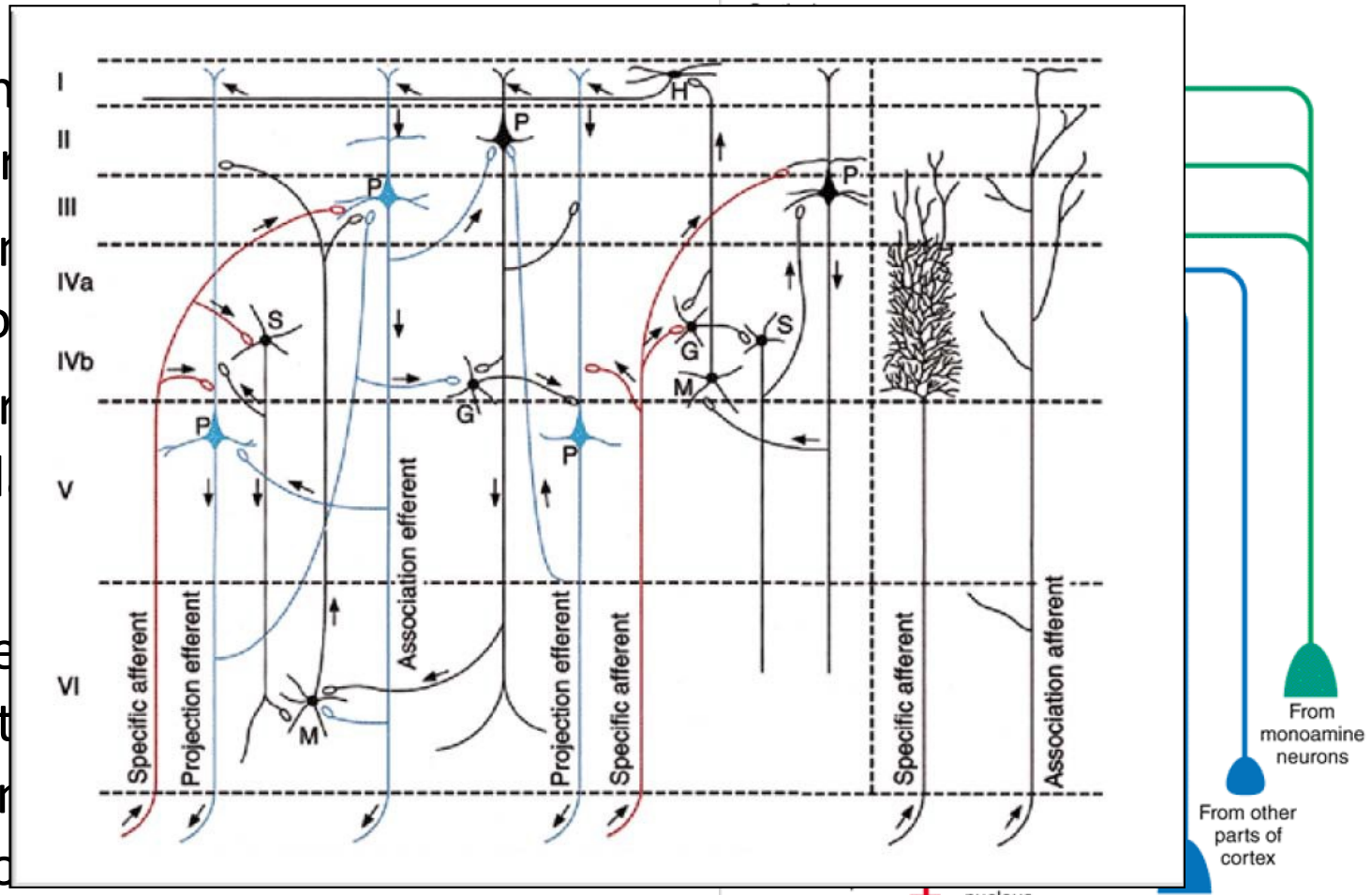

http://www.slideshare.net/drpsdeb/presentations



MUNI MED

# Organization of neocortex

- Specific in
  each layer
- Vertical ar
  connectio
- Each layer
  with simil
- Local diffe
  cytoarchit
  Brodmann
  the map c



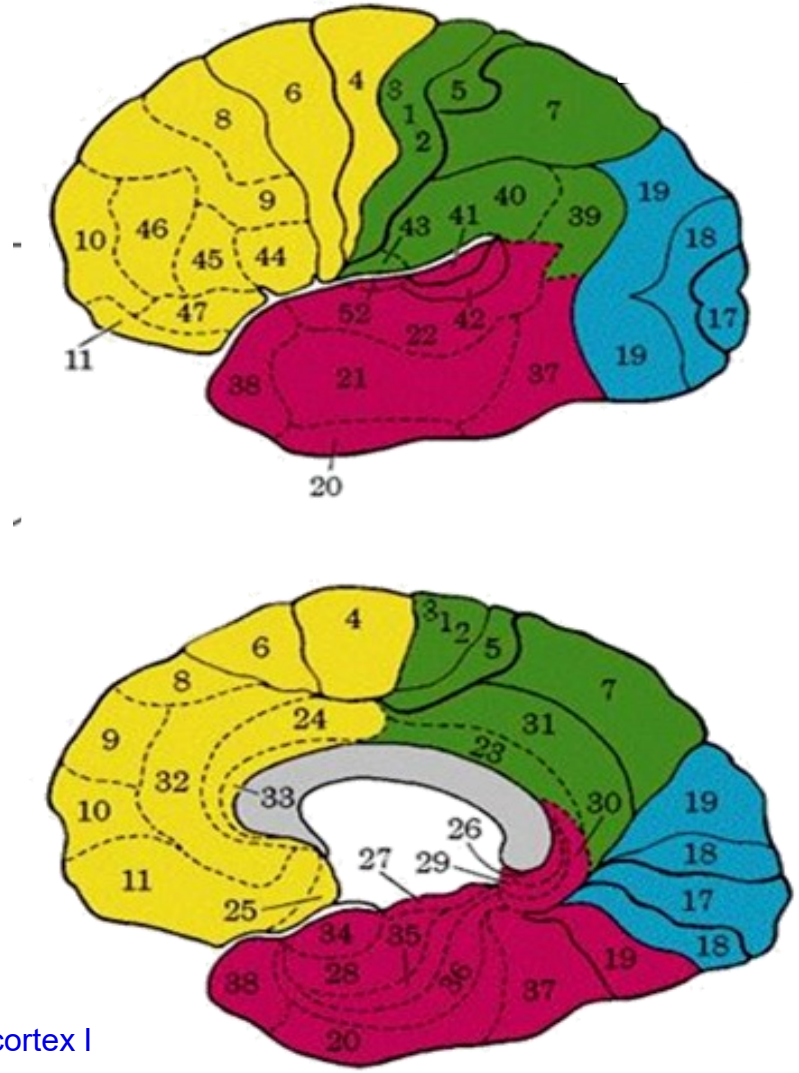

http://www.slideshare.net/drpsdeb/presentations

http://www.slideshare.net/drpsdeb/presentations



MUNI MED

# Brodman areas

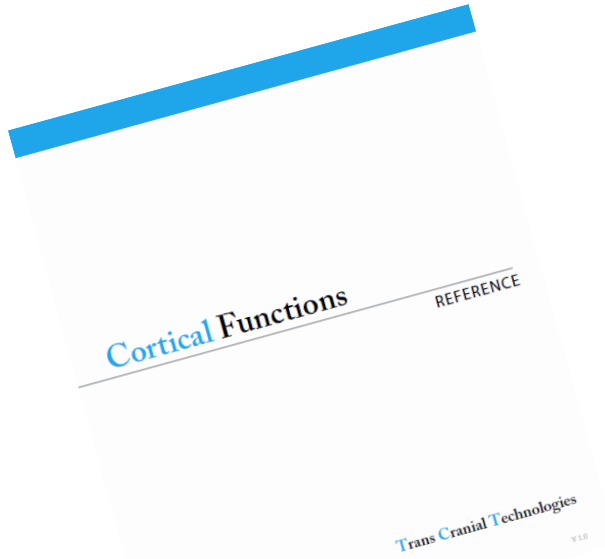



| Broadman's # | NAME | FUNCTION |
|---|---|---|
| 17 | Occipital Lobe | Visual Projection Cortex |
| 18 | | Visual Association Cortex |
| 19 | Posterior Parietal Lobe | Visual Association Cortex |
| 37 | Tempero-parietal-occipital area | General Sensory Association Cortex |
| 39 | Angular Gyrus | Word 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 | Preftontal Cortex | General Motor Association Cortex |
| 11 | Orbital Gyri | General Motor Association Cortex |



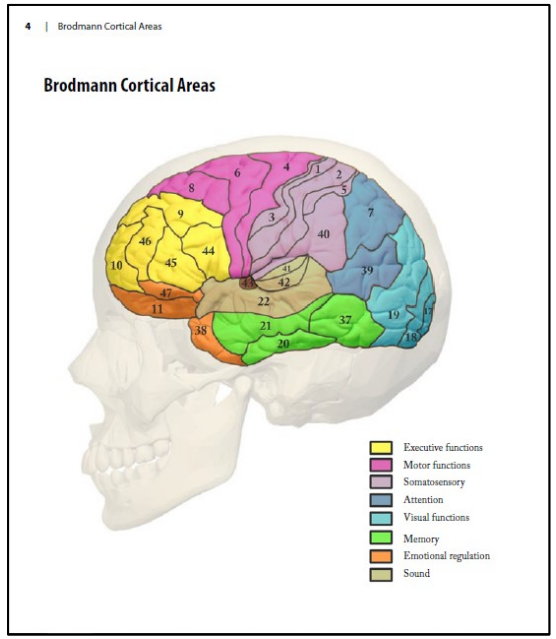
MUNI MED

https://www.trans-cranial.com/docs/cortical_functions_ref_v1_0_pdf.pdf


Cortical Functions

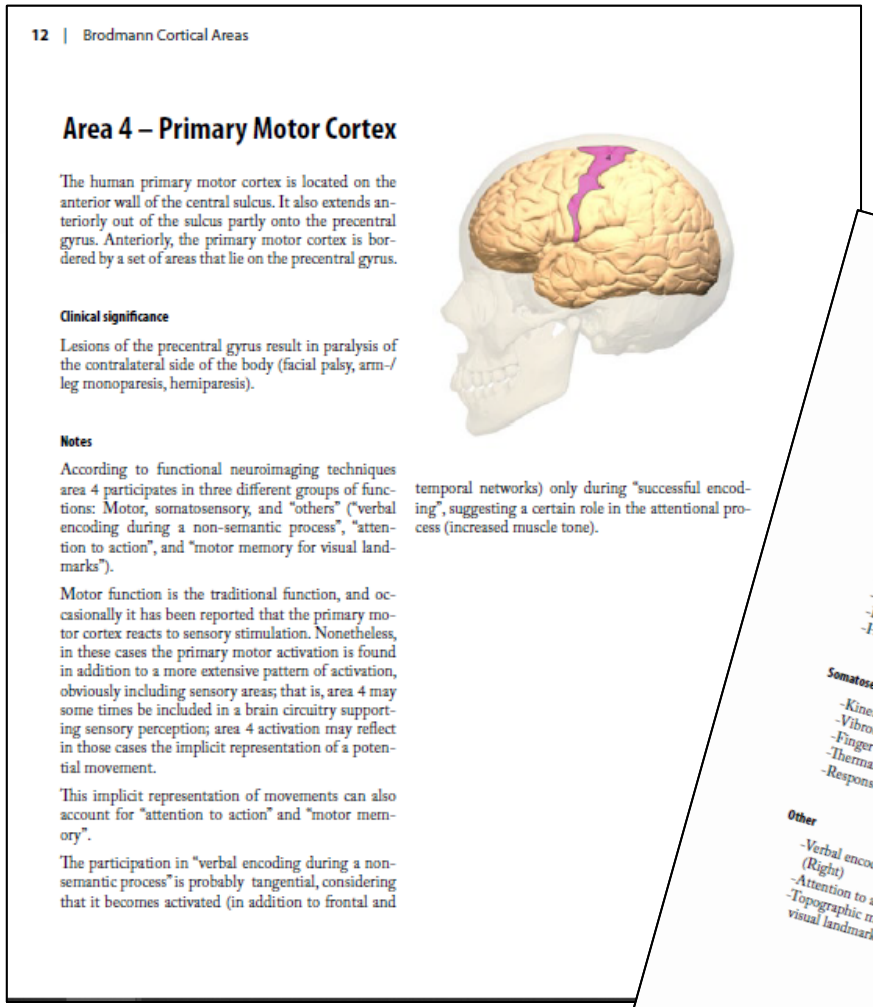
REFERENCE

Trans Cranial Technologies


4 | Brodmann Cortical Areas

Brodmann Cortical Areas

Executive functions
Motor functions
Somatosensory
Attention
Visual functions
Memory
Emotional regulation
Sound


12 | Brodmann Cortical Areas

## 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**

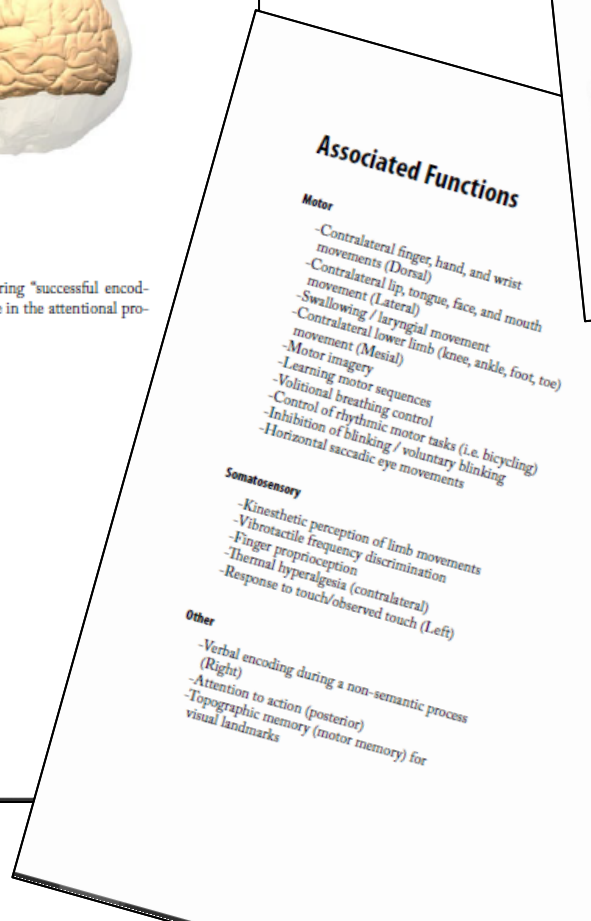
According to functional neuroimaging techniques area 4 participates in three different groups of functions: Motor, somatosensory, and "others" ("verbal encoding during a non-semantic process", "attention to action", and "motor memory for visual landmarks").

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**

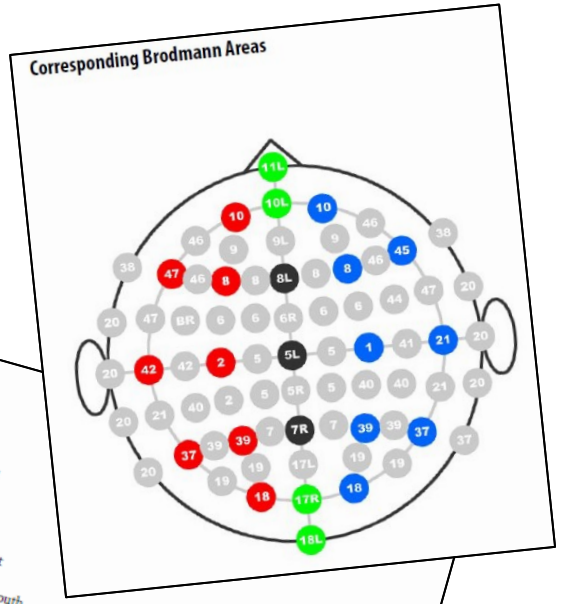
-Contralateral finger, hand, and wrist movements (Dorsal)
-Contralateral lip, tongue, face, and mouth movement (Lateral)
-Swallowing / laryngial movement
-Contralateral lower limb (knee, ankle, foot, toe) movement (Mesial)
-Motor imagery
-Learning motor sequences
-Volitional breathing control
-Control 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

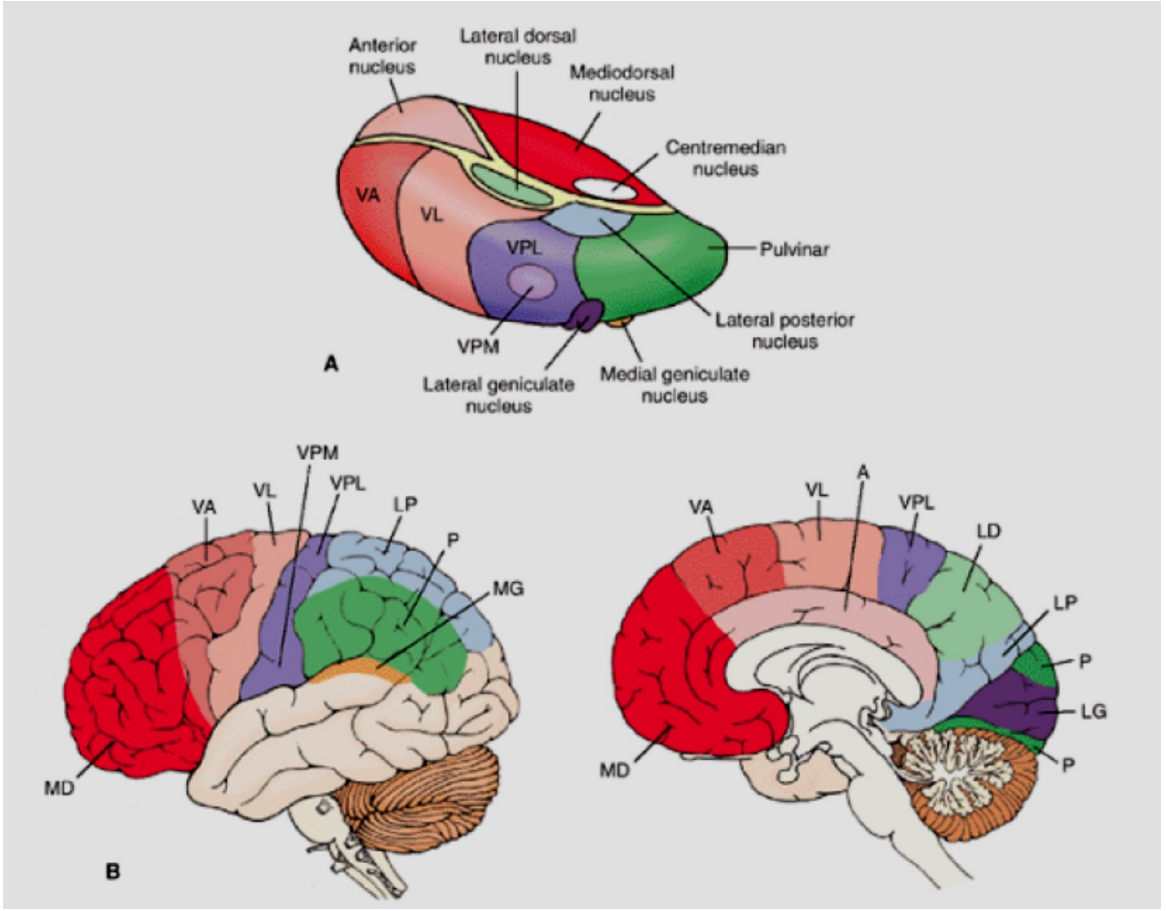

Corresponding Brodmann Areas



MUNI MED

# 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

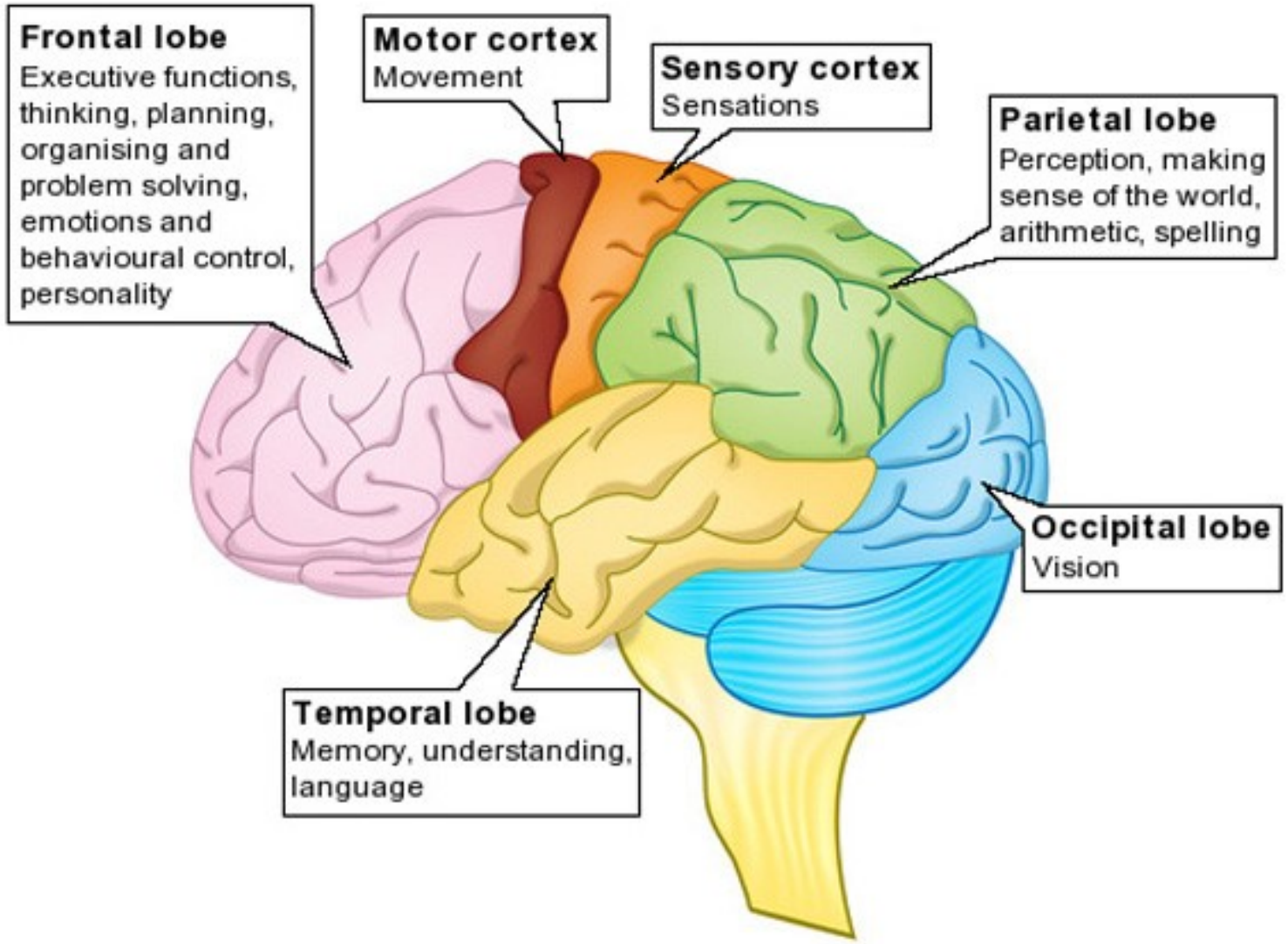



http://www.slideshare.net/drpsdeb/presentations



MUNI MED

# Cortical functions

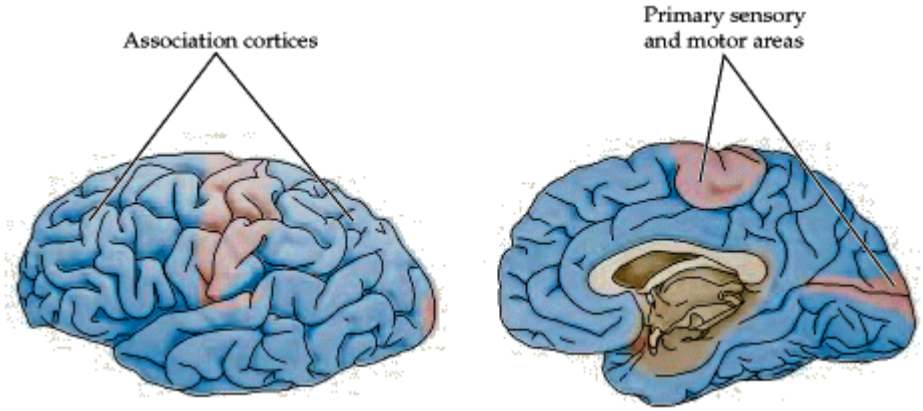



http://www.modernfamilyideas.com



MUNI MED

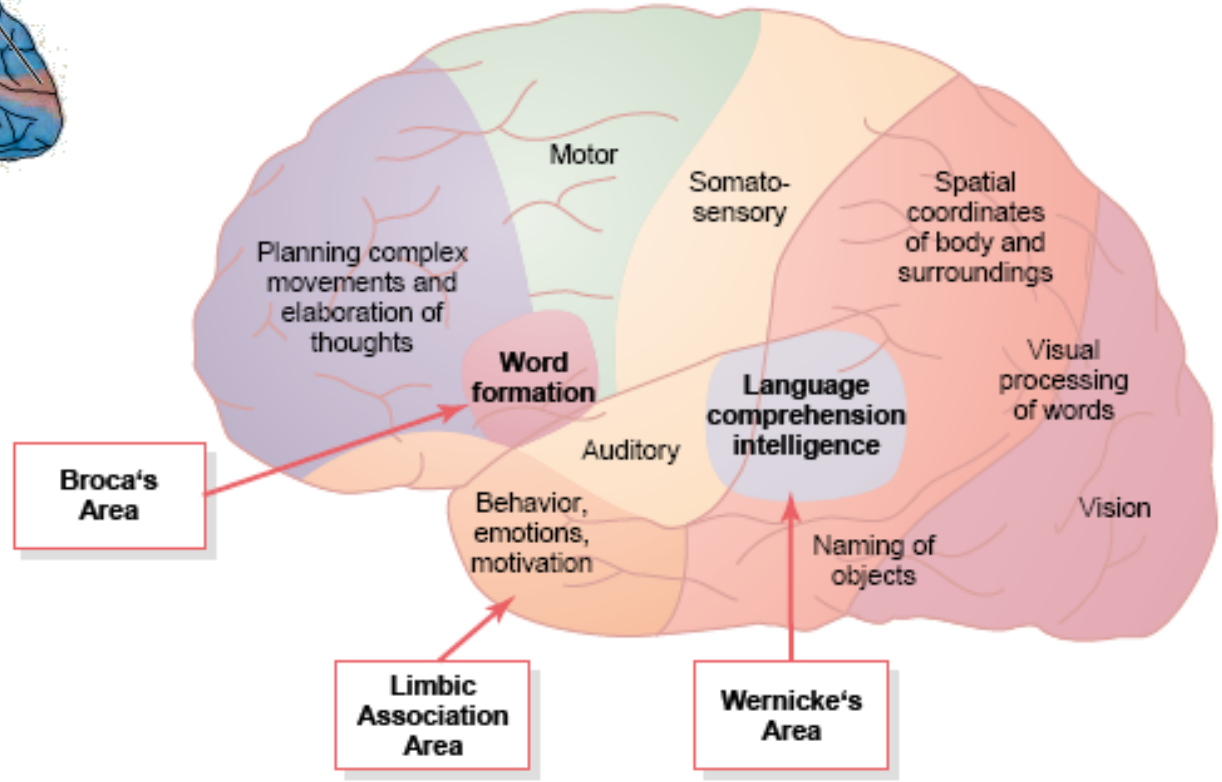
# Association areas




- Neither receptive
- Nor effector

- Integrative function

- Limbic
- Parieto-occipito-temporal
- Frontal

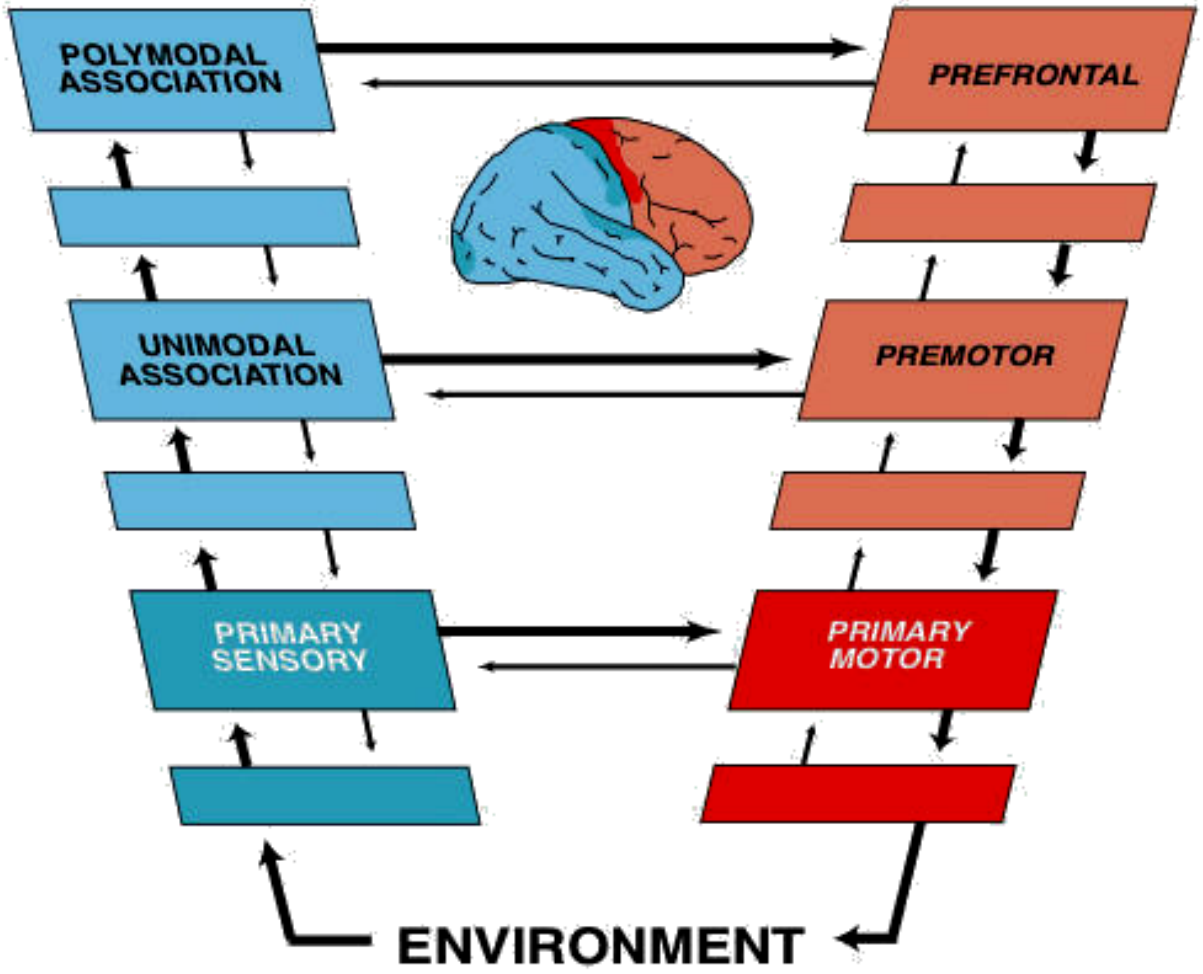



http://www.slideshare.net/drpsdeb/presentations



MUNI MED

# Signal processing algorithm



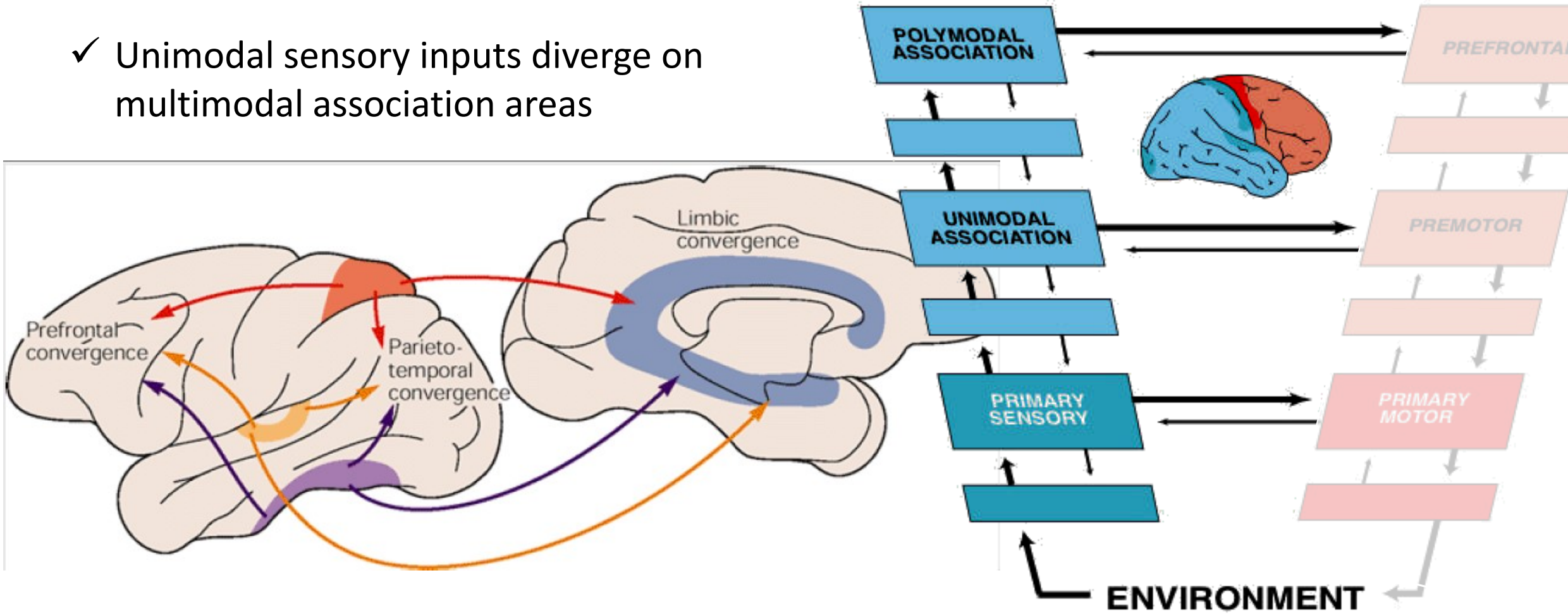

http://www.slideshare.net/drpsdeb/presentations



MUNI MED

# Aferentation

- ✓ Unimodal sensory inputs diverge on multimodal association areas

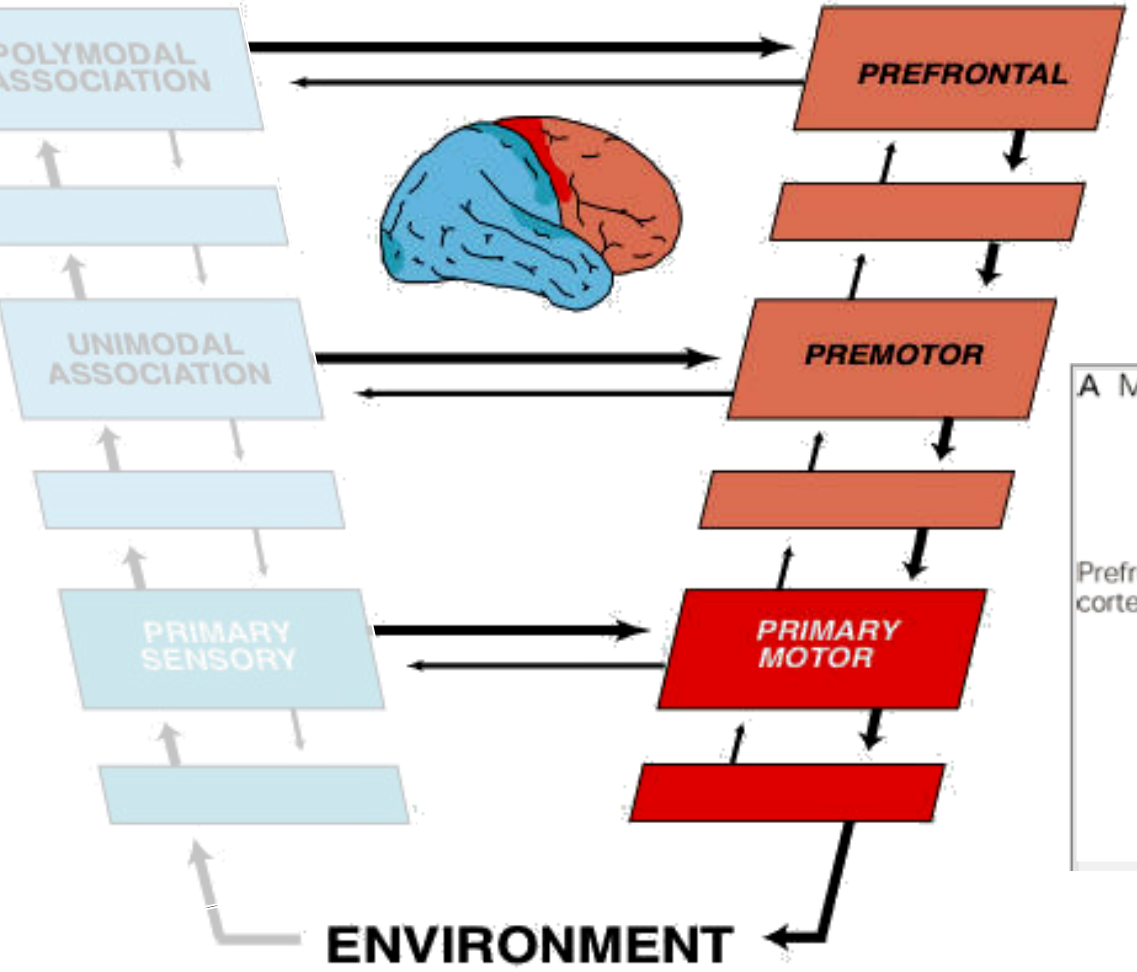



http://www.slideshare.net/drpsdeb/presentations

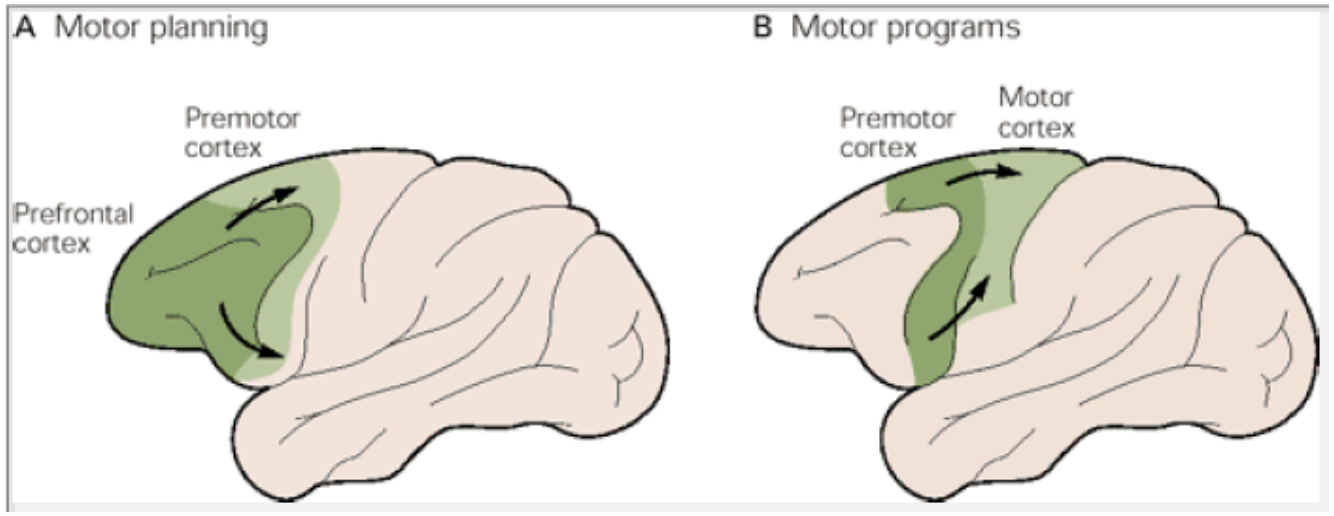


MUNI MED

# Eferentation




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




http://www.slideshare.net/drpsdeb/presentations



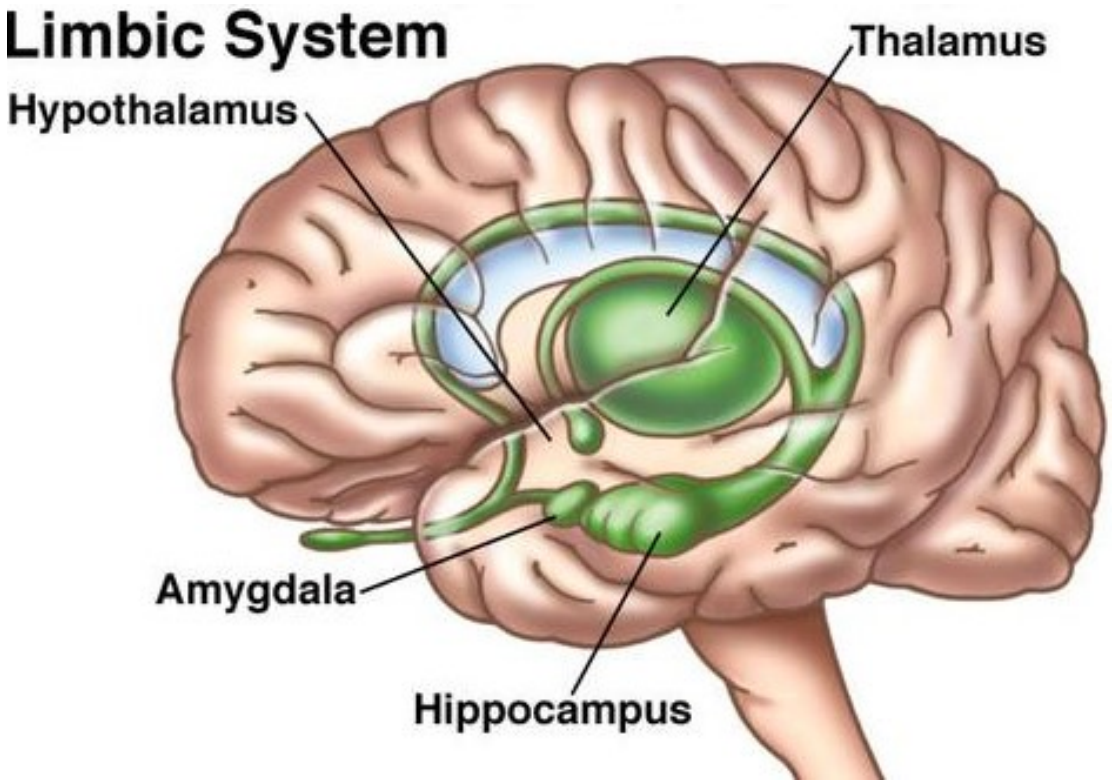
MUNI MED

# Limbic association area

- Integration of information from inner and outer environment

- Hypothalamus

- Emotions
- Motivation
- Instinct behavior




http://www.mhhe.com/biosci/genbio/enger/student/olc/art_quizzes/genbiomedia/0665.jpg

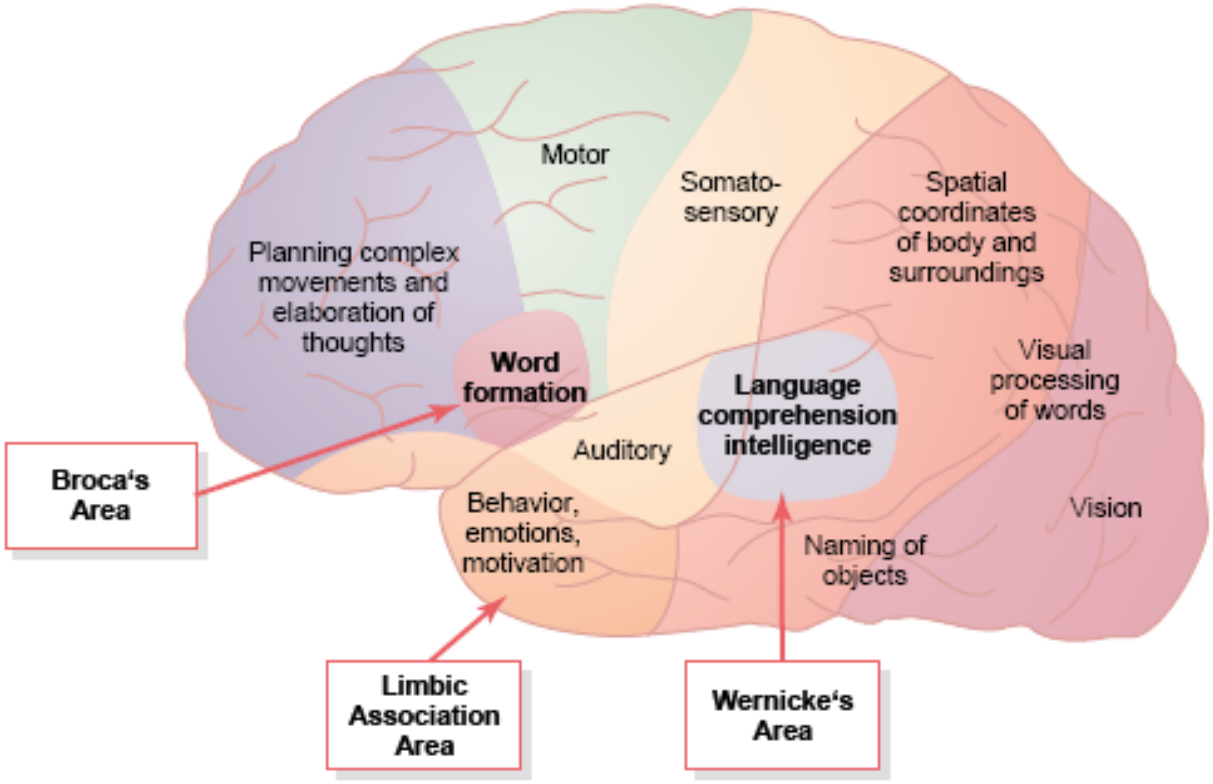


MUNI MED

# 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

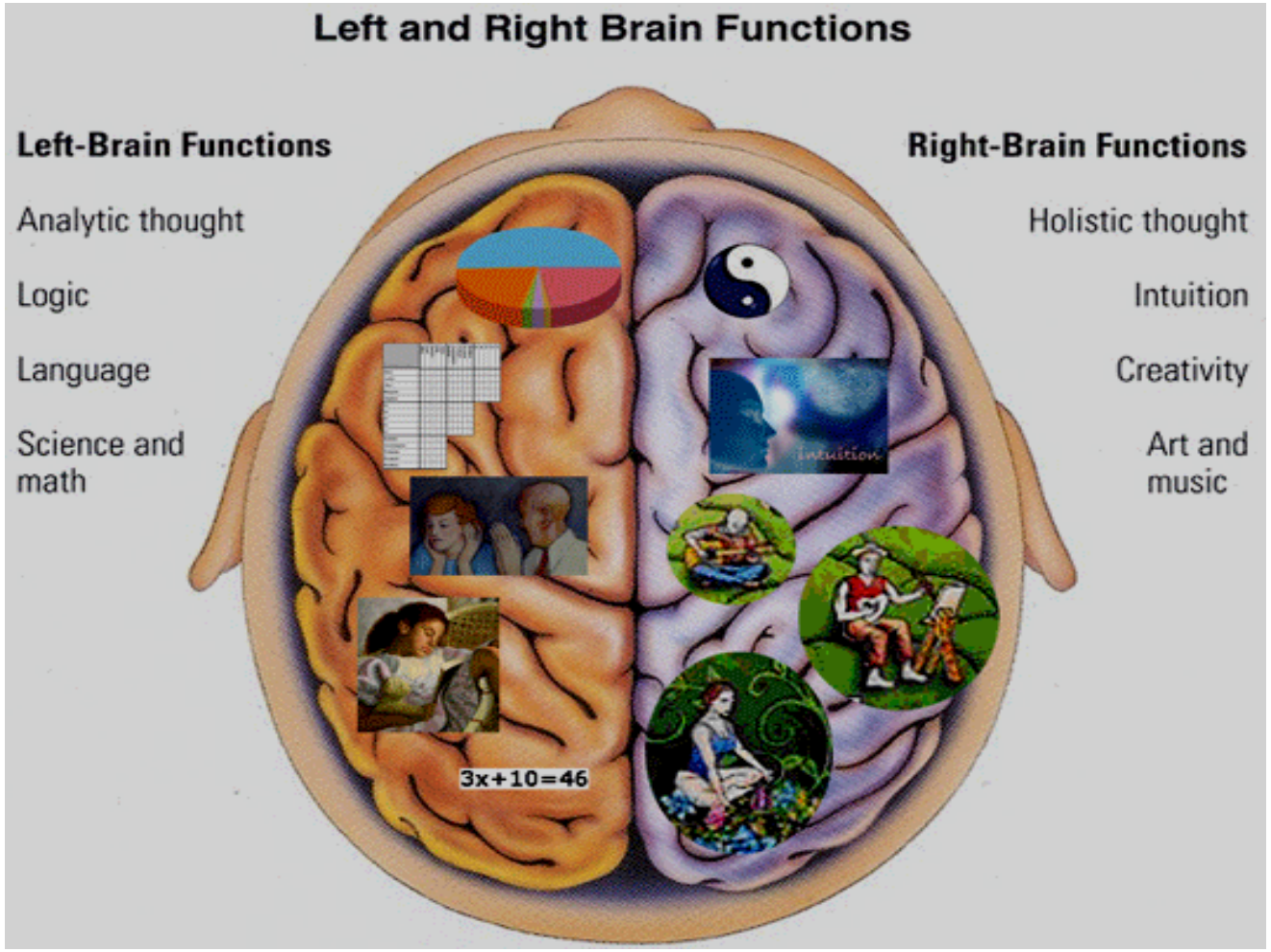



http://www.slideshare.net/drpsdeb/presentations



MUNI MED

# Lateralization of cerebral functions




http://www.slideshare.net/drpsdeb/presentations



MUNI MED

# Lateralization of cerebral functions

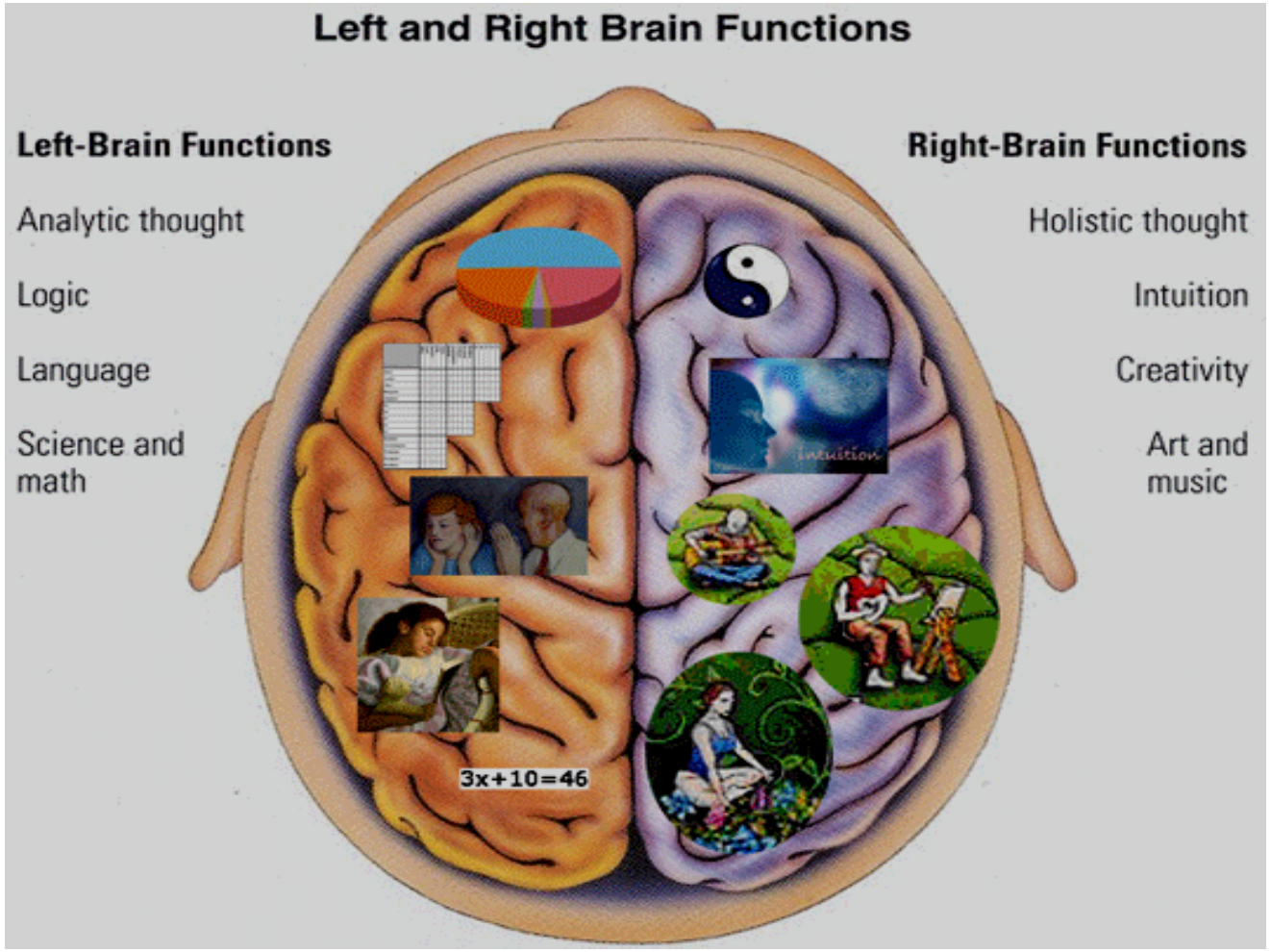
Aphasia

Acalculia

Tactile agnosia

Conceptual apraxia

Ideomotor apraxia




http://www.slideshare.net/drpsdeb/presentations

Orientation disorders

Constructional apraxia

Anosognosia

Neglect syndrome

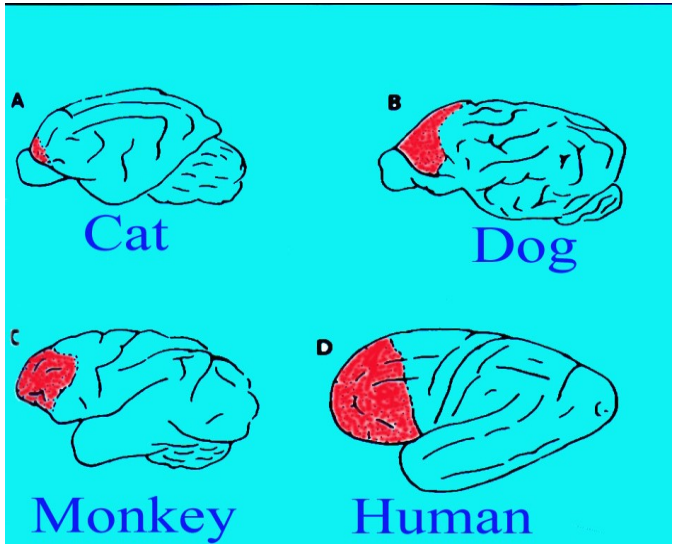


MUNI MED

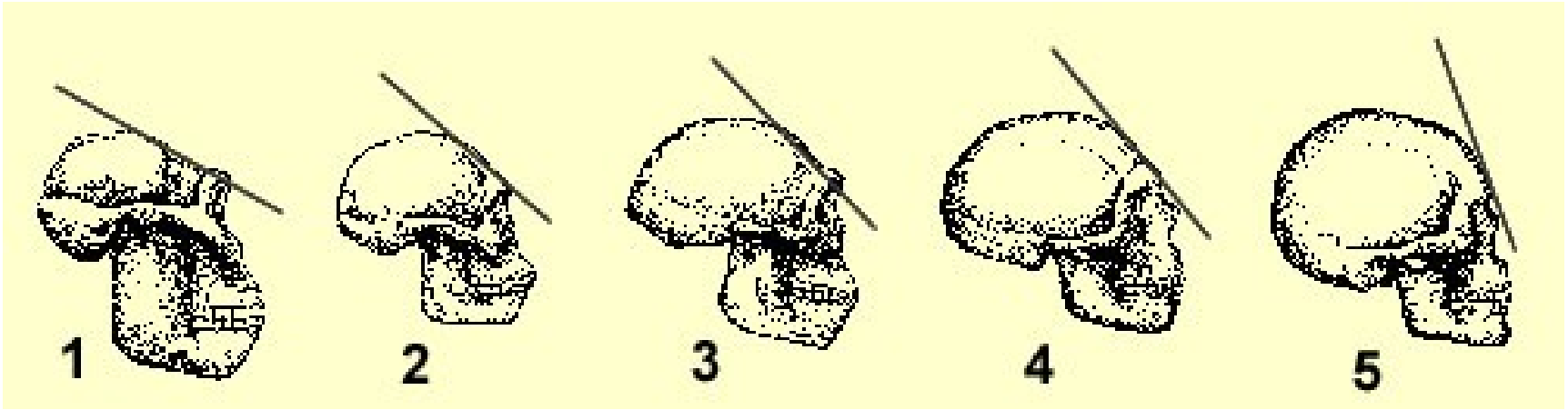
# Frontal association area

- Executive function
  - Motor / behavioral
  - Cognitive

- Mostly developed in human



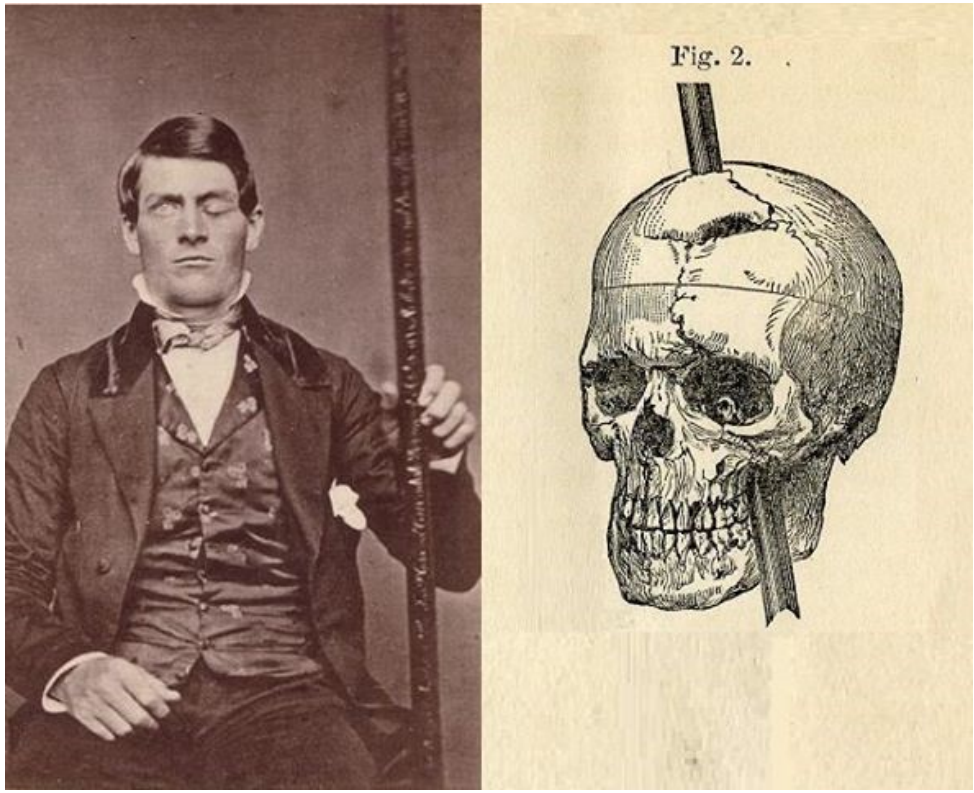

http://www.slideshare.net/drpsdeb/presentations




•1. *Australopithecus robustus* 2. *Homo habilis* 3. *Homo erectus* 4. *Homo sapiens neanderthalensis* 5. *Homo sapiens sapiens*

# Phinease Gage (1823 – 1860)

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



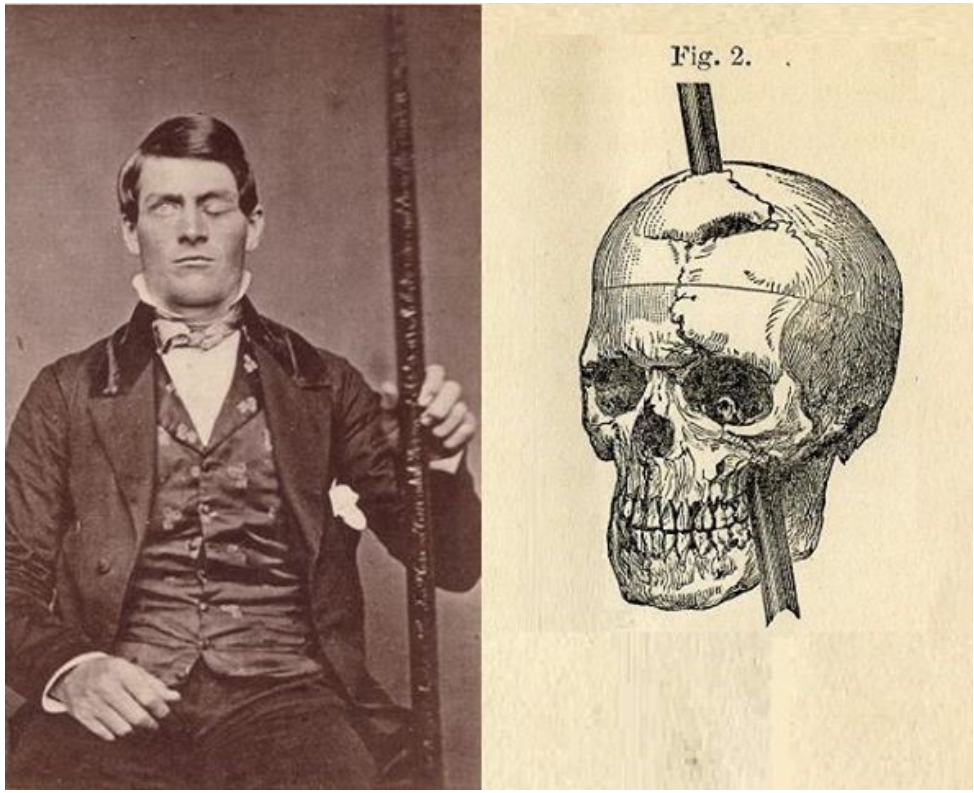

http://65.media.tumblr.com/553d3c3f3f579f57273b8598ec6739ab/tumblr_o11oqt0MUK1uaq7mqo1_1280.jpg



MUNI MED

# Phinease Gage (1823 – 1860)

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

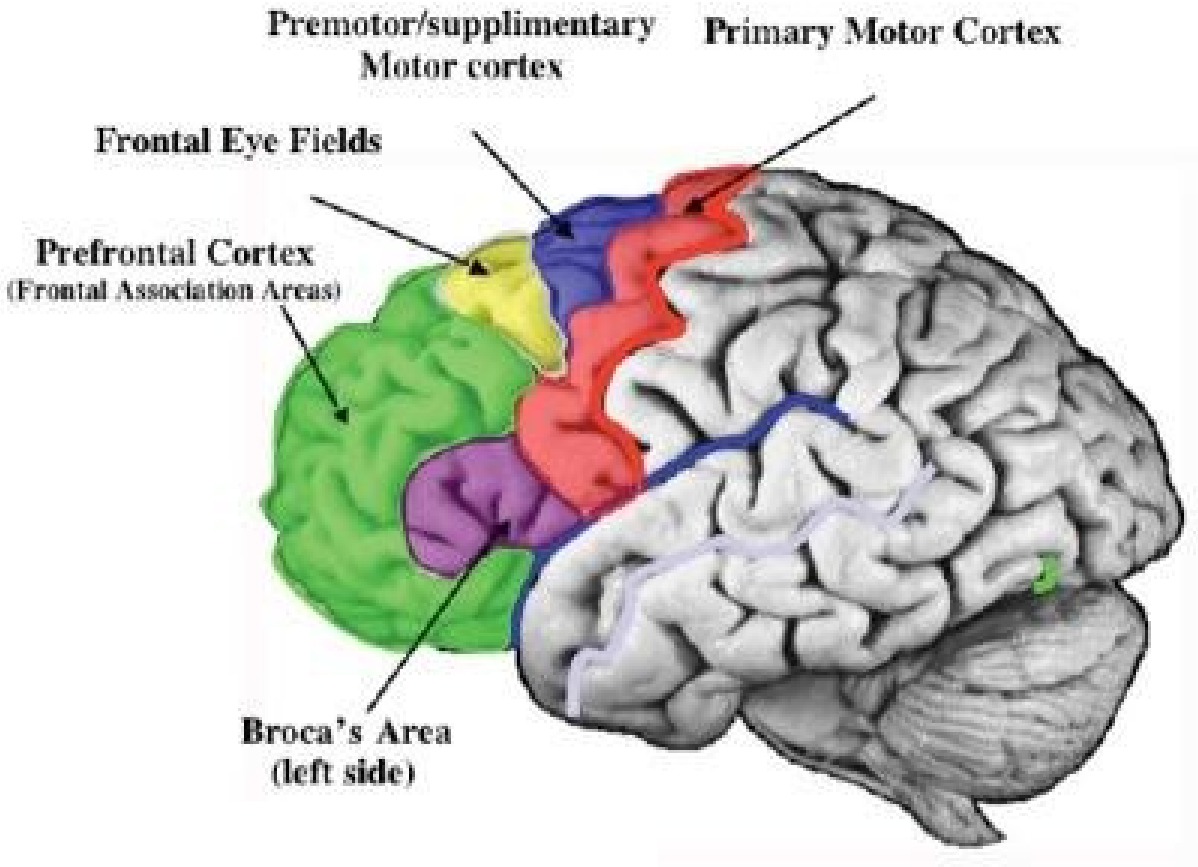



http://65.media.tumblr.com/553d3c3f3f579f57273b8598ec6739ab/tumblr_o11oqt0MUK1uaq7mqo1_1280.jpg



MUNI MED

# Frontal lobe



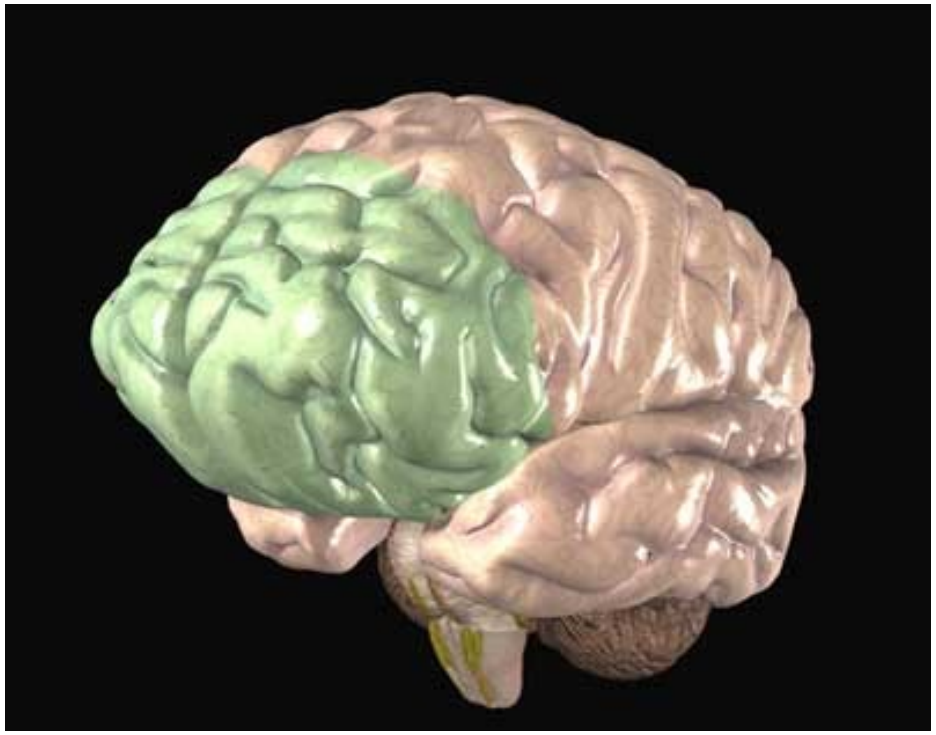

https://d2gne97vdumgn3.cloudfront.net/api/file/edAV1gWAQ2uYSdYHSiPj



MUNI MED

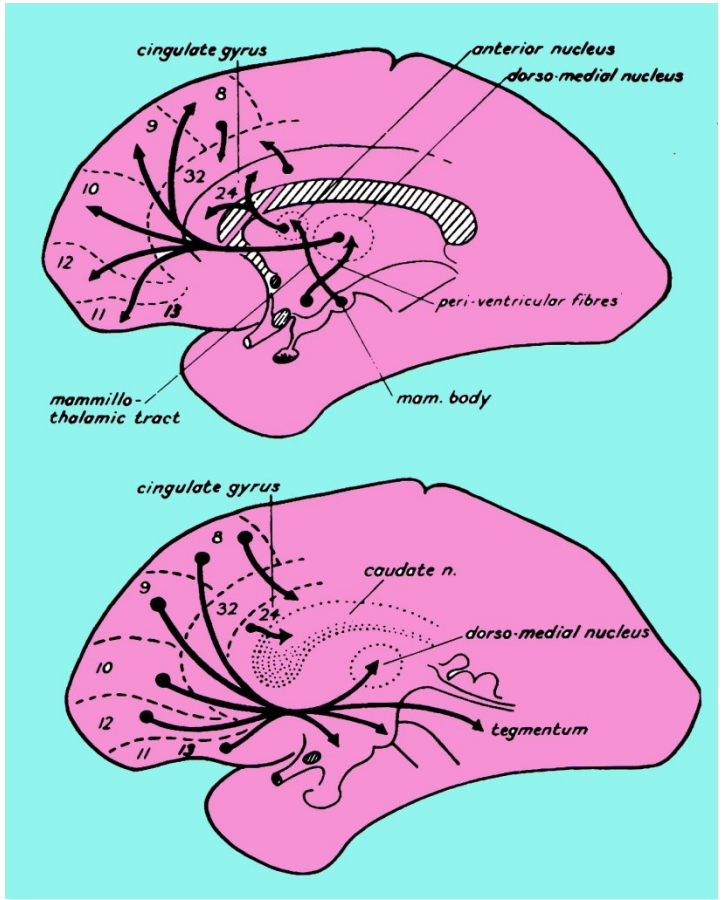
# Frontal association area

- ~ 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




http://www.slideshare.net/drpsdeb/presentations



MUNI MED

# Functions of frontal association area

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

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

- 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



MUNI MED

# 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

http://www.123rf.com/stock-photo/brain_icon.html?mediapopup=14828479



MUNI MED

# 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

http://www.123rf.com/stock-photo/brain_icon.html?mediapopup=14828479



MUNI MED

# 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

http://www.123rf.com/stock-photo/brain_icon.html?mediapopup=14828479



MUNI MED

# 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

http://www.123rf.com/stock-photo/brain_icon.html?mediapopup=14828479



MUNI MED

# 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



MUNI MED

# Frontal lobe functions

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

MUNI
MED

# 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
  - Somathotopic vs. non-somathotopic
  - Unimodal and polymodal association areas
- Toppographical overview of cortical functions (localization and fuction)
  - Primary areas (motor, somatosensory….)
  - Association (…Parietooccipital – „analytic“, frontal – „executive“, limbic – not a neokortex, but from functional point of view it is a regullar and the most important association area – integration of information from inner and outer environment, neocortex is overrided by hypothalamus)
  - Lateralization of brain functions

MUNI
MED